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Dr. Swapnesh Taterh

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FOREWORD

I am pleased to put into the hands of readers Volume-5; Issue-9: 2018 (Sept, 2018) of “**International Journal of Advanced Engineering Research and Science (IJAERS) (ISSN: 2349-6495(P) | 2456-1908(O)**”, an international journal which publishes peer reviewed quality research papers on a wide variety of topics related to Science, Technology, Management and Humanities. Looking to the keen interest shown by the authors and readers, the editorial board has decided to release print issue also, but this decision the journal issue will be available in various library also in print and online version. This will motivate authors for quick publication of their research papers. Even with these changes our objective remains the same, that is, to encourage young researchers and academicians to think innovatively and share their research findings with others for the betterment of mankind. This journal has DOI (Digital Object Identifier) also, this will improve citation of research papers. Now journal has also been indexed in **Qualis (Interdisciplinary Area) (Brazilian system for the evaluation of periodicals, maintained by CAPES)**.

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

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

With warm regards.

Dr. Swapnesh Taterh

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Geoepidemiology of American Cutaneous Leishmaniasis (ACL) in the South of Rondônia, Brazilian Amazon

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Abstract— American Cutaneous Leishmaniasis (ACL) is one of the parasites with specific characteristics in several regions of Brazil. In recent years, there have been variations in the increase in the number of cases of this disease in different regions of the country. In the state of Rondônia, ACL is considered one of the endemic diseases. Objective: This study described epidemiological aspects of ACL in a subspace of Rondônia, Western Amazon, in the period between 2012 and 2013. Method: This is a retrospective epidemiological study developed in 02 municipalities located in the south of Rondônia according to with model developed by Paraguassu-

Chaves [3] comprising the municipalities of Vilhena and Chupinguaia. Results: The study revealed that 370 human cases of ACL were reported in the study period. The male gender predominated with (89.5%) of the total cases, the age range (20 to 39) years (36.6%) prevailed, low schooling (80%) had a maximum of complete elementary education (62.5%). The greatest number of cases came from the urban zone (66.9%), resulting from the adaptation of sandflies to the periurbanization of cities in the Amazon, as predicted by Paraguassu-Chaves [3]. Some of these variables presented significant differences when compared to production and distribution in the

State of Rondônia. Prevalence of autochthonous cases was 81.7%. Regarding the clinical aspects, the cutaneous lesion (CL) predominated with 90.8% of the new cases. As expected, the cases confirmed by confirmation criteria indicate 89.5% clinical-laboratory confirmation in the studied subspace and 94% in the State of Rondônia. Of the cases confirmed by evolution of the case prevailed to cure with 77.5% and 12.5% ignored or recorded in the blank. The dropout still stands out negatively with 8.4%. Conclusion: The ACL presents a public health problem due to its high endemicity. It was identified some important epidemiological variables for the study in the Brazilian Amazon and that can condition and / or determine areas associated with possible risks of infection by the parasites.

Keywords— American Cutaneous Leishmaniasis (ACL), Epidemiology, Subspecies, Rondônia.

I. INTRODUCTION

The distribution of the most incidental diseases in the epidemiological context of Rondônia is associated with the diverse socioeconomic and environmental processes that are decisive in the construction, configuration and reconfiguration of the geographic space, and they potentiate or amortize the determinants and determinants of the disease production process. Both malaria, tuberculosis, measles, leishmaniasis, leprosy, pertussis, and those related to sanitation, such as diarrheal diseases and infectious hepatitis, are currently reported to be common damage to underdeveloped regions [1]. The problem of our inquiry is American Cutaneous Leishmaniasis - ACL. How does this disease behave in the southern region of Rondônia, Western Amazon? What are its determinants and / or determinants? What is its endemicity?

From the foundations of tropical pathology, a set of diseases, many of them endemic in nature, whose presence is conditioned to the existence of etiological agents or "transmission mechanisms" ", Clearly related to certain bioclimatic conditions of the tropical environment, despite the practices of hygiene and modern medicine have overturned the old damages of the climatic fatality.

The geographical environment creates constant and necessary conditions for the incidence and spread of numerous diseases in the Amazon. Both the development of vectors and the multiplication of pathogenic organisms are linked to the geographical environment and especially to climatic conditions. Nonetheless, the development of social medicine, collective health, and even social ecology posits the broadening of the definition of pathogens to social components. Among the proposals for exchanges in current public health theory, they propose to recognize as central pathogens of analysis, inequities,

class hierarchy, racism, regional decay and social fragmentation [3,4,5,6,7].

American Cutaneous Leishmaniasis (ACL) is a pleomorphic parasitic skin and mucosal disease caused by protozoa of the genus *Leishmania*. Cutaneous disease is classically characterized by papules, which develop into ulcers with raised borders and granular bottoms, which may be single or multiple and are painless. They may also be manifested by warty, papular, localized or diffuse plaques [8]. This pathology is characterized by being primarily a zoonosis of wild animals such as marsupials and rodents, and with the urbanization of ACL, animals such as dogs, horses and domestic rodents are involved in the epidemiological chain as reservoir [9].

Infections caused by protozoa of the Order Kinetoplastida - trypanosoma cruzi, *Leishmania chagasi* and *Leishmania brasiliensis* are enzootic in the tropics, where there are abundant mammalian reservoirs, vectors and natural ecotopes where the chain links are observed. The degradation of this ecosystem by the anthropic action as deforestation can lead to the rupture of the trophic chain, propitiating the transfer of the enzootia to the human population [10].

The mode of infection by the parasites of the complexes "mexicana" and "brasiliensis" depends on the direct contact of the individuals with the forest environment, since their vectors have the biotopes and the activities located there.

Lainson and Shaw [11,12,13] attributed the high incidence of leishmaniasis in certain areas of the Amazon to large human contingents that penetrate into the forest, not only as a consequence of road openings but also because of the occupation of large empty spaces in the region. There is evidence that the groups of workers who cleared the forest for the construction of highways or carried out works of vegetal extractivism, were the most attacked [14,15]. It also states that no control of the disease can be proposed without the deep knowledge of the parasite and its epidemiology, since leishmaniasis is predominantly wild diseases, and the incidence has been verified in several regions of the world, especially in tropical forest areas. The Amazon is the largest tropical region and the area where the largest variety of *leishmanias* has been found.

According to Corrêa [16] referring to Fraiha (1976), the incidence of leishmaniasis in the Amazon is still not well known due to the difficulties in the differential diagnosis with other dermatoses and also because a small number of patients seek the doctor for treatment, either by ignorance or lack of resources. Thus, the disease presents a high prevalence, especially in rural areas, with nosological conditions that assume severe forms that lead to mutilations and serious defects, sometimes permanent.

According to Paraguassu-Chaves [3], the taxonomic revision of the New World leishmaniasis was carried out in the Amazon by the Evandro Chagas Institute of Belém - State of Pará. There are three biologically and biochemically different species of parasites present in the Amazon region : *L. braziliensis* or *Leishmania (viannia) braziliensis* (Viana, 1911); *L. braziliensis guyanensis* or *Leishmania (viannia) guyanensis* (Floch, 1954) and *L. mexicana amazonensis* or *Leishmania amazonensis* (Lainson and Shaw, 1973).

In the particular situation in Rondônia, American Cutaneous Leishmaniasis, considered enzootic among wild animals, increased the number of epidemic peaks in areas of primary forest subjected to human intervention in the 70s and 80s, and still in the current two remains high incidence. The rich phlebotomine and mammalian fauna have been found *Lutzomyas*, *Psychodopygus* and *Brumptomyia*. Of the 40 sandfly species cataloged in Rondônia, there is a predominance of *P. davisi* species, and *P. geniculatus*, *L. umbratillis*, *L. whitmani*, *P.welcome*, *L. flaviscutellata*, *P. ayrozai*, *P. llanosmartinsi* [3,4,5,6,7].

The objective of this study was to describe the epidemiological aspects of ACL in a subspace of Rondônia (subspace 08) for the years 2012 and 2013 and to identify the epidemiological profile of individuals diagnosed with ACL by characterizing the following variables: gender, age group, occupation, degree of schooling, economic activity and origin / origin, type of injury.

II. METHOD

It is a retrospective epidemiological study developed in 02 municipalities located in the south of Rondônia according to a model developed by Paraguassu-Chaves [3], comprising the municipalities of Vilhena and Chupinguaia.

For the analysis of the epidemiological profile in patients affected by the ACL, surveys of the records contained in the SINAN database (National System of Aggravation and Notification) were carried out with the State Health Secretariat for the period of 2012 and 2013.

The data contained in the forms of the National Health Foundation (FUNASA) and their respective analyzes were transcribed to a worksheet in MS Excel Office XP Program, where a descriptive statistic was used to characterize the sample in the variables studied, using the geometric mean, median, standard deviation and percentage.

The data without information were disregarded.

Later they were prepared through the program IPI-INFO 6.04 to carry out the statistical analysis. The associations of interest were verified through chi-square test and t-test, with 95% confidence interval and p value ≤ 0.050 .

Epidemiological indicators were based on the Brazilian guidelines [4], where the incidence coefficient was calculated. To verify the incidence coefficient of cases, they were adapted to the standards recommended by the Ministry of Health [10,11] [17,18], which guides the calculation of the following topics: Number of confirmed new cases of ACL (code B55 .1 and B55.2 of ICD-10) per 100,000 inhabitants in the population living in a given geographical area in the year under consideration. In this study the calculation method was used for 10 thousand inhabitants.

The spatiality model proposed by Paraguassu-Chaves [3] identifies 11 subspaces in the state of Rondônia, among them subspace 08 with the following description: subspace where are located the municipalities of Vilhena and integrates to him the municipality of Chupinguaia. Both are considered municipalities in the southern region of the State of Rondônia. According to Paraguassu-Chaves [3], in this subspace, we observe one of the sources described as the increase of notifications for ACL has been associated with the predominance of pastures and need concrete studies that allow to discern the existence of a new geoepidemiological pattern of transmission.

III. RESULTS AND DISCUSSIONS

The data indicate that 370 new cases of ACL were reported in this subspace during the study period.

In this same period in the state of Rondônia were notified 2,346 new cases of ACL distributed in 52 municipalities or 11 subspacialities. The subspace 08 comprised by the municipalities Vilhena and Chupinguaia, located in the southern part of Rondônia, accounts for 15.8% of the ACL reported in the State.

Among the reported cases, 367 (89.5%) occurred in males and 43 (10.5%) in females (Table 1). The distribution of new cases was similar in each subspace with respect to gender, with no significant differences ($X^2 = 3.0900$; $p = 0.0787$).

Table.1: Distribution of new cases of ACL, reported in the years 2012 and 2013 in subspace 08, according to gender. - Subspace 08 Rondônia

Gênero	F	%	F	%
Male	328	88,65	2077	88,5
Female	42	11,35	269	11,5
TOTAL	370	100,0	2346	100,0

Source: SINAN / MS, 2015.

In this same period in Rondônia, in a total of 2346 new cases, it predominated in the male population with 2,077 new cases, corresponding to 88.5% of the people affected by the ACL.

It was identified that the age of the individuals notified with ACL varied from less than 1 year of age to greater than 60 years. The new cases were more prevalent in the

age group of 20 to 39 years with 36.6% of the new cases. Among the new cases that arouse attention, there are the <15 years with 24.6% (table 2).

Table.2: Distribution of new cases of ACL, reported in the years 2012 and 2013 in subspace 08, according to the age group.

Age Group	F	%
1-14	87	24,6
15-19	27	7,7
20 a 39	129	36,6
40-59	70	19,8
60 ou mais	19	5,4
Ignorado	21	5,9
TOTAL	353	100

Fonte: SINAN/MS, 2015. * 17 casos foram desconsiderados por falta de informação.

The level of schooling was low, where it is verified that 80% had at most the complete elementary education, the others with levels of schooling (20%) between half incomplete / complete or did not inform their schooling. With regard to schooling, the distribution of categories was similar to that of the State of Rondônia ($\chi^2 = 8.8353$ and $p = 0.1830$).

Regarding the considerations of color classification specified by the Ministry of Health of Brazil, the analyzes revealed that there was a higher prevalence in white with 62.5%. In the other color categories, they showed significant differences in relation to Rondônia.

Table.3: Characterization of people notified with new cases in the subspace, according to ethnicity/color. - Subspace 08 Rondônia

ETHNICITY	Subspace 08		Rondônia	
	F	%	F	%
White	231	62,5	849	36,2
Black	9	2,5	159	6,8
Yellow	0	0	17	0,7
Brown	78	21,0	1152	49,2
Indigenous	9	2,5	86	3,6
Ignored	43	11,5	83	3,5
TOTAL	370	100	2346	100

Source: SINAN / MS, 2015.

Differently from what is found in subspace 08, in the territory of the State of Rondônia, people who are affected by ethnic / brown ACL predominate with almost 50% of the new cases and 36.2% of the white population. Regarding the area of residence, 66.9% of the individuals reported in the subspace reported residing in the urban area. In the distribution by place of residence the differences were significant in relation to the State of Rondônia ($\chi^2 = 21.6104$; $p = 0.0000$).

Table.4: Place of residence and distribution of persons notified with new cases of ACL in subspace 08, in the years of 2012 and 2013.

PLACE OF RESIDENCE	F	%
Urban area	194	66,9
Countryside	63	21,8
Peri-urban	24	8,2
Uninformed	9	3,1
TOTAL	290	100,0

Source: SINAN, 2015. * 80 cases were disregarded for not including the data in the file.

Regarding the origin or origin, of the total number of individuals with ACL reported approximately 90% of the subjects are born or migrants considered to be of the municipalities studied.

Among the reported cases, it was verified that most of them, (81.7%) of autochthonous. The indigenous people resemble those of the State of Rondônia, 82.7%.

Table.5: Cases confirmed by Autochthonous in subspace 08 and in the State of Rondônia, in the years of 2012 and 2013.

AUTOCHTHONOUS	Subspace 08		Rondônia	
	F	%	F	%
YES	294	81,7	1942	82,7
NO	47	13,0	316	13,5
Indeterminado	19	5,3	88	3,8
TOTAL	360	100,0	2346	100

Source: SINAN, 2015.

The reported individuals presented several activities being the most prevalent: several workers (17%), agricultural workers (13%), agricultural workers (6.0%), students (6%), drivers (4%) and stonemasons (%). In general, among those who reported, approximately 75% are people who work directly in the urban area.

Regarding the clinical aspects observed, it was verified that in the clinical evaluations performed in which there was positivity with respect to some type of lesion that were 90.8% for cutaneous lesion, 9.2% for mucosal lesion. It is not different from that of the state of Rondônia, with 91.4% in cutaneous clinical form and 8.6% in mucosa.

Table.6: Cases confirmed by Clinical Form in the years of 2012 and 2013.

CLINIC FORM	Subspace 08		Rondônia	
	F	%	F	%
Cutaneous	336	90,8	2146	91,4
Mucosa	34	9,2	200	8,6
TOTAL	370	100	2346	100

Source: SINAN, 2015.

Of the cases confirmed by type of entry 97% in subspace 08 resembles the 95.3% of new cases confirmed in the State of Rondônia.

Table.7: Cases confirmed by Type of Entry in the years of 2012 and 2013.

Input Type	Subspace 08		Rondônia	
	F	%	F	%
New Case	359	97	2292	95,3
Relapse	6	1,6	96	3,9
Ignored/White	5	1,4	21	0,8
TOTAL	370	100	2409	100

Source: SINAN, 2015.

As expected, the cases confirmed by confirmation criteria indicate 89.5% clinical-laboratory confirmation in subspace 08 and 94% in the State of Rondônia.

Table.8: Cases confirmed by Confirmation Criteria in the years 2012 and 2013.

CONFIRMATION CRITERIA	Subspace 08		Rondônia	
	F	%	F	%
Clinical-Laboratory	331	89,5	2204	94,0
Clínico-Epidemiological	39	10,5	142	6,0
TOTAL	370	100	2346	100

Source: SINAN, 2015.

Of the cases confirmed by evolution of the case prevailed to cure with 77.5% and 12.5% ignored or recorded in the blank. The dropout still stands out negatively with 8.4%. In this case there is a statistically significant difference between the evolution of new cases between subspace 08 and the State of Rondônia.

Table.9: Cases confirmed by Case Evolution in the years 2012 and 2013.

EVOLUTION OF THE CASE	F	%
Ignored/White	45	12,5
Cure	279	77,5
Abandonment	30	8,4
Death by ACL	0	0,0
Death by another cause	2	0,5
Transfer	4	1,1
Change of Address	0	0,0
TOTAL	360	100,0

Source: SINAN, 2015.

ACL is considered one of the public health problems in several regions of the world. In the state of Rondônia - Brazil, it represents one of the main endemic problems related to the health of the population. Recognizing the different aspects related to the disease can help characterize the different spaces of this region, contributing to the changes related to the well being of the population [16].

The data revealed that there were 370 new cases registered in subspace 08 corresponding to the municipalities of Vilhena and Chupinguaia located in the southern region of the State of Rondônia, representing 15.8% of the ACL reported in the State of Rondônia.

It was verified that there is a prevalence of the male gender representing 89.5% of the cases. It was also verified that between the subspace and the State of Rondônia there were no significant differences, being evidenced in the chi-square test ($\chi^2 = 3.0900$; $p = 0.0787$).

As far as the age group was concerned, these ranged from 1 year old to 60 years old, prevailing among the 20 to 39 year olds with 36.9% of the new cases. Among the new cases that arouse attention are the <15 years with 24.6%. The distribution of new cases with respect to age did not show significant differences between the subspace and the State of Rondônia.

In order to corroborate or not with the findings in subspace 08 (South of Rondônia), similar studies were searched in specialized literature. As for example, the data obtained by Magalhães et al [19] in a study on the comparative clinical aspects of ACL in the Amazon Region and Central West Region, verified that there was a significant incidence of ACL in the 15-25 age group. Menezes, Aquino and Caldas [9] verified similar data (16 to 30 years). According to Brazil [17,20], this age pattern suggests that the occurrence is related to the activities developed by ACL patients, because they are in a period of productivity. These data, which can be observed by checking the prevalence period of the disease, the economic activities and the development aspects of the region [16].

Corrêa [16] it is still observed that, when the other age patterns are observed, it is verified that there was less frequency in the occurrence. An explanation is given by Veloso et al. [21], when they describe that ACL can reach individuals of any age, being more frequent from 20 to 40 years. Other researchers corroborating the findings are Vieira, Jacobina and Soares [22], who describe that the highest concentration of cases of ACL is in the most productive age group (15-60) of age and in the male gender. Still, according to the same authors, this factor is related to the occupational character of this endo-epidemic.

Although there was no difference between the subspace studied and the State of Rondônia regarding the distribution by gender and age, it is important to note that there are other factors that can provide the infection of these patients, as already mentioned by Passos et al. [23], which suggests the coexistence of two models of ACL transmission. The greater care of men and adults suggests outside the home transmission in an economically active population, a fact that may be related to the greater

number of cases in relation to the masculine gender detected in this study. Another observation is that data contained in the literature describe that in parallel to the anthropic actions that have been established since the late nineteenth and early twentieth century, large outbreaks of ACL have led to the rapid recognition of the occupational character of the parasitose [24].

According to the data obtained, the region presents greater agricultural activity than in other areas of the State. The prevalence of men, with productive age range and low level of schooling, is related to the social behavior of the residents of this region and to the profile of the patients studied in this study. Other studies also reveal similar data, Name et al., [25] observed the prevalence of the incidence of ACL in men, farmers, in the economically active age group. Guerra et al. [26], in studies in the Amazon region, reported that a significant number of ACL patients had activity that exposed them to the *Leishmania* vectors, such as agriculture and labor, and farms. Most were of the male gender and were between 20 and 29 years of age [16].

A relevant data to be considered is that, currently, there has been a change in the epidemiological pattern of leishmaniasis transmission in several South American countries, as an important vector domiciliation in countries such as Venezuela, Peru, Bolivia and Brazil [27]. This could explain the high incidence of ACL in the urban area of the municipalities that make up the two subspaces. This hypothesis has already been raised by Paraguassu-Chaves [3] when it states the readjustment of sandflies in the peri-urban zone and urban area of the cities in the Amazon and especially in the municipal and district headquarters in Rondônia.

With regard to the low educational level, one of the factors that can contribute to this pattern is the fact that a large part of the population, mainly in the Legal Amazon region, where the data contained in the literature show a predominance of patients with low educational level, low income, and consequently the predominance of low-skilled occupations. This pattern is already evidenced by Oliveira-Neto et al., [28], Passos et al., [23]; Brazil [20] also reveals that ACL, as well as most of the infectious-parasitic diseases, mainly affect the most deprived populations that may be involved in the factors associated mainly with occupational and leisure activities, associated to the disorderly exploitation of forests and road building. Hydroelectric plants, settlement, extraction of wood, development of agricultural activities, among others, determine this process [16].

Regarding the care given to women, children and other non-agricultural occupations, this may be related to intra and/or around home activities, as observed by Passos et al. [23], Oliveira-Neto et al. [28]. Data that can collaborate with this information are described by Costa

et al. [29], who report the occurrence in children under 5 years of age, collaborating the hypothesis of intra and/or around home transmission.

It is verified that there are other factors that must be considered in this study, such as the urbanization process, which is characterized by the growth of cities in an area where there is the focus of the disease or the vector. Information already observed in the studies carried out by Profeta da Luz et al., [30] in Minas Gerais, where an urbanization process of ACL was described in the metropolitan region of Belo Horizonte. In addition to this consideration, it is worth mentioning that in the study of Brazil [8] there is evidence that the areas analyzed in this study are in an ACL circuit in the State of Rondônia and the dynamics of projection of ongoing development of the State observed in the mapping by socio- of Rondônia.

As for ethnicity / color distribution, it was observed that there was a predominance of white color (62.2%), differently from that found in other subspecies that make up the State of Rondônia, which predominates in brown skin color. It is suggested in this study that one of the factors to be considered is related to the very characteristic of the distribution of color-related ethnic groups in Brazil, according to IBGE (2000) data, 53%, declare to be white and 39.1% brown. These two with predominance. This subspace is characterized by the greater concentration of people declared white, migrants from the southern region of the country. It may justify this frequency, since in the state of Rondônia the brown color predominates (49.2%) followed by the white color with 36.2%.

Name et al. [25], in an analysis of data from the University Hospital of Brasília – FD (Federal District), observed that 57% of the patients were brown, 27% were white and 13.2% were black, while the indigenous Orientals corresponded to 2% of cases. These data differ from the white and brown color observed in the studies and data of the Brazilian Institute of Geography and Statistics [3]. Thus, one of the factors that may be related is the population migratory process or the deficiency in the definitions of skin color observed by the population, since color registration is defined by the declarant's own concept, and may have influenced the this survey.

Regarding the occupation, the patients presented the most varied professions, and it can be observed that in relation to the places where they develop it, there was predominance in the urban environment with 66.9%, while in the rural area 21.8%. Although it has not been observed which factors may have influenced the data in this study, it can be suggested that they are related to the development of leisure activities and to the urbanization process of the ACL, the extractive activities among others already observed by Brazil [17, 20].

Researchers such as Lima et al. [31] contribute to the interpretation of this study when describing the distribution of cutaneous leishmaniasis by remote sensing images, in the State of Paraná, Brazil, observing a greater number of cases of leishmaniasis in male adults probably related to the rural work near forests as already mentioned by other researchers, and also emphasize the leisure activities (mainly the fishing) in the margins of rivers and streams with riparian forests that, although altered, maintains the enzootic cycle of *Leishmania*. This behavior may be occurring in the subspace studied, since it presents characteristics such as well distributed hydrography and leisure activity probably unrelated to the urban environment because these are small and expanding municipalities, suggesting the urbanization process of ACL, as mentioned by Passos et al. , [23] and Oliveira-Neto et al., [28].

WHO [32] points out that urbanization is correlated with increased global mobility. As a risk factor, it affects each of the eco-epidemiological entities, which causes leishmaniasis, three of which are shown in detail. Zoonotic Cutaneous Leishmania (ZCL), Anthropic Cutaneous Leishmania (ACL) and Visceral Zoonotic Leishmania (VZL) also describe the understanding of the integration between changes in the urban environment and sandflies as vectors are a prerequisite for the appropriate design to strategy of disease prevention and control.

Other data corroborating these observations are those described by SUCEN [33] in which there is a report that the ACL is in a geographic expansion phase, with changes in behavior in the last decades, with a double epidemiological profile expressed by the maintenance of cases originating from or near the old outbreaks, and by the appearance of epidemic outbreaks associated with the factors resulting from migratory population processes, as well as disorganized growth and urbanization in rural areas where there is the zoonotic cycle and environmental changes produced by the men.

Regarding the data related to the urbanization of the ACL, it is observed in the studies of Sampaio and Paula [34], that 11 cases of ACL, in patients residing in the Federal District (Brasília) and have not left their area for a time ranging from 6 to 6 months to two years before the onset of the disease and that six of the 11, resided in the satellite city of Planaltina. Thus suggesting that they are cases in which to house or periodicize results of the growth of cities and places of focus.

Wiieyaratne, Arsenault and Murphy (1994), commented that the greater occurrence of urban outbreaks of leishmaniasis, when compared to other parasitic diseases, can be explained by its ability to expand very rapidly when introduced into endemic areas [16]. This factor may have occurred in subspace 08, since there was a greater

occurrence of cases and there is great agricultural expansion in one of the municipalities. It is suggested, therefore, that the urbanization process observed in the municipalities, new states and places of residence should be considered and that this factor may have occurred in both subspaces, but with different intensities.

Regarding the clinical aspects, there was positivity regarding some type of lesion. The positive results were cutaneous lesions 90.8% and 9.2% for the mucosal lesion, not different from that found in the aggregate of the municipalities of Rondônia, with 91.4% in the cutaneous form and 8.6% in the mucosa.

The Paraguassu-Chaves study [35] presented similar findings to that found in this study. In their study "Primary skin lesions are the main clinical forms of the disease, accumulating in the years of study, between 98% and 100% of the total. Mucosal (secondary) or cutaneous-mucosal lesions are rarely diagnosed. Between 5% and 10% of the total cases are allochthonous and come mainly from the neighboring country, Bolivia."

In the study period the cases confirmed by type of entry prevails with almost 100% in new cases. Paraguassu-Chaves [36, 37] found similar results in a study carried out between 2009 and 2011 and the same findings by Corrêa [9] in the same subspace.

The most unique and adopted confirmation criterion in the Amazon region is clinical and laboratorial, which confirms the confirmation rates of cases in this study of 89.5% and for the State of Rondônia the index of 94%. These findings confirm those found by Paraguassu-Chaves [36, 37]. The prevalence of the confirmation criterion is justified by the model of the program adopted by the public health policies of the Health Department of the State of Rondônia, which instrumented the service with attention directed to the clinical-laboratorial service. Of the cases confirmed by evolution of the case prevailed to cure with (77.5%) which seems to be below the recommended average. What may have happened is the fact that in subspace 08 in 2012 and 2013, 12.5 cases were recorded as ignored. In any case, these data seem to be worrying and require a better response from the public health service and a more in-depth study to identify what actually occurred in that period in relation to the evolution of new cases of ACL in the South of Rondônia.

IV. FINAL CONSIDERATIONS

During the study period, 370 human cases of ACL were reported in only two municipalities located in the south of Rondônia, corresponding to more than 15% of all new cases of ACL in the State of Rondônia.

The male gender prevailed, the age range (15 to 30), low schooling, and white-skinned people prevailed.

The greatest number of cases came from the urban zone, resulting from the adaptation of sandflies to the

periurbanization of cities in the Amazon, as predicted by Paraguassu-Chaves [3]. Regarding the clinical aspects, the cutaneous lesion (CL) predominated.

The ACL presents a public health problem in subspace 08 of the Rondônia spatiality due to its high endemicity.

It was identified some important epidemiological variables for the study in the Brazilian Amazon and that can condition and / or determine areas associated with possible risks of infection by the parasites.

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Perspectives of PV Microgeneration in Brazil: A Proposition of Regulation Enhancement Methodology

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Abstract—The solar photovoltaic (PV) generation is disseminating on multiple kinds of sites due to the energy market liberalization, the renewable energy sources subsidies policy, the decreasing of acquisition costs and the adaptability to different installation conditions. These factors allowed the growth of PV generation, especially in the distributed generation (DG) segment. Meanwhile, the development of a legal and regulatory apparatus became mandatory to assure benefits to DG-adopters, without causing damages to the utility grid, preventing technical failures and eventual excessive pricing to non-adopters. As the technology innovations impose new possibilities and the number of adopters grows exponentially, the challenges become more visible and a regulation update, urgent. In this context, this paper aims to review the current pricing model for DG in Brazil, focusing on PV microgeneration, and to propose a methodology based on the Delphi Method to enhance the most critical topics of the on-going regulation.

Keywords— Solar Photovoltaic Energy, Distributed Generation, Net Energy Metering, Delphi Method.

I. INTRODUCTION

The Intergovernmental Panel on Climate Change (IPCC) reported that heat and energy generation, as well as correlated activities (processing, transmission, and storage) accounted for 34,6% of greenhouse gases (GHG) emissions in 2014 [1]. As the global temperature rises and greatly impacts on the biosphere and on the human life quality, the establishment of a worldwide agenda to promote renewable energy sources (RES) and to reduce fossil fuels consumption became a necessity to humankind survival [2]. Hence, in 2016 the RES-generation answered for approximately 62% of new

power additions to the world grid, 47% of which represented the PV-generation share. The environmental benefits add up to the economic ones: more than 9.82 million created globally are linked directly or indirectly to this sector, with an annually cash flow above 200 billion American dollars (US\$) along the last eight years [3].

Simultaneous to the increasing participation of RES in the energy generation share, a shift in the consumer relations occurred in several market sectors, including the energy market, predominantly dominated, especially in the case of Brazil, by a centralized structure, characterized by centralized power generation in large hydropower plants and wired to main consumer centers by long-distance transmission lines. Thus, the technological advances in electronic sciences allied to the liberalization of the energy market, which started in Brazil in the mid-90s, turned the business environment more attractive to cost reduction demands through self-generation and energy commercialization [4,5].

The intersection of both phenomena, demand for self-generation and RES promotion policies, privileged the solar PV when compared to other RES, especially among residential and small commercial sectors. The privilege of PV generation, in this case, links directly to the great distribution of solar resource; high modularity and adaptability of PV installations to buildings and urban areas; easy installation and operations with low impacts during and after its realization; reduced need of maintenance; besides the descendent costs of equipment acquisition during the past years [2,6].

In this scenario, the distributed generation (DG) emerge as any generation system connected to the utility grid, close to the consumer unit and targeting its energy demands. Beyond the environmental and economic

advantages, DG based on PV microgeneration supplies short-period demand increases; enhances the global efficiency of the system by reducing distribution and transmission losses; and contributes to the stability and reliability of the electrical system by providing power reserve with lower failure risks. Nevertheless, the penetration of the DG imposes challenges of technical and economic nature, such as a higher complexity of planning, coordination and operation of the energy system; and a lower income of the utilities, which may lead to energy pricing rises [4-6].

This paper aims to review the current legal panorama in Brazil for DG based on PV microgeneration with focus on the pricing policy and to propose a methodology based on the Delphi Method to point viable solution for the critical points. Thus, Section 2 describes the evolution of the Brazilian regulation model on the main areas of interest. Section 3 describes the current situation and the critical points for PV microgeneration deployment. Section 4 introduces the main concepts of the Delphi Method and briefly reviews its utilization by other authors, while Section 5 presents the proposed methodology. At last, Section 6 concludes this paper and points out important remarks, relating future expectations.

II. EVOLUTION OF THE DG BASED ON PV MICRO-GENERATION REGULATION

The main regulation of Brazil on DG based on RES dates from 2012, with the approval of the Normative Resolution (REN) 482/2012 by the National Agency of Electric Energy (ANEEL). Despite REN 482/2012, the legal aspects of DG in Brazil remain diffuse and does not apply as a structured promotion policy [7]. The following discussion describes the regulation in four distinct macro-areas: administrative (includes pricing model), environmental, fiscal and technical.

2.1 Administrative regulation and pricing model

The law n° 10,439 of April 26, 2002 and the decree n° 5,163 of July 30, 2004 paved the road for RES development in Brazil. The first one created the National Program of Incentives to Alternative Sources (PROINFA) to foment the energy generation through wind power, biomass combustion and small hydro by independent producers. The second one indicates the guidelines for energy commercialization, in addition of legally defining DG as any generation plant connected directly to the distribution grid of a buyer (permission holder, concession holder or any legally authorized agent) excepting hydropower plants above 30MW and thermal power plant based on fossil fuels or cogeneration with efficiency rate lower than 75% [8,9].

Following those, REN 77/2004 described as subsidization chronogram for DG based on RES power plants, reducing

or abolishing the distribution grid charges, while REN 167/2005 restricted the DG installed capacity to a maximum of 10% of each utility peak demand and formalized the commercialization bureaucratic process between the utility and the DG-entrepreneur [8,9].

Nevertheless, only in 2012, with the publication of the REN 482/2012, the ANEEL would set a more direct legal approach to PV microgeneration, reviewing some of the former guidelines and establishing the Net Energy Metering (NEM) as the pricing model in force [7,10-13]. The main points of REN 482/2012 and its updates are detailed in Table 1:

Table.1: Highlights of REN 482/2012 and following updates [7,10-13]

	<ul style="list-style-type: none"> ▪ Establishes NEM as the pricing model; ▪ Defines microgeneration as plants with installed capacity lower than 100kW and minigeneration, between 100 kW and 1 MW;
REN 482/2012	<ul style="list-style-type: none"> ▪ Limits the DG to self-generation by solar PV, solar thermal, wind, biomass and small hydro; ▪ Allows the charge for grid availability; ▪ Determines the compensation period as 36 months; ▪ Abolishes any previous installed capacity cap.
REN 517/2012	<ul style="list-style-type: none"> ▪ Allows remote self-generation; ▪ Allows energy credit transference between different consumer units inside the same utility grid and belonging to the same registered CPF (equivalent to Social Security Number in the US) or CNPJ (equivalent to EIN in the US); ▪ Restricts the DG plant installed capacity to the grid availability of the consumer unit.
REN 687/2015	<ul style="list-style-type: none"> ▪ Reduces microgeneration installed capacity limit to 75kW and expands the minigeneration to 5MW, excepting small hydro; ▪ Increases compensation period up to 60 months; ▪ Establishes new business models: condominiums, consortiums and cooperatives.
Circular Letter 010/2017	<ul style="list-style-type: none"> ▪ Emphasizes the illegality of the division of a consumer unit, aiming to pass the DG plant as mini- or microgeneration; ▪ Emphasizes the illegality of charging in basis of generation (R\$/kWh).

2.2 Environmental regulation

The Resolution n° 001 of 1986 of the National Board on Environment and Renewable Resources (CONAMA) dismisses the presentation of an Environmental Impact Assessment (EIA) for any power plant with installed capacity lower than 10MW. There is a lack of specific federal regulation for mini- and microgeneration regardless of the energy source [14]. Thereby, the state environmental agencies answer for most of the legal aspects regarding DG. In general, plants with an installed capacity lower than 1 MW are dismissed of licensing, and those between 1 MW and 5 MW have a simplified legal procedure.

2.3 Fiscal regulation

The fiscal regulation encompasses subsidies in two different areas: equipment purchasing and energy generation billing. The Agreement 101/1997 of the National Finance Policy Council (CONFAZ) represents the first one, exonerating all state-level commercialization taxes (ICMS) for PV generators and wind turbines. Furthermore, energy generation billing subsidies involve tax-release from both levels of government, federal and state. The federal law n° 13.169 of 2015 modifies the energy bill tax calculation, applying the charges only on net consumption, rather than total energy consumption. Following that, the Agreement 16/2005 of the CONFAZ also applied the same calculation method for ICMS. However, 4 out of 27 states are non-signatory of this agreement [7,12], as explicit in Table 2. It is also important to highlight the fact that both federal and state taxes represent an average of a third of the energy bill final amount.

Table 2: Signatory and Non-Signatory Brazilian states of CONFAZ Agreement 16/2005

Signatory States	Non-Signatory States
Acre, Amapá, Alagoas, Bahia, Ceará, Distrito Federal, Goiás, Maranhão, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Pará, Paraíba, Pernambuco, Piauí, Rio de Janeiro, Rio Grande do Norte, Rio Grande do Sul, Rondônia, Roraima, São Paulo, Sergipe, Tocantins.	Amazonas, Espírito Santo, Paraná, Santa Catarina.

2.4 Technical regulation

The Manual n° 3 of the Procedure of Electric Energy Distribution in the National Grid (PRODIST), published by the ANEEL, lists the minimum criteria for access, project, operation, maintenance and security of any electrical installation connected to the grid [15]. Moreover, each utility shall elaborate their own technical procedures and standards based on their interpretation of the REN 482/2012 and its following updates. It is also a

part of the utility the examination, authorization, and inspection of all installation connected to the grid.

Due to the lack of national standards for micro- and mini-generation regardless of the source, the IEEE 1547, Standard for Interconnecting Distributed Resources with Electric Power Systems, must be observed. In terms of PV generators and installations, the Brazilian Association of Technical Standards (ABNT) dictates the test procedures for anti-islanding (NBR IEC 62116); the minimum equipment technical parameters for grid connection (NBR 16149); the assessment tests to evaluate the equipment technical parameters (NBR 16150); the commissioning, inspection and evaluation procedures (NBR 16274); and the PV electrical installation minimum requests (NBR 16690), the last one still under discussion.

III. CURRENT SCENARIO AND CRITICAL POINTS

The approval of the REN 482/2012 leveraged the number of installations of DG based on RES plants. Though some of them already existed previously to the establishment of the current regulation, being added to the initial statistics, the higher share of the installed capacity represents new additions to the grid. During the last six and half years, the growth of installed capacity of DG based on RES presented an exponential curve, as showed by Fig. 1, reaching 441.5 MW till August of 2018, according to the Registration System of Distributed Generation (SISGD) maintained by ANEEL and updated by the utilities. PV mini- and microgeneration plants, represent over than three-quarters of the total capacity, adding up to the grid approximately 348.9 MW (Table 3) [16].

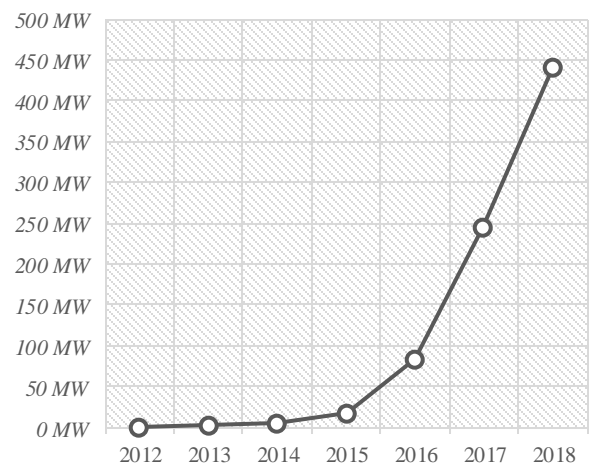


Fig. 1: DG mini- and microgeneration installed capacity growth after REN-482 [16]

Table.3: Total DG vs. PV mini- and microgeneration installed capacity from 2012 to August-2018 [16]

Year	Total DG	PV Generation
2012	0.4 MW	0.4 MW
2013	1.8 MW	1.8 MW
2014	5.2 MW	4.2 MW
2015	16.9 MW	13.8 MW
2016	83.0 MW	62.2 MW
2017	244.3 MW	183.1 MW
2018	441.5 MW	348.9 MW

In reason of the increasing installed capacity, the penetration of DG and PV microgeneration started to induce some questions or criticism by different stakeholders. Zinaman *et al* [17] comments that one of the main issues in NEM pricing models is the rate of energy exportation to the grid, leading to overcompensation and cost shifting. Eid *et al* [18] estimates the utility income losses due to PV microgeneration, concluding that the combination of volumetric energy billing and NEM leads to loss of revenue for the distribution company, especially for those units with little or no coincidence between generation and consumption peaks. Bird *et al* [19], however, affirms that for lower penetration levels, the effects on the utilities finances are neglectable and cost shifting improbable. This affirmation correlates to the Technical Note 56/2017 issued by ANEEL [20], which predicted for the period of 2017-2024 an averaged accumulated impact of 1.9% on energy prices caused by PV microgeneration, with most of the utilities having a predicted rate variation between 0.5 and 1.5% (Fig. 2). However, the quantification of the ideal penetration level is still unclear and concerns about changes in the future scenario of energy prices remain.

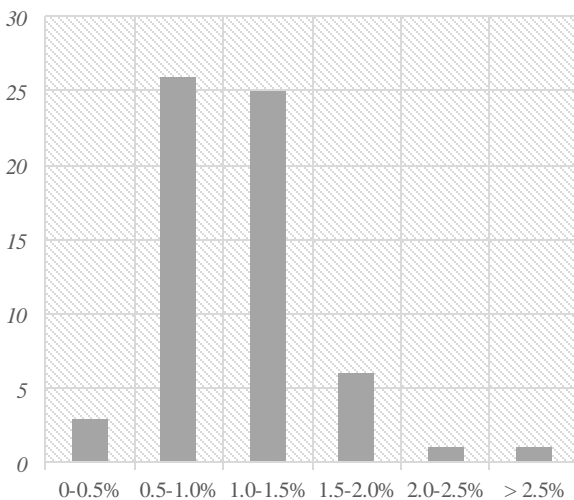


Fig. 2: Distribution of Brazilian utilities according to the impact of PV microgeneration on energy prices [20]

Section 2.1 elucidates the evolution of REN 482/2012, commenting on the existence of five business models for PV microgeneration, which present a considerable difference on the level of grid usage between them. Self-generation has the lowest usage level, while remote self-generation, consortium and cooperative may export the entire energy, generating virtual energy credit and transferring them to other consumer units. These asymmetries turn questionable the applicability of the same energy exportation rate regardless of the business model, without accounting the costs incurred to the distribution network and the impacts on its quality and functionality [17,18].

Though the expansion of the business model may lead to a further expansion of installed capacity, there are still fewer facilities framed under condominium, consortium and cooperative generation models. Partly due to the non-applicability of the Agreement 16/2015 tax exemptions to those business models and partly due to the lack of clarification about the regulation and the bureaucratic complexity [7,12]. The bureaucratic complexity is also verifiable by the utility approval of the electrical project. Norms, technical requirements, and documental requests change from one distribution company to another, as well as the charges applied during the billing process, producing a range of localized impacts on the viability of the PV microgeneration installations.

Apart from that, both mini and microgeneration rely on high initial investments with great dependency on credit programs with attractive interest rates. As observed by Ramalho *et al* [7], the absence of a nation-wide program of credit financing for a private person to promote PV microgeneration along with the prohibition of energy credit selling to the distribution company diminishes the accessibility range for people of lower income and the development of new business models.

Besides those issues related to pricing, bureaucracy, and financing, the use of a bidirectional meter imposes a technical planning challenge. As the energy exported to the distribution network fluctuates in reason of the intermittency of the RES and the load curve of the consumer unit, the total amount of energy generated in the grid without subtracting consumption is unknown by the planning authorities [18]. The estimation of the generation may incur an increase in the residual error and lead to misjudgments, false premises and wrongly based decisions. As policy planning relies strongly on the reliability of the collected data, any additional variability shall be avoided.

IV. DELPHI METHOD: CONCEPT AND APPLICABILITY

Conceptualized as a method to structure a group communication process in a manner to guarantee the

effectiveness of dealing with complex problems, the Delphi emerges out of the Specialists Methods as a tool to evaluate complex and interdisciplinary questions. The model delivers its final responses over a proposed issue through the consensus of a group of individuals with a high level of knowledge on a specific matter. Delphi application is suitable for situations with scarcity or imprecise historical data; with extrinsic factors predominating the intrinsic ones; or else, with substantial interdisciplinary. Moreover, the Internet dissemination allows the participation of experts from different locations in a larger number [21,22].

According to the goals of the group and the typification of the problem, there are two distinct Delphi Methods: Predictive and Political. The first one seeks to design future scenarios, assisting a decision-making process; while the second one functions as an analysis of political alternatives, exploring each angle of the situation to assess the consequences of any particular option.

A brief literature review of the application of the Delphi Method shows a diversity of studies on the Predictive area, targeting mainly the forecast of energy sources and technological potentials to assist policymaker's decisions. In this sense, Czaplicka-Kolarz *et al* [23] developed a foresight evaluation of technological advances and key sectors in the energy sector to coordinate public investments in Poland. Celik *et al* [24] presented a prognosis for the participation and benefits of renewable energy in Turkey by applying an online survey. Varho *et al* [25] used the method to list opportunities and challenges for DG in Finland, assessing different future scenarios and analyzing public responses and involvement to the theme.

Regarding the Political Delphi Method, the focus relies mostly on policy assessment. Carrera *et al* [26] set social indicators and, through a survey applied among experts in France, Germany, and Switzerland, rated energy technology according to its contribution to social development. Hsueh [27] took a local approach, evaluating the effectiveness of a community environmental policy involving afforestation and PV generation. The studies of Galo *et al* [28] elaborated a questionnaire to indicate the lowest cost policies for the deployment of smart grids.

In reason of the nature and purposes of this paper, the construction of the proposed methodology took basis from the Political Delphi, since this method is more adequate to the achievement of the goals mentioned on Section 1.

V. PROPOSED METHODOLOGY

The result obtainment by a participative process may only achieve consensus through an active mediation without discouraging the discussion. The active mediation shall be

prepared on the discussed matter, assuring its enrichment and conducting it by pre-established, well-based and clear methodology.

As briefly pointed out in Section 3, some issues arise from the recent deployment of DG and PV microgeneration. Targeting those issues and preventing future necessities encompasses and strengthens the legal framework, creating an environment of thriving business possibilities for all stakeholders.

The following methodology based itself on the Delphi Method presented in Section 4. The main steps are schematized in Fig. 3 and detailed in the subsequent subheadings.

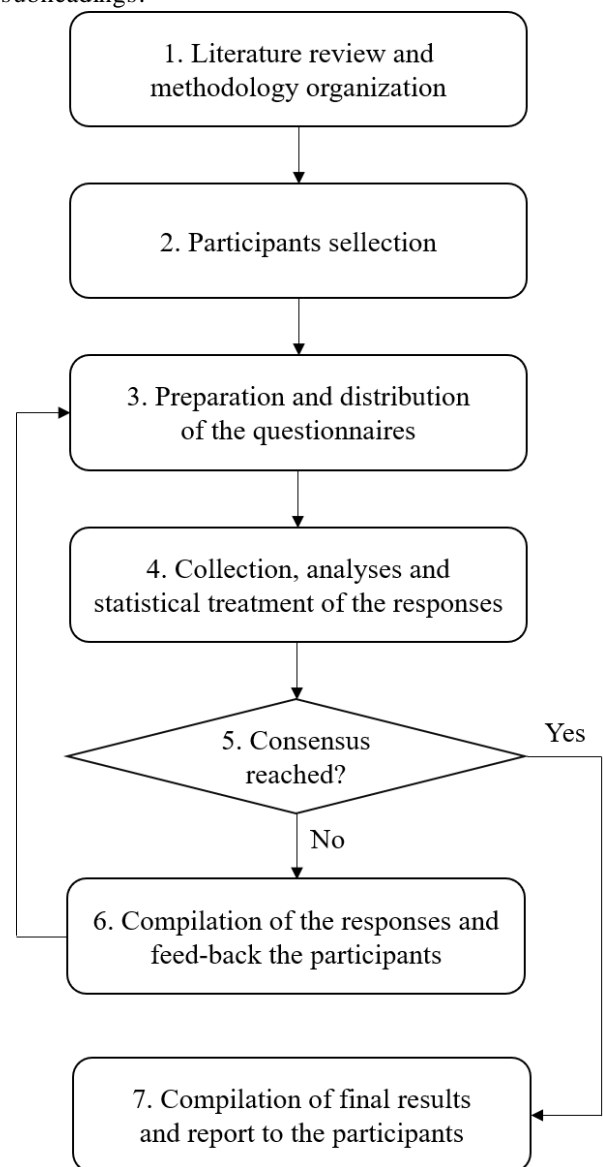


Fig. 3: Schematically representation of the regulation enhancement methodology based on Delphi Model

5.1 Literature review and methodology organization

During this step, all relevant data, report, paper or work on the future discussed matter shall be gathered and analyzed. It is also recommendable some previous surveys with key stakeholders and civil society to collect

a more subjective type of information as opinions, beliefs and feelings toward the approached issues.

5.2 Participants selection

The invitation of experts to participate in the discussion group shall be accompanied by a clear explanation of the methodology and the importance of maintaining the level of participation through the entire process. The expert choice shall cover different activity areas of the civil society to provide a wider view on the matter and enrich the discussion. It is important not to attain to location and time issues, using a virtual tool as online forms and e-mails to ease the application of the method and minimize its time-consuming feature.

5.3 Preparation and distribution of the questionnaire

The questionnaire shall contain a previous briefing on the current scenario, presenting the main gathered data in a didactical approach without forcing any prejudice from the organization group over the discussion group.

The questions shall be clear and quantifiable; it is suggested the use of an agreement scale from 1 to 4 for the answers, avoiding a central number representing a neutral opinion over the question issue. It is also important to create groups of questions to assess each issue, presenting different approaches to the problem to force the participant over a self-contradiction situation.

Following each question, there shall be a justification request, where the participants shall use their knowledge and expertise to base an argument justifying the agreement choice.

The preparation of the questionnaire is key to the success of the methodology. Thus, it is important to maintain it as clear and concise as possible, without lacking any important point.

During the application of the questionnaire it is also recommended to avoid contact among the participants, the discussion must take part without any social-economic bias to avoid the influence of a participant over the other.

5.4 Collection, analyses and statistical treatment of the responses

The collection of the responses is followed by its analysis. The configuration of the questionnaire in an agreement scale facilitates the application of a statistical treatment, evaluating the difference level among the answers.

Following the treatment, a report shall be made to feedback the participants. The main points presented in the answers justifications must be exposed to induce a reflection on the group over different points of view, reassessing their previous answers.

5.5 Consensus reaching and final results

After a statistical treatment, the measurement of the consensus level is taken through the distance between the third and first quartile to the median. Thus, the establishment of a consensus threshold is necessary. If the

quartiles-median distance is greater than the consensus threshold, the feedback report will be accompanied by a second-round questionnaire, similar to the first one, leading the participants to reevaluate their first answers in face of the answers of the group. This loop happens till the quartile-median distance is lower than the consensus threshold, indicating that the group achieved an acceptable level of agreement.

In the case of DG and PV microgeneration, the problem approach shall consider the pricing model review, the impacts of different business models over the grid, the fiscal and bureaucratic complexity and the technical issues, besides preparing the regulation for the entrance of storage systems, electric vehicles and other innovations that reached a commercial scale. A consensus over such wide matter may not be easily reached, but during the application of the subsequent rounds, the questionnaire may be adapted to focus on the gains of each participant, catalyzing the establishment of a common agreement.

VI CONCLUSION

The deployment of DG plants, notably PV micro generation, is a worldwide trend, urging governments and policymakers to formulate proper regulation to face technical and economic issues, allying the DG and PV microgeneration main benefits with the social welfare and the quality and efficiency of the electrical system.

The approval of REN 482/2012 and subsequent establishment of NEM as pricing model favored PV microgeneration in Brazil. Nevertheless, the increasing dissemination rate and the technological innovations demand continuously regulation update.

Due to the interdisciplinarity nature of the main critical points about DG deployment and the lack of empirical data suitable for the social-economic frame of Brazil, this paper suggests the application of a methodology based on the Delphi Method to analyze and propose alternatives for DG and PV microgeneration obstacles through a consensus process among experts on this matter.

The methodology proposed in this paper aimed to serve as a participative tool to assist the enhancement of the DG and PV Microgeneration policy in Brazil and to promote tangible and balanced solutions with lower global impacts over the key stakeholders.

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Physiochemical Characterization of the Brewers' Spent Grain from a Brewery Located in the Southwestern Region of Paraná - Brazil

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Abstract— *Brewers' spent grain is a by-product generated in the production process of breweries formed by the solid part obtained from the wort filtration before boiling. It is mainly comprised of pulp and husk residues of the malt, but it also contains grains of the adjuncts, such as rice, maize and wheat. Quantitatively, brewers' spent grain is the main byproduct of the brewing process and currently it is used as animal feed. The objective of this study was to determine the physiochemical composition of the brewers' spent grain and its potential use in human food. To this end, brewers' spent grain samples were collected from a craft beer brewery located in the southwestern region of the state of Paraná, determining such parameters as moisture, ash, total proteins, lipids, crude fiber, carbohydrates and energy. The results revealed that the moisture and ash levels were 78.23 ± 1.45 and $3.76 \pm 1.23 \text{ g.}100\text{g}^{-1}$, respectively. The figures for carbohydrates, total proteins, total fats and crude fibers were 1.89 ± 1.21 ; 4.89 ± 0.29 ; 2.67 ± 0.68 and 4.19 ± 0.56 , represented in $\text{g.}100\text{g}^{-1}$ respectively. The energy values obtained were $109.23 \pm 4.23 \text{ kcal.}100\text{g}^{-1}$. As such, the conclusion can be drawn that brewers' spent grain can be used in both animal and human food.*

Keywords— *Food, Waste, Agriculture, Bromatological Analyses.*

I. INTRODUCTION

According to the Brazilian department of Agriculture (Brasil, 1977), every grain that is subjected to a malting process, i.e., the grain is subjected to partial germination and subsequent dehydration and/or toasting at appropriate technological conditions, should be called malt followed by the name of the grain. Malted barley, or malt, is one of the main raw materials used in the manufacture of beer (Reinold, 1997).

In the first step of the beer manufacturing process, called mashing, two fractions are obtained: a liquid fraction (wort) and a solid fraction (brewers' spent grain), which is characterized as waste. For every hundred liters of beer produced, 20 kg of dry waste is generated, representing 85% of the total solid residue from the production process (Reinold, 1997).

Brewers' spent grain is the brewing residue resulting from the initial beer manufacturing process and it is generated from the filtering of the wort (mixture of ground malt and water) before boiling. This spent grain is basically made up of the husks of the malted barley.

Brewers' spent grain is predominantly fibrous (70 percent of dry weight) and proteinaceous (15 to 25% of dry weight), and it also contains lipids, minerals, vitamins, amino acids and phenolic compounds. Starch is the main source of glucose in the human diet, representing 40 to 80% of the total energy value in daily nutrition and being of considerable importance. Proteins are essential molecules for maintaining the structure and functioning of all living organisms and they have different properties and functions (Aliyu and Bala, 2011; Lima 2010; Robertson *et al.*, 2010).

Since brewery waste has a rich composition of organic compounds with a significant nutritional value, it must be treated before it is released to the environment in order to prevent changes to the ecological equilibrium. As such, there is a great incentive to reduce the generation of waste or to promote its reuse in other processes. From the perspective of producing higher value added products and allocating the generated waste to more noble ends, industrial bioprocesses have presented themselves as a potential way of allocating these residues (Pandey *et al.*, 2001), in addition to their potential applications in animal and human food (Mendonça and Oliveira 2012).

According to Aliyu and Bala (2011) and Souza *et al.*, (2011), various applications can be cited, such as: animal and human food and nutrition; energy production through direct burning or through biogas production via anaerobic fermentation; production of charcoal; adsorbing material in chemical treatments; cultivation of micro-organisms and obtaining of bio-products through fermentation; support for cellular immobilization; among others.

According to Borges and Neto (2009), Nogueira (2010) and Mega and Andrade (2011), it is estimated that the global annual production of brewing residue (RC) is approximately 30 million tonnes, while Brazilian production accounts for around 1.7 million tonnes/year. From the perspective of sustainability, social and environmental responsibility, these numbers have a severe impact and there is a lack of efficient waste management since its allocation is the responsibility of the generator, who may incur legal penalties if its removal is inappropriate. According to the authors, the inadequate disposal of these residues can cause damage to the environment and its direct elimination in the soil or in sanitary landfills has been shown to be inefficient because there are not enough of these to handle the large amount produced each year.

Considering the nutritional potential of the waste arising from the beer manufacturing process, the objective of this study was to determine the physiochemical composition of the brewers' spent grain in the Southwestern region of the state of Paraná in order to evaluate its use for consumption by humans and household pets.

II. MATERIALS AND METHODS

We used the humid brewers' spent grain from a brewery located in the southwestern region of the state of Paraná. Two kg of sample was collected at the end of the filtration, prior to the removal of the spent grain to the spent grain box. The sample was stored in hermetically closed and cooled packaging and was subsequently transported to the food analysis laboratory of the *Fundação para o Desenvolvimento Científico e Tecnológico* - Fundetec - located in the city of Cascavel - PR - Brazil.

The brewers' spent grain was subjected to physiochemical analyses, in triplicate, regarding the following parameters: moisture (oven drying method at 105° C for 24 hours), ashes (calcination of samples at 550° C), total proteins, lipids, crude fibers, carbohydrates and energy, according to the analytical standards of the *Instituto Adolfo Lutz* (Brazil, 2005).

III. RESULTS AND DISCUSSION

The results of the physiochemical characterization of the brewers' spent grain are shown in Table 1. The values of 78.23± 1.45 and 3.76 ± 1.23 were obtained for the

moisture and ash content, respectively, when analyzing the data.

The values found for the moisture and ash content of the brewer's spent grain under analysis (Table 1) are consistent with the literature data. Santos *et al.* (2003) evaluated the moisture and ash content of 8 batches of brewers' spent grain, consisting of 80% of malted barley and 20% of malted corn, obtaining values between 76.8 and 78.9% for moisture, and between 3.4 and 4% for ashes on a dry basis. Zhaoxia *et al.*, (2012) found a water content of 79% and an ash content of 4.4%, for the dry brewers' spent grain from commercial breweries. Robertson *et al.*, (2010) determined the moisture content of the brewers' spent grain of the barley from 10 commercial breweries, and found values between 75 and 80%. Dei Cedri (2006) found an ash content of 3.3% for the brewers' spent grain after mashing of the pure malted barley. In other literature reviews, values between 2.3 and 7.9% were found for ashes, and between 75 and 85% for moisture in the composition of the brewers' spent grain (Olajire, 2012; Aliyu and Bala, 2011).

Table.1: Physiochemical composition of the brewers' spent grain (b.u).

Analyzed Parameters	Values Obtained*
Moisture (g.100g ⁻¹)	78.23±1.45
Ashes (g.100g ⁻¹)	3.76±1.23
Carbohydrates (g.100g ⁻¹)	1.89±1.21
Total Proteins (g.100g ⁻¹)	4.89±0.29
Total Fats (g.100g ⁻¹)	2.67±0.68
Crude fiber (g.100g ⁻¹)	4.19±0.56
Energy (kcal.100g ⁻¹)	109.23±4.23

*Values for the sample expressed as a percentage (g.100g⁻¹) of the product on a wet basis (b.u).

According to Schmidt (1989), brewers' spent grain has a moisture of around 79%. According to Ascheri *et al.*, (2016), brewers' spent grain is characterized by a high moisture of 86% (b.u.) that limits its shelf life to up to 30 days for its fresh consumption. The high amount of water in the wet residue may result in other limiting factors, such as difficulties in long distance transport and storage. Regarding carbohydrates, total proteins, total fats and crude fibers, the values obtained were 1.89±1.21; 4.89 ± 0.29; 2.67 ± 0.68 and 4.19 ± 0.56, represented in g.100g⁻¹ respectively. The energy values obtained were 109.23± 4.23 Kcal.100g⁻¹.

When the data obtained in this study is compared with data from Murdock *et al.*, (1981); Polan *et al.*, (1985), Rogers *et al.*, (1986); NRC (1986) and Costa *et al.*, (1994) one can see that the content of total proteins, total fats and crude fiber is similar to the literature.

The carbohydrate content obtained for the brewers' spent grain (1.89g.100g⁻¹) is in agreement with the literature

data, which indicates that brewers' spent grain is predominantly a fibrous material (Aliyu and Bala, 2011; Lima 2010; Robertson *et al.*, 2010; Mussato *et al.*, 2006) that is poor in fermentable sugars. In addition, the washing until exhaustion of this residue for the recovery of the brewing wort extract, reduces the sugar content to its minimum.

The differences between the values obtained in this study and the literature are perfectly understandable when one takes into account that the proximate composition of the brewers' spent grain is a function of several factors, such as: barley variety, harvest time, grains used in the malting process, and the technological process used in the brewery, among others.

The total protein values found in this study were lower than those reported by Lima *et al.*, (2006) for crude green corn, rice and peas, and higher than those reported for tomatoes, paprika, avocado, pineapples, cashews, jackfruit and custard apples. Brewers' spent grain was also superior regarding the crude fiber content, coming second only to avocado and green peas.

Despite the great application of brewers' spent grains in animal feed, it can also be used for human consumption. Because according to Dongowski *et al.*, (2012), the high fiber value and the protein and sugar residues turn these spent grains into potential ingredients for use in bakery products, such as breads and cookies, where an increase in fibers, in particular, could bring benefits to consumers from a nutritional and functional point of view. These authors analyzed and characterized a bread with 10% brewers' spent grain (which was subjected to a drying and milling process) and concluded that after the addition of the residue, the bread took on a dark color with the appearance of whole bread. It also became more acid because spent grain has an acid pH.

Mattos (2010) also worked with brewers' spent grain and characterized a bread with 30% brewers' spent grain (which was not subjected to a drying and milling process) and he concluded that after the addition of the residue, the bread took on an appearance and texture similar to whole bread.

According to Cabral Filho (1999), the high availability, continuous generation and physiochemical characteristics of brewers' spent grains from the manufacture of beer are factors that corroborate its potential use as human food. One should also consider that the reuse of this brewing residue contributes to environmental sustainability by giving a proper destination to it, adding social and nutritional value to human food because of the increasing demand for nutritious and healthy food.

The obtained results reveal that brewers' spent grains can be used as human food since it has a similar, and in some cases even superior, composition when compared with other food items commonly consumed by human beings.

IV. CONCLUSION

Understanding the chemical properties of food is of fundamental importance to assess the availability of nutrients and the best characteristics for processing.

Brewers' spent grain has a high water content, and is therefore conducive to microbial development and rapid deterioration. On the other hand, it showed to have similar ash, protein, carbohydrate, fat and crude fiber contents as other foods, and it could therefore be used in animal and human foods.

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Data Mining Technique for Preventional Analysis of Work Accidents

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Abstract — *There are many oil companies operating in Macaé-RJ, Campos basin, they value the safety of work and the lives of its employees. These companies do a study to verify the health status of their employees' spine and result in a database with six attributes, such as: Pelvic incidence, Pelvic inclination, Lumbar lordosis angle, Sacral inclination, Pelvic radius and Degree of Spondylolisthesis. For in Brazil, recently, Social Security has released statistical studies that show back pain as leaders in the ranking of departures in the first half of 2016, a fact that directly affects the productivity of companies and health of their employees. This article aims to apply the KDD process, specifically the task of Data Mining classification, ie, classify if the employee will be fit or unfit for the job. The decision tree was the technique chosen through the algorithm J48 to verify the possibilities of treatment of the collaborators in the prevention and improvement in the working environment, and even, a change in the management was made from the results found. It resulted in inadequate staff postures, inadequate service stations, lack of training in equipment handling, lack of knowledge about cargo handling.*

Keywords— *Data Mining; KDD; Column; Occupational Accidents.*

I. INTRODUCTION

In 1943, the creation of the Consolidation of Labor Laws (CLT) was approved, then sanctioned by the then president of the republic, Getúlio Vargas. One of the chapters dealt with occupational safety and medicine, establishing coordination, orientation, control and supervision of activities related to occupational health and safety throughout the national territory, including the National Campaign for the Prevention of Accidents at Work. In addition, it established as an assignment of the companies "to instruct the employees, through service

orders, as to the precautions to be taken to avoid accidents at work or occupational diseases". With CLT, Vargas would go down in history as the benefactor of the working class (FALEIROS, 2002).

The area of work safety directly affects all productivity of a company, and when accidents with time off from work, the sector from which it was deprived of the employee is below its normal production capacity. In Brazil, the National Health Survey indicates that more than 20 million people suffer from some chronic disease in the spine (FALEIROS, 2002).

The pains can worsen from several strands such as stress, overweight or smoking. In more severe cases, it is possible that repetition of movements, overload and poor posture can lead to scoliosis (curving of the spine) or even disc hernias. Depending on the position and function of the worker, it is still possible that other diseases, such as RSI / Dort, Repetitive Strain Injuries / Work-related Musculoskeletal Disorders, are developed.

The International Classification of Impairments and Disabilities of the World Health Organization recognizes low back pain as a compromise that reveals loss or abnormality of the lumbar spine structure of psychological, physiological, or anatomical etiology, or a disability that prevents the full performance of work activities (WORLD HEALTH ORGANIZATION, 1980).

Schilling, in 1984, proposed a classification of work-related diseases divided into three groups:

- I. diseases that have work as the necessary cause, such as occupational accidents and occupational diseases legally recognized;
- II. diseases that have work as one of the contributing factors;
- III. diseases that have work as aggravating or provoking latent or pre-existing disorders.

Using the Schilling classification, occupational low back pain can be classified as Schilling II when the work is considered one of the contributing factors for its onset, or Schilling III when the work is considered as aggravating factor of a preexisting disorder or pathology.

An alternative to avoid this kind of problem in companies is to establish a Health and Safety Management (TSS) that considers several aspects, such as the direct and indirect risks to which the worker is exposed. In parallel to this, encouraging other actions, such as Internal Week of Prevention of Work Accident (SIPAT) or Labor Gymnastics, can prevent the incidence of these diseases. In addition to the decrease in the rate of remoteness, OSH-related activities broaden the perceptions of the worker, who tends to become more aware and apply the knowledge also in personal life.

The study in question is the use of KDD (Knowledge Discovery in Databases) in the database of a multinational oil company that operates in Macaé-RJ, in the Campos basin, where six attributes were used: Pelvic incidence, Pelvic inclination, Lumbar lordosis angle, Sacral inclination, Pelvic radius and Degree of Spondylolisthesis.

The KDD process involves several steps ranging from understanding the problem to be solved to extracting knowledge through data mining techniques. KDD is a process proposed in 1989 that according to Fayyad et al. (1996, quoted by Liebstein, 2005) is not trivial, identifying patterns that are valid, new, potentially useful and understandable. This involves finding and interpreting patterns in the data, iteratively and interactively, by repeating the algorithms and analyzing their results.

In order to work with the prevention of spinal diseases and time involved with withdrawal that generate a very high cost for the company, the purpose of this article is to use the task of classification of data mining to define whether the employee is fit or not to the work.

What all companies have in common, regardless of the method used, is the need to analyse the economic efficiency of a particular project, by grouping all costs, the value obtained must be less than the estimated value that it can generate as revenues or benefits.

II. METHODOLOGY

The study in question is a database of a multinational oil company operating in Macaé-RJ, in the Campos basin, related to the column, having six main parameters, such as: Pelvic incidence, Pelvic inclination, angle of lordosis lumbar, sacral inclination, pelvic radius and degree of spondylolisthesis.

The open source data mining tool used was WEKA version 3.8 and the implemented algorithm was J48. The tool was developed by the University of Waikato in New

Zealand. It can be defined as a collection of machine learning algorithms to perform data mining tasks.

WEKA has been increasingly applied and some interesting features help to explain its success (MURASSE and TSUNODA apud MARKOV and RUSSELL, 2006):

- Contains several algorithms for data mining, web mining and machine learning;
- Has open source and is available on the Web for free;
- It is relatively easy to use, even by people who are not experts;
- Provides flexible resources for experiments;
- It is kept updated, since new algorithms are added as soon as they appear in the literature.

The data mining process comprises the following (MURASSE and TSUNODA apud MARKOV and RUSSELL, 2006):

- Raise data sources (databases, reports, etc);
- Perform a data cleaning to "load" to WEKA;
- "Upload" to WEKA the post-cleaning data file;
- Search patterns relevant to the problem in question

using the algorithms embedded in the software.

The Ministry of Labor and Employment and Social Security (MTPS) contains a website, a friendly and interactive environment for the user, which contains a set of data on the main causes of withdrawal from work throughout the country. In this, was downloaded the information referring to the main causes having column (low back pain) the record holder in the first place.

The discovery of the knowledge on the database was given by the results of the X-ray and Magnetic Resonance examinations together with the implantation of a database with 6 attributes in order to better monitor one of the main causes of low productivity in the company the withdrawal due to in the period from June 2, 2014 to October 31, 2016, specifically aimed at Colbal (low back pain), where it is worth mentioning that it is a record holder of accidents due to remoteness, according to data from the Ministry of Labor and Employment and Social Security, of a total of 310 employees investigated, totaling the members of the company's staff and released in the dataset, requested by the Work Doctor together with a colleague Orthopedist and the Labor Safety Engineer, who is responsible, together with the occupational physician, for the implementation of mitigating measures that may reduce the scenario of remoteness, where the occupational physician who works as coordinator of the Medical Control and Occupational Health Program (NR07) of the company studied, is a member of the company's Specialized Medical and Occupational Safety Engineering (NR04) sector.

In this algorithm, the decision tree is modeled based on the most significant attribute, which appears as the root of the tree. From this root, branches are generated,

which represent the relevance of this connection. These branches can also generate other branches that would work the same way. Such a structure would then have the capacity to represent, intuitively, where knowledge could be extracted.

Goldshmidt (2005) says that decision trees are also known by the names of regression trees, or even classification trees and that they are graphical representations of a set of rules, consisting of roots, branches and knots, similar to a tree, where the analysis of these representations must be performed from the top to the leaves. These decision trees have as nodes the leaf values of the attributes of the base and the leaf nodes as the instances of these, that is, each of the decisions taken

to carry out this classification are pertinent to a single node.

The J48 algorithm generates decision tree models from the top to the bottom, so that on each node other attributes are evaluated individually to determine their significance in the connection or even existence in it.

III. RESULTS AND DISCUSSION

It is noticed that with the degree of spondylolisthesis less than or equal to 19.85° and Pelvic Radius is greater than 125.21° , the collaborator is considered fit.

If the degree of spondylolisthesis is greater than 19.85° , the employee is considered as unfit.

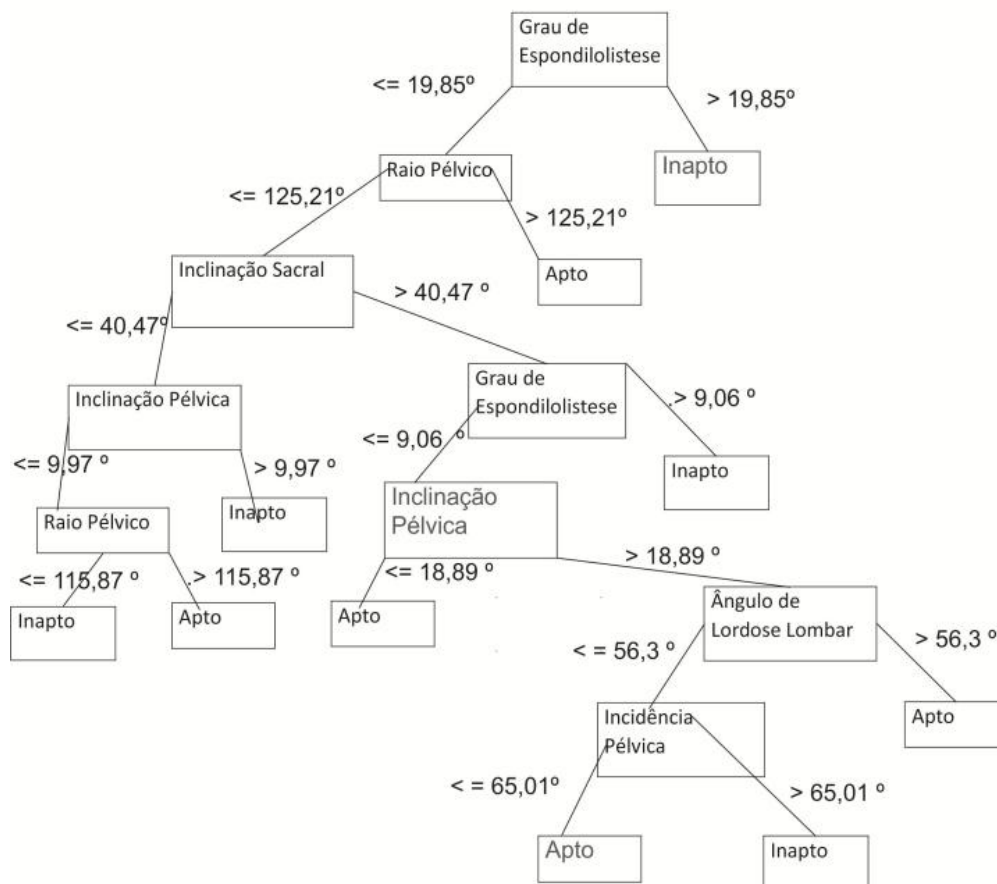


Fig.2: Decision tree. Source: WEKA - Algorithm J48.

When the degree of spondylolisthesis is less than or equal to 19.85° , the pelvic radius less than or equal to 125.21° , the sacral inclination is less than or equal to 40.47° , the pelvic inclination is greater than 9.97° , the employee is considered unfit.

When the degree of spondylolisthesis is less than or equal to 19.85° , the pelvic radius less than or equal to 125.21° , the sacral inclination is greater than or equal to 40.47° , and the degree of spondylolisthesis is greater than 9.06° , considered unfit. If, on the other hand, the degree of spondylolisthesis is less than or equal to 9.06° ,

the pelvic inclination is less than or equal to 18.89° is considered fit. If the pelvic tilt is greater than 18.89° degrees and the lumbar lordosis angle is greater than 56.3° degrees, it is considered as Apto. If the angle of lumbar lordosis is less than or equal to 56.3° and the pelvic inclination is greater than 65.01° , it is considered as unfit. If the pelvic tilt is less than or equal to 65.01° , it is considered fit.

When the degree of spondylolisthesis is less than or equal to 19.85° , the pelvic radius less than or equal to 125.21° , the sacral inclination is less than or equal to

40.47 ° and the pelvic inclination is greater than 9.97 °, the employee is considered unfit.

As a result of the analysis of the decision tree formed by the algorithm J48, it is possible to emphasize that the collaborators with diagnosis of spondylolisthesis are considered incapable for work activity, within the investigative clinical process, we tried to relate lumbar pain complaints with the cause. Considering this, and considering the attributes analyzed and the so-called normal parameters, it is perceived that the low grade spondylolisthesis associated with a sacral tilt out of normality also makes the collaborator incapable.

When the clinical investigation is the initial diagnosis is inconclusive for spondylolisthesis, analysis begins from the pelvic radius when out of normality, it is advanced to the analysis of the sacral inclination that when associated with spondylolisthesis or pelvic tilt is also considered inapt.

Collaborators who during the clinical investigation showed a sacral inclination associated with pelvic tilt were also unable to perform their activities, as well as those who presented lordosis associated with pelvic incidence out of normality.

This analysis becomes interesting for a company, since from it can develop a profile for physical evaluation compatible with the requirements necessary for the desired position, avoiding sick leave of the employee, also avoiding loss of productive capacity and consequently loss to the company.

IV. FINAL CONSIDERATIONS

This study presents an analysis of the factors that lead to work withdrawal, decreasing the productivity of companies and increasing the overload on social security agencies such as INSS. To identify these factors, a database with several attributes was used, which could influence the removal of the work, through spinal pain. This was possible using the KDD process, and with it was extracted rules that show possible causes that present the highest probability of the work spreads by the column through six attributes. This result allows the company to take mitigating actions to reduce work-related distress due to low back pain (column) and preventive actions such as an Ergonomic Work Analysis (AET), specific training recommended in MTPS NR-17.

The results obtained were also determinant for the Specialized Service in Medicine and Engineering of Work Safety of the company of the petroleum industry studied, in order to comply with the ergonomic procedures of all the platforms in which it provides service, being also possible to assist in the identification of which functions and areas require greater care, such as, for example, workers who work in the area of cargo handling.

Soon, the oil company may include in its work safety procedures and admission, a rigor in the need of hiring for jobs that allow the change of positions during the work day, with the addition of pauses that allow the body not to wear out too much.

In order to do this, it is necessary to design jobs that are adaptable to the anthropometric variations of the workers, in addition to avoiding the transportation of very heavy loads and for long journeys, considering whenever necessary, the rigor in the admission examinations compatible with the position to be occupied, in order to avoid future damage to the physical and mental health of the employee and the financial company.

From this, this article demonstrates the effectiveness of the J48 classifier in assembling a decision tree with the six attributes, with 81.61% of the instances correctly classified, being a satisfactory result for decision making.

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Expressions of Human Sexuality in the Phallic and Latency Phases: Reports from a Field Observation in Children of Porto Velho, Brazil

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Abstract— *The present study was conducted according to the Freudian subdivisions on human psychosexuality. The study on sexuality can be subdivided and directed to several themes, walking through several areas of knowledge, where each theoretical field contributes significantly to such study. This work was part of the studies of the discipline Human Sexuality of the Course of Psychology of the Federal University of Rondônia in the second semester of 2017 and reports an observation made with four children, having as subjects children in the age group of 3 to 8 years, whose names used in this Freud's contributions to human sexuality, with emphasis on the phallic phase and latency period, are fictitious and based on theory. To assist in the field observations on the phases, a plan of observations was made with a script of aspects to be observed considering the literature that already indicates some characteristics attributed to this*

stage of human life. As a result, it was observed that there are clear correspondences between the literature and the practice, however, there is a need to broaden the means and resources of observation to deepen the research, producing, in turn, a better analytical apparatus.

Keywords— *Sexuality and Psychosexuality; Phallic Phases and Latency; Psychoanalysis.*

I. INTRODUCTION

Several sciences or disciplines are concerned with the study of human sexuality, having as an observation that this requires the most varied sources of knowledge, giving it an essentially interdisciplinary character, from the different perspectives that are completed: Anthropology, Psychology / Psychoanalysis, Sociology, Medicine, Biology / Chemistry, History, Philosophy, Theology and Education / Pedagogy.

Taking into account this interdisciplinarity, it can be observed that the study on sexuality can be subdivided and directed to several themes, for example: Sexual practices, Sexual repression, Sexual attitudes, Sexual biology, Sexual therapy, Sexual chemistry, Sexual behavior, Relationships Family, Sexual Education, Sexuality and Gender, Sexual Hygiene, Sexually Transmitted Diseases, Sexual Development and History of Sexuality, among others.

Establishing a chronological period beginning in antiquity, art and literature have always dealt with sexual practices, through sculptures and paintings, poetry and plays, novels, philosophical works, and literature on sexual counseling. It is important to emphasize that in this period sexuality was directed towards the sexual act aiming at reproduction. The earliest Mesopotamian people already carved statues with highlights for the female genitals, and in Greece, it was common for vessels and chalices to have paintings and drawings depicting sexual relations.

Because of this, it is essential to produce this study that reports an observation made with four children, aged between 3 and 8 years, based on Freud's contributions to human sexuality, emphasizing the phallic phase and period of latency. To assist in the field observations on the phases, a script was carried out with a check-list highlighting some characteristics attributed to this stage of life of the individual, produced through bibliographical research on the above mentioned phases.

As a didactic division, we propose to make a historical survey that worked on the concept of sexuality from the earliest records to the elaboration of Sigmund Freud's psychoanalytic theory and its phases of the child's psycho-sexual development, explaining quickly which are these phases and attributing their characteristics in especially the phallic phase and the latency period, only to present the report of the observations and their results, finishing the work.

II. HUMAN SEXUALITY IN PHASES AND LATENCY PHASES

The term sexuality is still a taboo subject in today's society, little diffused, little clarified and confused with other terms, such as the very concept of sex itself. However, it is possible to understand that, compared to a few decades ago, this concept has changed greatly and changed the way we understand sexuality.

In the old days, the idea was that human sexuality was reduced only to the genitals, consequently it was linked to the sexual act and only for reproduction, where people would experience sexuality through sex, and could be performed as a form of ritual as well. It is perceived that this way of thinking was purely biological and did not

include other human aspects such as feelings, sexual orientation, previous experiences, life history and so on. Churches and religious aspects have a great influence on these thoughts, because they value the family very much and understand that sex and pleasure were an unfortunate necessity (Amaral, 2007).

In psychology, Freud is one of the first authors to study and describe human sexuality. He published a book in 1905 entitled "*Three Essays on the Theory of Sexuality*", which made a major impact on society at the time by the prevailing thinking to understand that sexuality was purely for reproduction and that never having been spoken of in infantile sexuality, repercussions between people. In this book, Freud brings a new concept of sexuality, describing the stages of development from childhood to adulthood: oral phase, anal phase, phallic phase, latency period and genital phase. It also appeared as another striking term in its history, the libido, which signifies an energy that drives life primarily to sexual energy (Amaral, 2007).

Freud's studies on human sexuality were enduring, as Hall and Lindzey (1984, p, 24) point out,

"For over forty years Freud has explored the unconscious by the method of free association, developing the first comprehensive theory of personality. He traced the contours of its topography, penetrated the sources of its energy currents, and determined the true course of its development. Performing these incredible feats, he has become one of the most influential and controversial figures of our time. "

There are other important authors who describe the concepts of human sexuality, such as Michel Foucault, Wilhelm Reich and Herbert Marcuse and who bring great contributions on this subject.

For the World Health Organization (WHO, 1975) cited by EGYPTO (1981, pp. 15-16) "*Sexuality is a part of one's personality, it is a basic need and an aspect of the human being that can not be separated from other aspects of life. Sexuality is not synonymous with coitus (sexual intercourse) and is not limited to the occurrence or not of orgasm. Sexuality is much more than that, it is the energy that motivates to find love, contact and intimacy and expresses itself in the way people feel, and how they touch and are touched. Sexuality influences thoughts, feelings, actions and interactions, and therefore physical and mental health. If health is a fundamental human right, sexual health should also be considered a basic human right.*"

Zornig (2008: 73) indicates that at every moment man seeks to satisfy his desires and, on account of this, sexuality should not be seen as merely instinctive. Sowe have:

The classic conception of instinct has as its model a behavior that is characterized by its fixed and preformed purpose, with a specific object and objectives, while the Freudian notion of sexuality defends the idea that human sexuality is not instinctive, since man seeks pleasure and satisfaction through various modalities, based on their individual history and surpassing the fundamental physiological needs. Thus, if sexuality begins with anatomy (at birth), its achievement depends on a long course during the construction of the child's subjectivity (ZORNIG, 2008, p.73).

From this, it is possible to perceive that there was a great change in the concept of sexuality and that there is a difference between sex and sexuality, according to Amaral (2007, p.3) can be defined and differentiated as follows: "[] the concept of sexuality is much broader and, by its characteristics, it is restricted to the human being. It is this broad concept that allows it to be a subject of multidisciplinary interest, in which Biology and Medicine give an account of the anatomical and physiological aspects, History and Sociology discuss sexual behaviors and their origins, Anthropology observes its cultural evolution, Psychology, in turn, has been interested in analyzing the feelings involved and how it develops in the individual. The concept of sexuality also leads us to the realization that sex can not be regarded as an act of pure instinct, for, as we have already seen, instinct is an innate behavior that serves a need. Sex could be looked at in this way, as it serves the reproduction of the species, as it does among animals. [...] in the sexual question, the partner's choice is made much more by the pleasure that the object of choice provides for us than by the pressure of the instinctive need for reproduction. In man, pleasure refines the instinct of reproduction, becoming more determinant and fundamental in sexuality."

It is important to emphasize that this new concept leaves from the more mechanical structure of only understanding sexuality through reproduction, for a more complete view of the individual in a biopsychosocial way.

2.1. Sexual development in the phallic phase and latency period

Freud is one of the first authors to speak and describe about child sexuality, his main book being related to this subject: "Three essays on the theory of sexuality", released in the year 1905.

In this book, the author divides the psychosexual development of the child into four phases: oral, anal, phallic and genital - having, in the phallic phase, a stage called the latency period.

The present work is based on the psychoanalytic theory of Freud and focuses on the development of human sexuality from the theory of child psychosexual development, taking into account a phase in question: the phallic phase and its latency period.

2.2. Phallic Phase

The phallic phase usually manifests itself between the period of three to six years of age. It is marked by the beginning of "normal" sexual life, in which the erogenous zone is the genitals, and also by the development of the Oedipus complex.

At this stage, the first manipulations take place in the genital organs in order to eliminate the stimulus and provoke the satisfaction. Masturbation is not eroticized and the child is devoid of shame, sometimes undressing, and satisfaction in it. It is during this period that the activity of the search for knowledge or of investigation arises, being common curiosity to see the genitals of their peers.

Freud thus manifests itself in this way:

Because of their anatomical position, the secretions in which they are bathed, the washing and friction arising from caring for the body and certain accidental excitations (such as migrations of intestinal worms in girls), it is inevitable that the pleasurable sensation these parts of the body are capable of producing a child's attention to the child already in the breastfeeding phase, raising a need to repeat it (FREUD, 2006, 177).

In this context, the child begins to realize that their organs are different from some colleagues (opposite sex) and that adults also have different structures. That is, the girl does not understand why she does not have a penis like the boy and realizes that women have developed breasts, unlike her; the boy has the same perception as the girl, but in it still accompanies the fear (fantasy) of castration for not understanding the distinction between him and the opposite sex, he also observes structures of different size with the father. Here you begin to notice the differences in terms of male and female gender.

The child's sense of threat to a child's arrival, fear of loss of parenting and caring for love ultimately leads the child to become reflective and observant. The first problem that confronts her does not originate in the questions of sexual differences, but in the great enigma; "Where do babies come from?" (FREUD, 2006, p 183, COSTA, OLIVEIRA, 2011). It is a time when she tries to understand the world around her, so the child mune questions and fantasies.

Because of this, it is at this stage that the Oedipus complex appears - characterized by the fact that the boy

desires the mother and the girl to desire the father, also desiring the removal of the other parent. Every child, of both sexes, has a stronger bond of love with the mother, for satisfying their basic needs; however, in the phallic phase, this changes a little, especially for the girls, which transfers that feeling to the father.

In this process of the Oedipus complex, the dynamics are as follows: boys believe (fantasy, fear) that the same-sex parent can castrate him, because he is "stealing" his wife; this leads the boy to repress the sexual desire for his mother and to diminish the resistance that had of his father, finding points of affection with both parts. Already the girl can often blame the mother for her "castration" (for lack of the penis) and with that approach the father, because he has what she wants and so she has an ambiguous feeling about the progenitor of the other sex, love and envy; the mother's relationship can be very conflicting if the girl puts all the blame on the mother because she does not have the genital organ sought.

A very common behavior at this stage is the girls want to be equal to the mother, using some feminine resources that the mother uses as putting lipstick, the mother's heel, some clothes and other habits of the mother. The boys are no different, to draw the attention of the mother to various behaviors similar to the father. At the end of this process, the former wish for parents now becomes a feeling of affection from son to mother and from daughter to father. However Farias, Nantes and Aguiar (2015) express that in the girl the complex is not repressed as in the boy.

Farias, Nantes and Aguiar (2015) cite Hall and Lindzey (1984, p. 42) in which they talk about Freud, in which he believed that everyone possesses a bisexual inheritance, since each sex shows a manifestation of attraction by persons of the opposite sex or same sex, and that Freud believed that it was the principle of homosexuality, even though in many people the impulses of homosexuality remain hidden.

Still, the authors argue that bisexuality gives rise to a major problem for the Oedipus complex, since the child will begin to invest in same-sex people, who in this case would be the girl with the mother and the boy with the father.

Because of this, the nourished feeling in which the boy begins to feel affection for the father and the girl, the

affection for the mother begins to present two values, becoming thus, ambivalent and no longer univalent (AGUIAR; .10).

2.3. Latency Phase

The latency phase usually occurs between the child's six to nine years. As Rappaport (2011) indicates, it is an intermediate moment between the infant stages of the organization of the libido and the adult stage characterized by the genital phase.

With the conclusion of the phallic phase, the basic modalities of affective relationship have been elaborated. The genital phase will resume them, however, replacing fantasy with reality. Therefore, this is a period in which it prepares the development of the individual for reality.

Due to repressions that occurred in the oedipal phase, there is a decrease in the child's fantasies and sexual activities. However, to satisfy the libido of the individual, a displacement of these energies ends up for the intellectual and social development of the child. It is at this stage that they begin to appear to sexual inhibitions, which cause disgust, morality and aesthetic desire to happen.

Costa and Oliveira (2011) report that "[...] it is during this period that sexual energy, sometimes total, but in some cases partial, is diverted to other purposes. Studies have stated that the deviation of the sexual instinctual forces, termed sublimation, becomes a component for cultural achievements. But sometimes sexual situations are manifested that have not been fully sublimated or in some cases certain sexual activities are preserved throughout the latency period until puberty"

For Fiori (2003) the libido is an energy that does not cease, is produced constantly and can not be contained simply. Thus, in this period of latency this energy is shifted to other ends as, through processes of sublimation, being channeled into the process of intellectual and social development of the child.

When there is a permanence of these sexual activities, not being able to sublimate them or partially, this can become pathological, being able to trigger in the genital phase.

Some characteristics of the phallic and latency phases are indicated in the table below:

Table.1: Some characteristics of phallic and latency phases

STAGE	AGE	IMPORTANT EVENTS	FIXINGS
PhallicPhase	3 a 5 years	Libidinal energy is focused on the genitals. Freud suggested that the main focus of the id's energy is on the genitals. The boy's experience is an experience of Oedipus Complex and the girl is	Phallic fixation. Men set at this stage may become overly aggressive or overly passive; women can become flirtatious

		Electra Complex, or an attraction to the parent of the opposite sex. To deal with this conflict, children adopt the values and characteristics of the same-sex parent, thus forming the superego.	or seductive.
Latency Phase	6 years old to Pre-Adolescence	A period of relative calm, when libidinal energies become less active. The ego and superego emerge. During this phase, the superego continues to develop, while the energies of the id are suppressed. Children develop social skills, values, and relationships with peers and adults outside the family.	Usually there are no attachments linked to the latency period, since it is a time of relatively little psychosexual development.

Source: Adapted from Psicoativo.com

To assist observation in the field was made a checklist with some characteristics attributed to this time of the individual's life in the Phallic Phase:

PHALIC PHASE - Road map for field observation
1. The notion of the differences between man and woman
2. Genital exploration (erogenous zone)
3. Jealousy of the parents (opposite sex)
4. Beginning of libidinal activities facing the external
5. Finding an object of external love
6. Beginning of masturbation and fantasy
7. "Repent" the same-sex parent

And in the Latency Phase:

LATENCY PHASE - Road map for field observation
1. The interests of libido are suppressed
2. The development of ego and superego contribute to this period of calm
3. Concern about peer relationships, hobbies and other interests
4. Sexual energy is directed to other areas, such as intellectual activities and social interactions
5. Development of social skills and communication and self-confidence
6. Exploring the pleasures of literacy, games, collections and group games
7. Ego attitudes arise as shame, repulsion and morality

III. RESEARCH METHODOLOGY

It is a qualitative, semi-descriptive research with notes to the discourse analysis or subject procedures. The study was part of the development of the discipline "Human Sexuality" in the eighth period of the Psychology course of the Federal University of Rondônia and had as an academic proposal to make possible the comparison between theoretical aspects and practical observation, in order to assist in the establishment of concrete data that promote group analysis, reflection and discussion, as a contribution to the training and professional growth of the students involved.

The work was divided in two stages: bibliographical research and practical field observation. In the literature search, a brief state of the art was sought on the pattern of behavior expected in the phallic and latency phases of the

development of human sexuality, resulting in the production of two scripts (both presented in the body of this study) that served as a comparison tool.

The observation, in turn, was performed in two stages - corresponding to the two phases of Freud's sexual development and which were established as an emphasis in the present study.

In the first phase corresponding to the phallic phase of sexual development, we chose to observe two children. The first was given the fictitious name of Maria, four years old (at the observation period) and female. The second was given the fictitious name of John, of three years (also in the period of observation) and male.

In the second stage, two children were also chosen, but with age groups differentiated from those previously mentioned, being these new ones in the period equivalent

to that of latencies. The first child was given the fictitious name of Mario, eight years old and male. The second child was given the fictitious name Joseph, also eight years old and male. During this stage it was verified that the first child fictitiously identified as Mário has a diagnosis of mild autism.

IV. RESULTS AND DISCUSSION

With didactic purpose, it was preferred to explain the results in topic format, separating each child in their respective phases.

The first stage of observation involved the children Mary and John, culminating in the elaboration of a framework for each subject, as follows:

Table.2: Field observation - Maria - Phallic Phase

IDENTIFICATION	FINDINGS IN FIELD RESEARCH
Subject 1: Maria	Maria knows how to differentiate between men and women, both the physical structure and the stereotypes of each gender (ex: woman plays with doll, uses makeup and man likes ball and video game, on the genitals, also can perceive the morphological differences);
Age: 4 years	She clearly performs genital exploration on several occasions, soon there is masturbation;
Sex: Female	In relation to her father's jealousy and disgusting her mother, it was not possible to observe this behavior, but Maria wants to be in the middle of the two, kiss the two and stay in the middle of the couple;
PhallicPhase	Maria presents libidinal desires directed towards the external: as a desire to "have a love too", like that of mother and sister; has been focused enough on school activities; fantasy in relation to the stories.

From Table 2, it was verified that Maria shows several expected attributes for her age group, as pointed out in the commented literature. It presented capacity of sexual differentiation between masculine and feminine and the ludic behaviors pointed to a probable sexual definition where it was possible to be noticed that the girls develop feminine behaviors and the boys, masculine behaviors. Body exploration was also observed from the experimentation of the erogenous zones, resembling the masturbation patterns present in the genital phase, however without the primacy of mature sexual pleasure, but of an exploratory, playful nature and especially with

the intention of developing a learning about their corporeality.

The preference for the company of the mother or the father was not confirmed, nor was any level of disgust for the mother perceived, and it was possible to notice the manifestation of satisfactory levels of interpersonal relationship in a sort of triangle representing a relationship of the Father-Mother-Mother type, where Maria expressed satisfaction in living with both parents. With this, the well-known Elektra Complex pointed out in the literature did not classically consolidate in this study.

Table.3: Field observation - João - Phallic Phase

IDENTIFICATION	FINDINGS IN FIELD RESEARCH
Subject 2: João	João knows how to differentiate men and women, both from the physical structure and from the stereotypes of each gender; Ex: "Mom, girl has pepeca, right? And boy has pee-pee, eh? " "Girl wears lanjerie and boy underwear, eh, Daddy?"
Age: 3 years	Performs genital exploration and informs parents of their discovery; Ex: "Mom, Dad, look, my pee-pee stands!"
Sex: Male	There is no distinct repugnance to his father, but, though he relates very well to his parents, he prefers his mother's company; Ex: You play ball with your father, but you prefer to be with the mother.
Phallic Phase	João presents libidinal wants toward the outside: he likes to go to school and do his past activities home. It is stimulated by the mother (teacher) to know the letters and numerals. Draw your own name, the name of the father, the mother and the grandmother (see below).



Fig.1: Representation of the subject's name

From Table 3 shows similar findings to Table 1, but with the distinction of the male subject John. In the perception of his corporeality and in the learning about his corporal scheme, João manifests capacity of sexual differentiation between boys and girls from the use of the clothing, assigning the use of boys' underwear and panties for girls, still representing the same pattern present in the behavior of their parents, seeking in them the affirmation of their constructs.

The erogenous perception of the body to the genital manipulation expressed the discovery of the penile erection and the advent of the first sensations of pleasure

from the outside environment. To all this, it was possible to notice the presence of libidinal behaviors.

The preference for the company of the mother did not mean repugnance to the father and it was possible to notice the manifestation of satisfactory levels of interpersonal relationship in the representing, now the relationship John-Father and now the relationship John-Mother. With this, the well-known Oedipus Complex pointed out in the literature did not classically consolidate in this study.

The second stage of observation involved the children Mário and José, culminating in the elaboration of a framework for each subject, as follows:

Table.4: Field observation - Mario - Latency Phase

IDENTIFICATION	FINDINGS IN FIELD RESEARCH
Subject 3: Mário	The relationship with colleagues (in the main male) has more investment;
Age: 8 years	The energy of the libido can be observed from the exploration of hobbies and even in the school activities (soccer, running, dolls and the like) established;
Sex: Male	Social rules of differences such as female and male bathroom, boy and girl toy, boy and girl group are also very noticeable;
Latency Phase	There are still remnants of the phallic phase with the exploration and discovery of the body.

From Table 4 shows the fulfillment of several attributes pointed out in the explored literature, since sexual aspects did not show an emphasis on body perception, which was noticed as only a few behavioral remnants related to the phallic phase. Now the libido expresses itself differently from the previous phase in which the greater interest was noticed in the collective behavioral patterns where Mario was more interested in ludo-sports practices in the scope of the school activities such as playing soccer, to practice games of race like the joke of "run and get ", "hide and

seek "and others, and there was the main perception of pleasure. As pointed out in the literature, it was not possible to note the exploitation of erogenous zones (body and individual), but pleasure in social life (body and community).

In the social sphere, the use of environments suitable for men and women, such as the men's room and the women's room, have already been noticed. Also present the practice of forming homogeneous groups where boys group with boys and girls group with girls.

Table.5: Field observation - José - Latency Phase

IDENTIFICATION	FINDINGS IN FIELD RESEARCH
Subject 4: José	It presents shame in relation to the body and in performing some activities (what before did not present); repulsion and morality in various situations and speeches that he explains what is right and what is wrong for him; here is clear the development of the Ego and Superego;
Age: 8 years	José presents the exploration of pleasures in relation to games, friends, going to play in the street with colleagues and etc .; and even speaks of future activities that he wants to do;
Sex: Male	
Latency Phase	Developed social skills, such as: communication, expressing feelings, intellectual area (directed sexual energy); motor part and others;
	Concerns with colleagues, hobbies and interests: here José presents these aspects in a clear way, cares about friends, the activities he performs.

From Table 5, Joseph manifested moral and ethical traits or even self-reproach in the sense of shame. It was noted the formation of concepts about right and wrong as a way of confirming super-ego attributes. It was also observed the practice of social behaviors such as communication, correlated levels of intellectualization, motor activities such as games and games and also the wide participation in group formation and the manifestation of pertinence to such groups, especially in group activities among friends. There was also an interesting level of concern for the well-being of his friends.

In this observation, it was possible to perceive that the manifested behaviors were much more of social and coeviva nature than exclusively sexual.

V. FINAL CONSIDERATIONS

The concept of sexuality manifested by the subjects was very diversified in the different age groups, passing through several areas of knowledge and encompassing various cultural preconceptions. Today, although it is still divergent, it is concluded that sexuality is an essential part of human development and that it is not restricted to the biological character of sex but advances to the social character of human sexuality.

Within this perspective, we tried to analyze this concept in front of the psychology, from the theoretical postulates of the Freudian psychoanalysis and one of its most prestigious and well-known works: Three Essays on the Theory of Sexuality, released in 1905.

Considering the psycho-sexual development of the individual defended by Freud, we emphasize two of its phases (phallic and latency) in order to establish a correlation between theory and practice.

From this experience, we can emphasize that such an approach is essential to implement the discussions and reflections necessary for the critical formation of the professional of psychology, enabling not only professional evolution but also evolution as an individual

when discussing a subject surrounded by prejudices and considered, still, a social taboo.

The opportunity to go to the field, as well as to experience the contact with the other, allowed a greater assimilation of the academic content, also promoting, a new personal analysis of the strengths and weaknesses to be considered in the professional exercise.

In relation to the field activity, it was possible to verify that there were some correlations between the pre-established lists and the observation of the behaviors presented by the subjects. However, it was noticed the need for greater contact and the possibility of applying different theoretical approaches as a way of making possible a greater depth in the research, in order to validate more reliable of the findings, which implies to suggest the importance of conducting further studies about of this topic.

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Economic viability: A bibliometric study in the Scopus database.

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Abstract —The present work aimed to perform a detailed search on the methods applicable to the calculation of economic viability. The database used to develop this systematized literature review was Scopus Elsevier, accessed through the Capes Journal Portal. The study allowed to obtain a theoretical contribution to the accomplishment of the general objective of this dissertation. For each method, the resulting articles 3 were analysed and selected for presentation of a brief summary in order to exemplify the content available. It was possible to observe the state of the art of the theme, since the methodology allowed to identify the years with the highest frequency of periodical publication, and authors who published that subject, the countries with more engagement in this context, the types of mostly used publication and the areas of knowledge with the highest volume of published articles. It is also, possible to verify that the method tends to be increasingly applied, mainly within the area of Engineering, which was the area that stood out in this study, due to its flexibility to apply it in different scenarios. It was also found that China is the country with the most indexed documents on this basis, according to this issue.

Keywords— Financial Methods; Economic viability; Bibliometric Study.

I. INTRODUCTION

According to Capaz and Nogueira (2016), although energy efficiency projects have great benefits in reducing energy, it losses and contributes to the environment, only these factors are not enough to attract investors. Energy efficiency projects also need to be economically viable, so that an external investment can be better justified by those who intend to execute it. Thus, before choosing to raise investment for a particular project, it is necessary to calculate its economic viability.

According to Neumann (2017), the economic viability of a project is calculated through methods that aim at analysing data in comparison to the target for this particular project. That is different, companies have different goals and therefore can make use of different methods. What all companies have in common, regardless of the method used, is the need to analyse the economic efficiency of a particular project, by grouping all costs, the value obtained must be less than the estimated value that it can generate as revenues or benefits.

Based on this scenario, this study intends to address eight financial methods that are considered more compatible and recommended for economic feasibility analysis for projects such as the application of photovoltaic panels in a company located Macaé city / RJ - Brazil. For this purpose, concepts and a bibliometric study will be carried out regarding the selected methods, with the objective of analyzing and identifying the authors, periodicals, countries, type of publication and areas of knowledge with the greatest publications on financial methods. The aim of this study was to present three practical application studies for each method selected.

II. REVIEW OF LITERATURE

According to Jaffe et al. (2015, p.443), "when evaluating a project, we begin by determining the correct discount rate and use the cash flows counted to determine the Net Present Value." The author goes on to point out that the first measure to be taken when determining the flow of a company's cash flow is to analyse the activities related to its operation, that is, all the movement that composes its transactions involving products or services, according to the purpose of the For Marques (2007, p. 07), "the true strength of the company, which really matters for shareholders, is based on cash flow." The

author bases his assertion on the justification that the cash flow presents a great variety of information to be analysed, for example, payment deadlines in comparison with the payment deadlines, reduction in the volume of revenues, extrapolation of costs against the planned, among others. According to Sebrae (2018), cash flow is a "financial management instrument that projects for future periods all the inflows and outflows of the company's financial resources, indicating how the cash balance will be for the projected period". cash flow becomes a tool that allows for more conscious decisions that affect the overall outcome of the company. In the same way, cash flow can be segmented according to the information to be analysed, making the results more precise. For example, the returns on investment and the costs of obtaining resources are the interest paid, the interest dividends and the interest (CRCRJ, 2018) Marques (2007, p.82) states that "NPV is the difference between inflows and outflows of money from an investment brought at prices of the same date by the opportunity cost ". In practice, a basis for comparison needs to be defined so that a more in-depth analysis can be carried out and based on other available investment options. To carry out the calculation, attention must be paid to the use of a Minimum Attractiveness Rate - TMA or Capital Cost adequately. According to Camargo (2007, p.25), the minimum rate of attractiveness - TMA corresponds to the devaluation rate imposed on any future gain because it is not available at the time. Your choice requires great care, because the analysis of the same investment can show different results ". This statement reinforces the importance of using a set of indicators to carry out the analysis of the financial viability of any project in order to mitigate the risks of a partial and poorly-based analysis.

Chenço (2009) points out that in the case of discounted cash flow, for external factors and that may directly interfere with their future results, such as the country's economic situation or even at the global level. This means that not always a project with good NPV - Net Present Value or Internal Rate of Return will be, in fact, good investment. In order for the investor to be able to protect himself from the risks that cause incorrect decision making, the author gives tips such as, for example, asking about the reasons that lead the project to present a positive NPV; if it is possible to produce and distribute the product or service efficiently, and whether it will be possible to market the product or service at an attractive price to the final consumer. Regarding the discount rate, Jaffe et al. (2015, p. 139), states that "conceptually, the discount rate of a risky project is the return that can be expected to be earned on a financial asset of comparable risk." That is, discount rate is the rate used so that the following portions of the cash flow are deducted.

These three instruments are related to each other, as affirmed by Chenço (2009, p. 113), when stressing that "present value, discount rate and equivalence of cash flows are absolutely interconnected concepts."

The Internal Rate of Return (IRR) central importance in the decision-making process. Jaffe et al. (2015, p.143) state that "as a general rule, IRR is the rate that makes the NPV of the project zero." This method has as main objective to gather the maximum information to facilitate the analysis of the investor, taking into account internal aspects of the project in question and focusing its analysis on the issue that has the greatest impact on the overall economic viability: the expected cash flow. According to Gitman (2010) the Internal Rate of Return is composed by the discount rate at which the NPV - Net Present Value is equal to zero, since it reaches the same value of the initial investment as the investment opportunity in question. In practice, knowing the IRR of the project has as purpose to compare this percentage with the interest rates offered by the market, arriving at the conclusion that it is a profitable investment or not (Jaen, 2009) Jaffe et al. (2015) states that Payback is a way to focus attention only on the projects that interest the company, according to its estimated term of return. That is, if the company expects to work with a maximum return of three years, it can discard projects that have a return in term and analyse in greater detail only those that meet the established requirement. Chenço (2009) makes a comparison between the use of Payback and NPV for the analysis of investments, stating that the former is more suitable for projects with higher risk involved, since the latter does not take into account the time aspect of the investment. When you talk about Payback, your analysis can still be segmented according to the type of analysis you want to do, which in the case of this method can be classified as Simple Payback and Discounted Payback. According to Fapan (2018), Simple Payback is the attainment of the point at which the net related income is equal to the total amount of the investment previously made.

Jáno Payback Discounting the amounts received in the form of net income are then counted so that they can be compared to the initial investment volume, according to the analysis method used. "Another method used to evaluate projects is the so-called ILL. It is the quotient of the present value of the future cash flows expected after the initial investment divided by the amount of the initial investment. "(JAFFE ET AL, 2015, p.154) The profitability index is used to evaluate capital budget projects. This considers the value of money at current time, and can be used at the beginning for the selection of projects under capital rationing conditions (GITMAN, 2010).

The analysis of the result obtained in the operation performed to find out the IL of the determined project is

quite simple, as stated by Bourdeux-Rego et al. (2013) by checking that the result is smaller, greater than or equal to 1. If it is less than 1, it means that the investor will at least get his investment back, and will have a return proportional to how much greater than 1 is the result. If the IL is equal to 1, the investor should know that he will have his investment recovered, however, at the same rate as was initially required. However, if the IL is less than 1, it means that there will be no return of the invested amounts, meaning losses to the investor.

According to Romeiro Filho (2011) Return on Investment - ROI "measures the return on investment made and accounted for in months in which it will be amortized and then start to generate profits." The author stresses that the calculation of ROI can be done in several ways, according to the need for analysis. For example, by dividing net income by total assets, the investor will know the percentage of return offered by the company. Already dividing liquid by the invested amount, it will be possible to know the percentage value of investments. By doing this last operation in reverse, the investor will find the time it takes to recover the invested capital.

III. METHODOLOGY

The methodology selected for the elaboration of this work was the bibliometric study, since this one has the intention to present the scientific contributions on a certain theme or phenomenon (JUNG, 2004). It performs the state of the art through investigation or screening of the scientific production (OKUBO, 1970). In this way, a research will be carried out using key words related to eight different financial methods of economic analysis, having as base the Base Scopus, being accessed through the CAPES Platform. Financial methods are used to aid in the control and achievement of a company. This study intends to address eight financial methods that are most commonly used to analyse economic viability in companies, and thus, analyse them from the point of view of the application of the photovoltaic panels in a company located in the municipality of Macaé / RJ. For this purpose, concepts and a bibliometric study will be carried out regarding the selected methods.

The model used is the one proposed by Costa (2010), which is divided into six steps. The definition of the sample of the research, the research in the sample, the identification of the periodicals and of the authors with the greatest number of publications on the subject, a survey of the production chronology, identifying cycles of higher production and the selection of articles for composition of the "starting nucleus" for the bibliographical research. In this scenario, the objective is to analyze and identify the authors, periodicals, countries, type of publication and areas of knowledge in a large number of publications about eight financial methods.

The aim was to present three practical applications of the studied theme for each selected method.

3.1 Regarding the purpose

Concerning technical procedures, this is a theoretical-conceptual article, exploratory in nature and approach to qualitative research, inspired by the method, suggested by Costa (2010), to carry out the systematized literature review.

3.2 As to the methods

The work will follow six proposed steps: definition of the sample of the research, use of the keywords in the research of the samples, identification of the journals with the largest number of articles published on the theme, to carry out the identification of the authors with the greatest number of publications, the chronology of production is lifted, so that the cycles of greater production are identified. Finally, the articles are selected for the composition of the "starting nucleus" for the bibliographic research to be carried out. The database used was Scopus Elsevier, accessed in January of 2018, through the Portal of Periodicals of Capes. Exclusion filters were not used so that the document range of the area found was larger. The search criterion were established for the purpose of broadening the publications on the eight financial methods chosen. Table 1 shows the results obtained in the research.

Table.1: Keywords

Method	Keywords	Results
Valor Presente Líquido – VPL	"Net" AND "Present" AND "Value"	17.187
Taxa Interna de Retorno – TIR	"Internal" AND "Rate" AND "of" AND "Return"	4.610
Índice de Lucratividade – IL	"Profitability" AND "Index"	2.797
Payback Simples	"Simple" AND "Payback"	769
Payback descontado	"Discounted" AND "Payback"	304
Taxa Mínima de Atratividade - TMA	"minimum" AND "attractiveness" AND "rate"	55
Fluxo de Caixa	"Cash" AND "Flow"	14.521
Retorno sobre Investimento – ROI	"Return" AND "on" AND "Investment"	35.152

IV. RESULTS AND DISCUSSION

In this stage, the documents were analysed and a sample of articles was designed for each of the eight methods, and of these samples, three will be presented in brief summary formats. These were considered by the

author as the most relevant on the topics, since they are the most cited according to the Scopus data base. Thus, using this nucleus, graphs are presented here containing these publications, insofar as it relates to the quantity of publications per year, which authors published on the topic, where are the origins of the articles, as well as their affiliations. The amounts of publications by country and by area are also shown, presenting those that are highlighted

4.1 Net Present Value – VPL

For this method, the words "Net" AND "Present" AND "Value" were used as search terms, returning a total of 17,187 results.

4.1.1 Year of publication

The data contained in figure 1, illustrated below, demonstrate through graphic the frequency between 2000-2018.

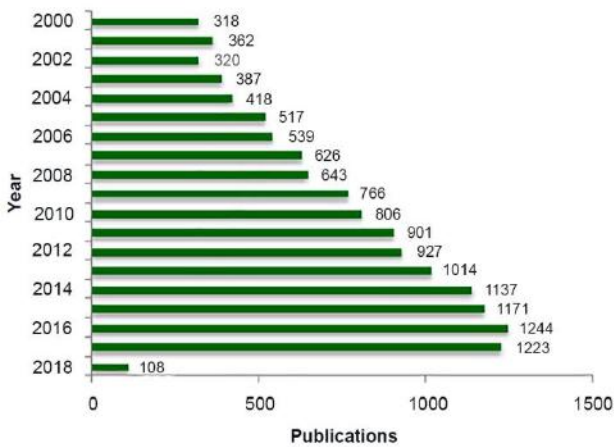


Figure 1 Graph of frequency of publications per year in the period 2000-2018

Source: Adapted from Scopus (2018).

It is possible to observe that, as of 2003, there was a progression in the publication values. The year 2017 is the one with the highest volume of publication, while the year 2018 presents 108 articles published until the date of the research.

4.1.2 Authors who published on the subject

The data contained in Figure 2, illustrated below, demonstrate through the graphic the authors with the highest frequency of publications per year in the period 2000-2018.

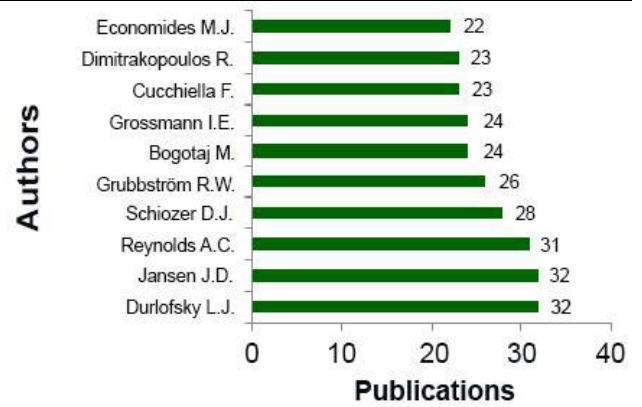


Figure 2 Graph of authors with higher frequency of publication

Source: Adapted from Scopus (2018)

It can be verified with the image that among the authors who publish more on the subject, stand out Durlofsky L.J. and Jansen J.D., with 32 publications.

4.1.3 Source of publication

The data contained in Figure 3, illustrated below, demonstrate through the graphic.

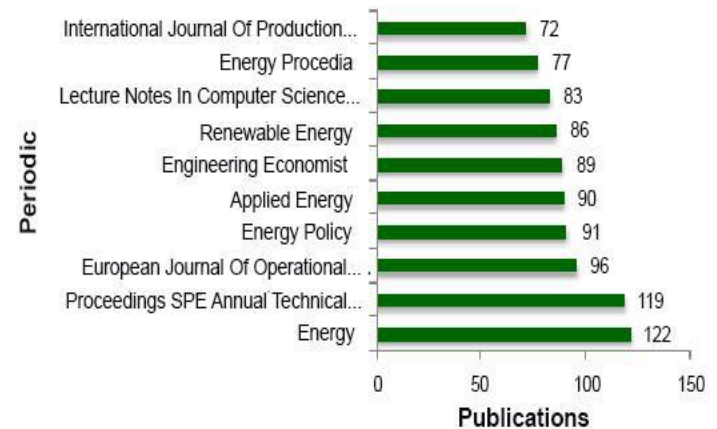


Figure 3 Graph of journals with higher frequency of publication

Source: Adapted from Scopus (2018)

4.1.4 Affiliation

The data contained in Figure 4, illustrated below, demonstrate the most frequently affiliated frequently published.

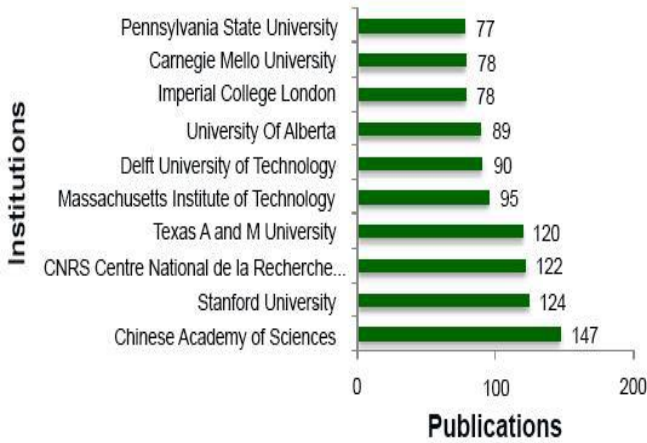


Figure 4 Graph of affiliations with higher frequency of publication

Source: Adapted from Scopus (2018)

4.1.5 Number of publication by country

The data contained in Figure 5, illustrated below, demonstrate the most frequently published countries through the graphic.

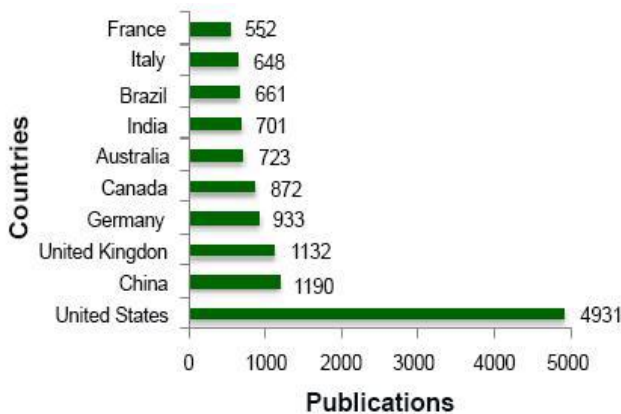


Figure 5 Graph of the countries with the highest frequency of publication

Source: Adapted from Scopus (2018)

As shown in the image, the United States continues to lead among the countries that publish on the financial method in question, with 4,931 publications, far above the others, such as China (1,190), United Kingdom (1,132) and Germany (933).

4.1.6 Number of publication by areas

The data contained in Figure 6, illustrated below, demonstrate through the graphic the areas of knowledge with the highest frequency of publication.

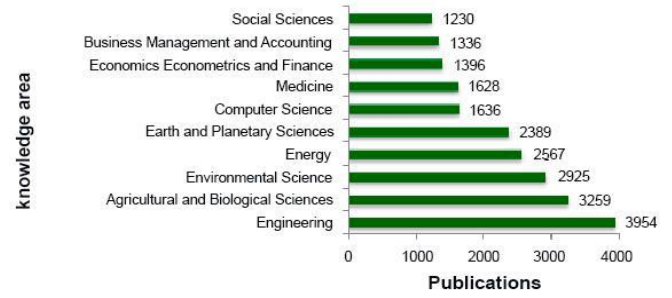


Figure 6 Graph of knowledge areas with the highest frequency of publication

Source: Adapted from Scopus (2018)

Among the areas that can be seen, we highlight Engineering, Agriculture and Biological Sciences and Environmental Sciences.

4.1.7 Analysis of articles

In Table 2 we present the articles selected as most relevant by the author, which were provided by the data base.

Table 2: Selected Articles for the Net Present Value Method - NPV

Title	Author	Year	Citations
<i>Managerial discretion and optimal financing policies</i>	STULZ, R.	1990	1105
<i>Valuation and clean surplus accounting for operating and financial activities</i>	FELTHAM G. A. et al.	1995	732
<i>The effects of management buyouts on operating performance and value</i>	KAPLAN, S.	1989	456
<i>On the welfare significance of national product in a dynamic economy</i>	WEITZMAN, M. L.	1976	365
<i>A real option approach to renewable electricity generation in the Philippines</i>	AGATON, C. B. et al.	2018	0

Source: Adapted from Scopus (2018)

Stulz (1990) examined the financing policies of a holding company owned by atomistic shareholders that did not observe cash flows or management investment decisions. It was observed that the administration receives investment benefits and invests as much as possible. Once the cash flow is very low, the author guides the financing of all projects net present positive value, thus, their claim will not be credible when cash outflow is really low. Consequently, management will be forced to invest very little when cash flow is low and should choose to invest more when it is high. Funding policies, by influencing resources under management's control, can reduce the costs of overinvestment.

Kaplan (1989) presented evidence of changes in operating results for a sample of 76 large management buyouts of public enterprises that were completed between 1980 and 1986. It was noted that in the three years following the purchase, these companies experienced increases in operating income (before depreciation) and a decrease in capital expenditures and increases in the cash flow. Thus, according to operational changes, the average increases in market value (adjusted for market returns) are 96% and 77% of the two months before the purchase announcement for the post-purchase sale. It has been noted that the evidence suggests that operational changes are due to improved incentives rather than layoffs or managerial exploitation of shareholders through inside information.

The authors evaluated the attractiveness of investing in renewable energy sources by continuing to use oil for electricity generation. The method used was the real options approach to analyze how the time of investment in renewable energy depends on the volatility of the price of diesel, the price of electricity and the externality for the use of oil. In their results, they presented a Net Present Value - NPV positive for investment in renewable energy. Under uncertainty in oil prices, dynamic optimization looks at how it expects or delays investment in renewable energy in losses. Reducing the local price of electricity and incorporating negative externalities favors investment in renewable energy over continued use of oil for electricity generation. They concluded that the real options approach emphasizes flexibility when making investment decisions. In the latest energy regime in the Philippines, replacing renewable energy is a better option than continuing to import oil for electricity generation. Politics should aim to support investment in maize-sustainable energy sources, imposing externalities for the use of oil or reducing the price of electricity (AGATON et al, 2018)

4.2 Internal Return Rate - IRR

Using the keywords "Internal" AND "Rate" AND "of" AND "Return", search done for publications on the

Internal Rate of Return (IRR) method returned 4,610 results, which were incorporated into the database for the analysis.

4.2.1 Year of publications

The data contained in Figure 7, illustrated below, demonstrate through the graphic the frequency of publications per year in the period 2000-2018.

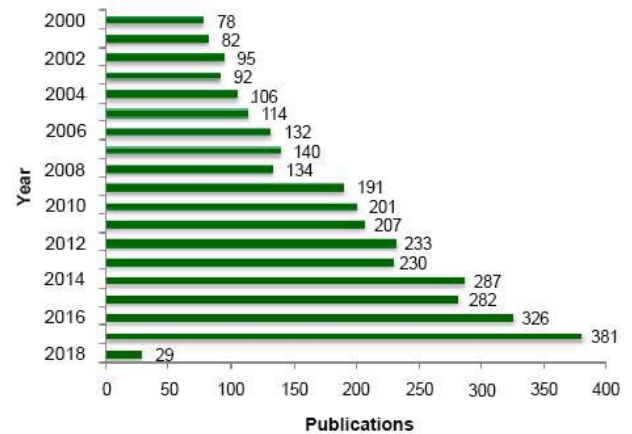


Figure 7 Graph of frequency of publications per year in the period 2000-2018.

Source: Adapted from Scopus (2018)

The same behaviour was observed previously, that is, the one with the greatest publication was 2017 and the year 2018 already presents 29 publications until the publication of this research.

4.2.2 Authors who published on the subject

The data contained in Figure 8, illustrated below, demonstrate through the graphic the authors with greater frequency of publication.

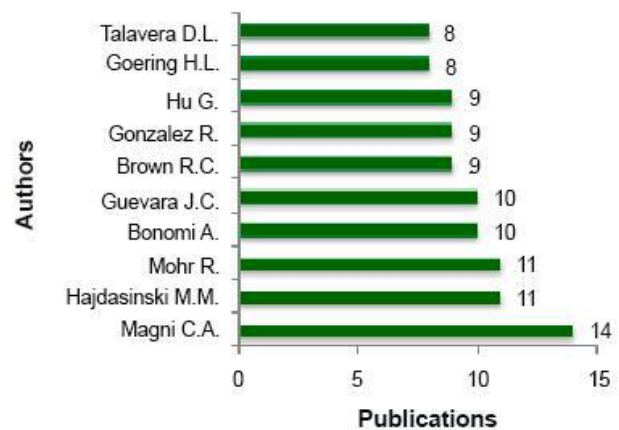


Figure 8: Graph of authors with higher frequency of publication.

Source: Adapted from Scopus (2018)

The data collected allow us to verify that, among the authors, we highlight Magni, CA with 14 articles

published, and Hajdasinski, MM and Mohr, R. with 11 publications each.

4.2.3 Source of publication

The data contained in Figure 9, illustrated below, demonstrate through THE GRAPHIC the periodicals with greater frequency of publication.

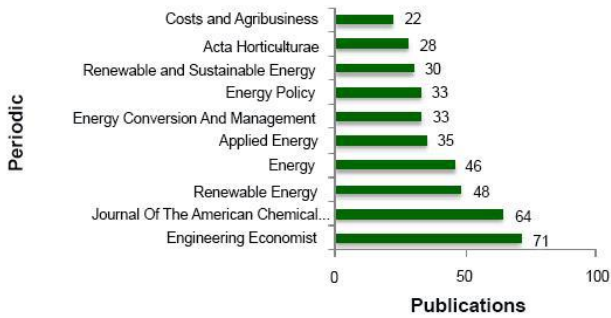


Figure 9: Graph of journals with higher frequency of publication

Source: Adapted from Scopus (2018)

In Figure 9, it is noticed that a Brazilian newspaper called Cost agrobusiness is among the list, however, it occupies the last position among the most published. The highlight is for the Engineering Economist, with 71 publications.

4.2.4 Affiliation

The data contained in Figure 10, illustrated below, demonstrate through the graphic the affiliations with the highest frequency of publication.

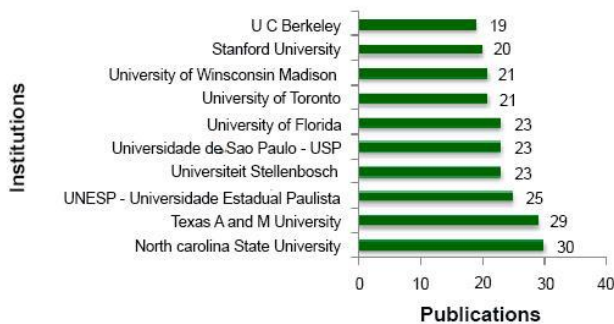


Figure 10. Graph of affiliations with higher frequency of publication

Source: Adapted from Scopus (2018)

It is possible to observe that there are two Brazilian universities in the list, being University of São Paulo (USP) with 23 publications and the State University of São Paulo (UNESP) with 25. However, the main ones are North Carolina State University with 30 publications and Texas A and M University with 29 published articles.

4.2.5 Number of publication by country

The data contained in Figure 11, illustrated below, show the most frequently published countries through the graphic.

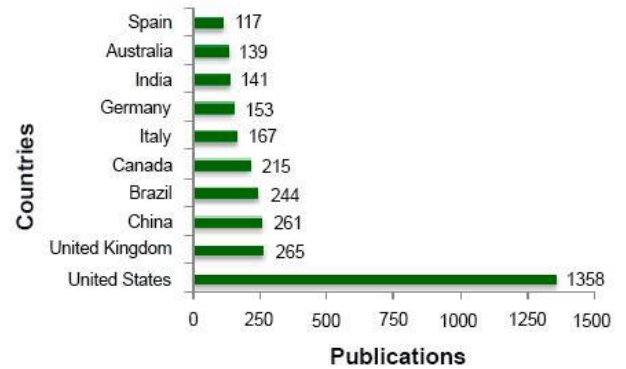


Figure 11: Graph of the countries with the highest frequency of publication

Source: Adapted from Scopus (2018)

The United States remains the leading among the other countries, common publication number well above all others, with 1,358 publications, while the second place (United Kingdom) has only 265 publications.

IV.2.6 Publication Number by Areas

The data contained in Figure 12, illustrated below, show the areas of knowledge with the highest frequency of publication through the graphic.

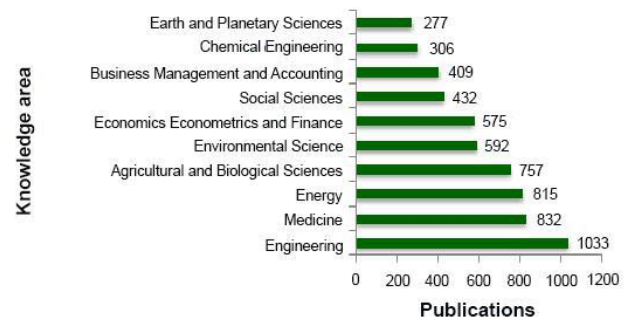


Figure 12: Graph of knowledge areas with the highest frequency of publication

Source: Adapted from Scopus (2018)

The publications were grouped in 10 knowledge areas, as shown in Figure 12. The Engineering stands out with 1,038 published articles, followed by Medicine, with 832 publications and Energy with 815.

4.2.7 Analysis of articles

In Table 3 we present the articles selected as most relevant by the author provided by the database.

Table.3: Selected Articles for the Internal Rate of Return (IRR) Method

Title	Author	Year	Citatio
-------	--------	------	---------

			ns
Combustion in swirling flows: A review	SYRED, N. et al.	1974	350
School subsidies for the poor: Evaluating the Mexican Progresa poverty program	SCHULTZ, T. P.	2004	316
Economic considerations and class size	KRUEGER, A. B.	2003	247
Migration incentives, migration types: the role of relative deprivation	STARK, O. et al.	1991	246
Some formal connections between economic values and yields and accounting numbers	PEASNELL, K. V.	1982	203

Source :Scopus (2018)

Schultz (2004) sought to evaluate how the Progress program, which offers low-income students in rural areas of Mexico, affected the number of enrolments made. Poor children residing in communities randomly selected to participate in the early phase of Progression compared to those residing in other (control) communities. The pre-program comparisons verify the design and the difference estimators of the double effect program effect on the treatment are calculated by grade and sex. Probit models are also estimated as to the probability of enrolment of a child, controlling the additional characteristics of the child, their parents, local schools and community, and the friction of the sample to assess the sensitivity of program estimates.

These estimates of the short-term effects of the program on enrolment are extrapolated to lifelong schooling and the gains of adults to approximate the internal rate of return on public school subsidies are likely to increase expected private salaries. A recent study found empirical evidence that the initial relative deprivation of families in their referenced village group plays a significant role in migration from Mexico to the US. Controlling the initial absolute income and expected income gains from migration, appropriation of households to participate of international migration was directly related to the relative deprivation of families. The rationale for the analysis is threefold. First, there is reason to expect that papal of relative deprivation is different between international migration and migration within a country, as explained below. Second, the sharp discontinuities in human capital returns between work of the country of origin and the host country may affect the

ability of families that differ in their human capital endowments to achieve income earning gains through international migration. Third, a relative deprivation approach to migration has important implications for developmental politics. In section I of the paper, they described the model of relative deprivation of migration and presented an illustration of the divergent political implications of a model of relative deprivation versus an absolute income model. In section II, a migration decision model is estimated and used to explore open and relative income motives for internal and international migration in a sample of rural Mexican households, as well as to test to what extent the labour market discontinuity shapes the choice of migrant destination. In Section III the conclusions were presented (STARK et al., 1991).

Peasnell (1982) presented a series of results concerning the relation between accounting and accounting values and income and economic values. Some of the results have appeared before in the literature and some are new. These were gathered together in a common analytical framework to demonstrate their formal and mathematical character. It is shown that the present value can be obtained by discounting almost all profit numbers; that the accounting rates of return define a discount function directly analogous to the structure of the term and the internal rate of return; and that the internal rate of return can be expressed as a linear sum weighted return rates.

4.3 Profitability Index – IIL

Con the keywords "Profitability" AND "Index", the search returned 2,797 newspapers. These data will be used for the analyzes shown below.

4.3.1 Year of publications

The data contained in Figure 13, shown below, demonstrate through the graphic the frequency of publications in the period 2000-2018.

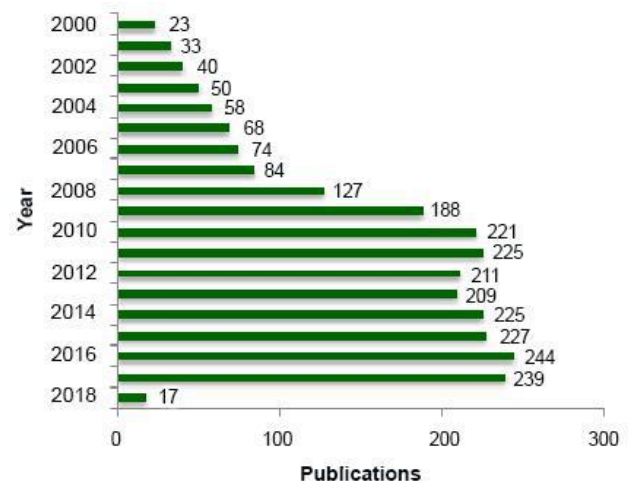


Figure 13. Graph of frequency of publications per year in the period 2000-2018

Source: Adapted from Scopus (2018)

It can be verified that from the year 2000 there was a gradual increase in the number of publications. However, the year 2016 presented a number of published articles greater than the year 2017, 244 and 239, respectively.

4.3.2 Authors who published on the subject

The data contained in Figure 14, illustrated below, demonstrate through the graphic the authors with the highest frequency of publication.

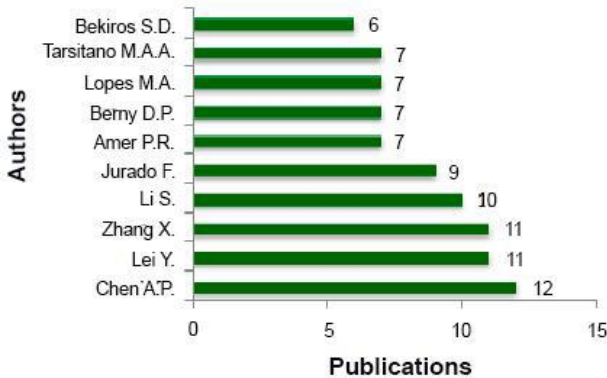


Figure 14. Graph of authors with higher frequency of publication

Source: Adapted from Scopus (2018)

According to the data presented in Figure 14, the most influential periodic in this theme is the Indian Journal of Agronomy with 31 publications, followed by the Expert Systems with Application, with 27, and Journal of Dairy Science, with 24

4.3.3 Membership

The data contained in Figure 15, illustrated below, demonstrate through the graph the most frequently published affiliations.

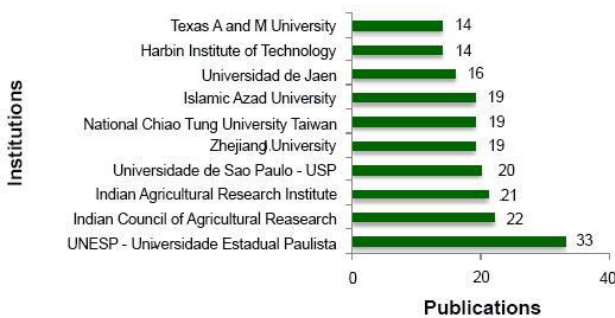


Figure 15: Graph of affiliations with higher frequency of publication

Source: Adapted from Scopus (2018)

A significant point of the data presented in Figure 15 is that the State University of São Paulo (UNESP) is the highlight among the institutions that study and publish on the Profitability Index (IL) method, after which two Indian institutions, the Indian Council of Agricultural Research and Indian Agricultural Research Institute.

4.3.4 Number of publication by country

The data contained in Figure 16, illustrated below, demonstrate through the graphic the countries with the highest frequency of publication.

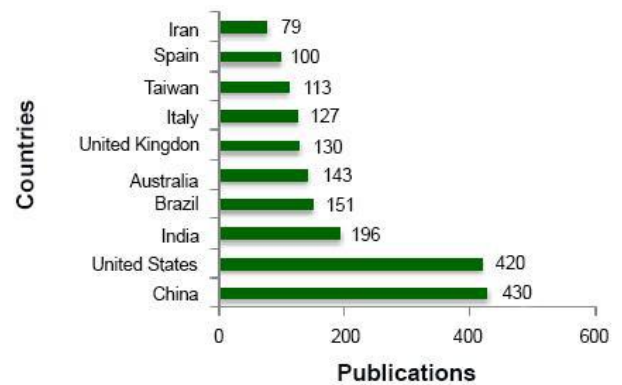


Figure 16. Chart of the most frequently published countries

Source: Adapted from Scopus (2018)

The data show that Brazil is once again among the leading countries provided by the database, fourth place after China (430), the United States (420), and China (430). India (196).

4.3.5 Publication Number by Areas

The data contained in Figure 17, illustrated below, demonstrate through the graphic the areas of knowledge with the highest frequency of publication

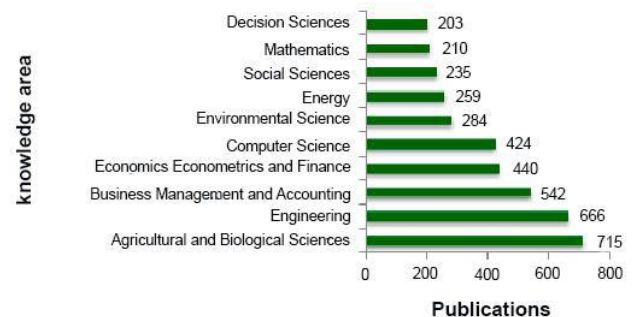


Figure 17. Graph of knowledge areas with the highest frequency of publication

Source: Adapted from Scopus (2018)

As can be analysed, the areas of knowledge that published the most were: Agriculture and Biological

Sciences with 715 publications, Engineering with 666 and Management and Accounting with 542.

4.3.6 Analysis of articles

In Table 4 are presented the articles selected as most relevant by the author provided by the database in the Lucratively - IL method.

Table.4: Selected Articles for the Profitability - IL Method

Title	Author	Year	Citations
<i>Customer satisfaction, productivity, and profitability: Differences between goods and services</i>	ANDERSON, E. W. et al.	1997	558
<i>The impact of culture and governance on corporate social reporting</i>	HANIFFA, R. M. et al.	2005	348
<i>Annual report readability, current earnings, and earnings persistence</i>	LI, F.	2008	294
<i>Associations between corporate characteristics and disclosure levels in annual reports: A meta-analysis</i>	AHMED, K. et al.	1999	264
<i>The determinants of voluntary financial disclosure by swiss listed companies</i>	RAFFOURNIER, B.	1995	237

Source: Adapted from Scopus (2018)

In order to investigate whether there are conditions of exchange between customer satisfaction and productivity, a school of thought is analysed that argues that customer satisfaction and productivity are compatible, since improvements in customer satisfaction can reduce time and effort to commit returns, rework, guarantees, and complaint management, while reducing the cost of making future transactions. Importantly, increasing customer satisfaction can increase costs as it often requires efforts to improve product attributes or product

design. A useful conceptual framework is developed to address these contradictory points of view. (Anderson, EW et al.) The model predicts that customer satisfaction and productivity are less likely to be compatible when: 1) customer satisfaction is relatively more dependent on personalization, the degree to which the company's supply is reliable, standardized and free from disabilities; and 2) when it is expensive to provide high levels of customization and standardization simultaneously. The central feature of this database is the set of customer satisfaction indexes provided by the Swedish Customer Satisfaction Barometer (SCSB). The SCSB provides a uniform set of comparable company performance measures based on the customer and provides a unique opportunity to test the hypotheses of the study. The findings indicate that the association between changes in customer satisfaction and changes in productivity is positive for goods but negative for services. In addition, while customer satisfaction and productivity are positively associated with ROI for goods and services, the interaction between the two is positive for goods but significantly less for services. Taken together, the results suggest support for the contention that compensation is most provable for services. Thus, concurrent attempts to increase customer satisfaction and productivity are likely to be more challenging in these industries. The findings should provide motivation for future research on the nature of customer satisfaction and productivity, as well as appropriate ethical strategies for each. (HANIFFA, R. M. ET AL.) It is worth noting that this is a problem that is not only important today but will certainly become even more important in the future. As service growth continues and global markets become increasingly competitive, the importance of customer satisfaction will also increase. In order to compete in such a world, companies must find the right balance between their efforts to compete efficiently and their efforts to compete competitively (Anderson et al., 1997) Since 1961, accounting researchers have investigated associations between corporate characteristics and disclosures in annual corporate reports. It was observed that the results consistently showed that company size and listing status were significantly associated with disclosure levels, while mixed results were found for leverage, profitability and size of the audit firm. The authors aimed to integrate previous disclosure studies and to identify the underlying factors that caused the apparent variation in results. (Anderson et al., 1997). The method used was the meta-analysis of 29 studies, so it was possible to confirm significant and positive relationships between levels of disclosure and corporate size, listing status and leverage. However, no significant associations were found between the corporate profitability or the size of the audit firm, with aggregate levels of disclosure. As a conclusion, this

study also found that, in addition to the sampling error, the results are driven by differences in the construction of the dissemination index, differences in the definition of the explanatory variables, and differences in search configurations (AHMED ET AL, 1999).

Raffournier (1995) aimed to relate the extent of disclosure in the annual reports of Swiss companies, in order to list the possible determinants that represent the political and agency costs. The object of the study was chosen because, prior to the implementation of the new company law on 1 July 1992, Switzerland's disclosure requirements were very low, so that most of the content of the annual report could be considered as voluntary disclosure. The sample included the 1991 annual report of 161 industrial and commercial companies. Where the extent of disclosure is measured by an index based on information the disclosure of which is required by the four and seventh directives of the European Union. Independent variables are measures of firm size, leverage, profitability, ownership structure, internationality, auditor size, percentage of fixed assets and type of industry. Relationships are evaluated using univariate analyses and multiple regressions. The main result is that size and internationality play an important role in the dissemination of companies, large and internationally diversified companies that tend to disclose more information than purely domestic companies. (RAFFOURNIER, 1995).

4.4 Simple Payback

For this method, periodic searches were performed using key words "Simple" AND "Payback", which ended up returning 769 results. With this information, different perspectives, such as the year of publications, most published authors, origin of publications, among others, will be analysed from this topic.

4.4.1 Year of publications

The data contained in Figure 18, illustrated below, demonstrate through the graphic the frequency of publications per year in the period 2000-2018

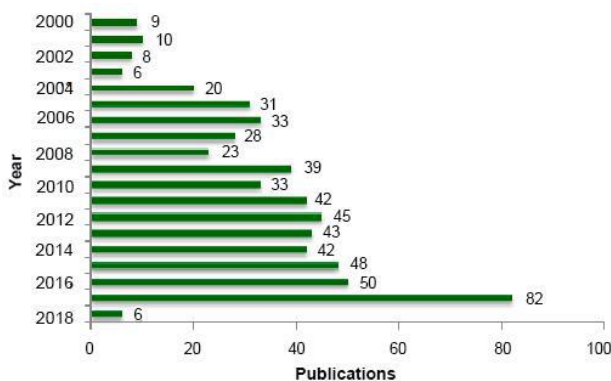


Figure 18. Graph of frequency of publications per year in the period 2000-2018

Source: Adapted from Scopus (2018)

It should be noted that there is a growing trend in publications. The largest anode publication was 2017, with 82 publications, and the year 2018 is already with 6 scientific works until the moment of the realization of this research

4.4.2 Authors who published on the subject

The data contained in Figure 19, illustrated below, demonstrate through the graphic the authors with the highest frequency of publication.

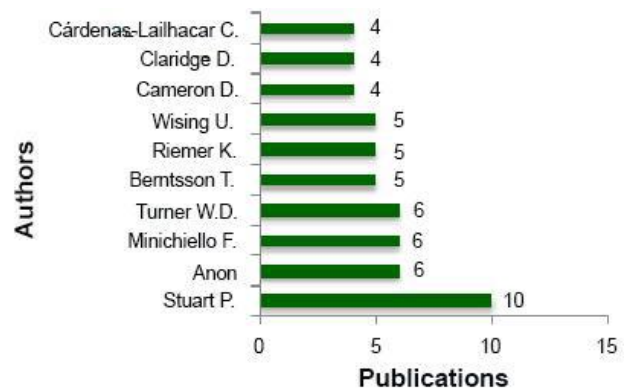


Figure 19: Graph of authors with higher frequency of publication

Source: Adapted from Scopus (2018)

It is already a great highlight for the writer Stuart P., who has 10 articles published, still 40% ahead of the second, third and fourth post that have only 6 publications each.

4.4.3 Source of publication

The data contained in Figure 20, illustrated below, demonstrate through the graphic the periodicals with the highest frequency of publication.

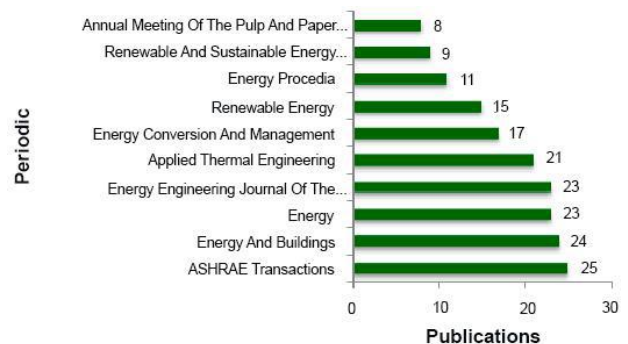


Figure 20. Graph of periodicals with higher frequency of publication

Source: Adapted from Scopus (2018)

The 10 most relevant journals provided by the database are shown in Figure 29. Most published was

ASHRAE Transaction (25), followed by Energy and Buildings (24).

4.4.4 Affiliation

The data contained in Figure 21, shown below, demonstrate through the graphic the affiliations with the highest frequency of publication.

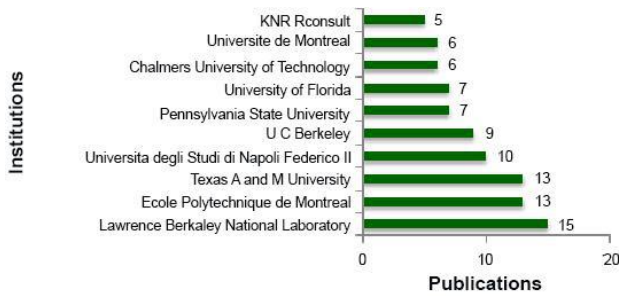


Figure 21. Graph of affiliations with higher frequency of publication

Source: Adapted from Scopus (2018)

The institution that most republished on this financial method was Lawrence Berkeley National Laboratory, with 15 scientific papers, followed by Ecole Polytechnique de Montreal, with 13 and Texas A and M University with the same number.

4.4.5 Number of publication by country

The data contained in Figure 22, illustrated below, demonstrate through the graphic the countries with the highest frequency of publication.

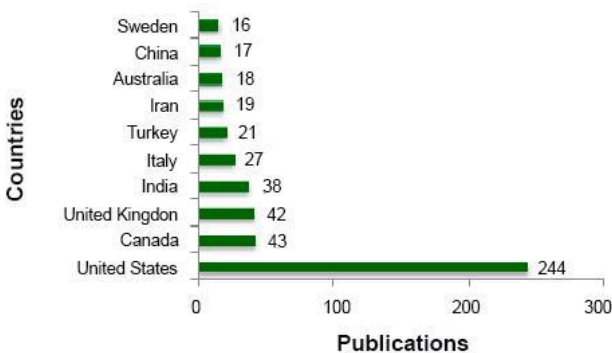


Figure 22. Graph of the countries with the highest frequency of publication

Source: Adapted from Scopus (2018)

The United States appears as absolute leader in the publications, responsible for 244 of them. In second place is Canada with 43 publications and third with 42.

4.4.6 Number of publications per area

The data contained in Figure 23, illustrated below, demonstrate through the graphic the areas of knowledge with the highest frequency of publication

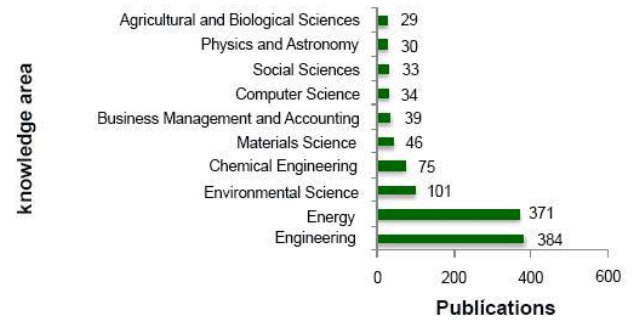


Figure 23. Graph of knowledge areas with the highest frequency of publication

Source: Adapted from Scopus (2018)

It can be noted, Figure 23, that the most published areas of knowledge were Engineering, with 384 publications and Energy with 371, well in front of the third place, Environmental Sciences, which had only 101 publications.

4.4.7 Analysis of articles

In Table 5 we present the articles selected as most relevant by the author provided by the database.

Table.5: Selected Articles for the Simple Payback Method

Title	Author	Year	Citations
Improved performance and stability in quantum dot solar cells through band alignment engineering	CHUANG et al.	2014	588
Simulink model for economic analysis and environmental impacts of a PV with diesel-battery system for remote villages	WIES et al.	2005	125
Cost of solar energy generated using PV panels	REHMAN et al.	2007	119
Dewatering of microalgal culture for biodiesel production: Exploring polymer flocculation and tangential flow filtration	DANQUAH et al.	2009	114
Intelligent speed adaptation: Accident savings and cost-benefit analysis	CARSTEN et al.	2005	109

Source: Scopus (2018)

Chuang et al. (2014) observed that the processing of solutions is promising for the realization of low cost, large areas, flexible and light photovoltaic devices with short and high power return time specific. But in contrast, solar cells based on generally reported organic, inorganic and hybrid materials suffered from low air stability, requiring an inert atmosphere processing environment or high temperature processing, which increases the complexities and manufacturing costs. According to Rehman et al. (2007), the manufacturing conditions low temperature and good atmospheric stability remains a great technical challenge, which can be approached, as demonstrated by the authors, with the development of ZnO / PbS quantum solar cells processed in ambient temperature solution. It was observed that by including the alignment of the quantum dots layers through the use of different ligand treatments, a certified efficiency of 8.55% was obtained. In addition, the performance of encapsulated devices remains unchanged for over 150 days of airborne storage. This material system introduces a new approach to the goal of stable high performance solar cells, compatible with simple solution and deposition processes on flexible substrates. Wies et al. (2005) sought to discuss the economic analysis and the environmental impacts of the integration of a Photovoltaic Matrix (PV) in energy systems diesel-electric to remote villages. Thus, MATLAB Simulink was used to combine the load with the demand and to distribute the electrical production between the PV and the diesel-electric generator. Since the economical part of the model calculates the fuel consumed, the kilowatt hour obtained per gallon of fuel supplied and the total cost of the fuel. The simulations were based on a real system in the Alaskan remote community of Lime Village were performed for three cases: 1) diesel only; 2) diesel battery; and 3) PV with diesel battery using a period of one year. The simulation results were used to calculate the energy return, the simple return time for the PV module and the avoided CO₂, NO_x and PM costs. The post-simulation analysis includes the comparison of the results with those expected by the Hybrid Optimization Model for Electric Renewable Energies (HOMER). The life cycle cost (LCC) and the air emissions results from the Simulink model were comparable to those predicted by HOMER. (WIES et al., 2005) Rehman et al. (2007) used the daily mean of solar radiation and data from the sun to study the distribution and solar duration over Saudi Arabia. The analysis also included the production of renewable energy and the economic evaluation of a power plant connected to the photovoltaic network of 5 MW installed for electricity generation. The study used the RetScreen software for energy production and economic evaluation. In their results, it was verified that global solar radiation varies between a minimum of 1.63 MWh /

m² year⁻¹ in Tabuk and a maximum of 2.56 MWh / m² year⁻¹ in Bisha, while the average remained as 2.06MWh / m² year⁻¹. The duration of sunlight ranged from 7.4 to 9.4 h with a mean of 8.89 h. It has also been found that the specific yield varies from 211.5 to 319.0 kWh / m², with a mean of 260.83 kWh / m². The renewable energy produced each year from the 5 MWp installed capacity plant ranged from 8196 to 12,360MWh while the average remained at 10,077 MWh / year⁻¹. Economic indicators, such as the internal rate of return, the simple recovery period, the positive cash flows, the net present value, the annual economy of the life cycle, the profitability index and the cost of producing renewable energy showed that Bishah was the best site for Power Plant Development based on PV and Tabuk the worst. From an environmental point of view, it has been found that approximately 8182 tonnes of greenhouse gases are prevented from entering the local atmosphere every year. (REHMAN et al., 2007)

4.5 Discounted Payback

For the performance of the searches related to the PaybackDescontado method, the keywords "Discounted" AND "Payback", return as data were used 304 results.

4.5.1 Year of publications

The data contained in Figure 24, illustrated below, demonstrate through the graphic the frequency of publications per year in the period 2000-2018.

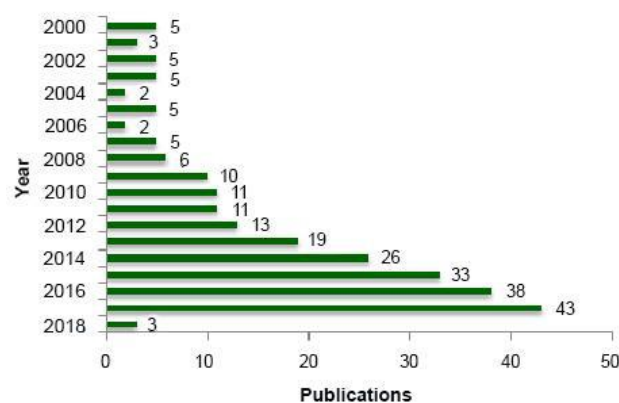


Figure 24. Graph of frequency of publications per year in the period from 200-2018

Source: Adapted from Scopos (2018).

Following the trend presented in the other methods already analyzed, the anode 2017 was the year that obtained the largest publication in the temporal cut, with 43 publications, followed by the year 2016 with 38. The year 2018 already presents published works (3) as can be seen in Figure 24.

4.5.2 Authors with higher frequency of publication.

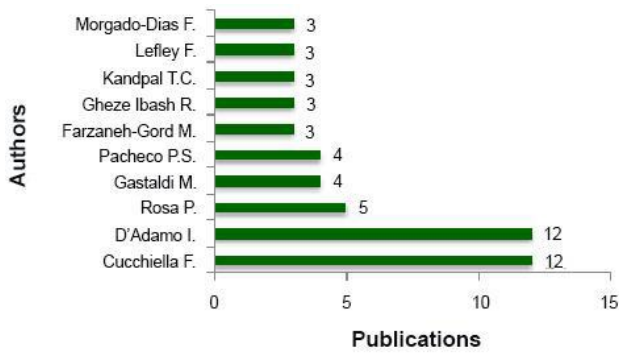


Figure 25: Graph of authors with higher frequency of publication

Source: Adapted from Scopus (2018))

Analyzing the main authors represented in Figure 25, it can be seen that Cucchiella, F. and D'Adamo, I. stand out among the others because they have more than two thirds of the list, Rosa, P., which presents only 5 published works on 12.

4.5.3 Source of publication

The data contained in Figure 26, illustrated below, demonstrate through the graphic the most frequently published periodicals.

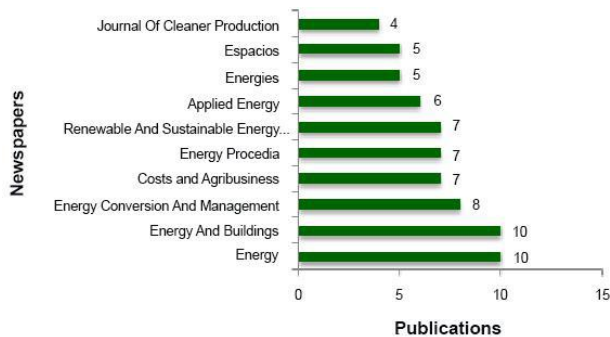


Figure 26: Graph of journals with higher frequency of publication

The main journals presented as a result of the energy-related research data are Energy, Energy and Buildings and Energy Conversation and Management.

4.5.4 Affiliation

The data contained in Figure 27, illustrated below, demonstrate through the graphic the affiliations with the highest frequency of publication

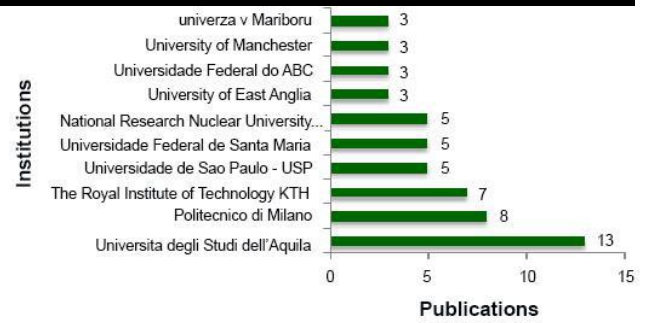


Figure 27: Graph of affiliations with higher frequency of publication

Source: Adapted from Scopus (2018)

Figure 27 shows the institutions most engaged in the publications, being first, with 13 publications, the University of Gli Studi dell'Aquila. An interesting fact is that the University of São Paulo (USP) is among the 10 most relevant with 5 published articles.

4.5.5 Number of publication by country

The data contained in Figure 28, shown below, demonstrate through the graphic to the countries with the highest frequency of publication.

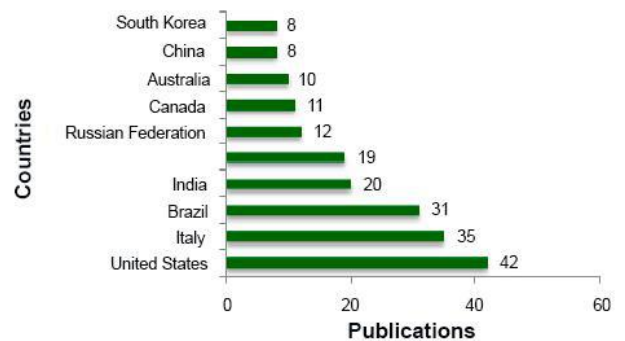


Figure 28: Graph of the countries with the highest frequency of publication

Source: Adapted from Scopus (2018)

Different from the pattern of most of the other methods investigated, in the discounted Payback method Brazil is in the list of the most influential countries, with 31 publications, being third only behind the United States, with 42 publications, and Italy with 31 publications.

4.5.6 Publication Number by Areas

The data contained in Figure 29, illustrated below, demonstrate through the graphic the areas of knowledge with the highest frequency of publication.

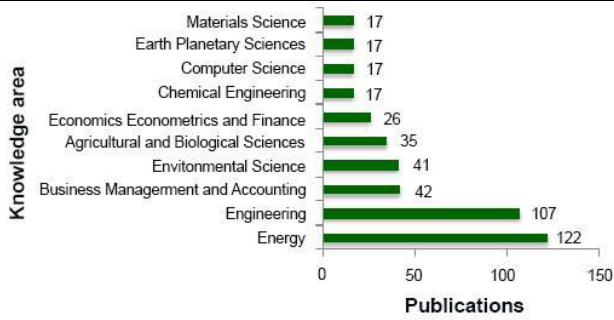


Figure 29: Graph of knowledge areas with the highest frequency of publication

Source: Adapted from Scopus (2018)

As in the previous method, in the analysis of the method of Payback Descanted the areas of knowledge that lead the list of the most relevant is the Energy with 122 and Engineering with 107 publications.

4.5.7 Analysis of the articles

In Table 6 are presented the articles selected as most relevant by the author supplied by the base.

Table.6: Articles selected for the Discounted Payback Method

Title	Author	Year	Citations
Methodology for the design optimisation and the economic analysis of grid-connected photovoltaic systems	KORNELAKIS et al.	2009	54
Algal biofuel production for fuels and feed in a 100-ha facility: A comprehensive techno-economic analysis and life cycle assessment	BEAL et al.	2015	49
Environmental and economic analysis of building integrated photovoltaic systems in Italian regions	CUCCHIELLA et al.	2015	38
Hybrid PV and solar-thermal systems for domestic heat	HERRANDO et al.	2016	36

and power provision in the UK: Techno-economic considerations			
Techno-economic analysis of solar photovoltaic power plant for garment zone of Jaipur city	CHANDEL et al.	2014	35

Source: Scopus (2018)

Kornelakis et al. (2009) presented a methodology for the optimization of the project and the economic analysis of systems connected to the photovoltaic network (PVGCSs). The purpose of this study was to suggest, from a list of commercially available system devices, the number and type of optimized system devices and optimum details of PV module installation details, so that the total net economic benefit achieved during the period operating system is maximized. The decision variables included in the optimization process were the ideal number and type of photovoltaic modules and DC / AC converters, the optimum angle of inclination of the photovoltaic modules, the ideal arrangement of the photovoltaic modules within the available installation area and the ideal distribution of the PV Modules between DC / AC converters. The economic viability of the resulting PVGCS configuration was exploited by the net present value, the return period of counted, and the internal rate of return methods. The proposed method was applied to the ideal design of a PVGCS interconnected to the electrical grid of an island with significant potential of solar irradiation. (KORNELAKIS ET AL. (2009) There are many factors that contribute to the definition of the economic and environmental performance of investments in solar energy, such as annual irradiation, consumer consumption, tariff incentive system, energy portfolio, emissions produced by photovoltaic system, nominal power of the modules modules, available income of the investor, availability of surface for the installation of photovoltaic panels and mission, which characterize the project (environmental maximization, economic maximization or self-sufficiency of the system during the first year) (KORNELAKIS ET AL Cucchiella et al. (2015) developed a study in Italy, taking into consideration and estimating the economic profitability and the environmental impact of these systems, first at the provincial scale and then at the regional scale, to delineate the general characteristics that were not caused by a single c Indicators used include the following: net present value (NPV), internal rate of return(IRR), discounted payback period (DPbP), aggregate cost-benefit ratio

(BCr), and carbon dioxide emission reduction (ERcd). The final objective of the work was to define the number of photovoltaic (PV) systems needed to achieve the objective of producing renewable energy in the above configurations. Where an appropriate overall scenario was examined to achieve the objective, as well as the implementation of the total wealth generated by this framework and the reduction of CO2 emissions resulting from the implementation of this plan. The indicators used were the net present value per capita and the reduction of per capita carbon dioxide emissions. (CUCCHIELLA ET AL., 2015) Herrando et al. (2016) analyzed the potential and cost-effectiveness of a photovoltaic solar power plant to meet the demand for energy from clothing in Jaipur, India. In addition to estimating the energy demand of garment zoning for 2011 (2.21 MW), and the 2.5 MW solar photovoltaic power plant project was proposed, which requires about 13.14 aces of area of land. Noting the shortage and the cost of land near the city, a proposal for the plant outside Jaipur was also considered and compared to the option in place. For the internal rate of return of the photovoltaic solar on-site network (IRR) was 11.88%, the discount rate of NPV 10% was INR 119.52 million, single return operation was 7.73 years and the discounted payback period 10% was 15.53 years, while the IRR of the off-site energy system was 15.10%, the NPV was 249.78 million INR, the simple payback period was 6, And the discounted payback period was 10.14 years. The energy cost is Rs. 14.94 and Rs. 11.40 per kW / h for solar photovoltaic plants in the off-site locale, respectively, discount rate of 10%, which is quite attractive. (HERRANDO ET AL., 2016).

4.6 Minimum Attractiveness Rate

The keywords "minimum" AND "attractiveness" AND "rate" are used in the search for this method, returning 55 results.

4.6.1 Year of publications

The data contained in Figure 30, illustrated below, demonstrate through the graphic the frequency of publications per year in the period 2004-2018.

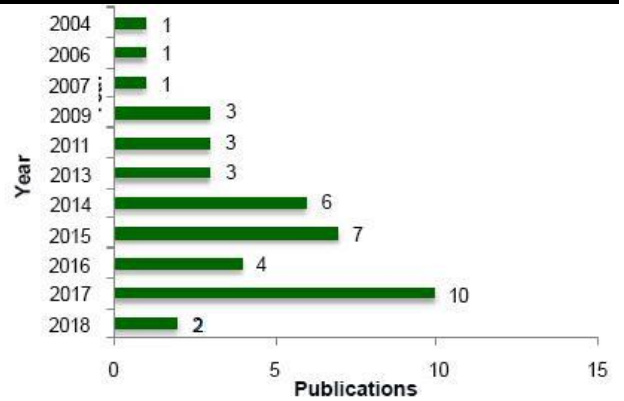


Figure 30: Graph of frequency of publications per year for the period 2004-2018

Source: Adapted from Scopus (2018)

As can be observed, the year of greatest publication, as expected, was 2017 with 10 articles, followed by 2015 with 7 publications.

4.6.2 Authors who published on the subject

The data contained in Figure 31, shown below, demonstrate through most frequently published authors.

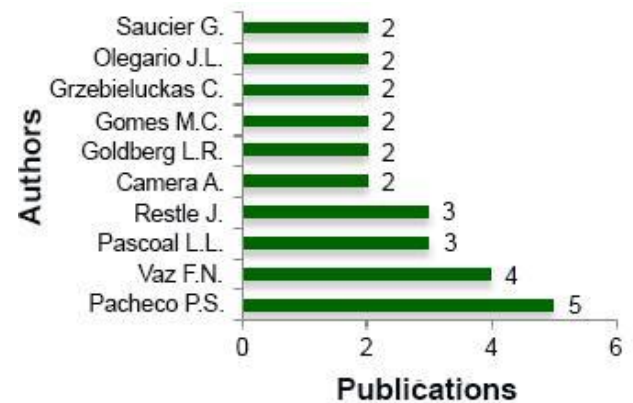


Figure 31: Graph of authors with higher frequency of publication

Source: Adapted from Scopus (2018))

Pacheco, P., with 5 articles, followed by Vaz, F. N., with 4 publications, Pacoal, L. L. with 3 papers and Restle, J, also with 3 papers.

4.6.3 Source of publication

The data contained in Figure 32, illustrated below, demonstrate through the graphic the periodicals with the highest frequency of publication.

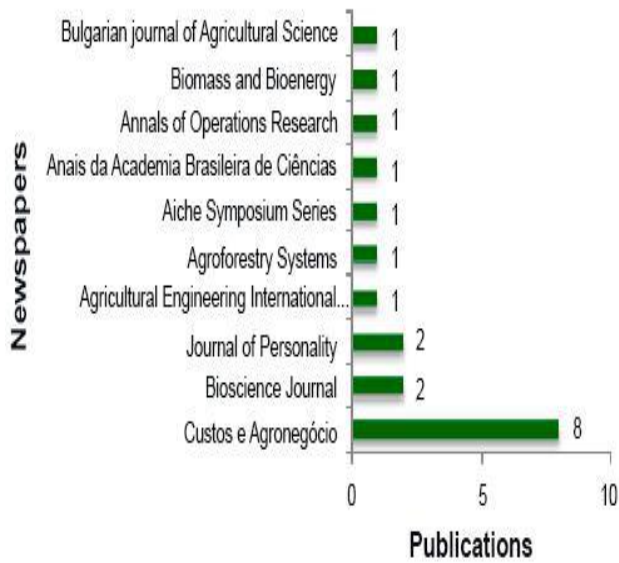


Figure 32: Graph of journals with higher frequency of publication

Source: Adapted from Scopus (2018)

Among the journals presented in Figure 32, two Brazilians stand out: Costs and Agribusiness, leading the list with 8 publications, and Annals of the Brazilian Academy with only 1.

4.6.4 Affiliation

The data contained in Figure 33, shown below, demonstrate through the graphic the affiliations most frequently published



Figure 33: Graph of affiliations with higher frequency of publication

Source: Adapted from Scopus (2018)

In terms of affiliation, Brazil again represents the majority of institutions that seek to study and publish on the topic, as can be seen in Figure 33.

4.6.5 Number of publication by country

The data contained in Figure 34, illustrated below, demonstrate through the countries with the highest frequency of publication.

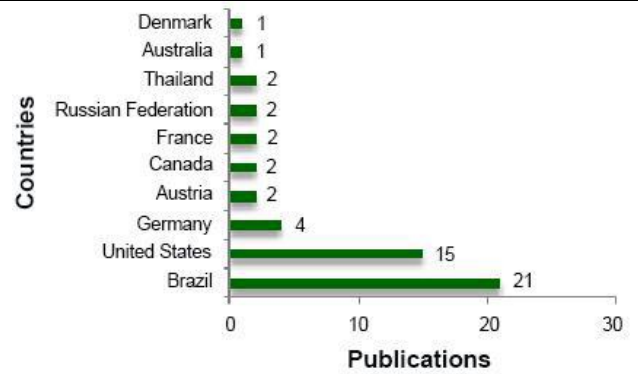


Figure 34: Graph of the countries with the highest frequency of publication

Source: Adapted from Scopus (2018)

Analyzing Figure 34, it is possible to identify that the United States ranks second, with 15 publications, followed by Germany with only.

4.6.6 Number of publication by areas

The data contained in Figure 35, shown below, the areas of knowledge with the highest frequency of publication.

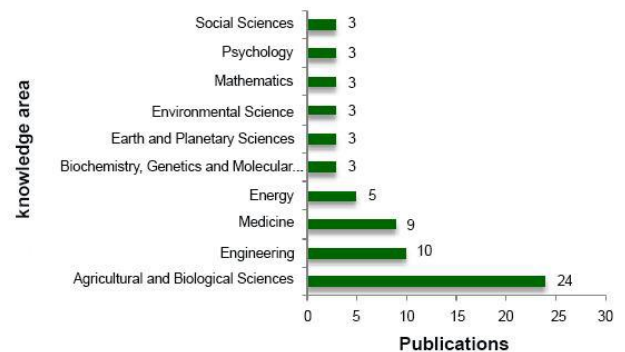


Figure 35: Graph of knowledge areas with the highest frequency of publication

Source: Adapted from Scopus (2018)

It should be noted that the main knowledge area returned by the research data was Agriculture and Social Sciences, with 24 publications, followed by Engineering with 10 and Medicine with.

4.6.7 Analysis of the articles

In Table 7 the selected articles are presented more pertinent to the theme of the Minimum Attractiveness Rate method, returning works from the authors provided by the base research.

Table.7: Selected Articles for the Minimum Attraction Rate Method

Title	Author	Year	Citations
<i>Electric energy production from swine deject: Analysis of financial feasibility with the use of monte carlo simulation for the implantation of bio-digester in Brazil</i>	CATAPAN et al.	2015	4
<i>Techno-economic assessment of a heat-integrated process for hydrogenated renewable diesel production from palm fatty acid distillate</i>	KANTAMA et al.	2015	3
<i>Methodology for the determination of optimum power of a Thermal Power Plant (TPP) by biogas from sanitary landfill</i>	SILVA et al.	2017	2
<i>Technical and economic study of a mobile system for extraction of eucalyptus essential oil</i>	VIVAN et al.	2011	2
<i>Stochastic processes and copula model applied in the economic evaluation for Brazilian oil fields projects</i>	MARQUES et al.	2014	1

Source: *Scopus* (2018)

Catapan et al. (2015) aimed to use the technical analysis of investments, to determine the break-even point, in number of animals, to allow the implantation of bio-digesters for the generation of electric energy with the use of swine projects. As methods, interviews were carried out with final owners, analysis of cost sheets and budget control with suppliers for the cash flow project. Then, the deviation indicators were calculated and the Monte Carlo simulation was done to measure the sensitivity of the input parameters. The results of the research pointed out that the balance point is 1009 pigs. Considering the premises of the Monte Carlo Simulation considering that p (Net Present Value <0) = p (Internal Rate of Return $<$ Minimum Attractiveness Tax) should be

a maximum of 0.20, it is suggested to implant bio-digester in properties with in at least 1075 pigs. Hydrogenated Diesel (HRD), which is defined as paraffinic hydrocarbon vegetable oil and animal fat, has received worldwide consideration with alternative diesel fuel. In this work, the production of DRH from palm oil fatty acid distillate (PFAD) was elaborated and a techno-economical evaluation of a heat integrated HRD production plantRD was attractive for investment with a VPN of 61.89 M \$ (KANTAMA et al., 2015). Silva et al. (2017) aimed at theoretically determining the electric power of LFG using the Maximum Net Benefit (MNB) methodology, taking into account the economic, demographic and regional aspects of the Inter-municipal Consortium of the Micro-region of Alto Sapucaí for Landfill (CIMASAS, as an acronym in Portuguese), located in the southern part of the state of Minas Gerais, Brazil. To this end, the prognosis for a 20-year period of household solid waste generation in this region has been estimated and quantified on the basis of population data in order to estimate LFG production and energy that can be generated. From this point, the ideal power for the power plant (TPP) by LFG was determined. The results indicated that the landfill in this region could produce 66,293,282 m³ of CH₄ (with a maximum power of 997 kW in 2036) in twenty years and that there would be no economic viability to generate energy from the LFG, since the Net Present Value (NPV) it would not be positive. The population for this can achieve a minimum attractiveness rate (MAR) of 15% of 3,700,000 inhabitants under the conditions studied. Considering the Resolutions of the National Electric Energy Agency (ANEEL), it would be 339,000 inhabitants installed 440 kW capacity. In addition, the result of the CIMASAS case study demonstrated the applicability of the MNB methodology for determining the potency of TPP

4.7 Cash Flow

For the researches carried out on this method, the key words "Cash" AND "Flow" were used, which returned which formed the basis of data for the analyzes on this topic.

4.7.1 Year of the publications.

The data contained in Figure 36, illustrated below, demonstrate through graphic the frequency of publications per year in the 2000-2018.

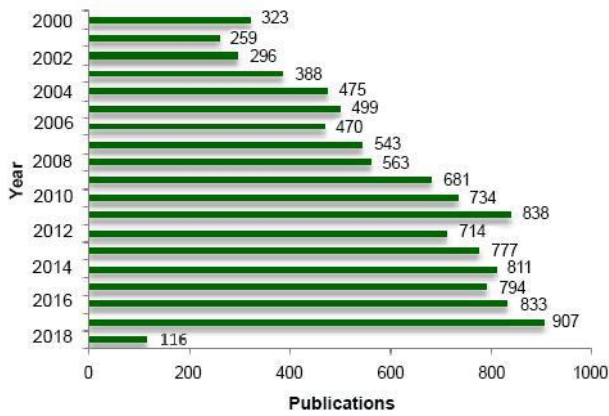


Figure 36: Graph of frequency of publications per year in the period 2000-2018

Source: Adapted from Scopus (2018)

Again, as can be seen in Figure 36, the year 2017 follows as the highest number of publications made, 907, followed by the year 211 with 838 publications. Although between the years 2001 and 2011 there has been an exponential decline of publications in this area, there was some stability from 2012, with reduced growth.

4.7.2 Authors who published on the subject

The data contained in Figure 37, illustrated below, demonstrate through the graphic the authors with the highest frequency of publication.

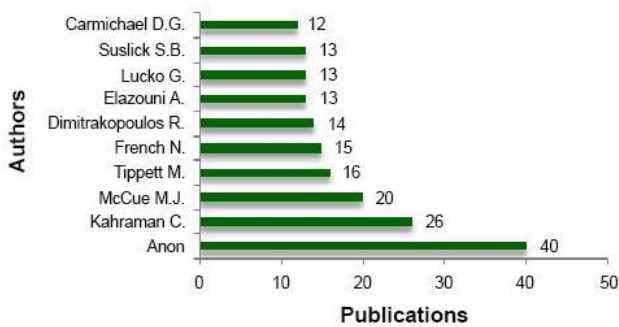


Figure 37: Graph of authors with higher frequency of publication

Source: Adapted from Scopus (2018)

In this methods the data returned a large number of works published the identification of the author, that is, anonymous publications. These represent a major part of the results, followed by Kahraman C. and McCue M.J., with 26 and 20 publications, respectively.

4.7.3 Source of Publication

The data contained in Figure 38, shown below, demonstrate through the graphic the most frequently published.

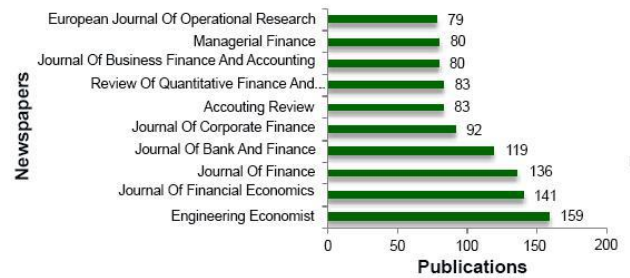


Figure 38: Graph of periodicals with higher frequency of publication

Source: Adapted from Scopus (2018)

Among the journals presented in Figure 38, the following stand out: Engineering Economist, Journal of Financial Economics and Journal of Finance, with 159, 141 and 136 published works, respectively.

4.7.4 Affiliation

The data contained in Figure 39, illustrated below, demonstrate through the graphic the affiliations with greater frequency of publication

New York University was the institution that most published about the method, resulting in 108 articles published.

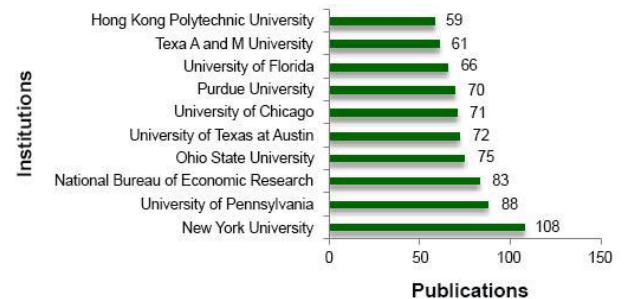


Figure 39: Graph of affiliations with higher frequency of publication

Source: Adapted from Scopus (2018)

4.7.5 Number of publication by country

The data contained in Figure 40, illustrated below, demonstrate through the graphic the countries with the highest frequency of publication.

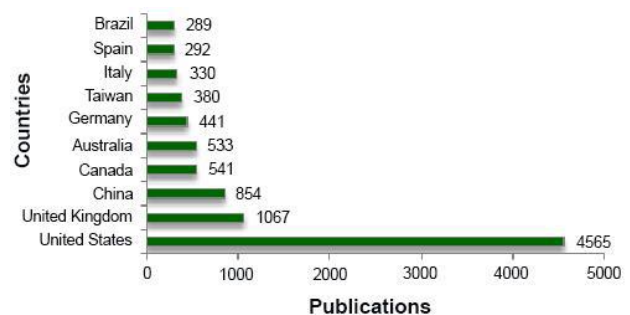


Figure 40: Graph of the countries with the highest frequency of publication

Source: Adapted from Scopus (2018)

The United States has more publication than the sum of the other Dalista countries, with 4,565. Brazil ranks tenth in the list of the most relevant countries, with 289 publications.

4.7.6 Publication Number by Areas

The data contained in Figure 41, shown below, demonstrate through the graphic the areas of knowledge with the highest frequency of publication.

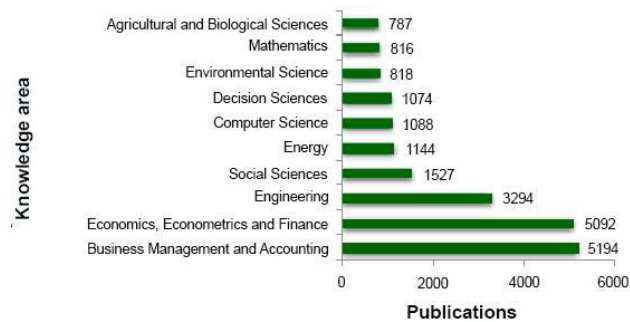


Figure 41: Graph of knowledge areas with the highest frequency of publication

Source: Adapted from Scopus (2018)

As can be seen in Figure 41, the most relevant publications related to the areas of Business, Management and Accounting, with 5,194 publications, and Economics Econometrics and Finance, with 5,092 published works.

4.7.7 Analysis of articles

The selected articles are presented in Table 8 as more relevant by the author provided by the basis for the Cash Flow method.

Table.8: Selected Articles for the Cash Flow Method

Title	Author	Year	Citations
Economic analysis of different supporting policies for the production of electrical energy by solar photovoltaics in western European Union countries	DUSONCHET et al.	2010	93
Techno-economic analysis of a wind-solar hybrid renewable energy	CHONG et al.	2011	91

system with rainwater collection feature for urban high-rise application			
Economic analysis of power generation from parabolic trough solar thermal plants for the Mediterranean region-A case study for the island of Cyprus	PULLIKKAS, A.	2009	83
Technical feasibility and financial analysis of hybrid wind-photovoltaic system with hydrogen storage for Cooma	SHAKYA et al.	2005	77
Optimization of photovoltaic penetration in distribution systems considering annual duration curve of solar irradiation	LIN et al.	2012	57

Source: Adapted from Scopus (2018)

Within several renewable energy technologies, photovoltaic (PV) energy today attracts considerable attention because of its potential to contribute a large share of renewable energy in the future. However, photovoltaic market development is undoubtedly dependent on the political support of any country. Dusonchet et al. (2010), after a brief analysis of the national PV support policies in the countries of the Western European Union (EU), carry out an economic analysis of the main support mechanisms implemented in the same countries, based on the calculation of the cash flow, (NPV) and the Internal Rate of Return (IRR). The analysis showed that in some situations support policies may be inconvenient for the owner of the PV-based generation system and that in many cases the differences between the implementation of the same policy in different countries can give rise to significantly different results. The analysis performed in this work could help in assessing the impact of photovoltaic energy policies in different member states of Western Europe, renewable

energy companies to identify potential photovoltaic markets and investigate the political landscape in Western EU countries. In the work of Pullikkas (2009), a study feasibility study was carried out to investigate whether the installation of parabolic solar thermal energy generation technology in the Mediterranean region is economically viable. The case study took into account the available solar potential for Cyprus, as well as all available data on the current Cyprus renewable energy policy, including the relevant feed-in tariff. In order to identify the least cost feasible option for the parabolic solar thermal plant, a parametric cost-benefit analysis was carried out through variable parameters, such as parabolic capacity through solar thermal energy, parabolic investment through solar thermal energy, hour operation, system price of carbon dioxide emissions trading, etc. For all of the above cases, the cost of the unit of electricity was estimated before taxes, as well as the cash flow, net present value, internal return rate and return period. The results indicated that, under certain conditions, these projects may be profitable

The penetration level of a photovoltaic (PV) system is often limited due to the violation of the voltage variation introduced by the large generation of intermittent power. Lin et al. (2012) discussed the use of an active energy reduction strategy to reduce the injection of photovoltaic energy during peak solar irradiation to avoid strain violation so that the PV penetration level of a distribution feeder can be increased to use fully to solar energy. The generation of photovoltaic energy was simulated according to the hourly data of solar irradiation and temperature provided by the meteorological agency.

By using the voltage control scheme proposed to limit the injection of photovoltaic energy into the study distribution feeder during periods of high solar irradiation, the total energy generation and the total energy delivered by the photovoltaic system over a period of one year are determined according to the annual solar radiation. The annual cash flow from sales of photovoltaic energy, the O & Mao cost over the life cycle of the system and the capital investment in the photovoltaic system were used to calculate the PV project's amortization years and net present value (NPV). With the voltage control proposed to execute partial generation of photovoltaic systems, the ideal installation capacity of photovoltaic systems could be determined by maximizing the net present value of the system so that a better cost-effectiveness of the PV project and a better energy utilization could be obtained

4.8 Return on the Investment – ROI

A research on the periodicals related to the Return on Investment method - ROI, used the set of keywords or key terms "Return" AND "on" AND "Investment", reaching 35,152 results.

4.8.1 Year of publications

The data contained in Figure 42, illustrated below, demonstrate through the graphic the frequency of publications per year in the period 2000-2018.

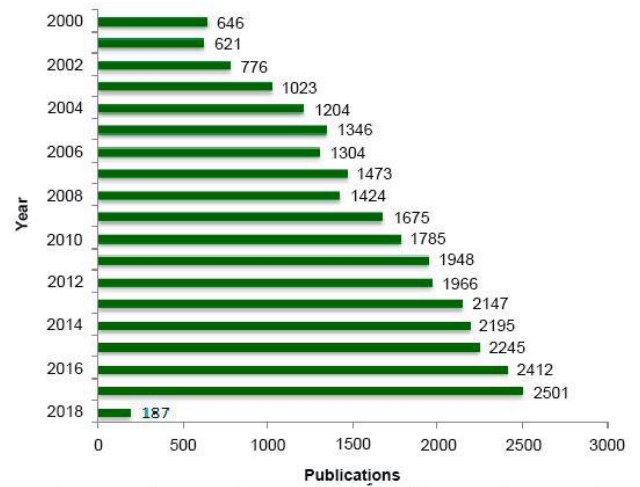


Figure 42: Graph of frequency of publications per year in the period 2000-2018

Source: Adapted from Scopus (2018)

As in the previous method, there is a gradual increase in the volume of publications over the years 2000 to 2018. The year that had less publications was 2001, and the one that had the most publications was 2017, 2018 presented 187 articles published until the current date of this search.

4.8.2 Authors who published on the topic

The data contained in Figure 43, illustrated below, demonstrate through the graphic the authors with the highest frequency of publication.

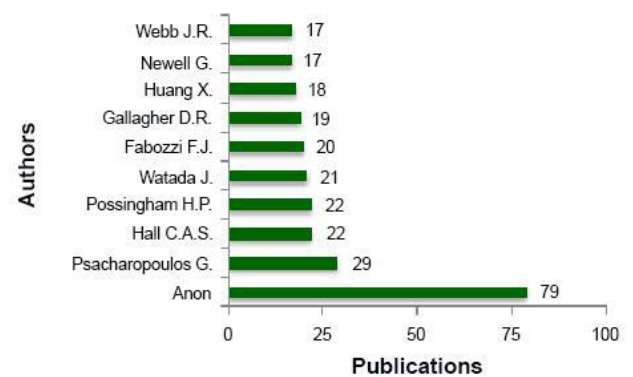


Figure 43: Graph of authors with higher frequency of publication

Source: Adapted from Scopus (2018)

In Figure 43 the most relevant authors given by the Scopus database are not found, of which 79 publications are by anonymous authors.

The identified author who most publishes is Psacharoulos G., with 29 publications, followed by Hall C. A. S.com 22.

4.8.3 Source of publication

The data contained in Figure 44, illustrated below, demonstrate through the graphic the periodicals with the highest frequency of publication

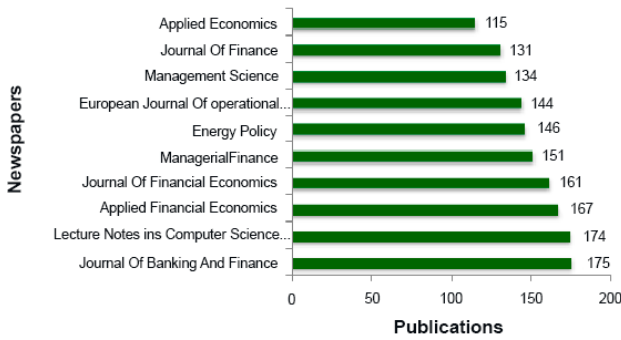


Figure 44: Graph of journals with higher frequency of publication

Source: Adapted from Scopus (2018)

The most relevant journals in the publication of this method in question, as can be seen in Figure 44, are the Journal of Banking and Finance and the Lecture Notes in Computer Science Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics.

4.8.4 Affiliation

The data contained in Figure 45, illustrated below, demonstrate through the graphic the affiliations with the highest frequency of publication.

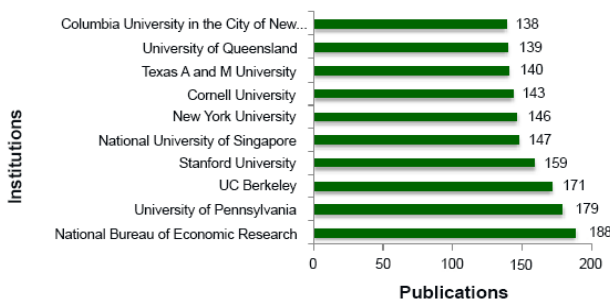


Figure 45: Graph of affiliations with higher frequency of publication

Source: Adapted from Scopus (2018)

Result, it can be seen in Figure 45 that the National Bureau of Economic Research has 188 publications, the University of Pennsylvania has 179 and UC Berkeley has 171 articles published.

4.8.5 Country publication number

The data contained in Figure 46, illustrated below, demonstrate through graphic the countries with the highest frequency of publication.

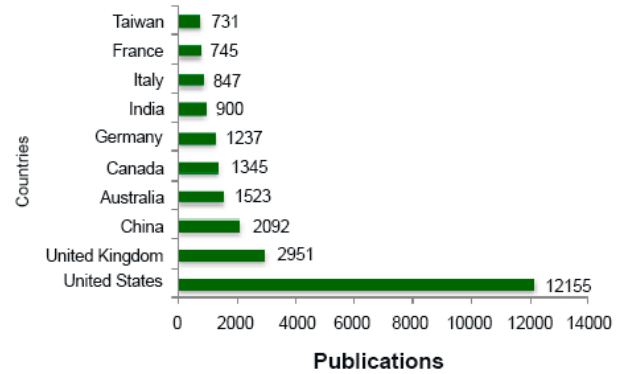


Figure 46: Graph of the countries with the highest frequency of publication

Source: Adapted from Scopus (2018)

As can be seen, the United States leads the list of countries with 12,155 published articles, followed by the United Kingdom (2,951), China (2,092), Australia (1,523) and Canada (1,345).

4.8.6 Number of publication by areas

The data contained in Figure 47, illustrated below, demonstrate through the graphic the areas of knowledge with the highest frequency of publication.

It is possible to analyze, through Figure 47, that the Economy, Econometrics and Finance area has the largest number of publications, with 9,468. In second place, we have Administration and Accounting, with 8,267 published in Engineering, with 7,645 publications.

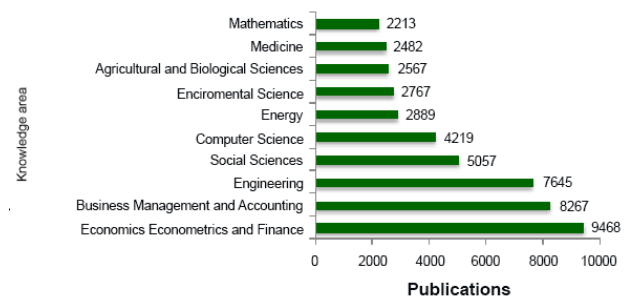


Figure 47: Graph of knowledge areas with the highest frequency of publication

Source: Adapted from Scopus (2018)

4.8.7 Analysis of articles

The table 9 presents the articles selected as most relevant by the author provided by the database.

Table.9: Selected Articles for the Return on Investment
Method - ROI

Title	Author	Year	Citations
<i>On persistence in mutual fund performance</i>	CARHART, M. M.	1997	3677
<i>The worldwide leaf economics spectrum</i>	WRIGHT, I. J. et al.	2004	2815
<i>Investor psychology and security market under and overreactions</i>	DANIEL, K. et al.	1998	1541
<i>On estimating the expected return on the market: An exploratory investigation</i>	MERTON, R. C.	1980	1014
<i>Open source software and the "private-collective" innovation model: Issues for organization science</i>	VON HIPPEL, E. et al.	2003	1012

Source: Adapted from Scopus (2018)

Carhart (1997) using a "bias-free" sample demonstrated that common factors in stock returns and investment expenditures almost completely explain persistence in average equity investment funds risk-adjusted returns. The result was mainly driven by the one-year impulse effect, however, it was noted that individual funds do not earn higher returns by following the momentary stock strategy. Since it indicates significant unexplained persistence, it is concentrated on an underperformance by the worst return investment funds. The results do not support the existence of qualified or informed mutual fund portfolio managers. The authors propose a market theory of exaggerated bonds and reactions based on two well-known psychological defects investor on the accuracy of private information and self-attribution tendentious, which causes asymmetric changes in investor confidence as a result of investment results. In their results, they showed that the excess confidence implies long-term negative correlations, excessive volatility, and when managerial actions are correlated with stock mispricing, return perceptibility based on public events. They concluded that biased self-attribution adds self-correlations to short-term positive short-term drift gains, but a negative correlation between future returns and long-term and stock market performance. In addition, the theory also offers several implications and untested implications for corporate financial policy (DANIEL et al., 1998).

The author believes that the expected return on the market is a number often needed to solve many investment and corporate finance problems, but compared to other financial variables, there has been little research

into estimating this expected return. Thus, current practice to estimate the expected market return adds the historical average of market responses at the current observed interest rate. However, even if this model explicitly reflects the dependence of market returns on interest rates, it does not account for the effect of changes in the level of market risk. With this, the author analyzed three equilibrium models that expected market returns that reflect this dependence. The estimation procedures that incorporate the restriction that the exaggerated equilibrium returns in the market are positive are derived and applied to the return data for the period 1966-1978. The main conclusions of this exploratory investigation are: (1) in estimating expected market returns, the non-negativity constraint of the expected return must be explicitly included as part of the specification: (2) estimators using returns must be adjusted for heteroskedasticity (MERTON, 1980)

V. CONCLUSIONS

This study was able to achieve the proposed goal by presenting a bibliometric study on eight financial methods that can be applied to economic viability in voltaic plates: IL; ROI, IRR, TMA, NPV, Payback (simple and discounted) and cash flow. Emphasis was given to the authors who study the subject, journals with the largest number of publications, countries and institutions that return their studies on the methods and routes of publications used and the areas of concentration that have a greater focus, which are presented in graphic form in this job.

With the large volume of results offered by the database, it is noted that the study of financial methods is of great interest, both globally and globally. These have a very great applicability, in several areas such as agriculture, education, medicine, biology, economics, among others. Thus, it can be said that it is of the utmost importance to continue the study of these methods applied to economic viability to aggregate the area of renewable energies, since sustainability and the use of renewable energies are of great interest to society. The bibliometric study model used in this work is the one proposed by Costa (2010), since it guides a researcher who does not have contact with the area, since he finds, in a single article, a selection of relevant scientific works on a certain theme. It is worth noting that the values defined for the time cut from year 2000 to year 2018, the 10 most relevant for each topic (authors countries, institution, type of publication, knowledge area) and selection of articles were author's choice and not a rule that must always be followed. A standard observed for all methods was the increase in the number of graduated publications over the years, a trend that demonstrates the increase in interest in

financial methods, which makes us believe that the topic is quite relevant and which has much to explore.

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Leadership Styles among Genders of Retail Managers

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Abstract—Themes that affect leadership have long aroused the interest of the academic community, especially regarding the categorization of the diverse forms of exercising this position and the impacts of these differences on the organizational environment. In this perspective, the interfering elements in the formation of the leader's style profile are also relevant, as the workforce is increasingly heterogeneous in terms of race, ethnicity, gender and other culturally diverse groups. However, segmentation of leadership styles is still observed exclusively by gender, which may give rise to spaces for the practice of prejudices and discrimination. In view of this, this work aims to identify the significant differences of styles of leadership between genders in the retail trade. To do so, a quantitative approach was carried out with a sample of 100 managers, male and female, self-reported by the participants, using the MLQ questionnaire from Bass, corroborated widely in several countries and populations. Data were treated using descriptive frequency statistics, as well as the Cronbach Alpha tests for reliability analysis, Confirmatory Factor Analysis for validity, and the T-Test for independent samples. The results indicate that the female gender has greater presence of the transformational leadership trait and the additional factors (extra effort, efficacy and satisfaction); and the transactional leadership styles and Laissez-Faire did not present significant difference of presence between the genders. Finally, this research demonstrates that there is evidence that scale is appropriate for different organizational cultures.

Keywords—Leadership Style, Genre, Transactional Leadership, Transformational Leadership.

I. INTRODUCTION

Organizational continuity depends on a variety of procedural, organizational, and economic factors, such as planning appropriate to organizational characteristics and efficient internal procedures. However, among the various economic and organizational factors for which every institution should be on the road to success, leadership is one of the key factors for organizational development (Northouse, 2010).

In addition, the leader is the figure within the organization that seeks to motivate and positively influence the organization's employees so that, together, they can achieve a future that is collectively coveted (Bass, 1990; Northouse, 2010). Therefore, "leaders are needed in all areas and at all levels to guide, build teamwork and inspire people to do their best" (Adair, 2003: 11).

Researchers have presented studies and theories in the face of the constant challenge of understanding leadership practices in organizations (Burns, 1978; Bass, 1990; Yukl, 2002; Bass & Avolio, 1991; Avolio & Bass, 2004; Khanin, 2007; Rezende, Carvalho Neto, & Tanure, 2014). By researching these practices, taking as a premise the triad leader, lead and organization, it becomes possible to understand the concept of leadership. In addition, we have studied the gender theme (Scott, 1989; Borges-Andrade & Pilati, 2001; Giddens, 2005), as well as

leadership and gender (Bass,1996; Hanashiro et. al, 2005; Cappelle et al., 2006; Carvalho Neto et al., 2010; Kanan, 2010; Santos & Antunes, 2011; Bastos, 2013).

There are significant studies on gender leadership, whereby some authors have inferred that women are provoking a considerable and considerable influence as a workforce in organizations. Consequently, the cadre of female employees in organizations, especially in leadership positions, is growing. However, these women still present low insertion in positions considered strategic in large organizations (Oikawa, Almeida, & Durigon, 2018).

According to the National Household Sample Survey in 2015, 63% of the management and management positions were occupied by men out of a population of 4.7 million professionals (IBGE, 2015). Noting that the highest-ranking positions in the business are mostly occupied by male leaders, as well as the difficulties encountered by women in taking strategic positions in organizations. It was decided to check the following question: what are the differences in leadership styles between the genders, at the management level, in the management of organizations, specifically in the retail trade of accessories, footwear and clothing located in Porto Velho? Thus, this study set out to identify the significant differences of styles of leadership between genders in the retail.

Although studies on the relationship between leadership and gender remain, this article applies to the business context of the retail trade of accessories, footwear and clothing, as well as to include people with cultures different from those contemplated in the most recurrent studies, since the locus chosen is the Amazon region. In this sense, according to Raptopoulos (2017), the perceived link between constructs and leadership styles is sensitive to economic contexts and the occurrence of crises. Thus, these relations can be observed under several parameters of analysis, so that the constructs already evaluated under the international context, for example, can not be summarily admitted to the Brazilian reality. From this perspective it is pointed out that the present research proposes to contribute with the scientific production as it observes population of its own social and cultural context.

For that, a research was conducted with a quantitative approach with a sample of 100 managers, contemplating the feminine and masculine genera. It is emphasized that when the authors use the terms man and woman in this work, they will be reporting, respectively, the masculine and feminine gender. This work is divided into five sections. This section is dedicated to the introduction that contextualizes the theme of the research, then exposing the problem investigated, the purpose and structure of the study. In the second section it

contemplates the theoretical foundation of the theme. The third section presents the methodological treatments of the research. Therefore, explain the results and the discussions. Finally, the conclusions are set out.

II. THEORETICAL REVIEW

This compartment identifies the conceptual parameters that define leadership themes, as well as the concepts of transactional, transformational and laissez-faire leadership, as well as the definition of leadership and gender as a social conception and the art of leading people.

Burns (1978) points to the process of leadership as the performance of leaders by driving followers along the path of daily action; here they enter variables such as the attempts, the goals that represent the values and the motivations, the needs, pretensions and the perspectives involving leader and led. Such a conceptualization advances in the view of Kouzes and Posner (1997), that links the leadership to the art of instigating others so that they want to fight for shared desires. Likewise, Yukl (2002) defines leadership as a process by which other employees are influenced to understand what needs to be done and how to be done in order to achieve shared goals.

Leadership style reveals how the leader exercises his or her office and responsibilities in organizations, being qualified (or categorized) according to a set of behaviors that represent it (Bass, 1990; Yukl, 2002). Approaches to transformational leadership were initially undertaken by Burns (1978), and later by Bass (1985); the former preceded and motivated the transformational theory, and can be pointed out as a phase; the second, has entered the research on the two theories, indicating that the transactional is divergent from the transformational, but that complement each other.

2.1 Transactional Theory

Burns (1978) points out that the basic characteristic of transactional theory is the perceived effort of leaders of the peculiar needs of their followers, with the aim of rewarding them for perfecting the tasks performed by them. That is, founded on the exchange between leader and leader. The achievement of objectives, determined by the leader, brings benefits to the leaders, and may be of political, economic or psychological content, ie, the leader encourages the exchange of a benefit for the good performance of his follower (Burns,1978; Bass, 1985; Kirkbride, 2006; Khanin, 2007; Cunha, 2008). The transactional priority is the link between performance and reward, therefore, the authors affirm that transactional leadership is very common in organizations (Jung & Avolio, 1999), that is, it indicates the essential and sustaining link between the interests individual, group and organizational (Rezende et al., 2014).

According to Bass and Avolio, (1994, 2004), transactional leadership is immediately linked to reinforcement by contingency, since the leaders are motivated by commitments made by the leaders and the rewards offered, and moreover, they are corrected in their attitudes through feedback threats, or corrective attitudes. For these authors, the forms of behavior management in this situation are: contingent reward, active management by exception and passive management by exception. The first one reveals that leaders have a duty to point out or consult their leaders on the tasks to be performed in exchange for tacit or clear rewards. The second is how leaders monitor their followers in ways that can correct team dysfunctions. Finally, there is passive management by exception, which highlights how leaders passively wait for the failures of the leaders and then correct them via critical feedback or warnings, which is directly related to Laissez-faire leadership.

Survey in Versiani and CavalhoNeto (2017) highlights the characteristics that a transactional leader should have, such as: mastering the exchange articulation, as well as how to negotiate it to achieve the achievement of its objectives; understand the needs of followers; have the capacity to motivate them through exchange; effort to meet the agreed; and resourcefulness when communicating; Also, it is necessary that there be the interest on the part of the leader to make exchange, that is, the link between performance and reward.

It is worth emphasizing that transactional leadership can be ineffective when the leader does not have the reputation or resources to meet the needs of his followers. Consequently, transactional leaders who live up to expectations acquire the image of being people who recognize and reward subordinates. However, those who misrepresent this reward process discredit their reputation and are likely to find it difficult to be perceived as efficient transactional leaders (Bass & Avolio, 2004).

2.2 Transformational Theory

Burns (1978) indicates the theory of transformational leadership as one that is likely to create leaders among the surrounding individuals. That is, in developing leaders, standards of morality, maturity, and motivation also rise in the institutional locus. For the author, the transformational leader instigates the leaders to overcome their own limitations, boosting their self-development, involving them in a context of change. According to Bass (1985), this style of leadership also seeks to raise team awareness by stimulating individual development, further delineating individual and institutional yearnings.

In addition to Burns (1978), Bass and Avolio (1990), Khanin (2007) and Versiani and Carvalho Neto (2017) join in affirming that the transformational leader is the one who retains the ability to assist the leader to carry

out his tasks with more perfection, through complementary characteristics such as trust, charisma and motivation, achieving an organizational environment more conducive to the development of the professional career. In addition, this leader, when necessary, results in intrinsic and extrinsic changes to the organization through the implementation of a vision of the future that can induce reliability and translate pretensions and safety to followers (Avolio et al., 1991; Day et al., 2014). This change agent is designed to transform the entity for which he or she is responsible and shows firmness to this, since he knows how to deal with reluctance, as well as to take positions, take risks and face reality (Cavazotte, Moreno, & Bernardo, 2013). This leader sees diversion as an opportunity for learning, and they do so because of uncertainty and complexity, presenting themselves as visionaries (Tichy&Devanna, 1986).

Bass (1990) and Oliveira et al. (2015) understand that followers transcend their peculiar propensities for the good of the group, organization, or society, targeting long-term growth and development. This style of leadership, the transformational one, is based on four basic elements: inspirational motivation, intellectual stimulation, charisma or idealized influence and individualized consideration. The first provides challenges and commitment of followers to shared endeavors; the second, encourages the conception of vision, critical study and evaluation of situations, implementation of parameters and formulation of creative results; charisma or idealized influence provide high levels of emulation, producing vision and trust; Finally, individualized consideration is based on the treatment of followers as individuals, through their capacity building, development and orientation, in search of their flowering (Bass, 1990).

2.3 Laissez-Faire and the Multifactorial Leadership Questionnaire

The Laissez-Faire (LF) leadership, according to Bass (1990), refers to a form of non-leadership, in view that this type of individual abdicates from his hierarchy by avoiding decisions or position. It is characterized by the absence of goal-setting and task oversight, as it omits its responsibilities and authority. In this case, leaders avoid the exercise of leadership, that is, they abstain from the role of leader.

The Multifactor Leadership Questionnaire (MLQ), developed by Bass and Avolio (1991) and updated by Avolio and Bass (2004), is a scientifically validated tool used by researchers to measure both efficiency of leadership in the institutional environment (Northouse, 2010). This instrument aims at empirically measuring the existence of attributes of transactional and transformational leadership, as well as the influence of one style on the other, or even the lack of leadership

behaviors, laissez-faire. In addition to these factors, Gonçalves (2008) indicates that the MLQ allows the analysis of other categories (leadership results) such as: Extra Effort, Efficacy and Leader Satisfaction, these categories being detailed in Table 1.

In this perspective, the mentioned instrument contemplates five key variables to measure transactional leadership: the element regarding idealized influence is segregated in the approaches of attribute and behavior, it also considers intellectual stimulation,

individualized consideration and, finally, inspirational leadership. In addition, it provides three other aspects for the evaluation of transactional leadership: consider contingent reward, active exception management, and passive exception management. From another perspective, it aggregates the laissez-faire leadership assessment, as well as other points that allow the critical examination of the exercise of leadership, such as extra effort, effectiveness and satisfaction (Santos, 2005; Bastos, 2013). In light of the above, Table 1 summarizes the differences between leadership styles.

Table.1: Characteristics of leadership styles.

I	Aspects	Characteristics
Transformational	Idealized Influence	Provides a vision and mission definition. The leader positions himself in front of the conflicts, showing conviction. In addition, they highlight their shared values and emphasize the relevance of having an objective and commitment, as well as making decisions based on ethics.
	Inspirational Motivation	It expresses its high expectations, employs symbols to focus efforts, as well as determining, in a simple way, the priority objectives. The leader builds the vision of the future, causing his or her leaders to overcome themselves, is motivating and creates a favorable scenario for change.
	Intellectual Stimulation	It provides rationality, intelligence and careful problem solving. The leader probes the status quo, beliefs traditions, drives new ways and perspectives to get things done and stimulates creativity.
	Individual Consideration	It gives attention to the leader in the form of the individuality of its peculiarities, advising and guiding them. That is, it prizes your particular needs, abilities and desires, listens carefully and is a strong communicator.
Transactional	Contingency Reward	The leader knows how to negotiate the exchange of rewards for commitment as well as reward for good results. It makes your expectations clear and makes good deals for everyone.
	Management by exception (active)	Seeks and investigates dysfunctions, taking the necessary disciplinary attitudes. This leader profile looks closely at any adversity and can monitor problems in advance.
Laissez-faire	Management by exception (passive)	It only interferes when the established standards are not achieved. The leader does not intervene until the moment the misfortune becomes serious and brought to his attention. It avoids unnecessary changes.
	Laissez-faire	The manager escapes from his duties and is not present when his team needs him. This manager avoids helping the team and is inert decision making, allowing others to do it, but giving little direction to it.
Results	Extra Effort	It is understood that the leader is able to achieve a superior performance than expected; the leader's expectations are exceeded by his subordinates.
	The effectiveness	It is observed when the leaders feel represented by the leader next to the superior hierarchies, or when the team performs well.
	Satisfaction	Indicates whether the leader's attitude leads to a productive environment, as well as examines the team's satisfaction with the leader's leadership style

Source: Adapted from Bass (1990), Gonçalves (2008) and Bastos (2013).

2.4 Leadership and Gender

It is necessary, initially, to show that there is a difference between the concepts of sex (male / female) and gender (male / female). For Giddens (2005), on the one hand, the term sex is generally considered as a physical construction and designates the genetic and anatomical-physiological characteristics of humans. On the other, gender is a concept of the Social Sciences, which emerged in the 1970s, related to the social construction of sex. That is, the concept of gender goes beyond the question of the biological sex of the individual.

Borges-Andrade and Pilati (2001) argue that gender can be perceived as the way in which the collectivity concatenates and assigns values and norms and, consequently, constructs the sexual distinctions and hierarchies, delineating what would be feminine and masculine roles, predicting that such concepts are permeated by social relations, discourses, organizations, doctrines and their own distinctive symbols. Scott (1989) defines gender as a constituent component of social interactions based on perceived differences between the sexes.

Regarding the historical context, according to Carrieri et al. (2013), in the early 19th century, the presence of women in the labor market was still restricted to weavers, dependent on male supervision. Although women have gained increasing space in the labor market over the years, gradually moving away from the image associated with domestic work (Cappelle et al., 2006; Carvalho Neto&Sant'Anna, 2013), still in the 19th century, women began to exercise occupation as a telephone operator and teacher (Kanan, 2010). The wars of the 20th century triggered a substantial increase in women's labor market, replacing men recruited by the military, reducing the difference in the number of men and women in business, causing greater impact on the structure of organizations. Women have come to conquer spaces formerly occupied by men, making it clear that the attributions are typical of the individual and not of one sex or another (CAVAZOTTE et al., 2010; CARRIERRI et al., 2013).

The 21st century was characterized by a renewal of gender studies dedicated to understanding the inequalities between male and female performance in the labor market (Cappelle et al., 2006; Carvalho Neto et al., 2010; Rodrigues & Silva, 2015). Santos and Antunes (2011) argue that despite advances made by women, gender dissimilarities up to this point have been the basis of social inequalities. Moreover, many women are placed in top-level leadership positions, being five times smaller than men. This representation is even smaller in management positions. It is likely that this difference is

related to the branch of the company and the lack of opportunity to take on positions of higher leadership (Oikawa, Almeida, & Durigon, 2018).

For Charness and Gneezy (2012) men and women react differently to situations involving risk and doubt because of the feelings that affect the evaluation of results differently for each gender. Since Bass, Avolio and Atwater (1996) already indicated some divergence between the female and male leadership, since women tend to develop the transformational style to a greater extent than men.

Kark (2004) reveals that, while transactional leadership points to male typified activities such as goal setting and reward trading processes, transformational leadership emphasizes the development and empowerment of leaders and the emotional link between them and their leaders. are more in line with the female leadership style. Eagly, Johannesen-Schmidt, and Van Engen (2003) already indicated that women are more conducive to transformational leadership. On the other hand, men, for these authors, tend more to exhibit the punitive element of transactional leadership, as well as the style of *laissez-faire*.

According to Bass, Avolio, and Atwater (1996), contingent reward leadership is primarily task oriented and is therefore more likely to be observed among male leaders. On the other hand, for these same authors, women tend to be more intellectually stimulating than male leaders. In light of this, the reason for this stimulation is due to female leadership being more willing and confident in their intuition and adopting non-traditional approaches to problem solving, and using less rigid guidelines and standard operating procedures. His style of problem solving has represented a further balance between the analytical and intuitive forms of problem solving that is reflected in the intellectually stimulating leadership (Bass & Avolio, 1993). In addition, individualized consideration and intellectual stimulation were expected to increase levels of trust, respect, and esteem, typically associated with charisma.

On average, male leaders are expected to exhibit more management leadership styles by active exception than women, given their orientation to perform tasks. However, it is not clear how women were perceived in terms of active versus passive and or *laissez-faire* leadership. Although they are generally considered in the literature to be less task-oriented than their male counterparts (Bass, 1990), they are also described as more participatory and collaborative - these being considered a management characteristic by active exception. Concisely, Bass, Avolio and Atwater (1996) did not find in their studies differences between men and women in the dimension of the *laissez-faire* leadership style.

As for the Additional Factors for Analysis (Leadership Outcomes) category, Bass, Avolio, and Atwater (1996) indicated that female leaders would be indicated in the surveys as more effective, satisfying, and exerting more extra effort than male leaders. That is, they were perceived as more effective and their followers were

more satisfied with their leadership. It should be noted that studies in Hanashiro (2005), Santos (2005), Bastos (2013) did not find significant differences in any of the hypotheses raised between the male and female genders. In this line, Table 2 mirrors the hypotheses that will be studied by the authors in this work.

Table.2: Hypotheses to be investigated

Hypothesis 1	There is a greater presence of Transactional Leadership style in the masculine gender in detriment of the feminine gender	Bass, Avolio e Atwater (1996); Eagly, Johannesen-Schmidt e Van Engen (2003); Kark (2004).
Hypothesis 2	There is a greater presence of the style of Transformational Leadership in the feminine gender in detriment of the masculine gender	de Bass, Avolio e Atwater (1996), Eagly, Johannesen-Schmidt e Van Engen, (2003); Kark (2004)
Hypothesis 3	There is no difference in leadership exercise under the Laissez-Faire style between genders	Bass, Avolio e Atwater (1996); Hanashiro (2005); Bastos (2013)
Hypothesis 4	There is a greater presence of additional factors for analysis (results) in the exercise of leadership by the female gender in relation to the male gender	Bass, Avolio e Atwater (1996)

Source: Prepared by the authors

III. METHODOLOGY

This research adopted the quantitative method for the approach to the problem and, for purposes, it is descriptive. Regarding the procedure, a survey was carried out which, according to Creswell (2010), denotes a quantitative or numerical description of trends, opinions or attitudes of a population, being studied a sample of this population. Based on the results of the sample, the researcher generalizes or makes affirmations about the population. It was decided to carry out a quantitative research due to the indication of the systematic review in Fonseca, Porto and Borges-Andrade (2015) that pointed out a lag in terms of leadership studies using the quantitative method in Brazil, while internationally it already presents a significant number of since the beginning of the 20th century.

The universe of data collected for this research was obtained from managers of companies in the retail trade of accessories, footwear and clothing located in Porto Velha - Rondônia, and the questionnaire was applied, mostly, to managers working in small companies. In this research, non-probabilistic sampling was used for convenience, in which the elements of the population were chosen for ease of access (Creswell, 2010).

The structured questionnaire applied through surveymonkey.com.br, specialized in online surveys and access link disclosure, was used as a data collection tool.

The multifactor leadership questionnaires (MLQ) questionnaire was applied to measure leadership style and gender, at managerial level, in the management of organizations, specifically in the retail trade of accessories, footwear and clothing. Since its inception, this instrument has been revalidated in several countries and in different contexts. It has 45 assertions, using a 5-point Likert scale, graduated as follows: never, rarely, sometimes, often and often. In addition to objective assertions, there were nine more questions about sociodemographic data.

A total of 143 questionnaires were applied, of which 102 returned answered, however, 2 were discarded from the results because they presented clearly corrupted answers, making up 100 component responses of the object of analysis of this research. In addition to the electronic questionnaire, a physical questionnaire was also applied through face-to-face contact with some respondents. It is worth mentioning that in this research, the study of social groups is based on the perception of differentiation between genders - female and male - based on the self-declaration of the respondents.

Table 3 shows the organization of the relationship between the collection instruments chosen in this research and the constructs and categories that guide the questions submitted to the investigation of the perception of the selected sample.

Table.3: Methodology for data collection and analysis.

General objective	References	Instrument	Sources	Types of leadership and categories
Identify the relationship between leadership style and gender, at managerial level, in organizations, specifically in retail stores. Model of Avolio and Bass (2004) through the Multifactor Leadership Questionnaire: MLQ - Multifactor Questionnaire Leadership;	Scott (1989) Bass (1990); Avolio e Bass (2004); Santos (2005); Gonçalves (2008).	Questionnaire 1ª. part Quiz 2ª. part Number of distributed questionnaires 143 Number of questionnaires received 102 Number of questionnaires analyzed 100	Socio-demographic data Questions 1 to 9 Transformational Leadership Questions : 2, 6, 8, 9 10, 13, 14, 15, 18,19, 21, 23, 25,26, 29, 30, 31, 34, 36 Transactional Leadership Questions: 1, 4, 11, 16, 22, 24, 27, 35 Laissez-faire leadership Questions:3, 5, 7, 12 17, 20, 28, 33 Additional Factors for Analysis (Results) Questions:37,38, 39, 40, 42, 43, 44, 45.	I Transformational Leadership <i>1. Idealized Influence (attributes and behavior)</i> 10, 18, 21, 25, 6, 14, 23, 34. <i>2. Motivational Inspiration</i> 9, 13, 26, 36 <i>3. Intellectual Stimulation</i> 2, 8, 30, 32 <i>4. Individual Consideration</i> 15, 9, 29, 31 II Transactional Leadership <i>1. Contingent Reward</i> 1, 11, 16, 35 <i>2. Management by Active Exception</i> 4, 22, 24, 27 III Liderança laissez- faire <i>1. Management by Passive Exception</i> 03, 12, 17, 20 <i>2. Laissez-Faire</i> 5, 7, 28, 33 IV Results <i>1. Extra Effort</i> 39, 42, 44 <i>2. Efficacy</i> 37, 40, 43, 45 <i>3. Satisfaction</i> 38, 41

Source: Prepared by the authors.

We used techniques described in the literature to validate both the questionnaire and the possible differentiation of the groups (Hair et al., 2005; Costa, 2011). For the author, validation of the questionnaire is an indispensable part of the measurement process, focusing on the data as a way of generating "measures" that clarify the nature and specificities of the phenomenon initially observed, so poorly elaborated measurement can impact on errors in generation of knowledge, making it inconsistent. In this way, the Cronbach's Alpha technique was used to analyze the reliability and Confirmatory

Factor Analysis for the validation of the instrument through the verification of the adherence of the items to the proposed constructs. To analyze the similarities and differences between the genders, the T-Test was used for Independent samples. We used the software: IBM SPSS version 24. The sample for the application of the MLQ scale was composed by 100 individuals.

Figure 1 shows the flow of interaction between the collection instruments used in this research, the methodological approach choices and the statistical tests considered more adequate by the researchers.

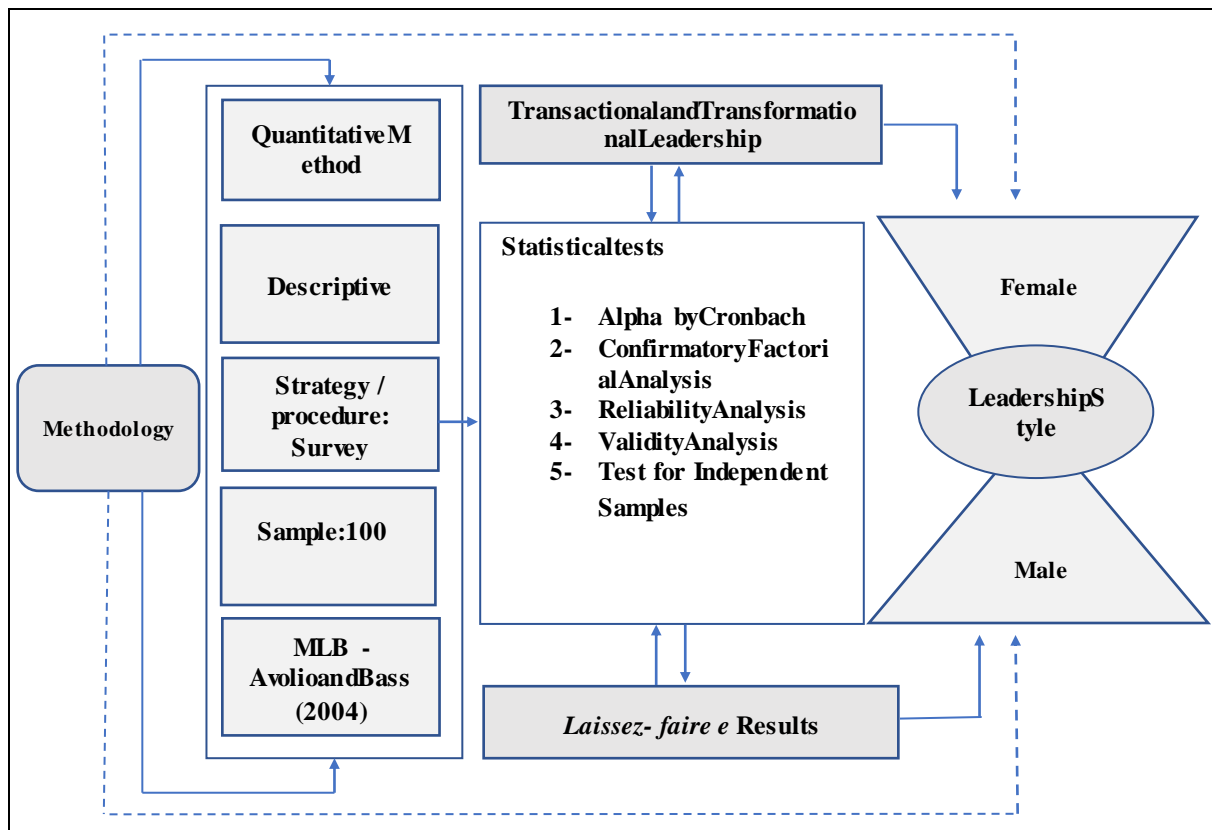


Fig.1: Methodology for data collection and analysis.

Source: Adapted in Creswell (2010).

IV. RESULTS AND DISCUSSIONS

Table 1 shows the sociodemographic data of the respondents. It can be noticed that the total number of male respondents (54%) and female (46%), with a

predominance of people aged between 18 and 29 years (39%), followed by the age group between 30 and 39 years old (35%), 40-49 years (19%) and over 50 years (7%).

Table.1: Sociodemographic summary of the 100 respondents.

Variable	Category	Count	Relative Frequency
Gender vs Occupation			
	Female	46	46%
	Male	54	54%
Age			
	From 18 to 29 years old	39	39,0%
	From 30 to 39 years old	35	35%
	From 40 to 49 years old	19	19%
	Over 50 years old	7	7%
Number of employees under direct responsibility			
	Up to 20	83	83%
	Over 20	17	17%

Source: prepared by the authors.

It is worth mentioning that, according to the number of employees under the direct responsibility of the leader, 83% of respondents have up to 20 employees under their direct responsibility and 17% have more than 20 employees. In view of this, it can be inferred that the companies investigated are small.

In order to check the reliability of the scale and to verify the correlation between the items of the construct, the most accepted method among the researchers was used, that is, using the Cronbach alpha coefficient with the help of the SPSS software. Reliability can be defined in how much the scale is constant in its results, consisting in analyzing the absence of random

errors present in the same. Regarding the Confirmatory Factorial Analysis (CFA), it consists on a procedure of reduction of variables, from the aggregation of a certain set of items. Conceptually, both exploratory and confirmatory factorial analysis consist in procedures with similar aims. There is, however, a central difference: in

the first case, no factorial structure has been defined a priori, and the collection of variable sets is left free, while in the second case the factorial structure is predefined, the hypothesis of adherence of the set of items to the factor (s) (Costa, 2011). Table 2 shows the reliability of the constructs.

Table.2: Reliability via Cronbach's alpha and EFA

Constructs	Instrument MLQ		
	Nº of itens	Alfa	Scores
Transformational Leadership	20	0,783	0.123-0.631
Transactional Leadership	8	0,646	0.276-0.666
Laissez-faire Leadership	8	0,608	0.368-0.790
Additional Factors for Analysis	9	0,922	0.457-0,779
Total	45	-	

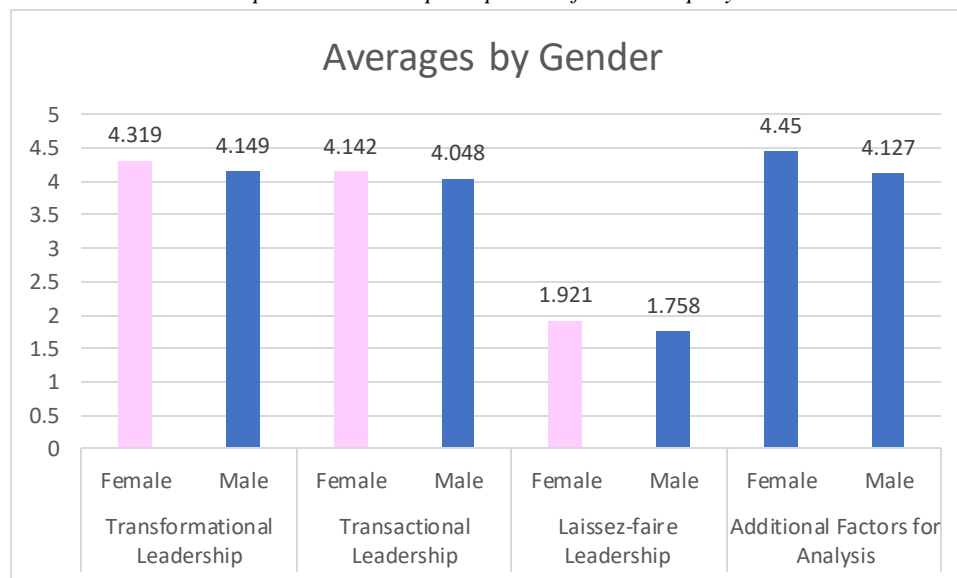
Source: prepared by the authors.

The result for the "transformational leadership" construct presented an alpha of 0.783, considered a regular reliability (Costa, 2011), with factorial loads of items ranging from 0.123-0.631, showing that some items presented low adherence to the factor; The "transactional leadership" construct presented an alpha of 0.646, considered a regular reliability (Costa, 2011), with factorial loads of items ranging from 0.276-0.666, demonstrating that some items presented low adherence to the factor. The laissez-faire leadership construct had an alpha of 0.608, considered a regular reliability (Costa,

2011), with factorial loads of items ranging from 0.368-0.790, indicating that some items had low adherence to the factor. The construct "additional factors for analysis" (leadership results) presented an alpha of 0.922, considered an optimal reliability (Costa, 2011), with factorial loads of items ranging from 0.457-0.779, indicating good adherence of items to factor.

To identify which constructs have significant gender differences, we will analyze the mean values of the perceptions of male and female leaders in relation to their leaders. Graph 1 shows the results obtained.

Graph 1 – Leaders' perceptions of leadership styles



Source: Prepared by the authors.

It can be seen that, at the level of Transformational Leadership, both female and male respondents registered a higher frequency at level 4 "many times". That is to say, they both perceive the behavior of a style of Transformational Leadership in

their leadership, however, as presented in Table 3, significantly, this style shows greater behavior in women. Regarding Transactional Leadership, it is understood that the mean of the responses of women and men are also at

level 4 "many times", however, this study found no significant difference between them.

Regarding the Laissez-Faire Leadership, although the perception of women has higher mean values ($M = 1.92$) than men ($M = 1.76$), this is practically the same, with no statistically significant differences. Regarding the additional factors for analysis (leadership results), the mean values were higher in the perception of

the female respondents ($M = 4.45$). And although the masculine gender has registered a higher frequency in level 4 "many times", it is explicit in the light of Table 3 that women have greater results in the leadership of their collaborators. To verify the means and significance of the difference between leadership styles, the outputs of the -T Test for independent samples will be observed in Table 3.

Table.3: Mean and Significance of Constructs

	Male	Female	Sig
Transformational Leadership	4,149	4,319	0,027
Transactional Leadership	4,048	4,142	0,337
Laissez-faire Leadership	1,758	1,921	0,174
Additional Factors for Analysis	4,127	4,450	0,005

Source: prepared by the authors.

The construct regarding transformational leadership showed that the female gender has, on average, more transformational characteristics than the male gender with statistical significance (bilateral) of 0.027, corroborating with the work of Bass, Avolio and Atwater (1996) Eagly, Johannesen- Schmidt and Van Engen, (2003), Kark (2004). It is noteworthy that the transformational approach proposes the position of leader from his capacity to behave as a transforming agent, from whom one expects the practice of vital skills for the optimal exercise of leadership; as an example, consider the competence to articulate interests preserving the empathic relationship between the stakeholders in the context of conflicts of purposes and needs (Bass, 1990; Avolio et al. 1991; Carvalho Neto et al. 2012). Added to this ability are those abilities related to the commitment and capacity for transformation, incitement to self-motivation, including in the construction of the environment that fosters empathy and affection that are common in creative modeling in innovative organizations.

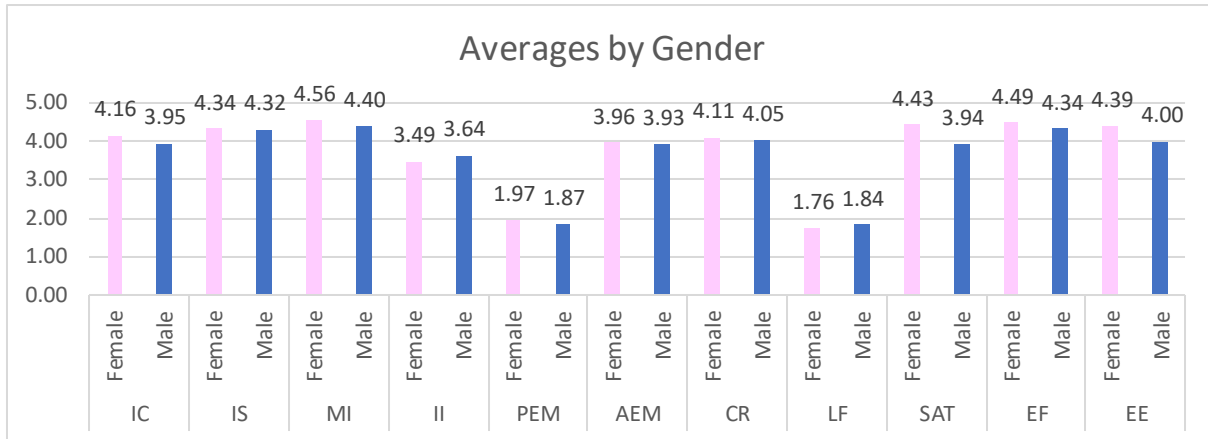
Regarding the transactional leadership construct and the laissez-faire leadership, these did not present statistically significant differences between the genders. Thus the transactional leadership outcome did not corroborate that of Bass, Avolio and Atwater (1996) Eagly, Johannesen-Schmidt and Van Engen, (2003) and Kark (2004). While the result of the laissez-faire leadership corroborated the study by Bass, Avolio and Atwater (1996), Hanashiro (2005) and Bastos (2013).

Finally, the construct Additional Factors for Analysis (leadership results) indicated a higher mean for the female gender (4,450) when compared to the male (4,127), with a bilateral statistical significance of 0.005, agreeing with Bass, Avolio and Atwater (1996). It was noticed, that the female gender had high index for extra effort, effectiveness and satisfaction as leader. This implies that women at managerial level have the ability to lead others to do more than expected and are able to represent their subordinates to the highest levels in the institutional hierarchy. In addition, they are satisfied with the management positions and, "as far as possible", try to create a suitable and pleasant work environment for their teams.

It is worth noting that if female leaders are characterized as more transformative and transformational leadership results in a better performance of followers and organization (Bass & Avolio, 1993), it can be inferred that many organizations may be belittling the full potential of women in his work force (Bass & Avolio, 1994). However, this connection was not examined in the present study and, at the moment, it is only known that male and female leadership styles were perceived differently.

In order to understand which categories have had the greatest expression in leadership styles, the average values of the male and female leaders' mensurations will be analyzed in relation to their leaders. Graph 2 shows the results obtained:

Graph 2 - Perception of leaders according to categories



Legend: IC - Individual consideration; IS - Intellectual stimulation; MI - Motivational Inspiration; II - Idealized influence; PEM - Passive Exception Management; AEM - Active Exception Management; CR - Contingent Reward; LF-Laissez-faire; SAT - Satisfaction; EF - Efficacy; EE - Extra effort.

Graph 2 shows that there are differences between the perception of male and female respondents, which are more evident in some categories. It is found that women refer more frequently to categories IC - Individual consideration; IS - Intellectual stimulation; MI - Motivational inspiration; PEM - Passive exception management; GEA - Active exception Management; CR -

Contingent Reward; SAT - Satisfaction; EF - Efficacy; and EE - Extra effort. Men have higher values in the remaining categories: II - Idealized influence; and LF-Laissez-faire. We can now see the categories that have stood out.

To verify the means and significance of the difference between the categories of leadership styles, the T-Test outputs for independent samples will be observed in Table 4.

Table.4: Mean and Significance

	Male	Female	Sig
Individual consideration	3,954	4,157	0,067
Intellectual stimulation	4,316	4,335	0,847
Motivational inspiration	4,396	4,563	0,095
Idealized influence	3,644	3,486	0,197
Passive exception management	1,868	1,970	0,469
Active exception Management	3,934	3,963	0,834
Contingent Reward	4,045	4,112	0,590
Laissez-faire	1,840	1,760	0,547
Satisfaction	3,944	4,434	0,000
Efficacy	4,335	4,492	0,152
Extra effort	4,001	4,389	0,004

Source: Prepared by the authors

According to Table 4, for the Transformational Leadership construct to present a significant difference between the genders, specifically showing a higher average for the feminine, the Individualized Consideration and Motivational Inspiration categories were predominant for this difference. Considering that, the Individualized Consideration category indicated a higher average for the female gender (4,157) in comparison with the masculine category (3,954), with a statistical significance of 0.067. Likewise, the

Motivational Inspiration category indicated a higher average for the female gender (4,563) when compared to the masculine (4,396), with a statistical significance of 0.095.

Given this, it can induce that the female gender is concerned with the development of the needs of the leader as well as with the treatment of their individual leaders. Transformational leaders emphasize individual interrelationship through individualized consideration, which includes teaching and coaching. It also includes

communicating relevant information to leaders as a way to provide continuous feedback. As for the motivational Inspirational category, leaders act to inspire people around them, providing meaningful references to organizational activities and goals, and challenging the day to day lives of their followers. The spirit of individual enhancement and team feeling are awakened. Enthusiasm and optimism are encouraged in the way the leader acts, which encourages followers to glimpse attractive and achievable future scenarios on their own merits.

The Satisfaction category indicated a higher average for the female gender (4,434) compared to the male (3,944), with a statistical significance of 0.000. Likewise, the Extra Effort category indicated a higher average for the female gender (4,389) when compared to the male category (4,001), with a statistical significance of 0.004. Consequently, the satisfaction and extra effort categories were critical for the Additional Factors for Analysis (leadership results) construct to indicate a higher average for the female gender. It should be noted that women with leadership positions stand out because they are charismatic and efficient in resolving conflicts by consensus, as well as encouraging their employees to participate more effectively in decision making (Bass & Avolio, 1993). This style elevates the performance of the leader, in view that the latter, because of his motivation, is more productive and satisfied, which may explain the higher leadership result found in the female gender in this work (Bass & Avolio, 1995).

V. CONCLUSION

The main objective of this research was to identify the significant differences in gender leadership styles in the retail trade through the Multifactor Leadership Questionnaire (MLQ) scale of Avolio and Bass (2004). Thus, as the main empirical contribution, we test the hypotheses that were raised in the specialized literature regarding gender leadership styles.

This study corroborated the use of the MLQ scale as an instrument to measure leadership styles. Therefore, it is possible to use it in vocational tests and also as a contracting criterion, according to the characteristics required for the position. In this way, MLQ is an important tool to characterize individuals and groups. The analyzes suggest that the scale used has demonstrated evidence of its validity to measure leadership styles in different cultures and socioeconomic environments.

In sum, it is concluded that (1) the female gender has a greater characteristic of transformational leadership than the male gender; (2) the transactional leadership construct has no difference in leadership between genders; (3) the laissez-faire leadership construct shows

no difference in leadership style between the genders; (4) For the Additional Factors for Analysis, the female gender has higher characteristics of this style than the male gender. However, for the Transformational Leadership construct to present a significant difference between genders, specifically showing a higher average for the feminine, the categories Individualized Consideration and Motivational Inspiration were predominant for this difference. Consequently, the satisfaction and extra effort categories were critical for the Additional Factors for Analysis (leadership results) construct to indicate a higher average for the female gender.

From the 45 initial items, it is suggested to exclude 3 items, because they presented low factor loads or, if they were excluded, could increase the reliability. For the "transformational leadership" factor it is suggested to exclude the item "I talk about my most important beliefs and values". For the "transactional leadership" factor it is suggested to exclude the item "I provide assistance to others in return for their efforts." For the "laissez-faire leadership" factor it is suggested to exclude the item "I am late to answer urgent questions". For the factor "Additional factors for analysis" it was not suggested to exclude items because all presented good reliability. The constructs can change their meaning over the years, due to the breakdown of paradigms and behavioral changes of societies (Costa, 2011).

Finally, as suggestions for future studies, it is proposed to conduct comparisons of leadership styles between private and public institutions, as well as with a more significant sample. However, this research demonstrates that there is evidence that scale is appropriate for different organizational cultures.

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Analysis of Process Parameters in Wire EDM on D2 Tool Steel using Taguchi Method

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Abstract—This paper focuses on the effect of input parameters like pulse on time, pulse off time, servo voltage, and kerf width on the output characteristics of CNC wire EDM process such as material removal rate (MRR), surface roughness (SR), and kerf width (KW). The optimum process parameters and corresponding output responses are found out using Taguchi Method. In this research, High carbon high chromium D2 tool steel is used as the work piece with 0.25mm brass wire as tool.

Keywords—WEDM, MRR, SR, KW, S/N Ratio.

I. INTRODUCTION

Achieving high accuracy and tighter tolerances during machining of materials is essential for many industries. Wire electric discharge machining (WEDM) helps to produce parts in economical way than traditional manufacturing process. In WEDM the material removal is through, electro erosion machining process, in which electric spark is generated between tool and work piece, flushed with de-ionised water. The material removal takes place due to repeated electric discharges between work piece and wire connected in an electrical circuit.

The literatures related with experiments focussing on characteristic features of WEDM, it is found that parameters like pulse on time, pulse off time, voltage and wire feed have significant role in determining the performance characteristics like material removal rate, surface roughness and kerf width. Kumar and Agarwal performed the experiments based on Taguchi's parameter design, which were carried out to study the effect of various input parameters on the material removal rate and surface finish. Duraraj et al. performed the experiments to find out the effect of process parameters on surface roughness and kerf width. Lia et al. performed conducted experiments on WEDM to investigate the surface integrity of INCONEL 718 with respect to varying energy. Rozenek et al. studied the effect on surface roughness and machining feed rate during WEDM of metal matrix. Meena et al. carried out an experimental

study to find out the effect of wire feed rate and wire tension on surface roughness during machining of Ti-10V-2Fe-3Al. Liao et al. conducted an experimental study with the implementation of the pulse generating circuit and capacitance on the surface roughness. Manna et al. investigated the effect of various machining performance criteria such as MRR, SR, gap current, spark gap.

II. DESIGN OF EXPERIMENTS

According to the capability of machine tool, cutting tool and work piece, various process parameters and the levels for each parameters are selected and are listed in the Table 1.

Table.1: Machining Parameters and Levels

Sl. No.	Process Parameters	Level 1	Level 2	Level 3
1	Pulse On Time (μ s)	115	120	125
2	Pulse Off Time (μ s)	48	50	52
3	Servo Voltage(V)	20	25	27
4	Wire Feed (mm/min)	2	3	4

The designed combination of input parameters based on L9 orthogonal array are shown in Table 2 and its corresponding material removal rate, surface roughness and kerf width are shown in the Table 3.

Table.2: Combination of Input Parameters

Sl. No.	Pulse On Time (μ s)	Pulse Off Time (μ s)	Servo Voltage (V)	Wire Feed (mm/min)
1	115	48	20	2
2	115	50	25	3
3	115	52	27	4
4	120	48	25	4
5	120	50	27	2
6	120	52	20	3

7	125	48	27	3
8	125	50	20	4
9	125	52	25	2

7	3.103569	-10.8753	6.075962
8	-15.5947	-9.1264	2.492089
9	1.101711	-8.75515	8.627514

Table.3: Experimental Results

Sl. No.	MRR	SR	KW
1	0.43	3.7	0.36
	0.476	3.762	0.4
	0.44	3.731	0.38
2	0.85	2.294	0.23
	0.9	2.256	0.21
	0.89	2.283	0.2
3	0.161	1.871	0.17
	0.14	1.91	0.15
	0.156	1.892	0.17
4	0.36	3.462	0.16
	0.340	3.491	0.17
	0.375	3.483	0.14
5	1.172	2.81	0.4
	0.911	2.781	0.41
	1.166	2.798	0.44
6	0.259	3.016	0.43
	0.17	3.126	0.46
	0.2	3.032	0.45
7	1.38	3.418	0.51
	1.52	3.571	0.48
	1.4	3.502	0.5
8	0.185	2.812	0.76
	0.152	2.921	0.71
	0.166	2.845	0.78
9	1.15	2.754	0.35
	1.12	2.718	0.39
	1.136	2.748	0.37

Since material removal rate is desired to be at maximum, larger the better characteristic is used, meanwhile for getting lower surface roughness & kerf width, lower the better characteristic is used for calculating S/N ratio.

The mean values of S/N ratio for MRR are shown in the Table 5 (larger the better for MRR).

Table.5: Mean of S/N Ratio for MRR

Process Parameters	Level 1	Level 2	Level 3	Delta Value
Pulse On Time	-8.164	-7.459	-3.796	4.368
Pulse Off Time	-4.273	-5.402	-9.746	5.473
Servo Voltage	-12.177	-2.984	-4.259	9.193
Wire Feed	-1.792	-3.989	-13.639	11.847



Fig. 1: Main Effects Plot for S/N Ratio of MRR

III. ANALYSIS OF PROCESS PARAMETERS

Process parameters are optimized to obtain high quality maintaining cost economy via Taguchi technique. The optimum combinations are obtained from the S/N ratios. According to Taguchi method, the S/N ratio is the ratio of signal to noise, where signal represents the desired value and noise represents the undesired value. The output responses are used to calculate the S/N ratios given in Table 4.

Table.4: S/N Ratios for MRR, SR and KW

Sl. No.	MRR	SR	KW
1	-6.98598	-11.4375	8.396315
2	-1.11836	-7.15002	13.40401
3	-16.3877	-5.53414	15.72406
4	-8.93534	-10.8283	16.07303
5	0.508556	-8.93186	7.597004
6	-13.9509	-9.70984	6.996944

The delta value is the variation of mean S/N ratio from first level to the third level, and thus shows how on each parameter affect the particular response. It can be seen that wire feed has the highest delta value and hence wire feed has the highest influence on MRR. From the main effects plot of MRR (Fig. 1) it is clear that the optimum process parameters for getting the optimum MRR is Pon = 125µs, P off = 48, µs V = 25V, wire feed = 2mm/min. The regression equation for MRR is found as follows;

$$MRR = -2.46 + 0.04185 \text{ pulse on} - 0.0619 \text{ pulse off} + 0.0907 \text{ servo v} - 0.3314 \text{ wire feed} \quad (1)$$

The mean S/N ratio values for surface roughness are shown in Table 6 (smaller the better for SR). Here pulse off time has the highest delta value and hence influence the surface roughness the most. From the main effects plot

of SR (Fig. 2), the optimum process parameters are found to be pulse on time = 120µs, pulse off time = 48µs, servo voltage = 20v, wire feed = 2mm/min. The regression equation for SR is found as follows;

$$SR = 12.94 + 0.0399 \text{ pulse on} - 0.2515 \text{ pulse off} - 0.0711 \text{ servo v} - 0.1731 \text{ wire feed} \quad (2)$$

Table.6: Mean S/N Ratios for SR

Process Parameters	Level 1	Level 2	Level 3	Delta Value
Pulse On Time	-8.041	-9.823	-9.586	1.783
Pulse Off Time	-11.047	-8.403	-8.000	3.047
Servo Voltage	-10.091	-8.911	-8.447	1.644
Wire Feed	-9.708	-9.245	-8.496	1.212

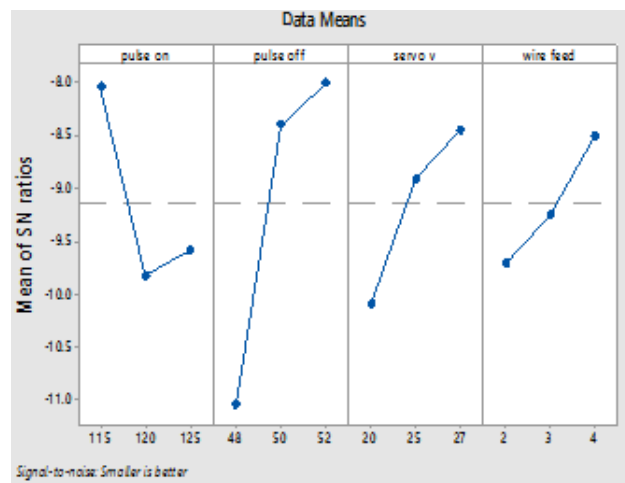


Fig. 2: Main Effects Plot for S/N Ratio of SR

The mean S/N ratio values for KW are shown in Table 7 (smaller the better for KW). Here pulse on time has the highest delta value and hence influence the surface roughness the mostly. From the main effects plot of Kerf Width (Fig. 3) the optimum process parameters for kerf width are found to be, pulse on = 125µs, pulse off = 50µs, servo voltage = 20V, wire feed = 2 mm/min. The regression equation for KW is found as follows;

$$KW = -2.073 + 0.02867 \text{ pulse on} - 0.0044 \text{ pulse off} - 0.02996 \text{ servo v} - 0.0161 \text{ wire feed} \quad (3)$$

Table 7: Mean S/N Ratios for KW

Process Parameters	Level 1	Level 2	Level 3	Delta Value
Pulse On Time	12.508	10.222	5.732	6.776
Pulse Off Time	10.182	7.831	10.450	2.618
Servo Voltage	5.962	12.702	9.799	6.740
Wire Feed	8.207	8.826	11.430	3.223

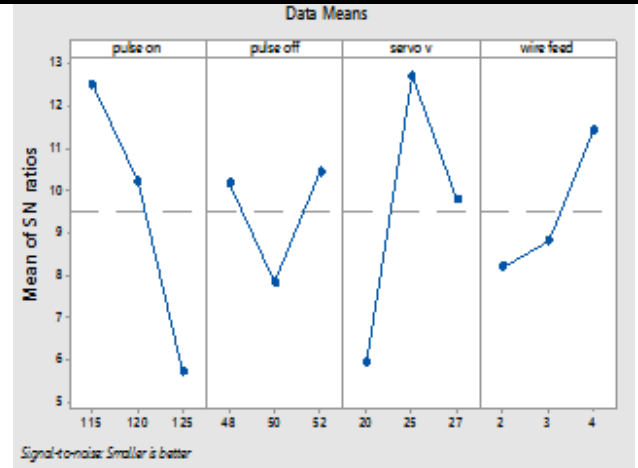


Fig. 3: Main Effects Plot for S/N Ratio of KW

The results obtained from Taguchi optimization technique to get the best MRR, minimum surface roughness and minimum kerf width are shown in the Table 8.

Table 8: Optimum Combination of Process Parameters

Process Parameters	MRR	SR	KW
Pulse On Time(µs)	125	120	125
Pulse Off Time(µs)	48	48	50
Servo Voltage (V)	25	20	20
Wire Feed (mm/min)	2	2	2

The optimum output responses are found using regression analysis as shown in Table 9.

Table.9: Optimum Output Responses

Sl. No.	Output Responses	Optimum Value
1	Material Removal Rate (gm/min)	1.42975
2	Surface Roughness (µm)	3.8878
3	Kerf Width (mm)	0.65935

IV. CONCLUSIONS

Experimental investigation of D2 tool steel has been done on wire EDM and the following conclusions were made;

- It was found that material removal rate was most influenced by wire feed, surface roughness by pulse off time and kerf width by pulse on time.
- The optimum combination of process parameters for material removal rate, surface roughness and kerf width were found.
- The optimum output responses were also found using regression analysis.

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Removal of Excess Toxic Chloride and Fluoride Anions from Wastewater Employing Eggshells Waste Remains

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Abstract— Eggshells waste was investigated for its sorption ability as an environmentally-friendly and cheap sorbent for removing excess anions from wastewater. The milled size of the waste was found to be $\leq 63 \mu\text{m}$, with round and smooth morphology. Moreover, the Fourier transform infrared spectrometer spectrum showed functional groups such as carbonate and hydroxyl. The X-ray diffractogram of the eggshells showed the presence of calcite, which mostly compose of calcium and carbonate ions. Multivariate methodology was employed for optimization of factors that affect sorption studies; initial ions concentration which was found to be 24.45 and 23.24 mg/L, the sorbents dose which was found to be 85.20 and 81.56 mg/L, contact time, which were found to be 69.37 and 70.28 min and solution pH 7.19 and 7.97 for chloride and fluoride anion respectively. The eggshells also exhibited high percentage removal efficiencies for chloride (80.70% \pm 2.01%) and fluoride ion (93.18% \pm 1.67%) from real wastewater samples. The adsorption isotherm was satisfactorily fitted with Langmuir isotherm model. The thermodynamics kinetics studies showed that the adsorption of fluoride and chloride ions onto the eggshells was endothermic and spontaneous and the adsorption data followed second-order kinetics supporting that chemisorption process was involved.

Keywords—Chloride, fluoride, eggshells waste-remains, adsorption and wastewater.

I. INTRODUCTION

Processed wastewater is widely employed to compensate for the shortage of benign and uncontaminated freshwater (Stevens & Batlokwa, 2017). Wastewater treatment methodologies have been developed by several researchers for treating and reutilizing wastewater for use in irrigation, animal and human consumption, groundwater boost, non-potable reuse and domestic activities. Nevertheless, the presence of excess and toxic anions such as chloride and

fluoride ions in the wastewater pose a serious health hazard to aquatic animals and the environment (Chuang, Chang, Chang, & You, 2006). Agricultural activities such as the use of potash fertilizers for soil enrichments, road salts, industrial activities and natural calamities have continuously increased the amount of chlorine and fluoride ions in the aquatic ecosystems (Butt & Riaz, 2017). Naturally, chloride and fluoride ions exist in fresh or ground waters in considerable concentrations and are essential to life. For example, chloride ions are micronutrients essential for plant development and it constitute approximately 0.05% of the earth's crust (Hunt, Herron, & Green, 2012). It is required in low concentrations by most plants, and it plays an essential role in stomatal regulation. However, high levels of chloride ion may alter reproduction rates, increase species mortality and may also change the characteristic of the entire local ecosystem. Furthermore, as the concentration of chloride ion increases due to the above-mentioned activities or reasons, and filters into underground waters and wastewaters, it may strain plant respiration and change the quality of the wastewater effluent as well as drinking water (Asche & Lead, 2013). Fluoride on the other hand, is essential to human health specifically for the bones and dental health, however, this is plausible only at low levels ($\leq 1.0 \text{ mg/L}$) (Bhaumik et al., 2012). Consumption of high levels of fluoride ions is detrimental to human health and aquatic life. For example, ingesting high levels of fluoride ions browning and mottling of the teeth, bones fluorosis (Fawell & Nieuwenhuijsen, 2003), depression (Crisp et al., 1998), urinary tract malfunction and red blood cell deformities (Thole, 2013).

Henceforth, it is essential that the concentration of chloride and fluoride ions in recycled wastewater be considerably reduced to acceptable levels (200 mg/L and 1.0 mg/L for chloride and fluoride respectively) as set out by international monitoring agencies such as the World Health

Organization (WHO) (Javed & Usmani, 2013), Food and Agriculture Organization (FAO) (Elnabris, Muzyed, & El-Ashgar, 2013) and Botswana Bureau of Standards (BOBs)(BOTSWANA BUREAU OF STANDARDS, 2011). Adsorption has wide been employed as an efficient and economically viable technology for the removal of removing excess and toxic chloride and fluoride ions from water. Lately, low cost sorbents, especially naturally occurring materials such as activated carbon from plant materials (Chuang et al., 2006), calcium alginate beads (Bhaumik et al., 2012), fly ash (The & Convention, 2008), rice husk (Xu, Chen, & Jiang, 2015), tea ash powder, clay materials, limestone as well as commercially available calcium containing materials such as calcium hydroxide, and calcium sulphate have been employed to remove chloride and fluoride from water (Bhaumik et al., 2012) (El-Hassan & Al-Sulami, 1994). However, these methods present some drawbacks, including the high cost (Hanafi & Abdel Azeema, 2016), and the disposal of the resulting sludge (Gilbert, Woodhouse, Stieb, & Brook, 2003)

Eggshell is mainly composed of calcium carbonate (94.03%) and it also contains calcite and valerite. Additionally, eggshells are composed cellulosic structure and contains amino acids; making it an excellent adsorbent (Yi, Guo, Zhang, Yu, & Li, 2004). In Botswana, eggshells are largely produced as waste domestically, commercially as well as industrially. These waste (eggshells waste remains), are usually disposed in landfills and have no economic values.

In this paper, pulverized eggshells were employed as an environmentally friendly and readily available adsorbent for the removal of excess toxic chloride and fluoride ions from wastewater sample. FTIR, SEM and XRD were employed for characterization of the eggshells waste remains. The significance of various sorption parameters including pH, adsorbent dose, contact time, initial concentration of the anions was investigated. Adsorption isotherm models were employed to describe the adsorption equilibrium data. Pseudo-first and second-order and intraparticle diffusion were employed to investigate the kinetics of the adsorption process. The thermodynamic parameters, such as ΔG , ΔH and ΔS were also calculated from the adsorption measurements.

II. MATERIALS AND METHOD

Materials and Instrumentation

The eggshells waste remains employed for this experiment was collected from the Moghul Refectory located on the main campus of the Botswana International University of Science and Technology (BIUST), Palapye, Botswana.

Ultra-pure water of 18.0 M Ω /cm resistivity, Type I, was prepared by a Elix 5 Millipore water purification system from Merck, (Darmstadt, Germany) and was used to prepare all solutions. Reagents used were: SPAR white spirit Vinegar, which was employed to treat the waste materials, was purchased from SPAR (Palapye, Botswana), elemental standard solution of Cl⁻, and F⁻ with a concentration of 1000 mg/L and NaOH (97%) pellets were purchased from Rochelle Chemicals (Johannesburg, South Africa). For determination of size, morphology and nanoparticle composition, JSM 1700 SEM coupled with EDX, obtained from USA was used. The instrument resolution was about 50eV at amplification time of 5 microseconds, it uses an Electron Dispersive X-ray (EDX) back scattering detector operated in spectra mode (elemental composition), point and shot mode and mapping mode (distribution of compounds). Analysis was done employing a Philips GSR v, 3.2 software. The SEM worked at beam voltage of 1.0 kV LED, low vacuum (typically 2 to 6 Torr), and utilizes a chamber gas (H₂O) for imaging, charge suppression and sample humidity. An E6700 Polaron range high vacuum evaporator sputter coater, obtained from the United Kingdom (UK), was used to coat the fish scales remains and untreated waste materials prior to SEM-EDX analysis. Perkin Elmer System, Spectrum two Fourier transform infrared (FTIR) spectroscopy was used to determine the functional groups of materials. The FTIR spectra were recorded in the wavenumber range 400-4000 cm⁻¹ on a Perkin Elmer system 2000 FTIR. The adsorbents were kept at ambient temperature. 1mg of the adsorbents per 200 mg of KBR was weighed. The powder was pressed into pellets by using a 15 ton hydraulic press. The data were collected at 2.0 cm⁻¹ resolution, and each spectrum was a result of 256 scans. A powder D8 Advanced Powder X-Ray Diffractometer (XRD) obtained from Bruker (Karlsruhe, Germany) was employed for characterization of the eggshells waste remains. Meanwhile, the presence of chloride and fluoride anions effluents during the entire experiment were investigated by employing a Shimadzu S 150 ion chromatography system (SHIMADZU, Japan) obtained from SHIMADZU (Johannesburg, South Africa). The instrumental parameters were those recommended by the manufacturer.

Pre-treatment of the Eggshells Waste Remains

The eggshells waste remains employed for this experiment was collected from the Moghul Refectory located on the main campus of the Botswana International University of Science and Technology (BIUST), Palapye, Botswana. The remains were washed thoroughly with deionized water to

remove dirt and eggs remains. Then it was sun dried for 48hrs, after which, it was pulverized employing a Fritsch pulverisette 5 pulverizer, operated at 400 rpm for 90 min in both milling and reverse mode. The pulverized materials were then sieved to 63 – 200 micron mesh size, after which they were rewashed with deionized water several times to remove color and dirt. The product was then treated with SPAR white spirit vinegar to remove inorganic pollutants. Finally, they were dried in an oven at 65 ± 2 °C for 6hrs 11.

X-ray Powder Diffraction (XRD)

A powder D8 Advanced Powder X-Ray Diffractometer (XRD) analysis was employed to investigate the physical properties as it relates to the crystallinity of the waste material. The XRD was operated with Cu K α emission ($\lambda = 1.54105\text{\AA}$, 40 kV, 40 mA per sec) and with high efficiency linear detector of Lynx Eye type. The scanning mode used was coupled with $2\theta/\theta$ on the scanning range $10^\circ - 120^\circ$ values. The crystallite size of the sample was calculated by Deby-Scherrer method.

Fourier Transform Infrared Spectroscopy (FT-IR)

Fourier transform infrared (FTIR) spectrometer was employed to identify the functional groups craved on the surface of the eggshells waste remains. The FTIR spectra were recorded in the wavelength range 500-4000 cm^{-1} on a Nicolet iS10 Thermo Scientific FTIR. The data were collected at 2.0 cm^{-1} resolution, and each spectrum was a result of 250 scans.

Scanning Electron Microscopy Coupled with Energy Dispersive X-ray Spectroscopy (SEM-EDX)

Scanning Electron Microscope coupled with Energy-dispersive X-ray spectrometer (SEM - EDX) (JSM -

7100F), was employed to determine the surface morphology of the eggshells waste and to determine its elemental composition. An E6700 Polaron range high vacuum pressure sputter coater (Quorum Technologies, UK) was employed to coat the eggshells wastes with carbon. These were then taken for SEM-EDX analysis, which operated under high vacuum and beam acceleration voltage of 10.0 kV (the recommended operating voltage for organic material samples). The results from this analysis were then used to determine the surface morphology and elemental composition of the eggshells waste.

Batch Adsorption Studies for Cl⁻ and F⁻ Removal Employing Eggshells Waste

All experiments were carried out in batches and done in triplicates. A 100 mg/L standard mixture of chloride and fluoride was prepared from 1000 mg/L stock solution of each of the anions.

Optimization of Adsorptive Parameters of the Eggshells Waste

Optimization studies were carried out by employing multivariate optimization methodology. In this study, the eggshells were optimized by looking at four factors: contact time, pH, sorbent dosage, and initial concentration. These were first screened through the use of a two-level fractional factorial design. This evaluates the significance of each factor towards the experimental output.

The screening design was carried using the experimental conditions as described in Table 1. It was then filtered into a 100 mL volumetric flask and deionized water added to the mark. It was investigated for chloride and fluoride anions employing IC. The experiments were done in replicates to evaluate the adequacy of the method.

Table.1: Factors and their levels for the two-level fractional factorial design for the optimization of the eggshells waste remains

Variable	Factor	Low level	High level
A	dosage (mg)	10	1000
B	pH	2	10
C	Contact time (minutes)	15	180
D	Concentration (mg/L)	0	50

Following this, a face centered central composite design (CCD) was performed to investigate the optimum conditions for each factor that would result in a maximized response of the experiments. The optimization process was carried out with the use of Minitab Release 14 statistical software (Minitab Inc., USA).

Application of the Optimized Eggshells Waste Adsorption Method to Real Samples

The sorption nature of the eggshells waste remains was studied by applying the optimized parameters to wastewater samples collected from Gaborone waste water treatment plant. The eggshells waste remains were used for the adsorptive removal of chloride and fluoride anions from samples. 100 mL of wastewater samples were used and the

optimized conditions applied to the water samples. The mixture was subjected to a rotary shaker at 200 rpm under the optimal conditions, after which it was then filtered employing a whatmann No. 1 filter paper and put into 100 mL volumetric flasks. Deionized water was added to the flasks and filled up to the mark. The analysis was done in triplicates. Chloride and fluoride standards (from 5 – 10 mg/L) were prepared for the calibration curve. The effluents were investigated for the presence of chloride and fluoride ions by employing ion chromatography (IC) and the results analysed using Microsoft Excel 2016.

The percentage removal of chloride and fluoride anions was calculated using the formula below

$$\frac{C_i - C_f}{C_i} \times 100 \quad (1)$$

Where C_i is the initial concentration of metal ions in wastewater sample.

C_f is the final concentration of metal ion in wastewater after applying the eggshell waste remains.

Equilibrium studies

Adsorption equilibrium studies were conducted to determine the nature of the adsorption isotherms and the adsorption capacity of the eggshells waste remains for the removal of chloride and fluoride. For the isotherm studies, the initial ions concentrations were varied from 10 to 100 mg/L using 1 g/L (dry weight) eggshells waste powder. The adsorption flasks were agitated in a rotary shaker at 400rpm and samples were collected at specified time intervals,

followed by separation of the eggshells waste powder by filtration. The resulting solutions were analyzed employing IC for the residual anions concentrations.

Kinetic studies

Kinetic studies were carried out in a volumetric flask and samples were collected at different intervals of 15 min to 90 min. The samples were analysed for residual ions concentration.

The kinetics of adsorption was studied by using three kinetic models, pseudo first order, second order and intra particle diffusion models.

Thermodynamic studies

The experiments were conducted at different temperatures in the range of 0 – 50 °C in a rotary shaker for 90 min. The samples were filtered and analysed employing IC for the residual anions concentrations at the end of the experiments.

III. RESULTS AND DISCUSSIONS

X-ray Powder Diffraction (XRD)

The XRD phase analysis of the eggshells waste powder was performed employing JCPDS (Joint Committee on Powder Diffraction Standards) card number 01-073-0293. It was evident that a compound, calcite with the chemical formula CaCO_3 was the major component of the eggshell waste powder with a with *d- spacings* 0.845, 0.784, 0.712, 0.684, 0.600, 0.563, 0.489, 0.389, 0.301, 0.289, and 0.200 corresponding to the calcite structure as shown in Figure 1.

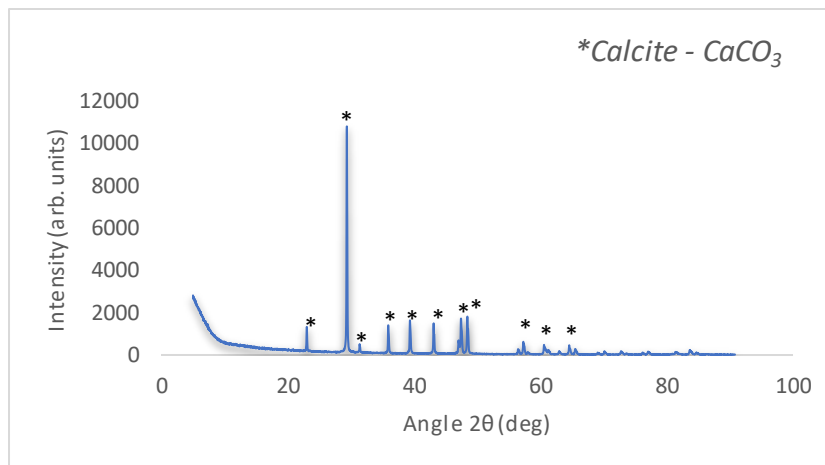


Fig.1: XRD diffractogram of the eggshells waste powders

Calcium and carbonate ions are the major constituents of calcite. Both ions have unsatisfied partial charges within the compound (Bhaumik et al., 2012). This charge imbalance is decreased by the hydrolysis of water, resulting in the

formation of calcium hydroxide ions and bicarbonate ions which has the ability to react with any other ions in solution based on the pH of the solution. At pH between 6 – 7.85, there is an increase in the number of CO_3^{3-} and Ca^{2+} sites on

the eggshells powder surface resulting in high adsorption efficiency for chloride and fluoride ions by the eggshell waste powder (Tsai et al., 2006).

Scanning Electron Microscopy Coupled with Energy Dispersive X-ray Spectroscopy (SEM-EDX)

Figure 2 shows SEM micrographs of the eggshells waste powder. The fish scale appears to have a round and smooth

morphology with a particle size of $\leq 63 \mu\text{m}$, which are excellent characteristics associated with excellent adsorbents. The micrograph is characterized by having two regions, one being darker and the other being white. The white region is rich in inorganic material containing high proportion of calcium and phosphorus, whereas the dark region is rich in protein because it has high proportion of carbon and oxygen as soon by Figure 3.

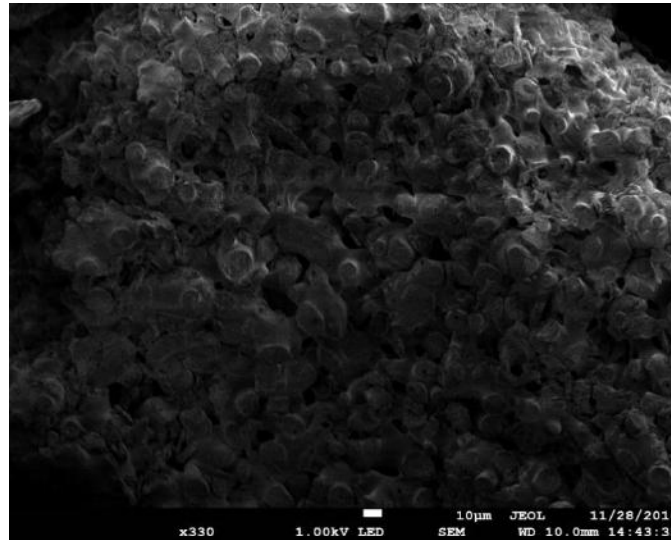


Fig.2: SEM image for the eggshell waste remains powder

Full scale counts: 1378

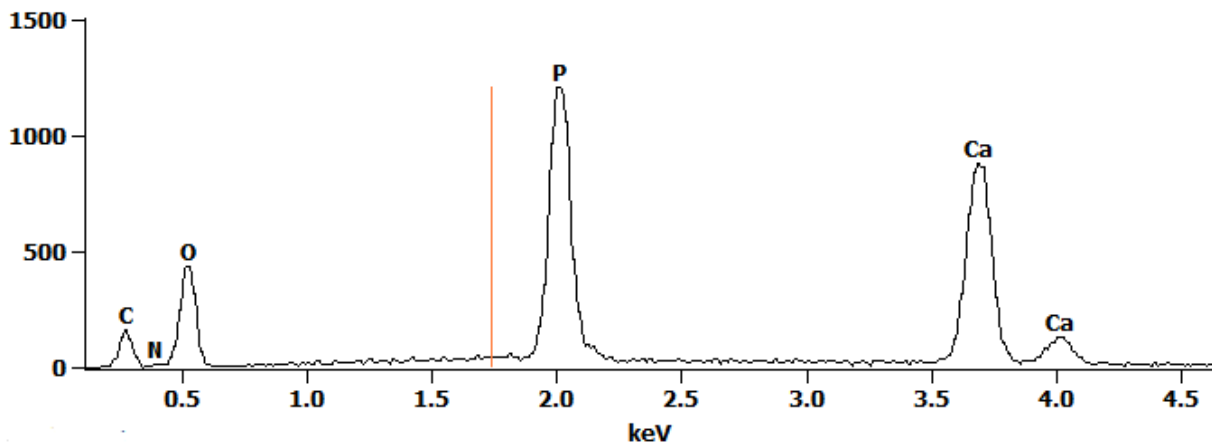


Fig.3: EDX of the eggshell waste remains powder

Fourier Transform Infrared Spectroscopy (FT-IR)

Eggshell is mainly composed of calcium carbonate (94.03%) and it also contains calcite and calcareous soil. Eggshell has a cellulosic structure and contains amino

acids; thus, it is expected to be a good adsorbent. Figure 4 below shows an FTIR of eggshells before removal (blue) and after removal (pink) of the chloride and fluoride ions from wastewater.

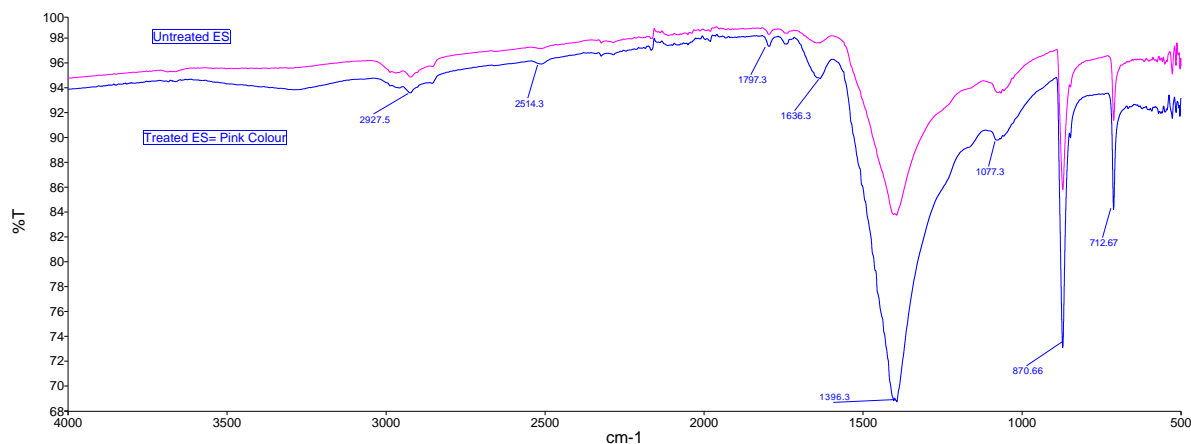


Fig.4.4: FTIR of Eggshells before removal (blue) and after removal (pink) of target analytes

The two most significant peak intensities were observed at 1396 and 870 cm^{-1} , which were strongly associated with the presence of calcium carbonate in the eggshell matrix (Haynes & Dean, 2010). The peak at 870 cm^{-1} confirmed the presence of valerite (Tsai et al., 2006). A moderately observable peak at 712 indicated the in-plane and out-planes deformation modes of calcium carbonate (Thomas et al., 2015). It has been reported that the most prominent peak in FTIR spectra of eggshell particles matched with that of carbonate minerals. The peak at 2927.5 cm^{-1} is due to presence of C-H stretching mode (Tsai et al., 2006).

Optimization of Adsorptive Parameters of the Eggshells Waste Remains

Experimental matrices were designed using Minitab for the optimization purposes. The yields were followed by the use of IC separation measurements of chloride and fluoride. Before performing the actual optimization, a $\frac{1}{2}$ fraction factorial design was employed in order to assess the level of significance of each factor under investigation. The factorial design comes as a screening phase, which allows screening a relatively large number of factors in a relatively small number of experiments that cover the whole experimental domain, with the result identifying the most influential factors towards obtained yields. Analysis of data was in the forms of normal probability plots of standardized effects, and residuals plots; as shown by Figures 5 and 6, respectively.

From the normal probability plot of standardized effects, the magnitude of the main effects of each factor as well as the effects brought about by the interaction of factors, towards the obtained yield are investigated. The magnitude of each type of effect is represented by its distance from the solid line, as well as the side on which the effect lies with respect to the solid line. Negative effects lie to the left while positive effects lie to the right of the solid line. The solid line indicates where the points would drop if the effects were zero, while the percentage in the y-axis signifies the weightage of each factor's contribution towards the obtained yield. The investigated effects exhibited a positive magnitude as they all appeared to the right of the graph, as can be observed in Figures 5. The main effects, due to Factors A (Contact time), B (pH), C (eggshells waste remains dosage) and D (initial concentration) were significant for chloride and fluoride. Factor D for both anions lay furthest to the right of the solid line, signifying that factor D had a greater positive magnitude towards contribution of the yields obtained. However, the contribution of each factors (A, B, C, and D) showed higher weightage towards the output as compared to that of effects brought about by the interaction of factors. The powder normal probability plots of standardized effects of Cl⁻ showed that there was a significant contribution towards the obtained yield as a result of interaction between factors (Factor A and Factor B) and the same for Factor A and Factor D for F⁻.

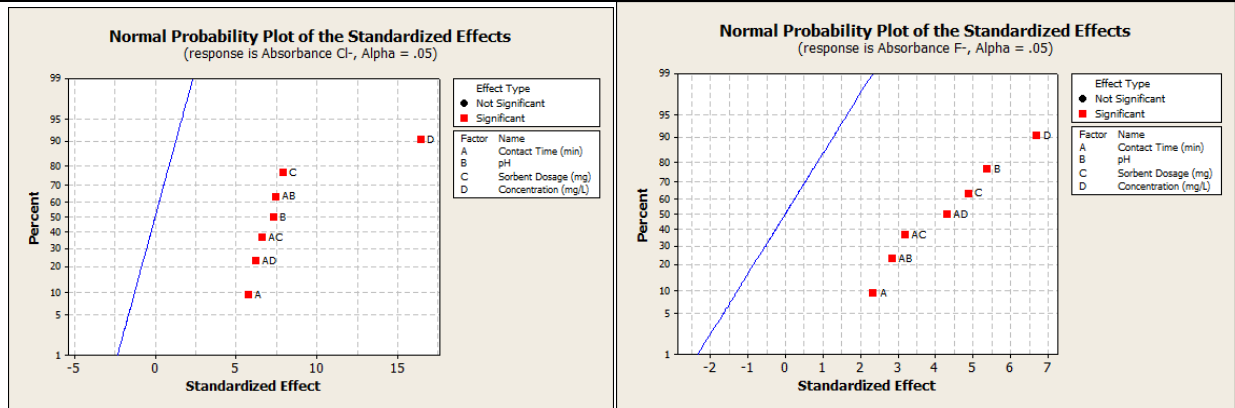


Fig.5: The normal probability plots of standardized effects of Cl⁻ and F⁻ for the eggshells

Figure 6 shows the residual plots for the yield obtained when using the eggshells waste powders. The plots probe into the distribution pattern of data points through the use of residuals. Residuals are the outcome of the difference between the observed and the fitted values (Ryan, 2006). Normal probability and histogram plots investigate whether the data obtained exhibits a standard Gaussian distribution. For normal probability plots, if the data points fall approximately along the straight line, then the residuals are said to be normally distributed, meaning the data follows the Gaussian distribution (Ziegel, 2004), which was the case for this work. A plot of residuals against fitted responses

(values) is used to detect unequal error variances and outliers, while the plot of residuals against order of the data checks for correlation of the residuals. The residuals against fitted values plot revealed a constant variance of the residuals about the center line. The plot of residuals against order of the data showed a randomized shifting pattern about the center line, signifying that the data was uncorrelated with each other. The plots for the eggshells show that the residuals were randomly distributed, hence, signifying absence of systematic errors and hence adequacy of the model.

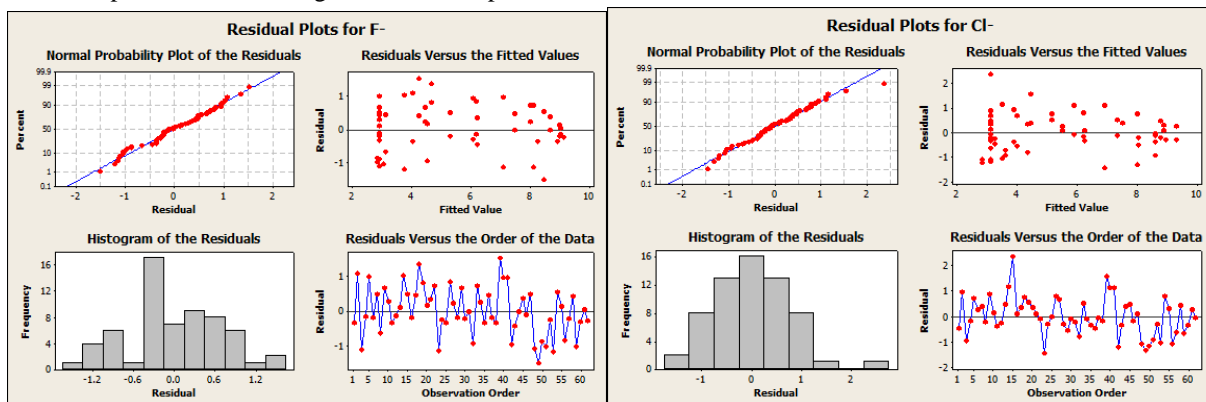


Fig.6: Residuals plots of standardized effects on the eggshells waste remains

Following the screening of significant factors using fractional factorial design, a response surface design was then created to determine the optimum conditions of each factor. This was achieved through the use of a CCD. The optimal conditions obtained for the eggshells waste adsorption of chloride and fluoride anions were 24.45 and 23.24 mg/L for the initial ions concentration respectively, the sorbents dose was found to be 85.20 mg/L (chloride) and 81.56 mg/L (fluoride), contact time, were found to be 69.37 min (chloride) and 70.28 min (fluoride) and solution

pH 7.19 (chloride) and 7.97 (fluoride). Furthermore, the regression coefficient, R^2 , was also used to assess the fit of the model to the experimental data which were 0.9901 (Cl⁻) and 0.9891 (F⁻). The relative standard deviations (RSD) for the experimental data were obtained to be 1.4% (Cl⁻), and 2.21% (F⁻).

Application of the Optimized Eggshells Waste Adsorption Method to Real Samples

After determining the optimum parameters, the parameters were applied in a 100 mL of the wastewater sample and the resulting solution was analysed using IC. Figure 7 below represent the percentage removal of chloride ($80.70\% \pm$

2.01%) and fluoride ion ($93.18\% \pm 1.67\%$) from real wastewater samples. The eggshells waste showed excellent removal efficiency towards the selected anions.

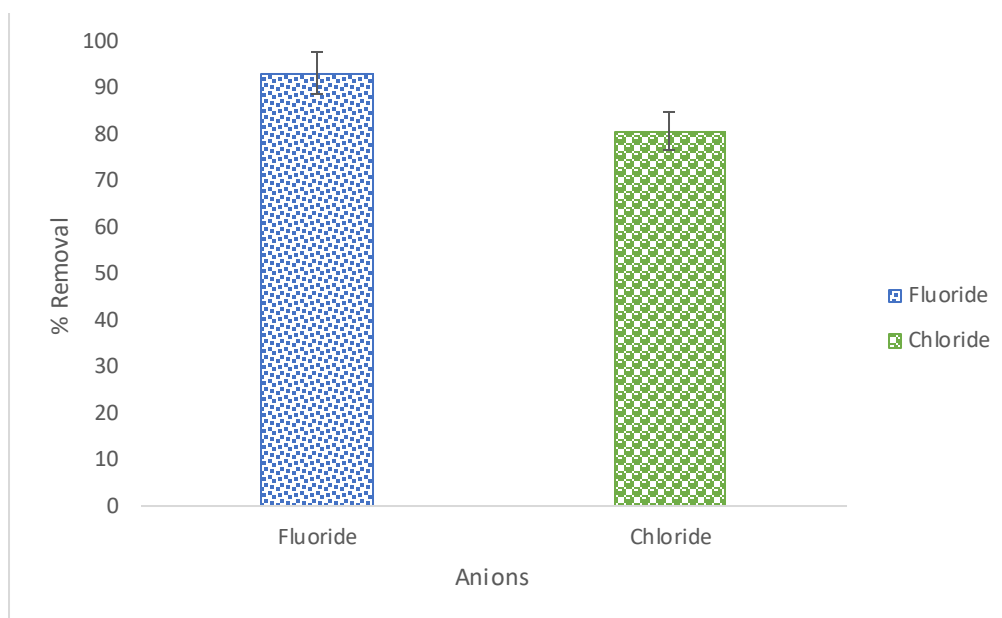


Fig.7: Percentage removal of chloride and fluoride anions from wastewater sample

Adsorption Isotherms

Adsorption isotherms show the distribution of solute between the liquid and solid phases and can be described by several mathematical relationships such as the standard Langmuir and Freundlich and Dubinin-Radushkevich models as described above. The linearized Langmuir and Freundlich adsorption isotherms as well as Dubinin-Radushkevich model obtained for the eggshells waste are shown in the Table 2, with the values of linear regression coefficients. In view of the values of the linear regression coefficients, Langmuir model fits very well to the sorption data in the studied concentration range studied. The higher the b , the higher is the affinity of the adsorbent for ions. q_{\max} can also be interpreted as the total number of binding sites that are available for adsorption and q_e as the number of binding sites that are in fact occupied by the ions at the concentration C_e (Umpleby et al., 2001). According to Table 2, the affinity order of the eggshells is $Cl^- > F^-$. The constant K and $1/n$ were determined by linear regression from the

plot of $\log q_e$ against $\log C_e$. K is a measure of the degree or strength of adsorption. Small value of K indicates the more adsorption (Whitcombe, Martin, & Vulfson, 1998) while $1/n$ is used as an indication of whether adsorption remains constant (at $1/n = 1$) or decreases with increasing ions concentrations.

The Langmuir constants of q_{\max} and b were determined from $1/q_e$ versus $1/C_e$ plot. The applicability of Langmuir isotherms implies that monolayer adsorption exists under the experimental conditions. The Langmuir isotherm constants do not explain the chemical or physical properties of the adsorption process. However, the mean adsorption energy (E) calculated from the D-R isotherm provides important information about these properties (Pamukoglu, 2008)(Branger, Meouche, & Margailan, 2013). The adsorption energies are less than 2 kJmol^{-1} suggesting that the sorption process was dominated by physical forces at all studied temperatures.

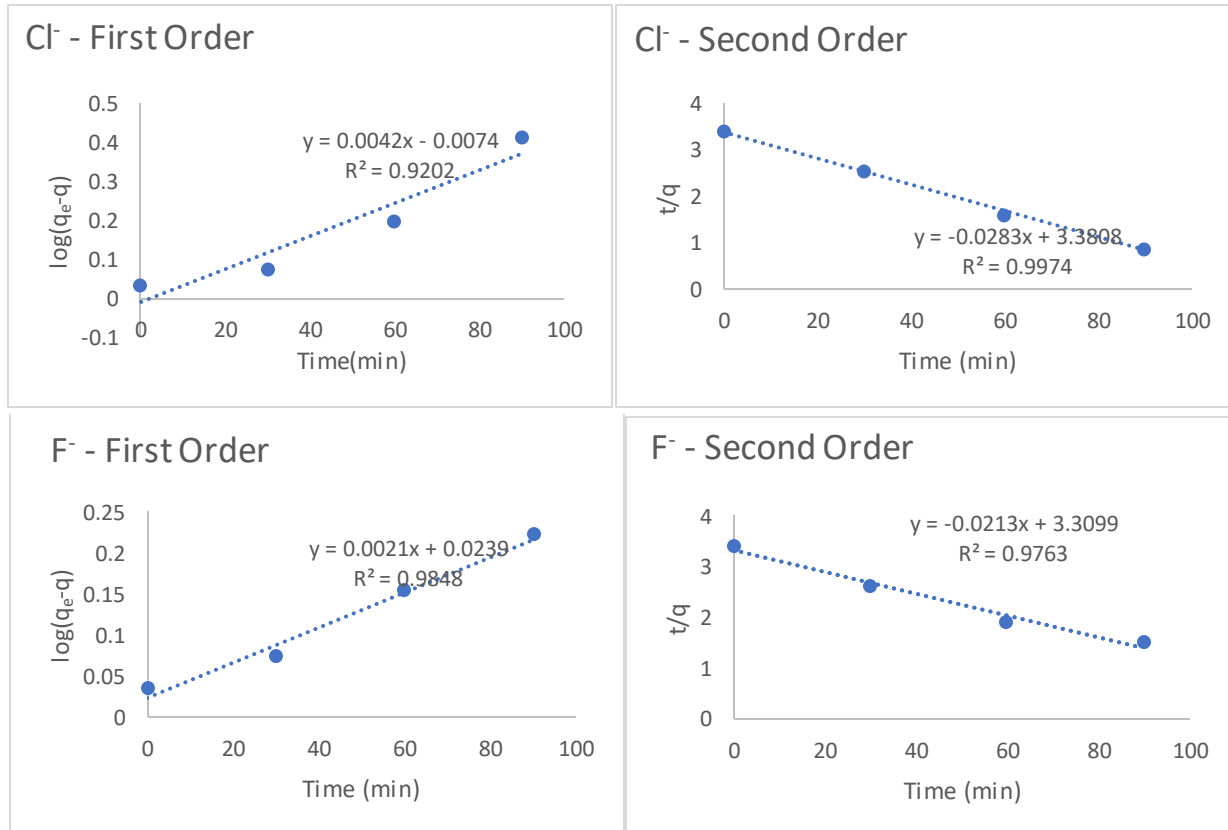
Table.2: Isotherm parameters for the adsorption of chloride and fluoride anions unto the eggshells waste remains

Ions	Langmuir Model				Freundlich Model			Dubinin Radushkevich Model		
	Temp. (K)	R ²	q _{max} (mg/g)	b (L/mg)	R ²	K	1/n	R ²	E (J/mol)	q _{max} (mg/g)
F ⁻	298.15	0.959	30.12	0.14	0.6557	0.46	1.02	0.9918	338.85	16.09
	308.15	0.9761	44.07	0.05	0.8516	0.72	1.11	0.9448	485.80	15.59
	318.15	0.8857	14.35	0.18	0.788	0.74	0.88	0.9445	584.91	17.68
	333.15	0.9907	1.30	0.45	0.91	0.89	1.15	0.9352	1125.10	17.50
Cl ⁻	298.15	0.9628	32.26	0.14	0.6395	0.44	1.03	0.9464	325.45	15.68
	308.15	0.9715	31.15	0.08	0.8464	0.72	1.07	0.9873	492.38	15.15
	318.15	0.9417	17.39	0.12	0.8718	0.86	0.92	0.9024	638.17	18.18
	333.15	0.9908	36.08	0.00	0.9548	1.31	1.01	0.9267	977.47	17.10

Adsorption Kinetics

The comparison of experimental sorption capacities (q_{exp}) and the predicted values (q_{cal}, k₁, k₂, k_d, R²) from pseudo first order, pseudo second order and intra particle diffusion constants are given in Table 3 eggshells waste. The pseudo first order (plot of log(q_e-q) vs. t) was not satisfactory to explain the experimental data, whereas the calculated, q_{cal}

values derived from the pseudo second order model for sorption of the selected ions were very close to the experimental (q_{exp}) values. The second order equation (plot of t/q vs. t) appeared to be the better fitting model than first order and intra particle diffusion equations because it has higher R² value as shown in Figure 8 (Abd. Hadi, A. Rohaizar, & Sien, 2011)(Ikram et al., 2016).



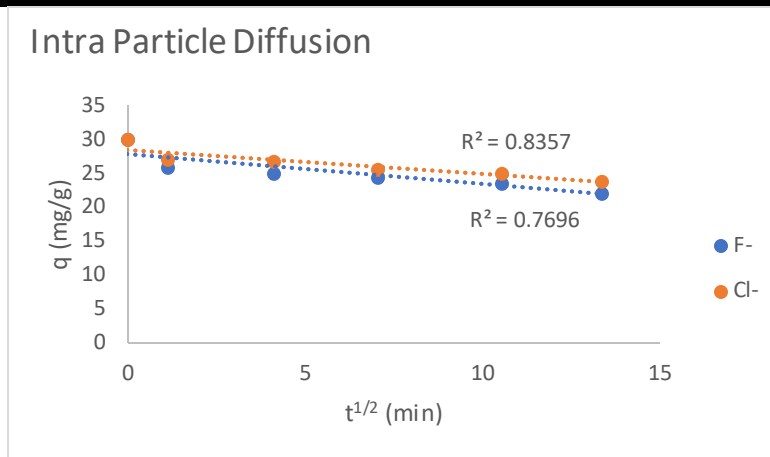


Fig.8: Pseudo first and second order adsorption kinetic and intra particle diffusion of the eggshells waste remains

Table.3: Kinetics parameters for the adsorption of the selected ions onto the eggshells waste remains

Ions	q_{exp} (mg/g)	Second Order			First Order			Intra Particle Diffusion	
		R^2	K_2 (g mg ⁻¹ min ⁻¹)	q_{cal} (mg/g)	R^2	K_1 (min ⁻¹)	q_{cal} (mg/g)	R^2	K_d (mg L ⁻¹ min ^{-1/2})
F ⁻	12.46	0.9763	0.012	13.66	0.9848	0.017	0.12	0.7539	0.289
Cl ⁻	12.02	0.9974	0.002	12.53	0.9202	0.023	0.18	0.7208	0.262

Thermodynamics Parameters

The results of these thermodynamic calculations are shown in Table 4. The negative values for the Gibbs free energy for all the selected ions, show that the adsorption process is spontaneous and that the degree of spontaneity of the reaction increases with increasing temperature. The overall adsorption process seems to be endothermic ($\Delta H = 39.37$, and 53.26 kJmol⁻¹ for Cl⁻ and F⁻ respectively). Table 4 also shows that the ΔS values were positive (which implies that entropy increases as a result of adsorption). This occurs as a result of redistribution of energy between the adsorbate (chloride and fluoride anions) and adsorbent (eggshells

waste powder). Before adsorption occurs, the anions near the surface of the adsorbent will be more ordered than in the subsequent adsorbed state and the ratio of free anions to anions interacting with the adsorbent will be higher than in the adsorbent state. As a result, the distribution of rotational and translational energy among a small number of ions increase with increasing adsorption by producing a positive value of ΔS and randomness will increase at the solid solution interface during the process of adsorption. Adsorption will occur spontaneously at normal and high temperatures if $\Delta H > 0$ and $\Delta S > 0$.

Table.4: Thermodynamic parameters for the adsorption of chloride and fluoride anions onto the eggshells waste remains

Ions	Temp. (K)	b (L/mol)	ΔG (kJ/mol)	ΔH (kJ/mol)	ΔS (kJ/molK)	R^2
F ⁻	298.15	1398.97	-17.96	39.37	0.2744	0.9917
	308.15	2904.89	-20.43			
	318.15	4193.82	-22.06			
	333.15	7421.09	-24.68			
Cl ⁻	298.15	2789.38	-19.67	53.26	0.4366	0.9871
	308.15	7119.08	-22.73			
	318.15	14589.71	-25.36			
	333.15	26656.39	-28.23			

IV. CONCLUSION

In this paper, an attempt to employed eggshells waste remains as an ecofriendly adsorbent for removing fluoride and chloride anions from wastewater was achieved. Adsorption studies were developed and evaluated. These studies demonstrated that pH, sorbent dose, contact time and concentration are significant factors in adsorption. The use of eggshell waste remain was found to be a green method therefore conserving the environment. Eggshells waste remains were proposed as cheap, easily available and efficient method for removal of chloride and fluoride anions from the environment. The adsorption isotherm was more satisfactorily fitted with Langmuir isotherm model. The thermodynamics various kinetics models including the Pseudo-first-order, Pseudo-second-order and intra particle diffusion constants of the adsorption process, ΔH , ΔG and ΔS were evaluated. The results showed that the adsorption of nitrate and nitrite ions onto activated carbon was endothermic and spontaneous. The adsorption data followed second-order kinetics supporting that chemisorption process was involved.

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Technology, culture and citizenship in education for creative economy in Brazil: the case of the NAVE Project in Rio de Janeiro

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Abstract— *The aim is to examine how the NAVE Project in Rio de Janeiro was able to develop and stimulate capacities for creative economy in its students, despite the socioeconomic and political crises Brazil and the state of Rio de Janeiro face. Based mainly in the theoretical work of Araya (2010), Venturelli (2000) and Hearn & Bridgett (2010) and following the methodological steps of Sécca & Souza (2009) with bibliographic and document research of NAVE Project in the city, we argue that the full-time activities carried out by NAVE intertwine technology, cultural activities and citizenship with the school life and encourage students to critically appropriate the main languages and techniques for creative economy. The conditions of possibility for this are, in this case, connected to the construction of partnerships between the government and the private sector, which can bring alternatives for funding activities in times of political and economic crises. However, as these partnerships face many difficulties to be constructed and maintained in many parts of the country, NAVE also develops low-cost and no-cost teaching activities which can be applied by professors in other public – and also private – schools in Brazil and develop transdisciplinarity among the technical / scientific, cultural and business pillars of creative economy.*

Keywords— *Creative Economy; Brazil; Rio de Janeiro; NAVE Project; Education.*

I. INTRODUCTION

The capitalist society has been going through multiple transformations, such as the transition from materialistic to post-materialistic values, which can be seen in the

attendance of aesthetic and intellectual needs of individuals and the emergence of the knowledge society. In the context of the fourth Industrial Revolution, an economy based on the intensive use of capital and labor changed into one in which capital is based on people's intellectual resources (Bendassolli et al., 2009).

In the core of this “new economy”, it is possible to identify several diversified activities based on individual and collective talents or abilities, such as crafts, fashion, the classic cultural industries – audio-visual, music and book sectors – and the new software and games sectors (Miguez 2007). These industries can be included into what can be called “creative economy”, which refers to activities that encompass the production, distribution and fruition of “goods and services based on texts, symbols and images and a diverse set of activities guided by the creativity, talent or individual ability” (Jesus & Kamlot, 2017).

“Creative industries”, which are parts of creative economy, are related not only to a transformation of sociocultural values in the capitalist economy, but also to development policies, especially on issues related to innovation and originality of ideas, an educational system that stimulates creative freedom and independent thinking, incentives for state and private investments in research and additional access to sources of capital for creative business (Venturelli, 2000). Creative economy also highlighted the need for collaborative networks and models, as well as the development of new technologies to produce creative goods and services and generate creative content. These changes not only gave the consumers freedom to search for creative products in a more autonomous way, but also brought

possibilities for the generation of income and jobs, the extension of access to cultural goods and services and the promotion of social inclusion, especially in underdeveloped and developing countries (Reis, 2008).

Education plays an important role in the development of creative and innovative skills. The educational process for creative economy is usually based on a multidisciplinary perspective and inclusiveness, entrepreneurial attitudes, social and communication skills, understanding of sociocultural dynamics and market and political analysis. This process results from the development of structural changes in the capitalist production, especially the greater relevance of information and communication for its development; the growing importance of globally fragmented production in continuous cycles of innovation and creativity; and the emergence of alternative production centers all around the world (Araya, 2010).

However, there are limited possibilities for the development of capacities for creative economy in Brazil, especially in high schools. Interdisciplinarity and transversality of the acquired knowledge by students is rarely stimulated. The development of artistic and critical aptitudes and the investment in disruptive and incremental innovation are usually replaced by the transmission of acritical knowledge for students, necessary for them to enter university and reproduce the logic of an industrial system based on the development of technical competences which marginalize creativity and critical notions of citizenship. Besides the problems in the organization of the educational curriculum for high schools in the country, there are also issues related to public education institutions, especially those associated to corruption and misuse of funds for education by politicians and businessmen (Jesus & Dubeux, 2018).

Nevertheless, there are some examples which show possibilities to develop alternative models that can strengthen the students' technical, creative and critical abilities, necessary for the development of creative economy in Brazil. One example is the Advanced Educational Center Project – NAVE, its acronym in Portuguese –, a program oriented to the research and development of educational solutions using the communication and information technologies in high school and educating students for professions in the digital area. NAVE was developed by Oi Futuro – a creativity and innovation institute led by Oi, a telecommunication company – in partnership with the State Departments of Education of Rio de Janeiro and Pernambuco. The initiative is structured on three pillars: the offering of a vocational

education integrated with the regular high school education at state public schools; the development of research and innovation activities and the dissemination of methodologies and practices developed by the program (Oi Futuro, 2018).

The NAVE schools in the cities of Rio de Janeiro and Recife – capitals of Brazilian states of Rio de Janeiro and Pernambuco, respectively – currently have 960 students and 100 educators. The student education contemplates a basic cycle in the first year of the program, when the offered technical vocational courses are presented. In the second year, the students decide for specific education formation in script preparation, social media, multimedia, and game programming areas. The NAVE School in Rio de Janeiro – the José Leite Lopes state school, in the neighbourhood of Tijuca – drew the attention of Microsoft, which, in 2009, chose the Rio school as one of the 30 most innovative schools worldwide. In 2010, NAVE was elected as a “Mentoring School”, within Microsoft’s Innovative School Programs (Oi Futuro, 2018).

The aim of the article is to examine how the NAVE Project in Rio de Janeiro was able to develop and stimulate capacities for creative economy in its students, despite the socioeconomic and political crises Brazil and the state of Rio de Janeiro face. Based mainly in the theoretical work of Araya (2010), Venturelli (2000) and Hearn & Bridgett (2010), and following the methodological steps of Sécca & Souza (2009) with bibliographic and document research of the NAVE Project in the city, we argue that the full-time activities carried out by NAVE intertwine technology, cultural activities and citizenship with the school life and encourage students to critically appropriate the main languages and techniques for creative economy. The conditions of possibility for this are, in this case, connected to the construction of partnerships between the government and the private sector, which can bring alternatives for funding activities in times of political and economic crises. However, as these partnerships face many difficulties to be constructed and maintained in many parts of the country, NAVE also develops low-cost and no-cost teaching activities which can be applied by professors in other public – and also private – schools in Brazil and develop transdisciplinarity among the technical / scientific, cultural and business pillars of creative economy.

II. METHODS

Following the methodological steps of Sécca & Souza (2009) for the analysis of education in Brazil, the bibliographic research consisted of reading, selecting and

organizing topics on the general causes of the difficulties in the promotion of education for creative economy in Brazil – especially in Rio de Janeiro – and the possibilities to overcome these challenges. The next step was the analysis of documents related to the NAVEProject in Rio de Janeiro, drawn from its official channels of communication and media. The analysis of the results focused on the ways capacities for creative economy are developed and stimulated in the students at the Rio's school, despite the economic and political crises Brazil and the state of Rio de Janeiro face.

III. RESULTS AND DISCUSSION

Creative economy and education in Brazil

If educational systems are capable to fill the creative economy demands, they need to develop specific skills in the teaching practice. With the greater economic relevance of cultural and creative resources, developing countries such as Brazil needed to rethink the foundation of knowledge in their educational systems from a model based in the preparation of a standardized labor force to a more flexible one, which interconnects knowledge about the development and use of innovation to solve problems in the professional area and the society, business practices and critical political and social thought (Florida, 2002, 2005).

In this sense, advanced intellectual and creative skills that connect interdisciplinarity and independent thinking are required from the earliest stages of the educational process and in secondary education. With the promotion of linkages among arts, humanities and sciences, such skills can be activated by methodologies that incorporate technologies and extraclass cultural activities into the educational process and stimulate independent actions, creative and imaginative engagement and research skills by students to produce innovation (Venturelli, 2000).

To achieve this, the educational process for creative economy should aggregate technical / scientific, cultural / creative and business pillars. The two former pillars are relevant because they allow the insertion of new topics of knowledge in creative sectors and the latter one turns them into products and services valued by the market and society (Hearn & Bridgett, 2010). However, it is important to highlight that the development of creativity by students also incorporates the valuation of traditional knowledge and practices –to think critically about past problems and imagine possible solutions for the future – and the formation of critical thinking in the light of political-economic and socio-cultural dynamics. The proposed interconnectedness goes hand in hand with the idea that collaboration on multiple platforms may lead to learning

and innovation based on collective intelligence networks that stimulate cooperation and innovation. The shift from the Fordist learning systems to systems based on experience, participation and talent development encourage students to become social agents and allow the interconnection among varied disciplines and critical and creative skills (Araya, 2010).

The Brazilian government recognizes that education is fundamental to creative infrastructure. For example, the National Education Plan indicates that, instead of understanding learning in terms of fixed objects transferred from one generation to another, it becomes necessary to define educational systems that support knowledge and learning in continuous cultural innovation. However, the same Plan makes clear that Brazilian educational system did not effectively deal with innovation, since it was extremely based in an industrial model and focused on a reproductive logic. Although the problem is recognized by many Brazilian authorities, the educational infrastructure does not give enough attention to interdisciplinarity and transversality of the acquired knowledge by students. The Plan does not show ways to promote them in schools or how to strategically develop transdisciplinarity since the earliest stages of the educational process (Jesus & Dubeux, 2018).

The now extinct Secretariat of Creative Economy emphasized the relevance of the stimulus to transversality, which meant bringing together concepts related to cultural, technological and business areas (SEC, 2012). However, the educational model of the industrial age still prevails. The difficulties of ownership due to cost and regulatory problems regarding new technologies are connected to a gap in the stimulation of technological skills in students and the marginalization of students' critical thinking and creativity in the teaching process (Reis, 2008).

It is also important to state that the lack of investment in creative economy is also motivated by the economic and the political crises Brazil faces, particularly the state of Rio de Janeiro. The elements make more difficult the development of transdisciplinarity and the access to innovation for creative sectors for great part of the Brazilian population. Regarding the first crisis, given the fall in the price of commodities of which Brazil remains extremely dependent, policies to encourage consumption continued in force by Brazilian government, but the side effect of this was an imbalance of public accounts, which undermined Brazilian credibility and limited the amount of money to invest in strategic sectors, such as education (Jesus & Kamlot, 2017). In the light of this reality, it became harder

to finance projects for the development of artistic and critical aptitudes in students and innovation, which would benefit not only companies, but the society in general. It would also be important to reduce Brazil's dependence on commodities.

However, the chaotic economic reality is combined with the political crisis motivated by corruption, structured in the public apparatus through the creation of personal networks and internalized in state's policies. The crisis became worse with the intensification of these personal networks, which have come to public notice even more since the beginning of the 2010s due to the greater performance of the Federal Police in investigating such cases, the greater action of the Judiciary in the punishment of politicians and businessmen involved in corruption cases and greater information brought by the media about the numerous events of corruption (Filgueiras, 2009). Nevertheless, with less resources because of misuse of public funds, the chances for investment in creative economy education became more difficult.

In the specific case of the state of Rio de Janeiro, the economic recession – coupled with the slowdown in the activities of the oil industry and the fall in tax revenues – led to the growing pauperization of the population, which was further exacerbated by the corruption spread by the political apparatus. This spread became evident from the arrest of former governor Sérgio Cabral Filho in 2016 in the context of Lava Jato Operation, as well as former secretaries and five of the seven Counselors of the Court of Auditors. The situation has led not only to a shortage of state officers' salaries, but to the gradual collapse of state government programs, such as Emergency Care Units (UPAs, their acronym in Portuguese) and Pacifying Police Units (UPPs, their acronym in Portuguese) in 2017. The chaotic situation of Rio de Janeiro – especially in its capital – complicates the access of students to schools because of the violence in many communities. Many of these students are not able to complete their educational formation because they must enter the job market earlier, in subaltern positions, or even see better opportunities of life working for drug cartels, for example.

However, when a country like Brazil must deal with economic crisis, innovation becomes necessary to boost economy recovery, and creative industries may also contribute to the creation of job and income opportunities (Li, 2013). The linkage of creative competencies into current educational programs, the encouragement of the interaction between technical schools and social initiatives and the strengthening of incubators and research centers in

creative economy have an essential role in the process of recovery. In some parts of the country, it is possible to see that public and private institutions have been dedicated to intensifying the relationship of creative economy to innovation to support creative endeavors through partnerships with schools and universities and the stimulus to incubators and creative education centers. This favors local and regional development in the basis of a “triple helix”, which engages the government, the market, and the education institutions in efforts for the development of capacities for creative economy. The private sector can show its commitment to social development by funding activities for the formation of creative professionals – especially in times of political and economic crises –, because this is not only positive for the companies themselves, but for the creation of qualified workforce for the general markets in which these companies operate and the society in the light of the promotion of social inclusion through the creation of job and income opportunities (Etzkowitz, 2009).

In the development of the “triple helix”, the three actors – the government, the market and the education institutions – interact across boundaries in the first phase, and their interaction is mediated by organizations and contractual offices. In the next phase, the helixes are defined as different communication systems. The interfaces among them operate on a distributed mode that produces potentially new forms of communication, such as in cases of technology transfer. In the third phase, the institutional spheres of the educational institutions, industry / business and government, in addition to performing their traditional functions, assume the functions of others, with the education institutions playing the role of regional or local organizers of innovations (Leydesdorff & Etzkowitz, 1998). When they refer to “education institutions”, Leydesdorff & Etzkowitz (1998) focus on the role of universities. However, in the case of this article, we recognize the necessity to extend the reflection to basic and secondary education, because, at these levels, the students can start developing their creative and technical abilities and critical thought and produce results that not only attend the market interests, but also strengthen their opportunities for social inclusion.

Education in Brazil and Rio de Janeiro

The 1996 Guidelines and Bases of Education Act establishes that it is the state's duty to guarantee minimum standards of quality of education, defined as the minimum variety and quantity, per student, of indispensable inputs to

the development of the teaching-learning process (Brazil, 1996). According to the General Coordinator of the National Campaign for the Right to Education, Daniel Cara, the Brazilian state, through several governments, has not given priority to financing the sector. As an example of this scenario, Cara points out that, since 2010, the National Education Council has unanimously standardized investments, but to date the decision has not been ratified. The mechanism translated into values Brazil needs to invest per student each year, in every stage and modality of public education. The purpose is to guarantee at least a minimum quality standard of education. The mechanism of standardized costs was included in the National Education Plan (PNE, its acronym in Portuguese) and should have been implemented by June 2016, which did not occur. With the constitutional amendment that limited the ceiling on public spending, Cara estimates that PNE's effectiveness is even more distant. He highlights that the tendency is under-investment and the permanent inability to supply structural inputs. According to the 2017 School Census by the Ministry of Education (MEC, its acronym in Portuguese), the presence of technological resources such as computer labs and internet access is still not a reality for many Brazilian schools. Only 46.8% of primary schools have a computer lab; 65.6% of schools have access to the internet; in 53.5% of schools, the internet is broadband. The Institute for Research and Administration in Education has recommended reforms, including extending the school period, investing in technology, fostering job stability for teachers, increasing efficiency in school management, and implementing appropriate policies from the federal to the municipal level. However, many measures seem improbable in the light of the limitation of resources for education in the country (Martins, 2018).

The state of Rio de Janeiro is one of the places in the country with the greater number of public schools. Its capital has more than 1,000 municipal schools. However, the quality of education in Rio de Janeiro has been the cause of frequent student protests, such as the March 2016 protest, in which students occupied public schools to demand higher standards of education and better conditions of learning. Between 2014 and 2015, the state of Rio de Janeiro also had a 72% drop in investment in infrastructure and maintenance. There was also no school building by the state government of Rio de Janeiro during this period, despite the promise of 177 new public schools by 2015, made before the 2014 World Cup. In case of the city of Rio de Janeiro, a survey conducted by the Municipal Department of Education in 2011 found out that 62% of the municipal school infrastructure was "poor or bad" (Longaigh, 2017).

Despite the national and state problems, the Common National Curriculum Parameters document for Secondary Education – whose approval is expected to happen through 2018 – suggests some practices that should be adopted by schools all over the country and adapted to different contexts. The document indicates the organization of knowledge into three fields of knowledge, namely Languages, Codes and Related Technologies; Natural Sciences, Mathematics and Related Technologies and Human Sciences and Related Technologies. This is grounded upon the clustering of types of knowledge that share a given subject of study and, therefore, communicate more easily, thus creating the conditions required for school practice to evolve into an interdisciplinary approach (Ministry of Education, 2018). The general competences, valid for basic education, should be strengthened in secondary education. They are indicated in Table 1, based on information provided by NAVE's Innovative Pedagogical Practices' Guide (NAVE, 2018).

Table.1: Competences to be developed, according to the Common National Curriculum Parameters

Competences	Description
Scientific and Creative Thinking	To exercise intellectual curiosity and make use of the sciences' own approach, including research, reflection, critical analysis, imagination and creativity to investigate causes, elaborate and test hypotheses, formulate and solve problems and create solutions (including technological ones) based on the knowledge from the different areas.
Communication	To use different languages – verbal, body, visual, sound and digital languages –, as well as knowledge of artistic, mathematical and scientific languages to express and share information, experiences, ideas and feelings in different contexts and produce meanings that lead to mutual understanding.
Digital culture	To understand, use and create digital information and communication technologies in a critical, meaningful, reflective and ethical manner in diverse social practices

	(including school ones) to communicate, access and disseminate information, produce knowledge, solve problems and play a leading role in personal and collective life.
Argumentation	To argue based on reliable facts, data and information to formulate, negotiate and defend common ideas, views and decisions that respect and promote human rights, social-environmental awareness and responsible consumption at the local, regional and global levels, with an ethical position in relation to self-care, other people and the planet.
Life project	To value the diversity of cultural knowledges and experiences and appropriate knowledge and experiences that enable people to understand the relations of work market and make choices aligned with the exercise of citizenship and their life projects, with freedom, autonomy, critical awareness and responsibility.
Self-knowledge	To know, appreciate and care for own physical and emotional health, understand other people in human diversity and recognize the one's and others' emotions, with self-criticism and ability to deal with them.
Empathy and cooperation	To exercise empathy, dialogue, conflict resolution and cooperation, promote respect for others and human rights, welcome and value the diversity of individuals and social groups, their knowledge, identities, cultures and potentialities, with no prejudice of any kind.
Cultural repertoire	To value and enjoy the diverse artistic and cultural manifestations, from the local to the worldwide ones, and participate in diverse practices of the artistic-cultural production.
Responsibility and autonomy	To act personally and collectively with autonomy, responsibility, flexibility, resilience and determination, making decisions based on ethical, democratic, inclusive, sustainable and solidary principles.
Knowledge	To value and use historically constructed knowledge about the physical, social, cultural and digital world to understand and explain reality, continue to learn and collaborate to build a fair, democratic and inclusive society.

The NAVE Project pedagogical practices in Rio de Janeiro

The analysis of the documents produced by the actors involved with the NAVE Project in Rio de Janeiro showed how the pedagogical project developed at the José Leite Lopes state school focused on the development and stimulation of capacities for creative economy in the students, despite the economic and political crises in the country and the state. To explore the possibility of the digital world, one of the projects developed by NAVE in Rio de Janeiro was the use of Facebook as a tool to verify the students' presence in the classroom and still open a virtual discussion with the class members, which awakens in the students a critical, reflexive and ethical understanding of information and communication technologies. The social network not only concentrates technical academic tasks in a closed Facebook's group formed by the teacher and the students, such as the verification of students' presence, but brings a collaborative knowledge space. The teacher can post contents related to the discipline relevant to the students, including links to texts, videos and news. The

digital environment becomes not only a repository of the discipline's works and tasks, but students are invited to have a main role in the virtual environment. Beyond the delivery of academic work, they promote interactions beyond the class time, and teachers can use the virtual environment to make diagnostics, useful for the planning of the future classes. A poll with the students in the group is a good way to evaluate their interests and prior knowledge about certain topics. Another suggestion is fun or riddling advertisements that stimulate the curiosity of the students on the theme of the following class. The virtual platform could also be used to communicate school news. The students became more engaged in the subjects of the disciplines, improved the self-management of the proposed tasks and works and participated in the exercises in a more qualified way. All records made by the teacher and the class on the virtual platform formed a memory of the course lived in the discipline, which is significant for the development of the evaluation processes. Regarding the use of technology, the digital games programming activities bring interactive

exercises that simulate the programming of traffic lights. Through the experiment, students learn the basics of robotics and develop computational thinking. The activity puts students in touch with the basic concepts of logic, electronics, physics and chemistry. The activity works on experimenting, launching challenges and structuring problem-based learning and brings elements of the programming language to the classroom, in addition to being an important qualification for the job market. Living this experience with computing science brought students to other processes of research and experimentation at the school. For example, in geography, students associated the debate on energy with the creation of a robotic artefact, which lit some LEDs when the user blew a weathervane, simulating the operation of wind energy (NAVE, 2018).

Many pedagogical practices developed in the scope of the NAVE Project are low-cost and no-cost teaching activities which can be applied by professors in other public schools with no use of digital technologies (Venturelli, 2000). In the return to “analogic tasks”, one of the proposed practices is called “baby steps”, in which the teacher structures a process for students to better develop activities of medium or high complexity. Students are invited to follow a path organized by themselves or the teacher in simpler and more orderly logical steps. When they finish every small step, they advance to the following one more easily, with more motivation and understanding the prerequisites and interdependence between the stages of the exercise. A math teacher may, for example, present a problem to students that will require the resolution of various equations. In this case, the teacher should suggest this resolution in small steps, orient first to isolate variables, then solve the formulas in the parentheses. A Portuguese language teacher can ask the students to elaborate a dissertation. The teachers indicate that students must choose and write the topic first, then write a sentence that summarizes the approach they want to use, create a list with all the arguments, and ultimately transform these arguments into paragraphs. Students are encouraged to complete all the steps. But even when they cannot reach the desired results, they can present part of the process to the teacher. In these cases, students may have a clear idea of what prevented them from continuing, how much they were lacking for the completion of the activity and may still think of more effective strategies for finalizing the work (NAVE, 2018).

Artistic expressions may work with contents related to self-knowledge, empathy, dialogue, cooperation and respect. For example, the debates on the roots of black music not only creates a dance ball in school, but historical

issues are brought into discussion, such as the urgent and fundamental debate on racism in Brazilian society. The work with Brazilian popular music and popular books for young people may help the study of history connected with other areas of knowledge, such as literature. In the activity called “Drummond in pieces”, students read passages of poems and thoughts of the Brazilian poet Carlos Drummond de Andrade and participate in a meeting to debate artistic issues. The aesthetic and sensorial experimentation base studies on the author’s work. The stages of Drummond’s production are presented to the students as well as the aspects of these stages. The activity is performed in the school library, with the class organized in a large round of discussion and the clippings with the texts are scattered in the center, with the written face down. Each student must remove a paper cut and a round of reading is done. They are invited to cheerfully declaim the passage and make a free comment. Students are encouraged to talk about the work and about themselves, what they feel when reading and how the author’s words can affect them. After everyone hears the “patchwork” of the poet’s work, a biography of Drummond is presented, relating the historical context to the characteristics of each phase of his work. Then the analysis of the fragments of the texts is resumed, now in a more qualified way. Each student is asked to reflect on the passage that is in their hands and try to identify characteristics related to the phases of Drummond’s literary production. They are oriented to “dissecting” the fragment, identifying and highlighting expressive features such as language figures and punctuation (NAVE, 2018).

In the activity “Funk is culture”, students are invited to relate Philosophy and carioca funk. Issues related to funk culture that have a strong impact on youth formation – such as violence, sexuality, gender issues and prejudice – are discussed. Students reflect on the relationship between aesthetics, art and the cultural industry. Then they prepare lectures on funk for the whole school, with the knowledge built up throughout the process. A funk ball is held at the end of the lecture cycle. Using a musical manifestation that is part of the students’ culture made engagement and motivation possible. The practice also made them think about social prejudice in relation to some areas of the city, such as the favelas, making connections with the reflections on aesthetics. As many students live in these communities, this was also a time to reflect on their own aesthetic experience. In the “Zé’s Round” activity, students participate in a series of creative processes and sensory experimentation with black dance, afro cinema and pop culture workshops, poster creation and musical

composition. The understanding of other cultures is stimulated in the activity “In the other’s shoes”, in which the students know the biographies of migrants and reflect on the refugee issues. They can experience the feeling of putting themselves in each other’s shoes, empathizing and reflecting on how to deal with the differences (NAVE, 2018). The respect for difference is necessary to stimulate the contribution from many cultures to creative and critical thought (Reis, 2008).

In the discussion of aesthetics, the activity “The city through a new perspective” developed in the scope of the NAVE Project in Rio de Janeiro invites students to take another look at the city where they live. Students make photographic records, illustrations or paintings of the area where they live, as if they were foreigners. In this exercise, they are encouraged to articulate aesthetic content learned in the discipline of philosophy and stimulated to break the exclusively Apollonian beauty standards. All the students must seek other aesthetic standards, based on experience. Students may portray landscapes, public spaces, objects, buildings and monuments, among other references. Photographs, drawings or paintings can convey impressions that highlight the aspects of the territory in which they are inserted, as well as more universal references about the city. In the activity “The stories that photos tell”, students photograph everyday situations in and out of school. The combination of these images inspires, in a second moment, the creation of original stories, which will be transformed by the students themselves into small videos. Students learn how to produce a script according to the technical norms and the theoretical foundations for the construction of arguments of audio-visual works. After the construction of technical roadmaps, the students are gathered in a session for sharing the creations. Each script is read aloud and other students can give suggestions, improving the quality of each proposal. The last step of the activity is to turn scripts into videos. In these productions, students should use the photos that gave rise to the story. In addition to the images, they can insert audios, songs, dialogues, subtitles and other effects, always according to what was conceived in the script (NAVE, 2018).

To develop their ability of argumentation, students engage in activities such as “When I was 10 years old”. They are invited to write a letter for themselves imagining they were 10 years old. The proposal is to produce a letter that brings reflections and recommendations that young people feel would have been helpful to themselves when they were that age. This activity challenges young people in the construction of a narrative from a point of view

displaced in time, which mobilizes their creativity. Students also reflect on their place in the world, within a society. One way to make the sharing of content more dynamic is to ask them to exchange the texts with each other. Thus, each one reads the letter of the colleague and identifies the main themes. Everyone talks in groups and signals which issues are most recurring. Finally, students are invited to share their feelings and individual learning with the experience, reflecting on the importance of the reading. The fact of promoting sharing and debate about the contents of letters also means that the activity, in principle an individual written expression, becomes a collaborative process of textual production, which is rich in reflections on youth, the process of growth, relationships and emotions. In this activity, it is important to indicate the competences of textual coherence, spelling and grammar, argumentation capacity and comprehension of the proposed theme. In the process of learning foreign languages, in the “In English, please !” activity, the students present, in English, the final works of other disciplines. The exposure should be done as a pitching, which in business language means presenting something to someone with the goal of convincing the other to invest in that idea. It is a short presentation, very well planned and with a total focus on the audience to which it is prepared (NAVE, 2018). As Florida (2002, 2005) argues, these activities promote the interconnection of knowledge about the development and use of innovation to solve problems in the professional area and the society and business practices.

In the learning of biology and chemistry, students are engaged in an activity called “Read the label”, in which they analyse labels of processed foods and drinks consumed in their daily lives. Students work in groups and evaluate the nutritional table and ingredient list of various packages, noting and comparing the available data. The activity begins with the separation of food and drinks packaging by categories (drinks, breads, pastas, sweets and biscuits, meats, oils and margarines, breakfast cereals, grains). The teacher organizes the tables of the classroom in working islands according to these groups, which can vary from what is available. Students highlight three labels that are made up of too much of an ingredient and relate that excess to some disease. The teacher then asks students to identify the healthiest foods in the group of labels analysed by the group. When the student makes the experiments brought by this practice, he/she can compare his/her diet with the parameters of a healthy one. They can check what needs to be changed in their consumption and better identify which foods would be the sources of quality nutrients. In “History

board”, students research, identify, and experience board games and cards that relate to the contents of history. Their curiosity about the presented themes is instigated with the gamification, which can also be seen in the “Teaching literature with games” activity, in which students are stimulated to create educational games about literature. The productions are inspired by traditional popular analogue and digital games and have low cost. They can be made with recycled materials. The games, together with the texts which construct their rules, gave students the ability to create a sequence in their process of knowledge construction. The concentration and organization improved greatly, as well as their understanding and assimilation. The same can be said about the “Geography Volleyball” activity, in which the classroom is organized as a volleyball court. The class is divided into two teams, which must be positioned on opposite sides. The questions that the teacher asks functions like the ball of the game, which goes from one side of the field to the other according to the students’ correct answers. The play is, in fact, a creative oral evaluation about the studied content (NAVE, 2018).

The planning abilities are stimulated by the “Planning together is necessary” activity, which aims to involve students into the organization of a training cycle, opening space for them to collaborate with the planning of strategies and pedagogical activities of the classes of a two-month period, including contents that are of their interest. It transforms the classroom into a collaborative learning environment. The teacher must make a prior planning of the formative cycle, evaluating which contents he/she considers to be priorities and what needs to be addressed according to the curriculum in that discipline. The teacher should also organize the strategies, specially how the contents can be addressed and distributed in each class. A spreadsheet can be used to organize this planning. For each class, the following data were defined: date, content, strategies / resources, skills and abilities. In “Author track” activity, students can develop a project from four categories: audio-visual, games, application and editorial. Students organize individual study paths throughout the process and can use the curriculum’s disciplines. This is an activity that needs the support from the school management, because it is necessary to articulate the time of different teachers and disciplines. This project is part of the so-called Integrated Workshop, which brings together all the elements of the technical education, with the focus on screenplay, multimedia and programming. The students receive the proposal to develop an author project, within four possible categories: audio-visual, games, application and editorial

process. They choose the category of the project they wish to develop, being able to work in groups or individually. The strategy of engagement in this proposal lies in the flexible management of time: the student can dedicate his/her time of a certain discipline of technical education to the production and development of his/her author project (NAVE, 2018).

IV. CONCLUSION

The promotion of education for creative economy in Brazil is connected to the necessity to incorporate contents linked to creative competencies into current educational programs, as well as the encouragement of the interaction between technical schools and social initiatives and the development of research centers in creative economy (Jesus & Kamlot, 2017). However, the constructive relations between the public sector, companies and education institutions – which created the basis for the success of the NAVE project in Rio de Janeiro – sometimes cannot be replicated for other parts of the country in the light of paternalist schemes, the discontinuity in public policies related to culture and education and the lack of interest by many businessmen. In the light of the possibilities of non-consolidation of these partnerships, there is still a way to promote creative activities with low-cost and no-cost initiatives which can still bring the technical / scientific, cultural / creative and business pillars of creative economy together. These initiatives can be built on the local potential of each community, with the creation of spaces of public discussions and art exhibitions, the development of interconnected activities among disciplines, the use of case studies applied to a simulated market or a social issue to be solved by students and the stimulus to local cultural expressions (Reis, 2008).

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Interaction of Closely Spaced Shallow Foundations on Sands and Clays: A review

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Abstract— *The evaluation of the static interaction of closely spaced footings and its influence in the overall bearing capacity and settlement on sand and clay soils is addressed in this review. The work is accomplished through a comprehensive look into all relevant literature regarding the interaction of shallow foundations, assessments are made, and conclusions are drawn which will ultimately be relevant to future endeavors associated with the design and the evaluation of closely spaced shallow foundations in terms of determining the optimal spacing between footings, enhancing bearing capacity, and controlling deformation. Furthermore, the work is divided to three major approaches: theoretical studies, experimental or field tests, and numerical analysis. Each have been discussed thoroughly in details, with indicating the shortcomings of previous studies and where each approach has reached. The result of this review has showed that nearly all previous research studies explored the effect of the interaction of closely spaced shallow foundations on the bearing capacity at the ultimate failure compared to the settlement behavior which is for some reason not addressed profoundly, even though it is more critical than bearing capacity. Additionally, current regulations and codes have not devoted a major effort toward addressing the influence of closely spaced shallow foundations appropriately, especially today, where the limitation of a site and the placing of footings close together in order to accommodate structural details are becoming a more common issue.*

Keywords— *Ultimate bearing, Clay, Interference footing, Interaction, Multiple footings, Offshore, Sand, Settlement, Shallow foundations, Skirted foundations, Tilt.*

I. INTRODUCTION

A shallow foundation is defined as a structure that is responsible for transmitting imposed loads into the ground, very near to the surface rather than the lower layers of the earth. Therefore, evaluating the capability of the soil to carry loads without a remarkable displacement in the structure and the ground nearby it, is an essential step in the design process. Several theories have been established

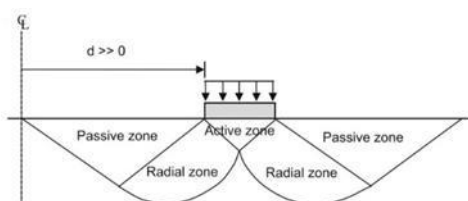
to study the behavior of shallow foundations (bearing capacity, settlement, failure surface, etc.), which are used widely in practice, are valid provided that the shallow foundations in the close proximity are isolated and no such interference does exist between footings. However, foundations encountered in practice are often closely spaced and are not separated. Consequently, the characteristic behavior of individual footings in a group will differ compared to an isolated one. In many situations such as area restrictions, the geometry of the structure, or structures near to each other force engineers to construct footings that interfere with each other to accommodate requirements. This interference quantitatively leads to excessive settlement and severe damages to the structures if not probably controlled, especially, when the distance between the footings are reduced. It should be noted that due to the massive load and limitation of a site, the interaction of closely spaced shallow foundation in the term of stress and failure zone may lead to unequal distribution of stress within the soil which affect the determination of bearing capacity and settlement of footings resting on sand or clay, when compared to single footing behavior (Shahein & Hefdhallah, 2013).

Studies of the interference of neighboring shallow foundations are relatively limited. In fact, few methods are available in the literature that accounts for this phenomenon (Mesri, 1991 and Lee et al., 2010). This problem has been addressed in three different trajectories; theoretical approach, experimental work, and numerical analysis. All studies are based on vertical and horizontal loading conditions. Recently, a couple of papers were published that consider the interference of closely spaced foundations under general loading (vertical, horizontal, and moment) to emulate offshore environment loading conditions. However, this area is still widely undefined (Fisher, & Cathie, 2003).

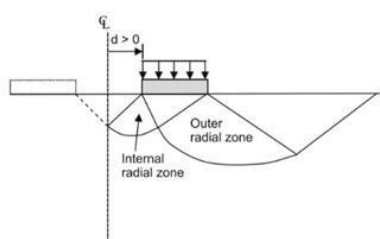
The purpose of this literature review is to investigate how adjacent spaced shallow foundations interact with each other on sand and clay soils and to report the studies that have been developed recently. To achieve this, in this paper, the results of a series of experimental tests and the results of numerical investigation are compared, and conclusions are made.

II. THEORETICAL STUDIES

The effect of closely continuously spaced foundations was theoretically examined by Stuart (1962) in cohesionless soil on the base of the limit equilibrium method. He assumed that the medium is homogeneous soil extending to great depth and the failure mechanism will have a similar geometry of that rupture assumed by Terzaghi. The rupture surface developed beneath the shallow foundation comprises of three zones; Rankine passive zone, radial zone, and triangular wedges (Fig. 1). Based on the center to center distance between the shallow foundations, Stuart (1962) concludes that as long as the rupture surfaces are only overlapping in Rankine passive zone, then there is no need to modify Terzaghi formula and should be applied directly. Nevertheless, the value settlement compared to individual footings will change at the ultimate loads. In the case if overlapping does exist in the radial zone, adjusting the bearing capacity is a necessity. For this case, Stuart introduces the use of efficiency factor (ξ) which is a function of spacing to width of the foundations and soil friction angle. Since the efficiency factor is greater than one, the ultimate bearing capacity increases as the center-to-center spacing between foundations decreases. However, settlement will be more significant than if compared to isolated foundations (Stuart, 1962). The effect of various parameters has not been considered in Stuart's assumptions; rigorous studies are required to include those parameters such as the variation of elastic modulus with depth.



(a) Failure mechanism of isolated foundation.



(b) Failure mechanism of closely spaced footings.

Fig. 1, Failure mechanism of isolated foundation and of closely spaced multiple footings (Lee & Eun, 2009).

Later, West and Stuart (1965) applied the method of stress characteristics to establish a solution for the interference of

a strip footing on sand soil. Their outcomes showed that the efficiency factor (ξ) values were smaller compared to those obtained by Stuart in 1962 (West & Stuart, 1965). The downside of their research is that they only configure a solution for a soil having friction angle of 35° (Ghosh & Sharma, 2010). Furthermore, Graham et al. (1984) investigated the interference of three closely spaced strip foundations on sand using the same method suggested by West and Stuart (1965). The results show that the method of stress characteristics is applied to designate the interference of the outer foundations on the bearing capacity of the central footing and it is not suitable theory for two closely spaced footings. This may justify why West and Stuart (1965) obtain lower efficiency factors (ξ). Kumar and Ghosh (2007) provide the failure mechanisms beneath two rigid continuous foundations coincided well with the assumption of Stuart (1965). Moreover, several types of research are reported on the bases of analytical approach, probabilistic approach, and upper bound limit analysis that the bearing capacity of neighbored foundation increases as the spacing between them is reduced (Ghosh et al. 2017).

2.1 Theory of Elasticity

Nearly all of the former research works mentioned above explored the effect of the interaction of closely spaced shallow foundation on the bearing capacity at ultimate failure. On the other hand, the settlement behavior under similar conditions was not adequately examined, yet it is anticipated to be more perilous. A case study done by Shahein and Hefdhallah (2010) showed that considering the propinquity of the surrounding shallow foundation in the determination of the settlement could change the foundation type from isolated to a raft. In the field, soil deposit can be non-homogeneous; therefore, Ghosh and Sharma (2010) conducted a theoretical study on two-layer soil by mathematically solving the equilibrium equations under the plane strain condition of two closely spaced rigid strip footings using the theory of elasticity approach. Unlike previous researchers, they took on considerations the variation of soil (sand and clay) parameters such as elastic modulus and depth of layers and pressure intensity on each footing to generalize the settlement behavior of closely spaced footings. The settlement increases at the center line of the footing as the spacing between two closely spaced foundation decreases. Fig. 2, depicts this phenomenon form a shallow strip foundation constructed at the top of two-layered soil that has the same depth at a various value of modulus of elasticity. The parameter (ξ_δ) represents the ratio of the settlement of an individual footing in the presence of another footing to the settlement of the single footing. The value of (ξ_δ) is equal to one only if the ratio of spacing between footing to the width is

greater than 4.5, which mean no interference existing among the shallow foundations. Otherwise, the interaction of closely spaced foundation must be taken on considerations to avoid catastrophic failure to any structure. Nevertheless, the developed chart for the efficiency factor (ξ_δ) could not be compared to available work on the same topic due to the lack of consensus on the parameters that match the one considered on this research (Ghosh & Sharma, 2010). However, three issues found in their research; first, the poisson's ratio is assumed to be constant for both layers. Second, the soil is also assumed to behave linearly elastic with depth. Finally, the load is applied in way such that no plastic deformation is experienced by the soil.

interaction of two asymmetric closely spaced footings has not been attentively addressed in previous research papers. Because of this, two horizontal strip footing resting on a dry homogenous soil deposit was studied by Ghosh, Rajesh, & Chand in 2017 using Pasternak soil model. The reason to adapting this model is due to its strong implementation capability. In their study, the soil obeys both linear and nonlinear elasticity behavior. Fig. 3, shows the model used in by Ghosh et al. The objective of their study is to investigate the interaction of asymmetric strip footings, noted as left and right footing, positioned close to each other at spacing, S, on the surface of a homogeneous soil layer and report the finding in term of interaction factors (ξ_L and ξ_R) for the footings with respect to the settlement. ξ_L and ξ_R are defined as follow based on Ghosh et al;

$$\xi_L = \frac{\text{Average settlement of the left foundation in existence of the right foundation}}{\text{settlement of the isolated foundation (left)}}$$

$$\xi_R = \frac{\text{Average settlement of the right foundation in existence of the left foundation}}{\text{settlement of the isolated foundation (Right)}}$$

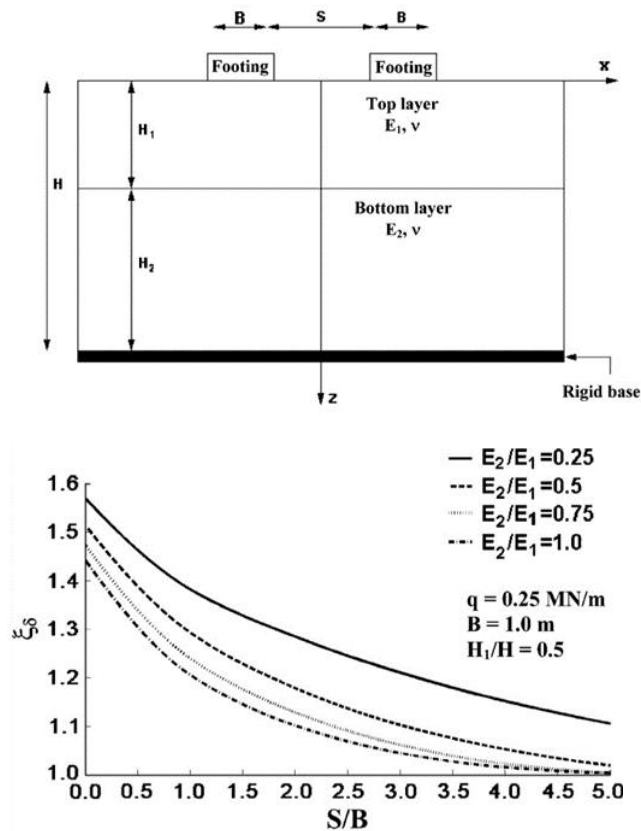


Fig. 2, Soil and footing configuration model studied by Ghosh, & Sharma (up) and Variation of ξ_δ with S/B for different E_2/E_1 (down), (Ghosh & Sharma, 2010).

2.2 Pasternak Soil Model

Mostly, the shallow foundations at different geotechnical work has dissimilar sizes and unequal loads. The

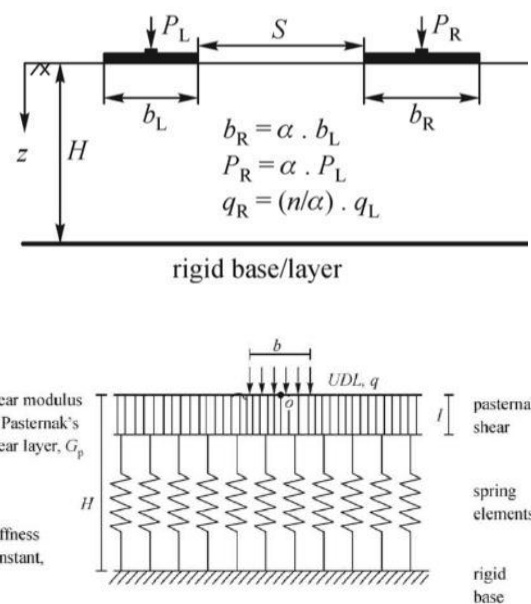


Fig. 3, Soil and footing configuration model studied by Ghosh, Rajesh, & Chand (up) and Pasternak soil model (down), (Ghosh et al., 2017).

During their study, the left footing as seen in Fig. (3) is kept fixed in terms of load and width, while the right footing is changing in terms of load and width. The variation of interaction factors for symmetric condition, both has the same width ($\alpha = 1.0$), in addition to asymmetric, both has dissimilar sizes ($\alpha = 2.0$), are shown in Fig. 4.

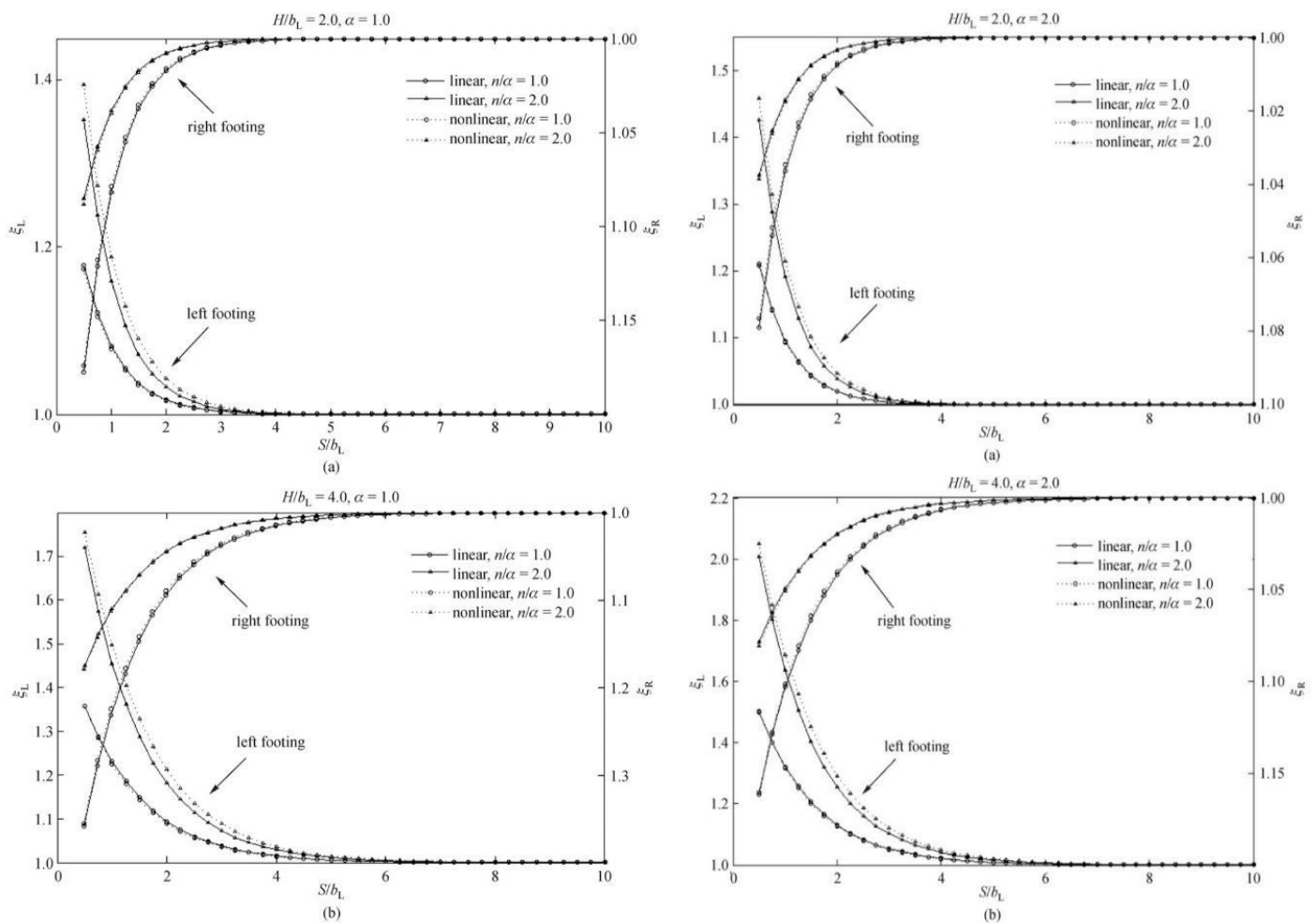


Fig 4, Comparison of interaction factors obtained from linear and nonlinear elastic analysis for symmetric ($\alpha = 1.0$), and asymmetric ($\alpha = 2.0$), footings with (a) $H/b_L = 2$ and (b) $H/b_L = 4$ (Ghosh et al., 2017).

Where, n/α represent loading to dimension ratio with left footing is considered to be as a reference. The depth of the rigid base is taken to be two and four times the width of the left footing ($H/b_L = 2$ & 4). When $n/\alpha = 2$, for instance, it means the load on the right footing is twice the load on the left footing (Ghosh et al. 2017). It can be observed for the above figures that ξ_L and ξ_R decreased to become one as the spacing increased. For linearly and non-linearly analysis the interaction becomes neglectable when the foundations are approximately positioned apart at a distance equal to 5 times the smaller width of the foundations for $H/b_L = 2$, similar to the result found of the theory of elasticity. For $H/b_L = 4$, the interaction becomes neglectable when the spacing between footings equal to 7.5 and 8 times the smaller width of the foundations. Hence, whenever the rigid base (H) increases, the interference effect is

increased. In conclusion, the finding of Ghosh, Rajesh, & Chand research can be summarized as follow;

- I. The outcomes found from the linear elastic analysis are larger than those determined from the nonlinear elastic analysis.
- II. The depth of the bearing layer affects the interaction of closely spaced foundation.
- III. In case of different footing size, the failure surface tends to be significant below the smaller footing and in case of asymmetric loading, the interference effect is more for the footing with smaller load.
- IV. ξ_L and ξ_R values get larger as the load increases in any footing that is located close to each other in the nonlinear elastic analysis.

III. EXPERIMENTAL TESTS

3.1 Sand

Besides these theoretical analyses mentioned above, a number of small-scale model test have been performed by different researchers. Das & Larbi-Cherif (1983) conducted laboratory study on two rough strip closely spaced foundation placed on the top of sand soil with a relative density of 54%. The interaction started to take place when the ratio of spacing to width of footing is equal or less than 4.5. The result was found to be similar to the theoretical result proposed by Stuart (1962). The bearing capacity and the settlement becomes larger as the footing

spacing is reduced. However, the interaction factor (ξ) was smaller than what Stuart (1962) suggested (Das & Larbi-Cherif, 1983). The inconsistency between the theoretical and experimental interaction factor (ξ) are may be due to the assumption of ideal behavior of soil or due to the self-weight of the soil which have been discarded in the theoretical approach. Furthermore, table 1, summarizes various researchers that investigate the load-deformation interference of two footings resting on cohesionless soil medium.

Table 1, A summary of the experimental work done on investigating the interaction of shallow adjacent footings on cohesionless soil.

No.	Names of the researchers	Type of the soil	Results
1	Selvadurai and Rabbaa (1983)	Ottawa sand	Interference initiated when spacing to ratio $S/B < 3$.
2	Graham (1984)	Ottawa and silica sand	The interaction depends on soil friction angle and efficiency factors for versus spacing are given.
3	Lee and Eun (2009)	Sand	Conducted field circular plate test. Failure stress of the soil beneath neighbored footing is higher than isolated footing; however, larger settlements occurs beneath neighbored footing.
4	Srinivasan and Ghosh (2011)	Dry dense homogeneous sand	They performed several laboratories scaled model tests of circular footings. Efficiency factors (ξ) are found to be maximum at $S/B = 0.5$.
5	Reddy, Borzooei, and Reddy (2012).	Medium dense sand	Square and circular footing model were conducted. On sand, the closeness of footings found to improves the responses of foundations both in terms of settlement and ultimate bearing capacity; nevertheless, increasing in settlements are being observed at between $B \leq S \leq 6B$.
6	Srinivasan and Ghosh (2013)	Two layers sand (weak layer underline by strong layer)	The bearing capacity and the developed settlement at failure declined with an increase in the depth of the upper weak layer. Efficiency factors (ξ) are found to be maximum at $S/B = 0.5$.

3.2 Clay

The interaction of closely positioned shallow foundations on clay is different than sand. The issue becomes more critical due to the tilting action of the footings which is significant as the spacing between footing decreases. The bearing capacity on clay is barely affected by the interference; in fact, for undrained condition, it can be ignored (Saran & Varma,1988). Therefore, during the

design process the shear failure, settlement, and tilt failure analysis is a necessity when designing closely spaced structures on clay. Saran and Varma were the first to conclude the tilting behavior of footings on clay; however, they did not show how failure surface is developed, and when the tilting is at its most value. Several years later, Amir (1992) conducted in his thesis a full laboratory study to predict the load-displacement and load-tilt characteristic of neighbored footings on clay. He noticed that the

interaction started to occur at a spacing to width ratio of 4, reaching to a maximum interference when spacing to width ratio of 1.5. Any further reduction in spacing the footing started to act as one block with a width equal to 2B.

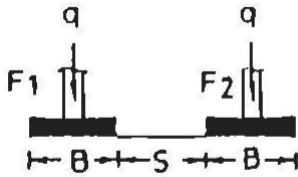


Fig. 5, Foundations model studied by Amir (1992).

The load-displacement and load-tilt curves have been obtained for the model shown in Fig. (5). The resultant curves are depicted in Fig. (6). It can be observed that there is no significant change in bearing capacity for a closely spaced isolated footings. This is similar to what Saran and Varma concluded; however, the tilting does happen significantly when the footings are located close to each other as seen in Fig. (6). The rupture surface will be similar to the one shown in Fig. 7 (A) as long as spacing to width is less than 3; if more than three the rupture surfaces will be identical to the one shown in Fig. 7 (B) (Amir, 1992). Amir's work can be summarized in three points:

- I. At a given load intensity, as the spacing to width ratio decrease, settlement and tilt increases.
- II. The tilting mechanism of the footing take place toward the center of the system; in other meaning tilt toward each other.
- III. The magnitude of tilting depends on imposed pressure, spacing, and the width of the foundations.

To be noted that no further experimental test explored in clay is found after 1992.

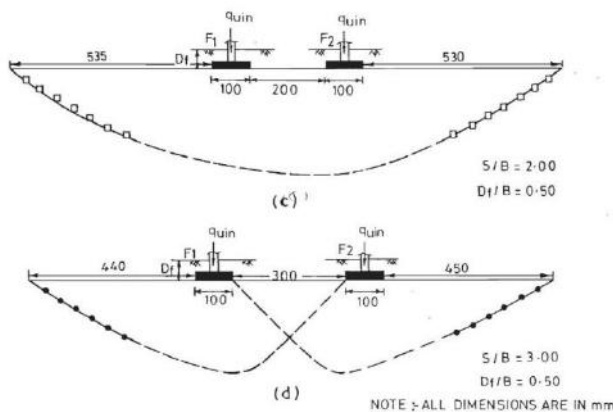
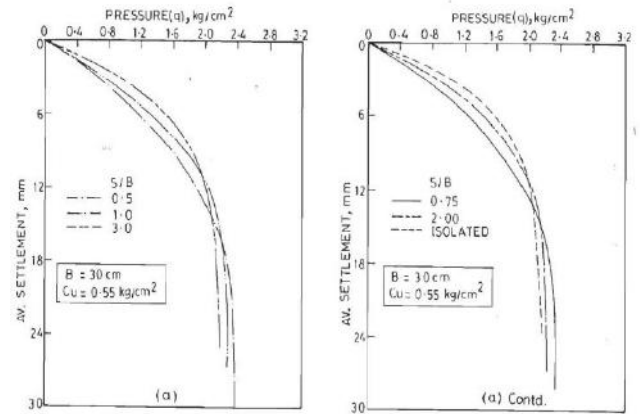
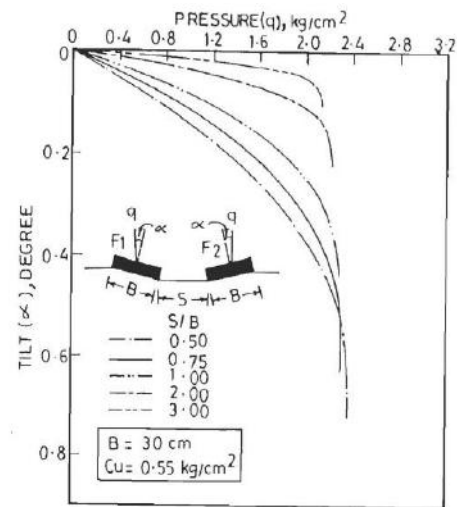


Fig. 6, Rupture surface patterns for closely spaced foundations in clay after Amir (1992).



(A)



(B)

Fig. 7, (A) pressure versus settlement curves and (B) pressure versus tilting for clay (Amir,1992).

IV. NUMERICAL ANALYSIS

Due to the advancement of computer coding, several studies have emerged in the same topic using finite element method (FEM) programs. Generally speaking, these programs have allowed performing geotechnical analyses on a variety of soil parameters and sources of variabilities on the performance estimation of structures.

4.1 Sand

The numerical results in the case of sand correlate well with the theoretical and experimental data mentioned above. The interference of shallow foundations gives bearing capacity noticeably greater than separate foundations that have the same dimensions. The interference is substantially important when spacing to width ratio is in the range of 0.1 to 0.5 for sand in which the friction angle is between 25° to 40°. The failure zone is comparable to the failure mechanism found by Terzaghi

and suggested by Stuart (1962). Furthermore, a triangular elastic wedge zone immediately forms between the foundations due to blocking effect behavior, also called “jamming soil”. This differs from isolated foundations where a triangular elastic wedge immediately underneath the footing is formed (Mabrouki et al., 2010). Moreover, the settlement due to the interference continuously decreases as the spacing to width increases and attains a value equivalent to that of the individual footing. The settlement interference reduces as the stiffness of the soil increases with depth (Nainegali et al., 2013a). However, the interference factor (ξ) is found to be similar to the values represented by Ghosh and Sharma (2010). Many researchers (Nainegali et al. 2013b, Eltohamy and Zidan 2013, Kumar and Bhattacharya 2013) have reported similar findings which are discussed in this section.

4.2 Clay

The interference of two symmetrical footing with a gap equal to B, resting on undrained clay soil was studied by the finite element method using a viscous-plastic algorithm with variable undrained shear strength values by Griffiths et al. (2006). The study indicated that if the two footings supported two separated structures then the interference generally increases the mean bearing capacity over isolated footing values; the failure surface will be similar to Fig. 8, (A). On the other hand, if the footings are supporting the same structure where the failure of one isolated footing is a failure to the whole system, the value of the mean bearing capacity owing to the interference was lower than that of an isolated footing; the failure surface will be similar to Fig. 8, (B).

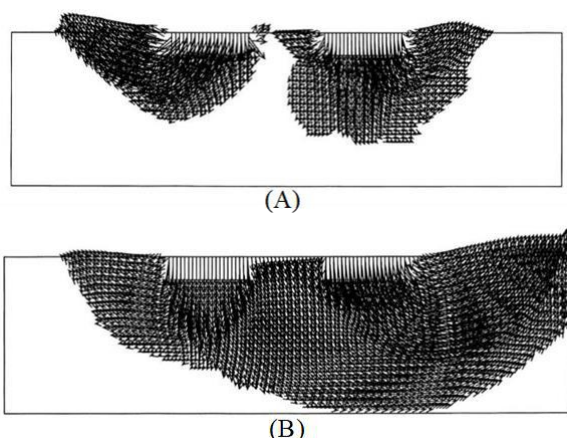


Fig. 8, Failure surface of closely spaced footing: (A) separated footings, (B) connected footings (Griffiths et al., 2006)

In both cases, the undrained capacity was no more than 10% difference (Griffiths et al. 2006). This work confirms the results of Amir (1992) in two sides; for fine grained undrained soil ($\phi=0$) the increases on bearing capacity is insignificant, and tilting is critical on clay soil as seen in Fig. (8) where the failure mechanism is shifted to the right. Therefore, the bearing capacity will reduce in contrast to the settlement which will augment as the spacing decreases in the close proximity of foundations. A need to determine the minimum distance where the footings should be placed for optimum performance is essential. In this regard, Nainegali and Ekbote (2016) published research where they studied the interaction of foundations on clay medium using a program called Plaxis 2D. The results are quite different than what Griffiths et al. reported in 2006. The bearing capacity is, in fact, reduces as the footings spacing decreases in order to maintain the allowable settlement at a tolerable value. Fig. (9), shows that the bearing capacity ratio and variation of the settlement obtained by Nainegali and Ekbote (2016)

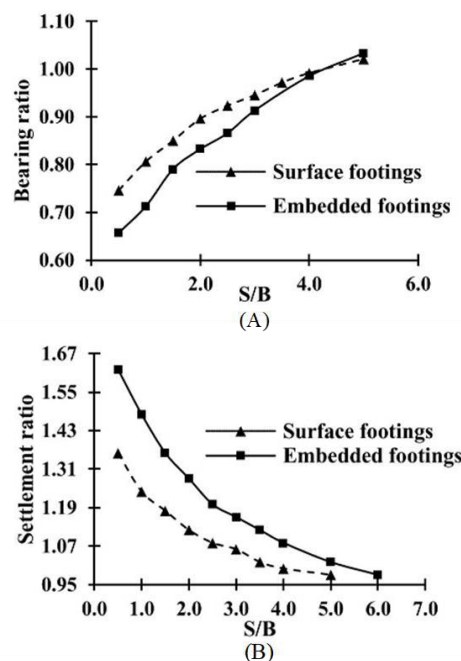


Fig. 9, variation of bearing ratio with S/B ratio (A), and settlement ratio with S/B ratio (Nainegali, & Ekbote, 2016).

It can be seen that the bearing capacity does change unlike what other previous research indicated. The reduction expected to be 25% compared to isolated foundation. Moreover, the most severe condition is when the spacing to width ratio is equal 0.5 where the settlement increase by 70% at the mid center of the two footings. The zone where there is no interaction is when spacing to width ratio is

equal five as seen in the figures above (Nainegali, & Ekbote 2016). The problem is there are not enough researchers done in cohesive soil compared to cohesionless soil which is well studied and categorized. A rigorous study is required to justify this diversity on the results reached by previous studies and outweigh one of them in regard to the interaction of closely spaced shallow foundation on clays.

V. CLOSELY SPACED SHALLOW FOUNDATION IN OFFSHORE STRUCTURES

Typically, conjoint offshore shallow foundations are assumed to be separated, and the bearing capacity is just the sum of the individual footings; ignoring any interference of the foundations which may add additional capacity or reduce the capacity due the severe stress develop because of such interaction. Currently, multi-footing foundation system is emerging as a support for offshore wind turbine structures. It considered as an alternative to the conventional monopiles. The interaction between tripod or quadruped shallow foundation systems under general loading is less clear. Only couple of studies exists in the literature which will be discussed here. A finite element investigation was carried out by Gourvenec and Steinepreis (2007) to determine the undrained capacity of conjoint rigid two foundation system resting on uniform elastic-perfectly plastic deposit under four loading conditions; pure Vertical (V), horizontal (H), and moment (M) loading plus a general combined loading (VHM). For a pour vertical loading condition, an increase on the

bearing capacity (V_{ult}) was observed when $S/B \leq 1$, reaching to a maximum value at $S/B = 0.25$; the rise in capacity is around 5% (where S/B is spacing to width ratio). If the distance is $S/B > 1$, the footings will act independently, hence, no additional capacity is developed ($V_{ult} = V_{ult}(\text{single})$). In the case of pure horizontal loading, the multi-footing foundation system has horizontal capacity equal to the sum of the single foundation. It is not affected by the interaction (Gourvenec & Steinepreis, 2007).

on the contrary to onshore, shallow foundations on offshore are subject to harsh environmental loading, especially extreme moments. The moment capacity of two-footing system tends to have three different behaviors. First, when the footing is positioned such as the S/B is less than 3, the moment capacity on this case contract proportional to B^2 as the S/B reduces. The failure surface encompasses of circular slip plain concurring at the edges of the footings, creating scoop mechanism failure. The upper limit moment capacity is presumed to be as the ultimate moment capacity of a single footing. The second behavior is when the footings are widely separated ($S/B > 5$), the moment capacity improved linearly as the S/B ratio increases. Typical shear failure mechanism arises underneath both footings. Third, is when the footings are located at approximately $3B$ and $5B$ apart. The failure surface comprises of both scoop and shear mechanism as shown in Fig. (10). However, a complex solution is needed to describe such case (Gourvenec & Steinepreis, 2007)

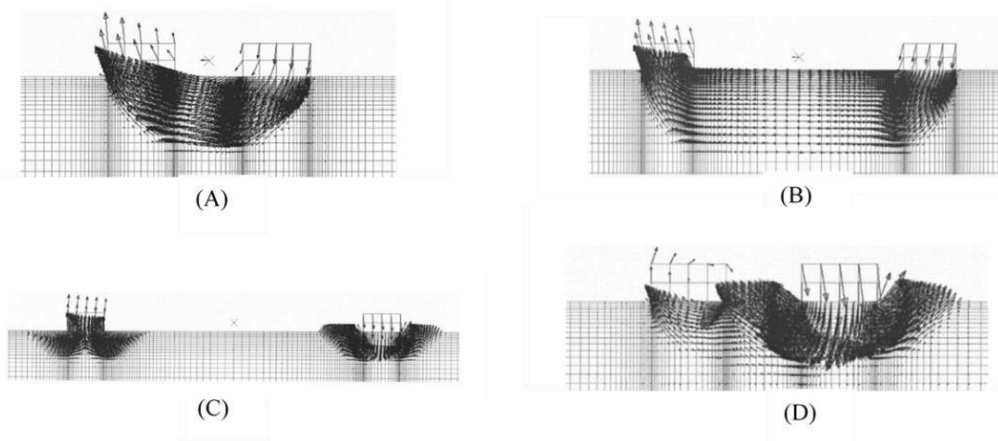


Fig. 10, failure mechanisms for closely spaced footings: (A) Two-footing scoop mechanism under pure moment, (B) Transitional mechanism under pure moment, (C) Independent push-pull mechanism under pure moment, (D) Failure mechanism at $V=0.5V_{ult}$ and $S/B=1$. (Gourvenec & Steinepreis, 2007).

If (VHM) loading conditions experienced by the conjoined shallow foundations, the failure surface and the interference will depend on the level of vertical loads as well as S/B ratio. In general, the horizontal and the moment capacity of the system reduces with the rise of vertical loads and increases with footing spacing. At vertical load equal or less than 25% of the ultimate vertical capacity (S/B = 0,1,2, and 3) with large horizontal and moment loads, the surface failure underneath the conjoined footings are a combination of scoop-wedge mechanisms which leads to a reduction on VHM system capacity (Gourvenec & Steinepreis, 2007). However, the reduction is small (Gourvenec & Jensen, 2009). Under high vertical load situations, the interactions mechanism is observed to be as those shown in Fig. (10) (Gourvenec & Steinepreis, 2007). Furthermore, the VHM capacity can be enhanced as the embedment depth of the closely spaced footings increases compared to surface footings. Though, the relative enhancement is basically unrelated to footing spacing (Gourvenec & Jensen, 2009).

5.1 Skirted foundations

A group of three rigidly coupled skirted foundations to support offshore wind turbines are currently grabbing attention due to the ease of installation and cost efficiency. Wind turbine is subject to high moment to vertical loading ratio (M/V), therefore, the compound effect of a moment and a vertical loading on closely spaced connected skirted foundations was investigated numerically by Stergiou et al. (2015) in order to establish comprehensive load interaction diagrams. They were able to produce a general equation that is applicable to any spacing and loading direction provided that the failure loads and the failure surfaces are suitably normalized. The equation is as follow:

$$\frac{M}{M_{ult}} = \min \left[\left(1 + 1.8 \frac{V}{V_{ult}} - \left(\frac{V}{V_{ult}} \right)^2 \right), 2.1 \left(1 - \frac{V}{V_{ult}} \right) \right]$$

The critical spacing beyond which there is no interaction and the multi-footings have no effect on each other is 4 times the skirted diameter. In the opposite, the group will experience a reduction on the gross undrained capacity when the skirted foundations are positioned at a smaller distance than 4 times the skirted diameter. The optimum reduction is approximately 12% (Stergiou et al.,2015).

VI. CONCLUSION

The following could be concluded based on in the information discussed above;

- The existing experimental and theoretical investigations invariably reveal that the magnitude of the ultimate bearing pressure,

increases substantially in the presence of another footing.

- Ultimate bearing capacity for interference footing is almost same as of isolated footing in case of clay while its higher in sand.
- In sands, the interference of the surrounding foundation on each other increases as the center to center spacing decreased, and the settlement value increases as the number of the around footing increases by 4 to 5 times the settlement of individual footing considering the spacing between footings.
- The settlement interference reduces as the stiffness of the soil increases with depth.
- In clay soil, the interaction will start to occur at a spacing to width ration of 4, reaching to a maximum interference when spacing to width ration of 1.5. Moreover, the tilting mechanism of the footings is more critical than settlement.
- Further studies are needed to investigate the interaction of adjacent shallow foundations based on the ultimate limit state especially for clay soils.
- A rigorous study is required to justify the diversity on the results reached by previous studies in regards of the interaction of closely spaced shallow foundation on clays.
- For a series of connected skirted foundation, the critical spacing beyond which there is no interaction is four times the diameter.
- Offshore closely spaced shallow footings will experience a minimum reduction in horizontal and moment capacity at relatively small vertical loads. In the contrary, the horizontal and the moment capacity of the system reduces substantially with the increase of vertical loads.
- The VHM capacity can be enhanced as the embedment depth of the closely spaced footings increases. Additional moment capacity is available for structurally connected footings.
- It is recommended to develop a standard code that clearly indicates the smallest distance after which engineers should consider the possibility of overlapping between potential failure surfaces of adjacent foundations in their design process because this could result in changing the foundation system from an isolated to a raft or even in some circumstances to pile foundation. This is significantly important today due to the limitation of space and the fast growth of cities.

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The Most Economical and Optimal Solution for Trusses in Gaza Strip

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Abstract— Due to siege imposed on Gaza Strip since 2007 and the prevention of importing specific steel sections to the Strip. This situation has led to a change in standard steel prices. It is known that there is a direct correlation between the weight of steel sections and their prices i.e. heavier steel sections are associated with higher prices and vice versa. However, prices of steel sections in Gaza Strip are subject to change according to their availability. In other words, light steel sections can be more expensive than heavier ones.

The major aim of this research is to investigate the best and most economical steel section to be used in Gaza Strip according to availability and local prices. Throughout this study, steel sections which are permitted to enter Gaza Strip have been used in this work such as L section, T section, I section, Square and Pipe sections. This research is a parametric study of different sections that can be used in the design of Howe roof truss subjected to vertical loads and later identifying the cheapest steel section to be used in Gaza, Palestine.

Keywords— Steel; Howe roof truss; I section; Material cost.

I. INTRODUCTION

A truss, or lattice structure, is a structural assembly of small interconnected elements. Trusses are formed by an interconnected assembly of relatively small elements, which create a lattice arrangement. The overall form, size and shape of the truss are as important as the strength of the individual components, and a wide variety of design options is available. A truss acts like a beam, with bending resisted by the couple created by forces in the top and bottom members. When an I-shaped beam is subjected to simple bending it can be seen that the bulk of resistance to bending moment is offered by a couple consisting of the forces in the flanges multiplied by the distance between them. Accepting that little error is involved in assuming that all resistance to bending is offered in this way, the most efficient system will be one in which the flange forces are reduced to a minimum

to save material, and the distance between them is increased accordingly.

Trusses have been used as an effective mean to span for long distances. Nowadays, airport hangars and industrial facilities guarantee the use of a structural member to span larger distances without needing middle supports. This gives open spaces below which are needed for the function of a building. Moreover, shorter spans can use trusses as an architectural characteristic. Examples of these facilities are churches and other religious places.

II. RESEARCH AIM AND OBJECTIVES

The Aim

The major aim of this study is to investigate which steel section is the most economical for use in Gaza Strip by analyzing and designing a simple Howe roof truss carrying only vertical loads.

III. LITERATURE REVIEW

3.1 Truss Mechanics

All trusses are composed of one or more triangles varying in shape and size. Triangles are the simplest, most structurally stable shape. Triangles will retain their shape without the need for intermediate braces or extra supports when lengths of their sides are fixed. For each extra member added to a simple geometric shape, additional bracing is required as is the case with a square, pentagon, etc.'

Due to the geometric arrangement of these triangles within a truss, loads that cause the entire truss to bend are converted into tensile or compressive forces in the members.

Space trusses in which members extend in three dimensions also exist and are suitable for specific applications. Space trusses, also known as space frames, commonly require more hand-analysis or computer analysis time and are less common for long spans, and therefore not included in this report. As well, many space trusses have become proprietary information to the companies spending

time and money to research new three-dimensional truss configurations (Chen & Lui, 2005).

One of the largest advantages of a truss is that it uses less material to support a given load.

3.2 Economy in the Design

With any structure, it is in the engineer’s best interest to make the most economically efficient structure for the owner, while meeting calculated capacities and mandatory code requirements. This will ensure the building owner is not paying extra for oversized structural components for the given loads.

However with trusses, economy comes in many forms such as material, shop labor, erection and temporary supports, and other miscellaneous items in addition to the engineering design fee.

While all construction materials see some degree of volatility in prices, steel has seen a sharp increase in recent

history. This drastic increase in steel prices can be tied to many different factors, but increased demand for steel scrap and other additives is the largest contributor. Steelmaking originally depended strictly on the mining of iron ore. Additionally, steel is an energy intensive material to produce the final steel shapes.

The cost of construction dictates that sections be efficiently designed. The simple principle is to design columns in such a way that the ratio of radius of gyration to the section depth or width is as high as possible, and that the α_c (for columns) and α_s (for beam-columns) values are as high as possible. Some column sections that are usually employed in practice are shown in Figure (1). If possible, compound sections should be avoided in the interest of economy. However, where heavy loads are to be resisted by the column, the use of compound sections may be the only feasible solution.

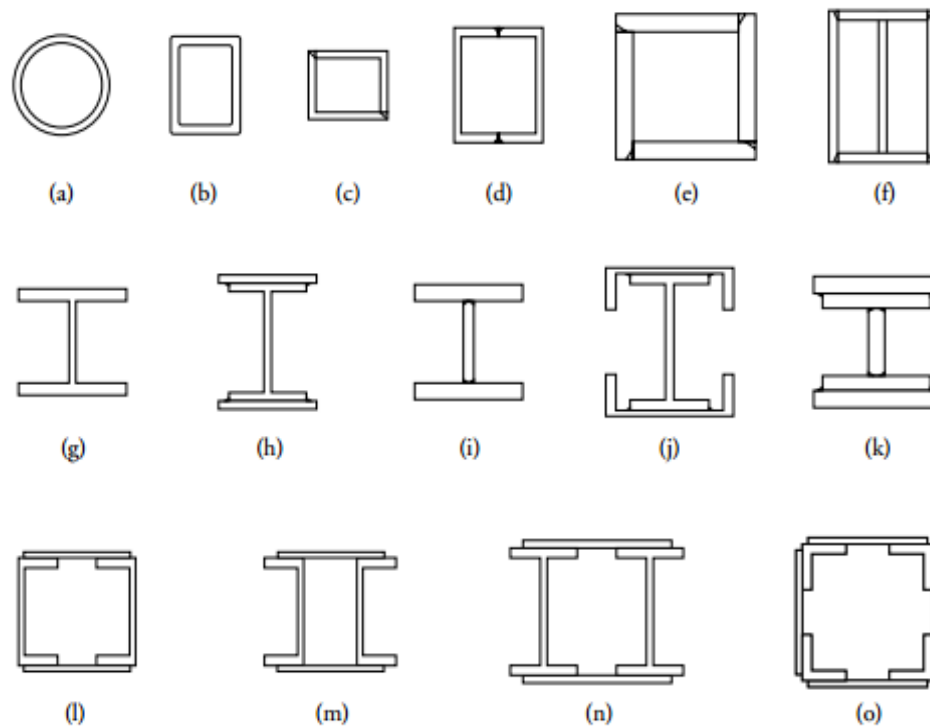


Fig1: Typical compression member sections.

3.3 Tension Members

Tension members are predominantly loaded in axial tension, although inevitably they are often loaded in combined tension and bending. The bending moments may arise from eccentricity of the connections, frame action and self-weight of the members. A simple classification of

tension members is presented in Table (1). This table gives an overview of the many types of tension member applications in building construction; it also serves as a directory to subsections covering the particular design aspects.

Table.1: Classification of tension members.

Aspect	Subgroup
(a) Type of construction	
Section type:	
Rigid	I-sections, hollow sections Angles and channels
Flexible	Plates, bars Steel rods Steel wire ropes
Construction	Single section Compound sections
(b) By position of restraints	End restraints at connections End and intermediate restraints
(c) By type of loads	Axial tension only Combined tension and bending
(d) By load fluctuation	Predominantly static loads Dynamic loads Impact

3.4 Compression Members

Compression members are structural elements that are subjected only to axial compressive forces; that is, the loads are applied along a longitudinal axis through the centroid of the member cross section. The stress can be taken as $F = P/A$, Where F is considered to be uniform over the entire cross section. This ideal state is never achieved in reality, however, because some eccentricity of the load is inevitable. Bending will result, but it can usually be regarded as secondary and can be neglected if the theoretical loading condition is closely approximated. Bending cannot be neglected if there is computed bending moment. The common type of compression member occurring in building and bridges is the column, a vertical member whose primary function is to support vertical loads. In many instances these members are also called upon to resist bending, and in these cases the member is a beam-column. Compression member are also in trusses and as components of bracing systems. Smaller compression members not classified as columns are sometimes to as struts.

IV. RESEARCH METHODOLOGY

This research shows the analysis and design of a simple Howe roof truss subjected to vertical loading. The aim is to

identify the most economical section with respect to factors such as local prices and availability of steel sections in Gaza Strip, Palestine. First, the truss will be sketched on SAP2000 software with the specified height of 9 ft, spacing between joints of 9 ft and vertical factored load of 12 kip. Then, analysis and calculation of internal force in each member will be made using SAP2000 software. After that, design of members can be done and detailed design of two members (tension and compression members) will be demonstrated in this study. Tension and compression members studied along with resulted steel section shapes that can be used and their prices will be shown in tables. Finally, the steel section with the lowest price per unit length will be the most economical section to be used in Gaza, Palestine.

4.1 THEORETICAL INVESTIGATION OF SIMPLE HOWE ROOF TRUSS

4.1.1 Analysis and Design of Howe Roof Truss

This is the truss used for the study, the height of truss is 9 ft and spacing between joints is 9 ft ($12@9 = 108$) as shown in Figure (2).

The load is factored loads equal to 12 kip.

30,33	292	C
31,32	255.5	C
38,47	38	T
39,46	40.3	T
40,45	43.3	T
41,44	46.86	T
42,43	50.1	T

Design of Member with “A36 Steel, Fy = 36 ksi, Fu = 58 ksi”

Design of Tension Member

The maximum value for tension member is 396 Kips

$$\phi_c P_n \geq P_U \rightarrow 0.9F_y A_g \geq P_U \rightarrow A_g = \frac{P_U}{0.9F_y} \text{ required}$$

To avoid fracture

$$0.75F_u A_e \geq P_U \rightarrow A_e \geq \frac{P_U}{0.75F_y}$$

$$\text{Required } A_g = \frac{P_U}{0.9F_y} = \frac{396 \text{ Kips}}{0.9 * 36 \text{ Ksi}} = 12.23 \text{ in}^2$$

$$A_e = \frac{P_U}{0.75F_u} = \frac{396 \text{ Kips}}{0.75 * 58 \text{ Ksi}} = 9.11 \text{ in}^2$$

∴ Area Required = 12.23 in²

From steel manual, the section W14 * 43 with A_g = 12.6 in² and A_e = 9.45 in² can be adequate for load.

All sections that are summarized in table below can be adequate, but we need the cheapest section.

Table.3: Sections that can be used along with their area and cost.

Section Name	A _g and A _e (in ²)	Shape	Cost (\$/ft)
W14*43	A _g = 12.6 in ² and A _e = 9.45 in ²	I shape	41.37
L8*8*1 7/8	A _g = 13.1 in ² and A _e = 9.83 in ²	L shape	40.25
WT12*42	A _g = 12.4 in ² and A _e = 9.3 in ²	T shape	38.42
HSS 8*8*1/2	A_g = 13.5 in² and A_e = 10.1 in²	Square shape	36.95
HSS 14 *0.312	A _g = 12.5 in ² and A _e = 9.38 in ²	Pipe	38.43
S15*42.9	A _g = 12.6 in ² and A _e = 9.45 in ²	I shape	39.15
HP10*42	A _g = 12.4 in ² and A _e = 9.3 in ²	I shape	44.38
MC18*42.7	A _g = 12.6 in ² and A _e = 9.45 in ²	[shape	42.78
C15*50	A _g = 14.7 in ² and A _e = 11.02 in ²	[shape	39.64
ST10*43	A _g = 12.7 in ² and A _e = 9.5 in ²	T shape	43.34

Design of Compression Member

The maximum value for compression member is 401.46

Kips with length of member is 9.12 ft

$$\text{Assume } F_{cr} = \frac{2}{3}F_y = \frac{2}{3} * 36 = 24 \text{ ksi}$$

$$\text{Required } A_g = \frac{P_U}{0.85F_{cr}} = \frac{396 \text{ Kips}}{0.85 * 24 \text{ Ksi}} = 19.68 \text{ in}^2$$

Try W12 * 72 with (A_g = 21.1 in²,

$$r_{min} = 3.04 \text{ in})$$

$$A_g = 21.1 \text{ in}^2 > A = 19.68 \text{ in}^2 \rightarrow \text{ok}$$

$$\frac{KL}{r_{min}} = \frac{1 * 9.12(12)}{3.04} = 36 < 200 \rightarrow \text{ok}$$

$$\lambda_c = \frac{kl}{r\pi} \sqrt{\frac{F_y}{E}} = \frac{36}{\pi} \sqrt{\frac{36}{29000}} = 0.4 < 1.5$$

Use AISC Equation [E2 – 2]

$$F_{cr} = (0.658^{\lambda_c^2}) F_y = (0.658^{0.4^2}) 36 = 33.67 \text{ Ksi}$$

$$\phi_c P_n = \phi_c * A_g * F_{cr} = 0.85 * 21.1 * 33.67 \\ = 603.87 \text{ Kips} > 401.67 \text{ Kips} \rightarrow \text{ok}$$

Check W12 * 65 ($A_g = 19.1 \text{ in}^2$, $r_{\min} = 3.04 \text{ in}$) "The next lightest"

$$\frac{KL}{r_{\min}} = \frac{1 * 9.12(12)}{3.02} = 36.23 < 200 \rightarrow \text{ok}$$

$$\lambda_c = \frac{kl}{r\pi} \sqrt{\frac{F_y}{E}} = \frac{36.23}{\pi} \sqrt{\frac{36}{29000}} = 0.406 < 1.5$$

Use AISC Equation [E2 - 2]

$$F_{cr} = (0.658^{\lambda_c^2}) F_y = (0.658^{0.406^2}) 36 = 33.66 \text{ Ksi}$$

$$\phi_c P_n = \phi_c * A_g * F_{cr} = 0.85 * 19.1 * 33.66 \\ = 546.47 \text{ Kips} > 401.67 \text{ Kips} \rightarrow \text{ok}$$

Check W12 * 53 ($A_g = 15.6 \text{ in}^2$, $r_{\min} = 2.48 \text{ in}$) "The next lightest"

$$\frac{KL}{r_{\min}} = \frac{1 * 9.12(12)}{2.48} = 44.13 < 200 \rightarrow \text{ok}$$

$$\lambda_c = \frac{kl}{r\pi} \sqrt{\frac{F_y}{E}} = \frac{44.13}{\pi} \sqrt{\frac{36}{29000}} = 0.495 < 1.5$$

Use AISC Equation [E2 - 2]

$$F_{cr} = (0.658^{\lambda_c^2}) F_y = (0.658^{0.495^2}) 36 = 32.50 \text{ Ksi}$$

$$\phi_c P_n = \phi_c * A_g * F_{cr} = 0.85 * 15.6 * 32.50 \\ = 430.95 \text{ Kips} > 401.67 \text{ Kips} \rightarrow \text{ok}$$

This shaped is not listed in the column load tables; the width-thickness ratio must be checked:

$$\frac{b_f}{2t_f} = 8.69 < 0.56 \sqrt{\frac{E}{F_y}} = 0.56 \sqrt{\frac{29000}{36}} = 15.89 \text{ (ok)}$$

$$\frac{h}{t_w} = 28.1 < 1.49 \sqrt{\frac{E}{F_y}} = 1.49 \sqrt{\frac{29000}{36}} = 42 \text{ (ok)}$$

All sections that are summarized in table below can be adequate, but we need the cheapest section.

Table.4: Sections that can be used along with their shape and cost.

Section Name	$\phi_c P_n$ (Kips)	Shape	Cost (\$/ft)
W12*53	430	I shape	45.12
S20*75	421.311	I shape	52.15
HP12*53	439.12	I shape	44.39
C15*50	439.57	[shape	39.13
L8*8*1	415	L shape	40.7
WT9*53	434.5	i shape	43.67
HSS 8*8*5/8	467	Square	37.55
HSS10.000	402.37	Pipe shape	38.23

V. RESULTS AND DISCUSSION

Conclusion

The result of this research demonstrated that using square shaped steel section (**HSS 8*8*5/8** for maximum internal force of compression member and **HSS 8*8*1/2** for maximum internal force of tension member) is the most economical among other sections according to availability, material cost and transport in Gaza Strip, Palestine.

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Migration of contaminants from food packages to its content – Brazilian scenario and regulation

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Abstract — Consumers demand pleasant taste and odor in the final food product. Changes in these characteristics may be due to food deterioration or migration of substances from the packaging into food. The production of plastics for food containers involves catalysts which may contain toxic elements. In Brazil, there are limits of migratory substances and procedures for determining its rate. We aim to emphasize the food risks of migration of toxic substances from plastic packaging into its contents, and the Brazilian regulations regarding this issue. PET (polyethylene terephthalate) as raw matter for food packaging, is a concern in Brazil. The research methods currently adopted in Brazil are efficient for As, Cd, Co, Cr, and Sb determination. During PET synthesis and recycling, secondary reactions may form acetaldehyde, diethylene glycol and toxic oligomers. Monitoring by government mechanisms is essential to enforce safe food packaging. However, migration over the product shelf life remains an issue.

Keywords — polyethylene terephthalate, PET, migration, recycling, legislation.

I. INTRODUCTION

The materials found in nature were useful to man as packaging for transportation and food storage. For this purpose, bladders and stomachs of animals, leather bags, leaves of plants, pieces of bamboo and hollow tree trunks, horns, gourds, pots of cooked clay, basket of vines, sewn straw and other materials were used as food containers (Risch, 2009). Foods are now marketed in packages made of various types of materials, such as paper, cardboard, glass, metal and plastic, among others. Due to its versatility, low weight, flexibility and low cost, plastic has been the most widely used material for manufacturing of packages (Vasco, 2012). Plastic food packaging was introduced after the World War II and one of the first products manufactured in 1946 were cups of polyethylene produced by Tupperware Co. founded by Earl S. Tupper.

Plastic arrived in Brazil in the 1950s (Wiebek and Harada, 2005).

As a consequence of its use, the polymeric material used in the preparation of the food packaging may contain residues of chemical elements from the materials used in its manufacturing, and these elements may migrate to the food (Shinamoto et al., 2011), in amounts compatible to its migrating rate and the time extent of contact between the food and its packaging (Risch, 2009).

Several studies have been carried out for the quantification of substances present in plastic packaging of soft drinks, water, milk, dairy products, juices and fatty foods, such as arsenic (As), cadmium (Cd), chromium (Cr), cobalt (Co) and antimony (Sb); being these metals great conductors of electricity and heat, of solid nature, flexible and malleable, with the exception of As that is not a metal and the Sb that is a semi-metal (metalloid), toxic in some chemical configurations; therefore, considered a great risk to human health (Soares et al., 2005).

The growth of the plastic packaging industry caused great concern, especially regarding its impact on the environment, due to the increase in the number of discarded packaging after the consumption of its contents. In Brazil, the National Sanitary Surveillance Agency (ANVISA), authorizes the reprocessing of PET (polyethylene terephthalate), which is a form of polyester and the most used plastic resin. However, its subsequent use in food packages is conditioned to strict rules.

Scientific studies report possibilities to use recycled PET in food packages, in three ways: (1) “half-PET” packages (Moura, 2011), where small proportions of PET-PCR is mixed to other substances in food packages manufacturing; (2) the external coating of virgin PET with recycled PET, for food packages; and (3) the use of recognized recycling technologies which have scientifically proved to supply uncontaminated

food-grade PET (ANVISA, 2016).

The migration of substances from plastic packaging into the packaged food is considered a public health issue. For this reason, many legislation systems have pursued harmonization policies, where regulations occur through lists of authorized substances and their use restrictions (ANVISA, 1999).

II. OBJECTIVE

In this context, we aim with this survey work, to emphasize the food risks that the general population runs due to the migration of toxic substances from plastic packaging into its contents, and the Brazilian regulations regarding this issue.

III. THE PET RESIN

The PET (polyethylene terephthalate) resin, a form of polyester, belongs to the group of three-dimensional polymers in which it has a structure that expands in all directions, that is, between the adjacent chains there are bonds through atoms that bind to others (Tavares, 2010). Polyester belongs to the group of condensation polymers whose polymerization takes place in two stages. The esterification of either the diacid or the diester with ethylene glycol, produces the monomeric diester, the bis-(2-hydroxyethyl)-terephthalate (BHET). When the starting substance used is terephthalic acid (PTA), such a reaction is recognized as a direct esterification, and when dimethylterephthalate (DMT) is used, the reaction is known as a transesterification reaction.

The byproducts of the direct esterification and transesterification reactions are water and methanol, respectively. Obtained by the oxidation of p-xylene, terephthalic acid is obtained, while ethylene glycol is synthesized from ethene, both of which are obtained from the Brazilian petrochemical industry. The PET obtained with the PTA route results in a polymer with a high content of impurity due to the difficulty in the purification of terephthalic acid (Nasser, 2005).

As example, in Brazil, Rhodia[®] operates with the PTA route while Proppet[®] uses the DMT route. They add catalysts such as calcium, magnesium, cobalt, manganese and zinc salts in order to accelerate the reaction and render it commercially viable. As a by-product at this stage, diethylene glycol (DEG) can be produced by the dimerization of ethylene glycol (MEG) (Nasser, 2005).

Another method was proposed for the synthesis of PET, based on the cyclic dimer polymerization without the use of catalysts and under atmospheric pressure, producing PET free of secondary products during the process (Al-Sabagh et al., 2016).

IV. RECYCLING OF PLASTIC MATERIALS

Defined as chemical recycling, or resin recovery, it comprises the depolymerization of plastic packaging materials, and the recovery and purification of the original monomers (Al-Sabagh et al., 2016). It consists in transforming or subjecting plastic materials to mechanical processes, shaping them physically into a form even different from the original. As in the case of thermoplastics, the primary plastic food packaging precisely fit the process, preserving to a large extent its physical, chemical and mechanical property of authentic polymers (Wiebek and Harada, 2005).

In the recycling units, the selected materials are subjected to an extrusion process, followed by abrupt quenching which, after being ground and dried, originates the recycled material, which is sold to the plastics industry for manufacture of new products or other materials. The main consumer market for recycled plastic in the form of beads are the plastic artifacts industries, which use the material in the manufacture of buckets, hangers, bottles for sanitation products, conduits and accessories for automobiles, among others (Vasco, 2012).

V. MAIN ADDITIVES AND CATALYSTS USED IN PET PROCESSING

Some of the most frequent additives for polymers are classified as plasticizers, thermal stabilizers, anti-UV and antioxidant substances. Even some studies mentioning PET as an additive-free material, some researchers have identified and, in some cases, quantified the presence of these additives in food-grade PET (Romão et al., 2009).

Despite being found a large and variable quantity of inorganic compounds that have catalytic activity for the production of PET in both stages, transesterification and polycondensation, the antimony dioxide (Sb₂O₃) is the most used catalyst because it shows a good balance of its catalytic activities, such as chemical stability in the presence of phosphorus-based stabilizers, final product color and low cost. Germanium oxide is also used; but even though it presents a higher catalytic activity compared to antimony, its high cost for PET production proves to be commercially unfeasible (Romão et al., 2009).

The production of PET for food and beverage packaging has been analyzed in the European and Asian continents; in some end products of food packaging or carbonated beverages, antimony-based residues were found, posing a risk to public health (Romão et al., 2009).

In the standardized test procedure ("challenge test" or equivalent) the compliance concentration limit of contaminants, compared to a standardized model for food-grade PET-PCR (Post-Consumer Recycled PET), is 220 ppb ($\mu\text{g kg}^{-1}$) for each contaminant into the PET used for manufacturing the food packages, or the limit of

10 µg kg⁻¹ in the packages, for each contaminant. These two limits for the case of food grade PET-PCR derive from the maximum concentration of contaminants admitted in the human diet of 0.5 µg kg⁻¹ of food (ANVISA, 1999).

VI. PET RECYCLING AND THE ENVIRONMENT

Recycling is one of the best alternatives to reduce the environmental impact of the discarded plastic material; the possibility of reprocessing the polymer can help reducing the environmental impact of the uncontrolled disposal of plastic wastes (Vasco, 2012). Since the PET

bottle takes about 100 years to decompose, recycling proves to be a good proposal (Formigoni and Campos, 2012). The recovery of resins, also known as chemical recycling, comprises the depolymerization of the materials that can then be polymerized again for the production of new primary plastic packaging or other materials (Vasco, 2012).

PET packaging is 100 % recyclable and the process can be mechanical, energetic or chemical. Among these the most used is the mechanic (Figure 1) because it is cheaper (Wiebeck and Harada, 2005).

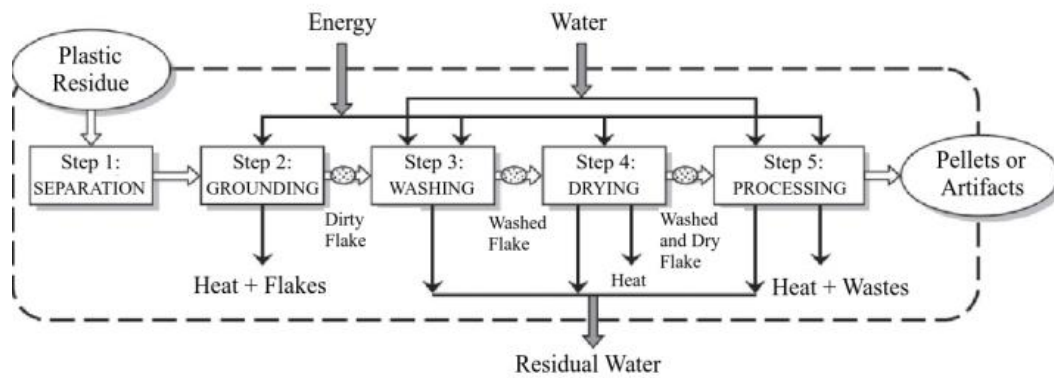


Fig.1: Schematic steps for plastic resin mechanical recycling. Source: (adapted from Formigoni and Campos 2012).

The processes of mechanical recycling of PET from beverage bottles produce flakes or grains and generally consist of the following steps: selection; crushing; milling; washing; separation by density difference; drying and extrusion. After drying the flakes, the material can be extruded and processed into grains for various applications (Wiebeck and Harada, 2005). This process is critical; during the melting of the material for grain production, the presence of small amounts of contaminants are evident and cause degradation, reducing the quality of the recycled PET and limiting its future applications (Risch, 2009).

In addition to the original chemical contaminants that may occur in the manufacture of PET, there are also the contaminants that can occur in recycled PET, either accidentally introduced or by chronic failures along the recycling process. The most evident contaminants of recycled PET are PVC (Polyvinyl chloride) in particular; but also, metals, sand and earth, glue, other plastics, and rust. Notwithstanding, multicolor packaging among

several PET-packaged products shows a factor much more focused on the expansion of consumption than on environmental responsibility (Vasco, 2012); they may be an issue on recycling.

The development of new technologies applied to recycling of plastic, aims to produce a material to replace the virgin plastic, helping reducing the exploitation of mineral resources and the environmental impacts caused by the mentioned exploitation itself and the inappropriate waste disposal (Formigoni and Campos, 2012).

The Brazilian Association of Technical Normalization (ABNT), through the Brazilian Normative (NBR) 13.230, published in 1994, establishes symbols for the identification of thermoplastics used in containers and packages; a task of paramount importance for economic and industrial viability of recycling. These standardized symbols are usually embossed on the bottom of the package (Formigoni and Campos, 2012), as shown in Figure 2.

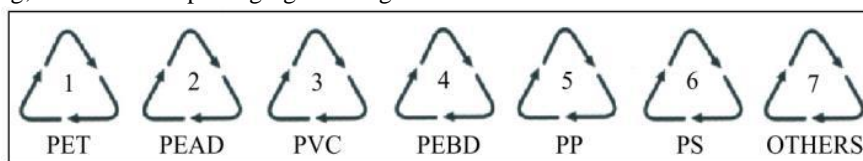


Fig. 2: Symbology used for recycling-able plastics. Brazilian Normative (NBR) 13230. Source: adapted from Formigoni and Campos 2012.

Such symbols only indicate that the materials are potentially recyclable. However, the coding system adopted warns that the presence of the symbol is not a stated or implied guarantee that any container is fit to be transformed into another product. Even if it is technically recyclable, no material should be considered precisely recyclable if there is no market for it (Formigoni and Campos, 2012).

VII. QUANTIFICATION OF CONTAMINANTS

In Germany, a method of mass spectroscopy of isotopic dilution with inductively coupled plasma source (ICP-IDMS) was used for the determination of Pb, Cd, Cr and Hg, and its results were compared with those obtained by isotopic dilution mass spectroscopy with thermal ionization (TI-IDMS), with promising results (Soares et al., 2005; Shimatomo et al., 2011; Aghae et al., 2014).

X-ray fluorescence spectroscopy (XRF) analysis was also tested in commercial polyethylene produced by Ziegler-Natta®, Philips® and metallocene® technologies. The XRF allows the direct determination of metals in polymeric matrices present at low concentration (1:1000) for elements presenting atomic number greater than, or equal to, that of Ti ($Z \geq 22$), that is, the technique proved to be effective for the determination of Ti, V, Cr, Al and Zr in polyethylene (Soares et al., 2002; Risch, 2009; Tavares, 2010).

VIII. MIGRATION OF TOXIC COMPOUNDS AND SUBSTANCES

The global migration limit established by the Brazilian legislation is 50 mg kg^{-1} of simulant and 8 mg dm^{-2} of surface area, for packages with capacity greater than, or equal to 250 mL ($\geq 250 \text{ mL}$). There is a specification of migration limits (ANVISA Resolution 105) for some PET starting substances (process-generated contaminants) (Table 1).

Table.1: Starting substances for PET manufacturing and its respective Specific Migration Limits established by the European Community (EC) and by the Brazilian Policies (Anvisa).

Starting Substance	SML (mg kg^{-1}) EC, 2016	SML (mg kg^{-1}) Anvisa, 1999
Terephthalic acid	7.5	7.5
Dimethyl terephthalate	Not established	7.5
Isophthalic acid	5	Not established
Dimethyl-isophthalate	0.05	Not established

Ethylene glycol	30	30
Diethylene glycol	30	30

The ANVISA resolution no. 105, of May 1999, is the current one. This resolution establishes the technical regulations on the use of plastic packaging and equipment that contact the food, as shown on Table 2.

Table.2: Maximum contaminant concentration (MCC) and specific migration limit (SML) of contaminants for some polymers (ANVISA, 1999).

Polymer	MCC ($\mu\text{g kg}^{-1}$)	SML ($\mu\text{g kg}^{-1}$)
PET	220	10
PS	180	6
PVC	90	5
PEAD	123	4
PP	78	25
PEBD	92	3

The health risk associated with the use of chemical substances depends, among other factors, on the dose of exposure and how they are metabolized by the human body. To assess the extent of this risk, it is necessary to know the physicochemical properties of the substances and their toxic effects in the short-, medium- and long-term. From these data, it is possible to characterize the potential adverse effects of human exposure to these substances (Nasser, 2005). The maximum amount of metals and / or simulant established by the Brazilian legislation is presented in Table 3.

Table 3: Maximum metal migration rate food content (specific migration limits – SML) established by the Brazilian legislation (ANVISA, 1999).

Metal	SML
Antimony (Sb)	0.05% (m/m)
Arsenic (As)	0.005% (m/m)
Cadmium (Cd)	0.01% (m/m)
Chromium (Cr)	0.10% (m/m)
Cobalt (Co)	0.005 (m/m)
Antimony (Sb)	0.05% (m/m)

IX. POSSIBLE HEALTH RISKS ASSOCIATED TO CONTAMINANT MIGRATION

Risks to health with respect to substances that migrate from food packages to their content are varied (Tavares, 2010). The present survey highlights only some of the main migratory elements, such as antimony (Sb), arsenic (As), cadmium (Cd), chromium (Cr) and cobalt (Co).

9.1 Antimony (Sb)

Since antiquity, antimony compounds are well known. In cultures of the ancient East and Egypt, compounds with antimony were used for medicinal and cosmetic purposes.

Nowadays, drugs with Sb are still applied in treatments of leishmaniasis and schistosomiasis; it can, however, result in various side-effects and potentially develop heart-, kidney- and liver-related problems. In addition, Sb_2O_3 is classified as possibly carcinogenic to humans (Sundar and Chakravarty, 2010).

Aghaee et al. (2014) studied the contamination of water packaged in PET bottles, regarding the presence of antimony. This contamination occurs from the leaching of this metal from the polymeric material into the water. The results indicated that, over a six-month period, the concentration of antimony in stored water may increase by up to 90 %. Such information highlights the need for the development of studies that quantify antimony in PET and that sanitary authorities establish maximum tolerable limits. They also provide an alert regarding the need for this parameter to be monitored in the quality control of the material.

9.2 Arsenic (As)

According to the World Health Organization (WHO), the most common route of human exposure to As is the consumption of contaminated water. Other natural sources of contamination include minerals and rocks that contain the element, which includes soils and sediments formed from these rocks and geothermal and volcanic phenomena; the anthropogenic sources come mainly from mining activities, with tailings piles being the main sources of release of this metal (Smedley, 2003).

It is an important element of attention. Due to its harmful effects on the body, exposure to As, mainly through the ingestion of inorganic As present in water, is an important public health problem. Its consequences include the occurrence of various forms of cancer, diabetes mellitus, peripheral neuropathies and numerous pathological effects on the skin (hyperpigmentation and hyperkeratosis), gastrointestinal tract, and vascular system (Rodrigues and Malafaia, 2008).

9.3 Cadmium (Cd)

As pure metal, it is used in various industrial processes as a component of anti-corrosive coatings, metallic alloys, pigments and stabilizers, electrical batteries, and also in the manufacture of PVC. This metal can be found in phosphate-based agricultural fertilizers, cement manufacturing residues and in industrial sewage. The main forms of exposure to cadmium are contaminated air, water and food (Angerer et al., 1989). Due to its slow excretion and long half-life (decades, in human organism), it has become one of the most researched metals. The ingestion of foods contaminated by this metal can cause renal malformations and disturbances in the calcium metabolism (Jean et al., 2018).

9.4 Chromium (Cr)

Chromium, Cadmium and Arsenic are metals that do not exist naturally in any organism, with no nutritional or biochemical functions. Furthermore, the presence of these metals in any living organism is harmful, at any concentration. With the discovery of metallurgy, the use of these metals has grown and its toxic effects have generated permanent health problems for mankind and permanent damage to the ecosystem (Vincent and Lukaski, 2018).

Chromium is also used in leather tanning processes (Chakraborty et al., 2009), being associated with hypersensitivity reactions, being highlighted as the second most frequent cause of contact dermatitis. Among the general population, about 8 % is sensitive to this metal (Vincent and Lukaski, 2018).

9.5 Cobalt (Co)

Like all essential micronutrients, cobalt has two sides of incompatible exposure; both deficiency and excess can lead to death as well as trigger some diseases (Alves and Rosa, 2003). In the industry, this metal is mainly used in the production of metallic alloys; the exposure occurs during ore milling, mixing the powder with the other components, synthesizing and later machining of the steel in the manufacture of tools and parts for machinery, such as drills and polishing discs (Wehner et al., 1977). Cobalt has its role in therapy to replace radio in the treatment of some types of cancer. In the therapeutic field, it has its purpose for the treatment of cyanide intoxication as CoEDTA (Nagler 1978). The respiratory system is the major route of exposure, with effects on the cardiac system and thyroid gland, as well as the potential for cancer development (Alves and Rosa, 2003).

The migration of the mentioned above contaminants, from PET packaging to packaged products, is particularly important for the Brazilian population. The industry was able to establish the public concept that in Brazil, the so-called *mineral water* (water obtained from a natural water spring, licensed by the Government, without any treatment) is the only source of healthy water for consumption; families have acquired the habit of buying bottled water in 1 L, 2 L or 20 L PET bottles, storing it at home and consuming it continuously. The increased contact time between the PET and the bottled water, mainly due to the storage time, can worsen the scenario of the migration of contaminants to the PET bottled water.

The majority of the Brazilian population seems not to have the view that the water provided by the public system is properly treated, and that the use of ordinary household filters would be enough to obtain drinking-quality water with less contaminants. In Brazil, there is a specific transportation market and all logistics for supplying the population with PET bottled water, and

there is no industry interest in replacing PET packaging for water storage with other materials.

X. BRAZILIAN LEGISLATION

The Brazilian legislation (Resolution 105 of the Sanitary Vigilance Service - SVS, 19 May 1999) prohibits the use of plastic materials from packaging, fragments of objects, or recycled materials, except for PET. The Ordinance No. 978, 08 Dec. 1998, allows the reuse of recycled PET resins only for the manufacture of bottles as a constituent of the functional barrier layer with thickness greater than, or equal to 25 μm ($\geq 25 \mu\text{m}$) and the recovered PET layer less than 200 μm ($< 200 \mu\text{m}$), for products with shelf-life up to one year, under temperature limited to room temperature (ANVISA, 1999).

In Brazil, it became possible to use post-consumer resin (PET-PCR) in multi-layer packaging for non-alcoholic, carbonated beverages. However, one aspect often discussed is the risk involved in using recycled post-consumer polymers to contain food, beverages and pharmaceuticals, because of possible – and probable – contamination. For this purpose, co-injected PET packages could be used with three layers, by making a virgin PET sandwich with recycled PET filling (Romão et al., 2008).

The use of plastic materials in Brazil for manufacturing of food/beverage containers was regulated after the creation of MERCOSUL (Padula and Cuervo, 2004). The MERCOSUL regulations were implemented in Brazil through Ordinance No. 26/SVS. The need for constant improvement of sanitary control in food production to protect the population's health, led ANVISA to review the Administrative Rule No. 26. This ordinance was revoked and currently, the Resolution No. 105, 19 May 1999, is the one in force. Therefore, this Resolution establishes the technical regulations on the use of plastic packaging and equipment in contact with food (Nasser, 2005). However, limits have not yet been set for the monomer bis (2-hydroxyethyl) terephthalate, as well as for PET oligomers.

The use of recognized recycling technologies which have scientifically proved to supply uncontaminated food-grade PET, is authorized in Brazil since 2008 (ANVISA, 2016). In this case, the food content can not be in contact with the recycled portions of the package, being the recycled resin used in external coating of virgin PET resin. The United States of America had recently approved the reuse of PET compounds by two technical processes (Supercycle[®] and Ecoclear[®]), and more recently, the technology Joncryl[®] claims to confer to recycled PET the same characteristics of a brand new PET resin. To date, Supercycle[®] is allowed in Brazil.

XI. CONCLUSIONS

The vast use of PET for food packages manufacturing, especially as container for beverages such as mineral water, fruit juice, and soft (carbonated or not) drinks, is a concern in Brazil. PET contains compounds with potential to migrate to food in contact; among these are the oligomers, for which there is not yet legislation established in Brazil. In this respect it is extremely important to know the hazardous components present in PET packaging and to have sensitive analytical methods that can be used to control and monitor its content in PET and migration rates.

The research methods currently adopted in Brazil are capable of evaluating the migration of elements from PET to its food or beverage content, mainly for As, Cd, Co, Cr, and Sb, which may constitute food contamination, causing human health harm. There are quantities allowed in the legislation, with the defined maximum tolerance limits (LMT); there should be analyzed, however, food and beverages to check if these limits are respected at the end of the storage period of the food packaged in PET.

During synthesis and also during PET recycling process, secondary reactions may occur forming acetaldehyde, oligomers and diethylene glycol. Such by-products, e.g. the oligomers, have the potential to migrate and contaminate packaged foods and beverages. There are few reports in the literature to explain the formation and possible migration of these compounds.

Therefore, in the initial synthesis or recycling of PET packaging, it is of great importance the monitoring by governmental Agencies, about the tolerable limits of contaminants, but the greatest issue seems to be a government monitoring program to evaluate residue levels in PET-packaged foods and beverages, at the end of its shelf life, or expiring date.

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Production system of organic orange and its implications: Study in the SOS site Agroecological, Northeast of Pará.

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Abstract— *The organic production of produce in Brazil has been increasing very year due higher demand for more health food, and many farmers are migrating to these concept of food production. Therefore, the aim of this study is to understand the philosophic concept, as well as doing a description and analyzing the implications of the production system of organic orange. The research was done at Sítio SOS Agroecológico, localized in the city of CapitãoPoço, northeast of Pará. The qualitative exploratory research was done with the owner of the area, who is also a producer of organic orange, through, mainly, visits, semi structured surveys, transect walks in the area, and photographic records. The production of the site is considered adequate; their main market are organic fairs and big supermarkets; however, price and logistic are the main obstacles, besides the certification, where in Brazil is still an onerous process. The production system of Sítio SOS shows certain similarities with the concept of biologic and natural agriculture since both systems goals are the reduction of the rural producer costs, the use of alternative products and/or natural available on the property.*

Keywords— *Agroecology, Certification, Agroforestry Systems.*

I. INTRODUCTION

During the last decades, agriculture has been changing its characteristics from the development of new technologies, agricultural machinery and chemical industry, that although it drives the production of foods, also produces side effects. From the concern with such side effects, farmers have developed agricultural methods and processes that they say are safe and sustainable. It is a production based on the dynamic interaction between soil, plants, animals, people, ecosystem and environment (IFOAM, 1998).

The growing concern with the environment has made the consumer become more and more demanding regarding the attributes of quality and safety of the products and the preservation of the environment. The irrefutable search for constant increases in agricultural productivity through the use of agrochemicals and heavy mineral fertilizers has caused food and environmental pollution at undesirable levels (Assis et al., 1995).

In this context, the organic process of production has been acting as a form of ecologically adequate agricultural exploitation in the face of environmental problems, opening space for the development of organic agriculture, which presents itself as a resumption of the use of old agricultural practices, but adapting them to the most modern technologies of agricultural production aiming at

the increase of productivity and causing the minimum of interference in the ecosystems, besides being one of the alternatives to make feasible the small property (ORMOND et al., 2002).

According to Law No. 10,831, dated December 23, 2003 (BRAZIL, 2015), it is considered:

The organic system of agriculture and livestock production, all those in which specific techniques are adopted, optimizing the use of available natural and socio-economic resources and respecting the cultural integrity of rural communities, aiming at economic and ecological sustainability, maximizing social benefits, the minimization of non-renewable energy dependence, using, as far as possible, cultural, biological and mechanical methods, as opposed to the use of synthetic materials, the elimination of the use of genetically modified organisms and ionizing radiation at any stage of the production process, processing, storage, distribution and marketing, and the protection of the environment.

In order to become an organic farmer, the applicant must undergo a rigorous process of research into the environmental conditions of the farm and potential for production. Certifiers must have their own guidelines and must exercise appropriate control over the use of their licenses, certificates and certification marks (BRAZIL, 2015b). In Brazil, "Quality Seals" (certification seal) are used together with the specific brand of each producer to indicate the agreement with the guidelines, which are certified by accredited certifiers to the National Association for Organic Production (CNPORG) (IBD, 2002).

The culture and commercialization of organic products in Brazil were approved by Law 10.831, of December 23, 2003. Its regulations, however, only occurred on December 27, 2007 with the publication of Decree No. 6,323 (MAPA, 2015). The demand for organic products in Brazil and around the world has increased in the last years, even though in 2006, only 1.75% of the establishments were organic producers (NUNES, 2006).

In the last ten years, citrus production in the state of Pará has reached high growth rates, mainly in the Guamá micro region, where the main producing municipalities like CapitãoPoço, Garrafão do Norte, Irituia and Ourém are concentrated, constituting the "productions center of citrus" State. With the advances of the citriculture in this period, Pará started to take a prominent position, being among the six largest producers of orange in Brazil. The area cultivated with citrus in the State of Pará has grown rapidly, reaching around 14,600 hectare in 2000, with an average yield of 15.6 tons / fruits / hectare (LEMOS et al., 2004).

In the Guamá micro-region, the SOS Agroecological Site has gained prominence. It is located in the municipality of CapitãoPoço, in the Northeast of the State of Pará, with the main activity of growing the fruit (*Citrus sinensis*) "organic". This activity started in 1997, but the marketing as an organic product was only from 2007, with organic certification by Biodynamic Institute Certifications (IBD). In this way, the objective of the present work is to understand the philosophical conception, as well as to describe and analyze the implications of organic orange production system in order to bring information to the institutions of education, research, extension to guide debates and actions on organic production and environmental conservation in the Northeast region and other regions of the State of Pará.

II. METHODOLOGY

The studied area has 75 hectares being called SOS Agroecological Site, with geographic position S 01 ° 47'57 " W 47 ° 06'40,8 ", located in the municipality of CapitãoPoço (Figure 1). The municipality is located in the physiographic zone of Guamá, territory of the Northeast of Para and microregion of Guama, with an area of 2,714.85 km. It is limited to the north with Ourém, to the east with Santa Luzia do Pará and Garrafão do Norte, to the south with Ipixuna do Pará and Nova Esperança do Piriá and to the west with Aurora do Pará, Mae do Rio and Irituia (NUNES, 2006).

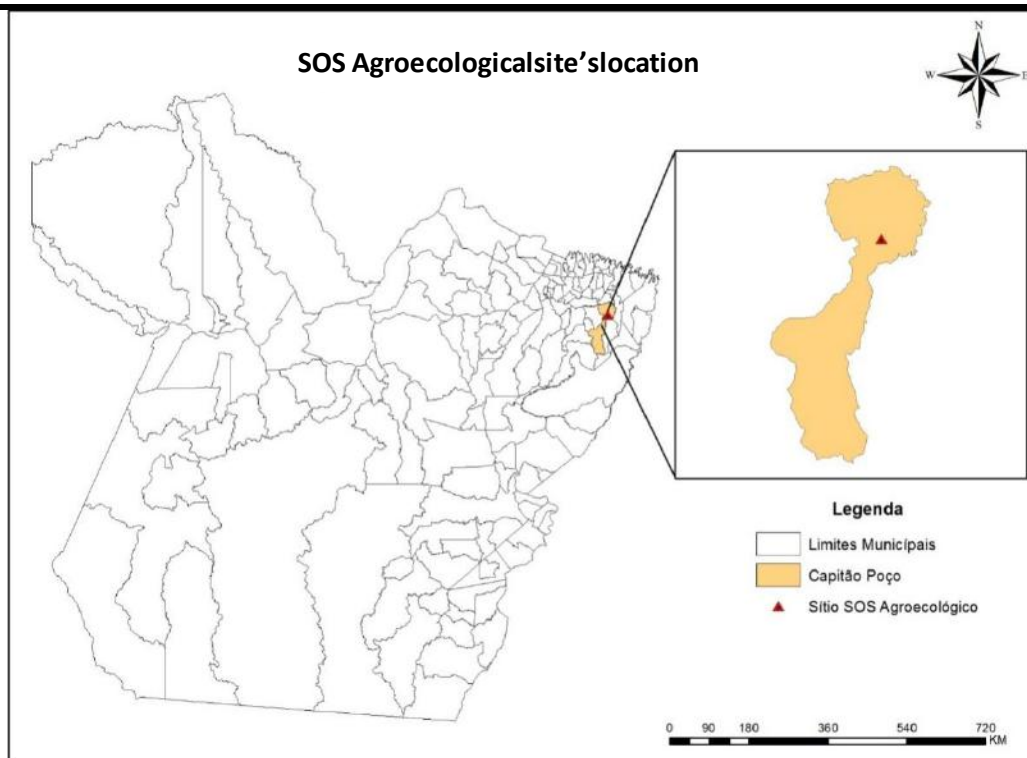


Fig. 1: Location map of the study area.

For the development of this study, a qualitative exploratory research was carried out with the owner of the area and producer of organic orange, mainly through visits, semi - structured interviews, cross - country walks in the area and photographic records.

Qualitative research makes it possible to capture the opinions and perspectives of individuals, information more difficult to obtain by quantitative research. The great advantage of this type of research for the study of organizations is the richness of the details obtained. Qualitative data expresses detailed descriptions of situations, subject events, experiences, attitudes, beliefs and thoughts (CASSAB, 2007).

The research in general, is a formal procedure, based on the method of reflective thinking, requiring a scientific treatment, where it is the way to know reality or to discover truths. The collected data, obtained in this type of research, are collected in situations where those interviewed in the research transit and build their life, where lifestyles, cultures and experiences hatch (CASSAB, 2007).

The variables observed and studied for the present work were: seedling production, main difficulties found for organic production, incident pests, management used and market logistics.

III. RESULTS AND DISCUSSION

According to the interviews carried out with the owner of the SOS Agroecological Site, the seedlings are acquired

by the conventional system, using the grafting method, whose purpose is to select the species with the highest productive potential and to reduce the risk of pest and diseases.

The rootstocks act in several horticultural and pathological characteristics of the citrus, emphasizing: the absorption, synthesis and utilization of nutrients; transpiration and chemical composition of leaves; response to leaf and fruit abscission products; size, precocity of production and plant longevity; maturation, weight and permanence of fruits in the plant; peel and juice coloring; content of sugars, acids and other components of juice; tolerance to pest insects; post-harvest conservation; productivity and fruit quality (SOUZA et al., 2010).

The arrangement between the graft and the rootstock plays an important role in the productivity and quality of the citrus fruit. Thus, the productive system used, the climatic conditions of the region, the existing and potential pests and diseases of the market to which the fruits are destined are important points to be considered (OLIVEIRA et al., 2010).

For the management of the planting, the fertilization is done through the area enrichment method, where the crushing of the "fertilizer" plants like Ingá (*Inga edulis* Mart) and Black Mucuna (*Mucuna atterima*), *Pueraria* (*Pueraria phaseoloides* (Roxb.) Benth) and phosphorus mobilizing plants occurs: *Titonia* (*Tithonia diversifolia*) and *Embaúba* (*Cecropia pachystachya*), in addition to

fertilization with sheep manure (Ovisaries) in the case of orange trees (1 to 2 paddles per plant). As the production system is organic, no chemical fertilizers or agricultural pesticides are used.

A study by Gallo and Rodriguez (1960) pointed out the importance of legumes and mulch in increasing orange tree productivity. Thus, it can be seen that without the use of chemicals, many benefits can be obtained in the production of orange, both in conventional and organic production.

Initially pest control was performed with alternative pesticides in the study area of the present study. But at the moment, the production system of the SOS Agroecological Site is in a environmental equilibrium. The effects of different dead coverings from the mechanical management with lateral trimmer that performs the deposit of phytomass in the orchard line concludes that the mulch with natural vegetation presented a suppressive effect on the weeds.

In the SOS Agroecological Site, inter-cropping is carried out in the oranges lines, such as Soursop (*Annona muricata L.*), Cashew (*Anacardium occidentale L.*), Noni

(*Morindacitrifolia L.*), Bacabi (*Oenocarpus bacaba Mart.*), Pineapple (*Ananas comosus L. Merrill.*), Brazilian mahogany (*Swietenia macrophylla King*), African mahogany (*Khaya senegalensis (Desv.) A. Juss.*), Chestnut of Pará (*Bertholletia excelsa Bonpl.*), Cedar (*Cedrela odorata L.*), Andiroba (*Carapaguianensis Aubl.*), Among others, Agroforestry (SAFs) with organic management, where the agroecological principles were incorporated in order to contribute to the biodiversity conservation and environmental balance of the area. The SAFs implemented in the production area of Orange tree contribute to the fertilization of the crop, increasing the productivity through the cycling of nutrients.

The main occurrences of pests and diseases that attack the planting are the ants (*Acromyrmex sp.*) and the fruit fly (*Ceratitisanastrepha*). The fruit fly is considered the main pest (Figure 2A), because it is responsible for transmitting leprosy, called Citrus leprosis virus (CiLV), a disease that influences the visual quality of the fruit (Figure 2B). For the control of disease proliferation, drastic pruning is performed.

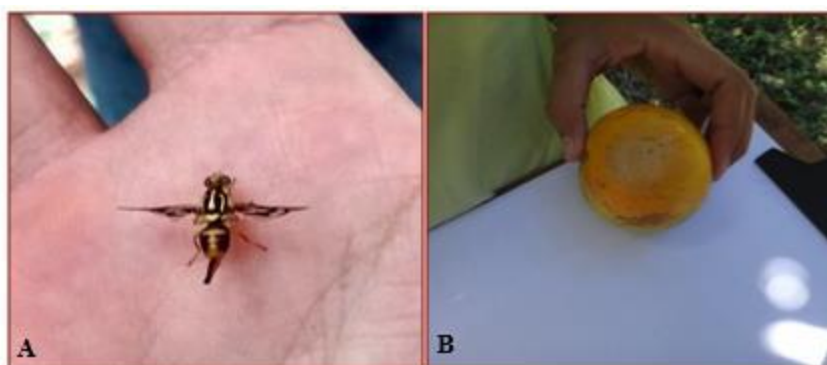


Fig. 2: A- Fruit fly (*Ceratitisanastrepha*); B- Leprosis.

In organic production, priority should be given to the use of resistant varieties to control the main fruit diseases (BORGES; SOUZA, 2005). The consequence of a mixed or consortium planting reduces the incidence of fertilization and the attack of pests and diseases, because the system is in equilibrium, so the resistance of the crop is greater.

According to the characteristics of the practices and management of the productive system of the SOS Agroecological Site it is clear that the same follows to the conception of two styles: *organic farming and natural agriculture*. The first is biological control and integrated pest and disease management. This agriculture reinforces the use of organic fertilization and other biological techniques. On the other hand, it recommends the least possible change in the natural functioning of ecosystems and uses microorganisms beneficial to plant and animal

production, known by the acronym EM (effective microorganisms).

The fundamental principle of organic farming is the fact that agriculture is based on the biological sciences, being defined as a system that tries to maintain the environmental balance. Maintenance of soil fertility and pest and disease control is done by the use of natural processes and cycles, with only a moderate expenditure of energy and resources, maintaining good productivity (HODGES, 1981).

As regards natural agriculture, it is defined as a system of agricultural exploitation based on the use of practices that seek to take full advantage of nature, as far as ecology and local natural resources are concerned. In other words, cultivation practices of natural agriculture are based on the natural method of soil formation, relying on the force of nature and with all the scientific technical knowledge acquired throughout human evolution (Assis, 2005).

Some of these unconventional forms have characteristics strictly related to agriculture, while others still add aspects related to education, religion and nutrition. However, among the characteristics of the various alternative styles, agricultural production strategies based on ecological concepts for the recycling of nutrients and optimized organic matter, balanced populations of pests and increasing multiple use of land are the common point among them (COSTABEBER, 2007).

Still on the two styles of organic agriculture and natural agriculture, it was verified that the cost of production is considered low, in relation to the conventional, since there is no use of herbicides, fungicides among other products that increase the value of the production. According to Neves et al. (2004), the cost of pesticides in citrus fruits reaches 45% of the cost of production.

In the table below are some of the characteristics faced by the producer of the Site to which it was made (Table 1).

Table.1: Aspects evaluated with organic orange producer.

ASSESSED ASPECTS	SOS AGROECOLOGICAL SITE
Certification period	1 year.
Forest species	Native and African mahogany, Chestnut of Pará, Cedro and Andiroba.
Difficulties in the production of organic orange	Specialized labor, neighbors surrounding the property use the conventional system (chemical fertilization).
Production cost: Organic x Conventional	Smaller for organic.
Productivity	Low
Main markets for marketing	Regional Market: Local Market and Metropolitan Region; national market: São Paulo.
Marketing price	30% more than the conventional one.

It is worth mentioning that organic agriculture has as principles the use of compounds, plants of deep roots and mycorrhizal performance in the health of the crops. Lately, there is great economic interest in this agriculture that has increasingly been seen as a profitable business (FEIDEN, 2005). According to the guidelines of the Biodynamic Certification Institute (IBD), areas or units that produce, process or export organic products must be clearly separated from others that handle conventional products.

However, when talking about biodynamic agriculture, it has more integrated approach to rural property, seeking to

see it and manage it as a living organism. From a practical point of view, what most distinguishes biodynamic agriculture from organic agriculture is the use of certain preparations incorporated in compost piles and natural manures, such as planting windbreaks, or spraying directly on plants (FEIDEN, 2005). It is in this context that the knowledge about the ecological characteristics of the species is of fundamental importance for the success of the enterprise, among them one can mention the flowering and fruiting (Figure 3).

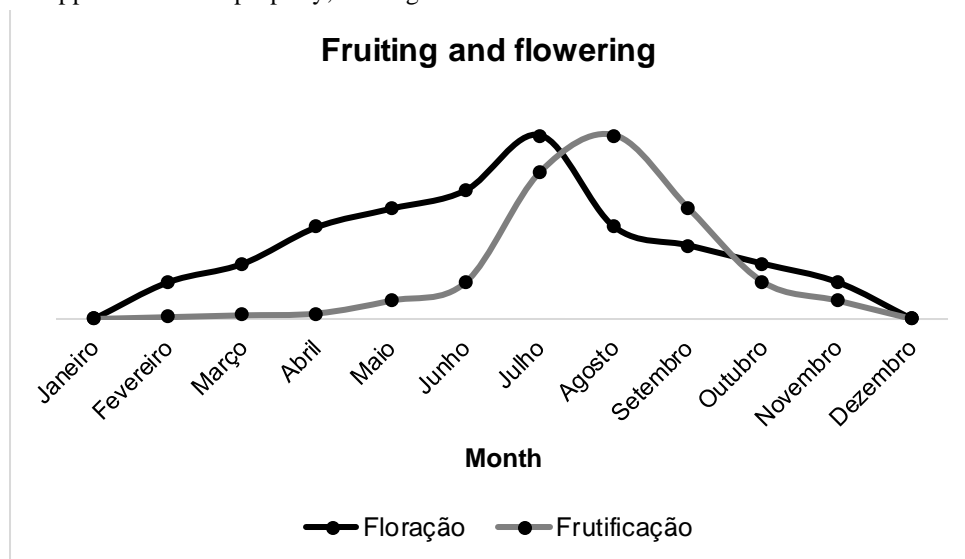


Fig.3 - Period of fruiting and flowering of organic orange, produced in the study area of the SOS Agroecological Site.

In this context, windbreaks in SAFs have been used in the SOS Agroecological Site as natural delimiters. In addition, the interaction between citrus plants and windbreaks usually focus on quantifying the effect of shading from installed windbreaks on yield and fruit quality, wind and cold damage, and the spread of disease (Oliveira et al., 2010).

The main marketing channels in descending order are: fairs, industry, organic / natural product outlets and

middlemen. The location of the property and the production runoff channels are among the factors that most interfere in the difficulty of commercialization (distant from large shopping centers and with high freight cost, in some cases not compensating the sale) (TURRA and GHISI, 2004). The impact on increasing product output decreases the value of freight and opens up new marketing opportunities at both the regional and national levels (Figure 4).

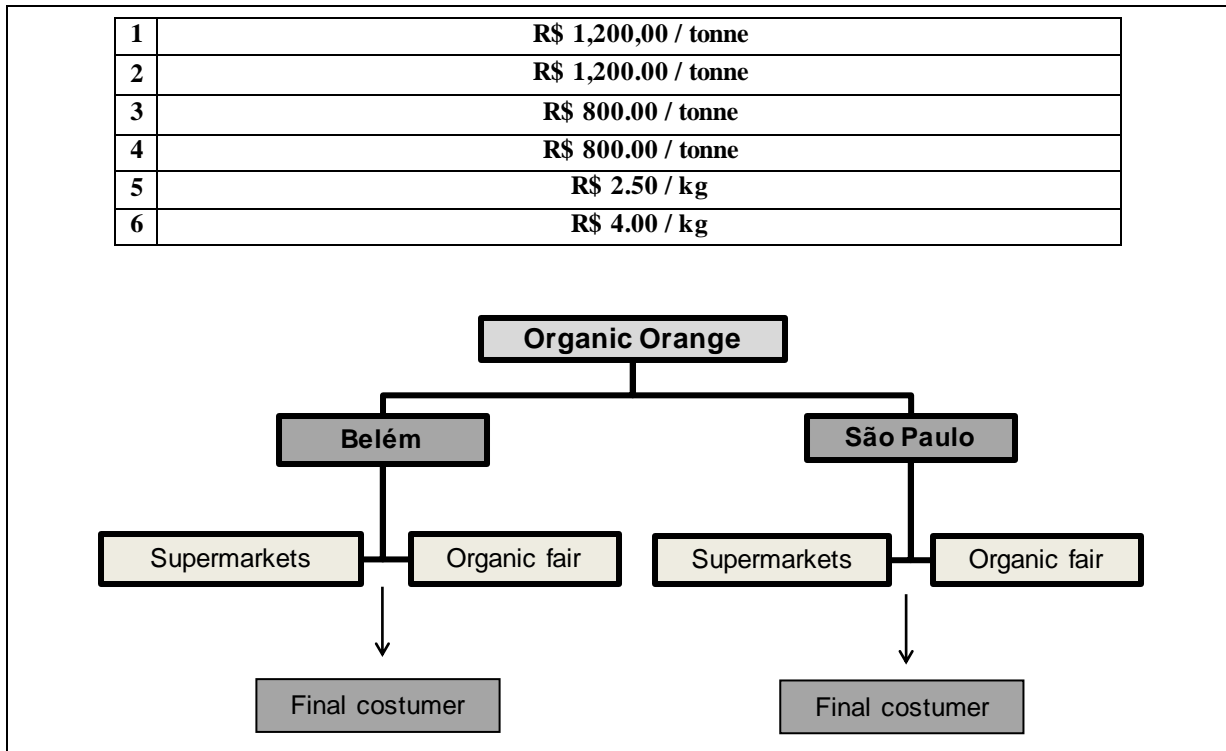


Fig. 4: commercialization flow of Organic Orange

IBD is responsible for the organic certification of the SOS Agroecological Site, where it is valid for one year. One of the difficulties of obtaining organic certification is that the process is time-consuming and expensive, since the property has to be in accordance with the norms required by the current legislation and for this it takes a longer time until this process is successfully achieved.

The main advantage of organic versus conventional refers to the lower toxicity index and the maintenance of the environmental balance. For the producer, one of the advantages of this system is related to the non-use of chemicals, since, according to Lima Neto et al., (2009), a large number of farmers do not use protective equipment, these chemicals being used indiscriminately.

Moreover, they are personally satisfied to offer consumers better quality products and to promote

improvements to the population close to the production sites, considerably reducing environmental contamination (PANZENHAGEN et al., 2008). The fact that organic farming requires more manpower, generating employment or the use of the family's own labor force can still be considered as another advantage.

Organic production has a high cost of implementation due to the process of conversion and certification that is submitted the property when adhering to organic cultivation (BRITTO, 2015). However, over the years, maintenance costs are lower than traditional production, because producers begin to manufacture many of the organic compounds needed for the activity, in addition to the differentiated price. This fact is easily visualized in the information of the Site studied (Figure 5).

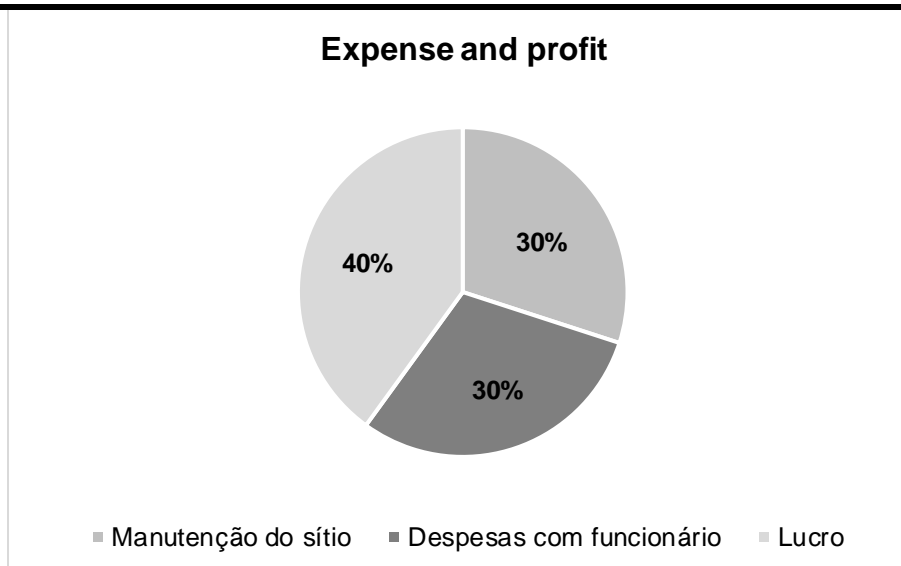


Fig. 4: Annual percentage of expenditure and profit for the organic production of orange from the SOS Agroecological Site

The main difficulties of the organic system are related to a change in the patterns of production and consumption, as well as the lack of effective public actions. The initial costs are high, because factors such as the acquisition of suitable implements and materials, seeds, the introduction of soil preparation and conservation practices, technical assistance among others, are inserted when converting from conventional to organic agriculture is desired (CAMPANHOLA ; VALARINI, 2001).

Another difficulty is the control of pests, as this can lead to contamination of soil, plant and man by worms, coliforms and excess nitrogen (ABREU JÚNIOR et al., 2005). As the scale of production is reduced due to the low number of farmers adhering to the organic method, these products have a higher cost to the consumer (ALMEIDA JÚNIOR et al., 2008). However, a study by the Gallup Institute revealed that about 70% of Brazilians are willing to pay 30% more for organic food (PORTAL SÃO FRANCISCO, 2015).

IV. CONCLUSION

It is concluded that the system of production of the SOS Agroecological Site presents a certain similarity with the conception of organic and natural agriculture, since both systems aim at the reduction of costs of the rural producer, the use of alternative and / or natural products available in the property - having as main product Organic Orange - excellent quality and much appreciated in the region.

It is also observed that the sustainable management of the Organic Orange system of the SOS Agroecological Site is characterized by a set of conservation and ecological practices that lead the system to balance with the environment, which facilitates certification and staggered production to the consumer market.

Despite the innumerable advantages of the organic system of the SOS Agroecological production site, obstacles to the permanence of certification of this new method in the region are still found, since producers have little or no tradition of organically producing.

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Synthesis and biological activity of some heterocyclic compounds contains N-benzylidene heterocycle and beta-lactam moiety

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Abstract—A number of N-benzylidene heterocycle derivatives have been synthesized and their antibacterial activities tested. The new chemical structures synthesized compounds were verified on the basis of spectral and elemental methods of analyses. The antimicrobial activity of the compounds was done by disc diffusion method. We synthesized two different types of compounds, a combination of compounds based on the structure of isatin and other compounds based on the structure of thiazole. Synthesis of thiazole was performed using green chemistry method and a three-step reaction was used in the synthesis of isatin compounds. We used the Stoell-Becker method to synthesize compounds based on the isatin structure.

The synthesized product was characterized by its physical properties, melting point, TLC and then subjected to the in vitro antibacterial activities against gram-positive and gram-negative strains of microbes

Keywords— Antibacterial activity, Green chemistry, isatin, thiazole, N-benzylidene heterocycle

I. INTRODUCTION

Green chemistry is called the environmentally friendly chemistry in which it seeks to use as far as possible methods that introduce the least harm to the environment [1]. Green chemistry focuses on the design of processes that reduce the consumption and production of hazardous chemicals. This part of the science of chemistry focuses on technologies that reduce the consumption of minerals and reduce the production of contamination. [2,3,4,5,6].

Green solvents usually come from renewable and natural sources. [7,8] Recently, juice is used as a catalyst for the synthesis of compounds that have medicinal properties [9] Juice is a great solvent because it is both available and non-toxic and safe. Lemon is a good alternative to the catalyst in the open-flame reaction. [10,11] A Schiff base is a compound with the structure OF R₂C=NR' (R' ≠ H)

[12]. The formation of carbon-nitrogen double bond is important in the organic synthesis. Schiff bases can be synthesized from an amine and a carbonyl compound [13,14]. Schiff bases compounds are known as organic chemicals due to significant biological activity such as anticancer [15], antitumor [16], anti-inflammatory agents [17], antibacterial [18], antibiotics [19], antimicrobial [20], anticonvulsant activity [21]. Isatin (Indolin-2,3-dione) derivatives are reported to show variety of biological activities like antibacterial [22]. Isatin is one of the most important heterocyclic compounds. For example, Schiff bases of isatin are used for their pharmaceutical properties [23]. Isatin (1H-indole-2,3-dione) was first obtained by Erdman and Laurent in 1841 as a product from the oxidation of indigo by nitric and chromic acids [24]. Substituted isatins are also found in plants, for example the melosatin alkaloids [25].

II. EXPERIMENTAL

2.1 Material and Methods

All chemical materials from Merck and Aldrich Company and used without further purification. The IR spectrum was taken with a Shimadzu 300 spectrometer using potassium bromide pellets. ¹H NMR (nuclear magnetic resonance) the spectrum of compound was recorded on a Bruker AMX 250 MHz spectrometer in the DMSO solvent using tetramethyl silan as an internal reference. Melting points of compounds were measured with an electro thermal melting point apparatus and were not corrected. The molar conductance of the complexes in DMSO (1×10⁻³ M solution) was performed at 25 °C using Oakton ECTestr 11 dual-range, conductivity tester. The progress of the reactions was monitored by thin-layer chromatography (TLC) on silica gel Polygram precoated TLC sheets.

2.2 Preparation of catalyst

In the synthesis of our thiazole derivatives, we used lemon catalyzer as a green catalyzer. The method of

obtaining this catalyst was to wash the fresh lemon first with water, then we cut the lemons with a knife and physically lemon juice. We extracted the lemons from the filter and then reacted with the fluid under the filter as a catalyst.

2.3 General procedure for synthesis of Thiazole compounds

A mixture of the selected benzaldehyde (0.1mmol) and 2-Aminobenzothiazole (0.1 mmol) and catalyst juice (lemon juice) (8ml) were added and stirred at 65 °C for the 8 hour. The reaction progress was studied by TLC. The products were dried and recrystallized in hot alcohol to obtain the pure product. The product was characterized by melting point, 1H NMR, IR.

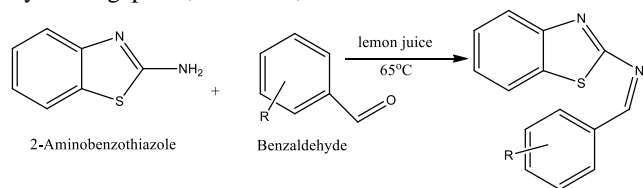


Fig. 1: Synthesis of Thiazole compounds

2.4 synthesis of compound and analytical and spectral data of products

2.4.1 4-((benzo thiazol-2-ylimino)methyl)phenol (a₁)
 ivory solide. Yield 75%, mp 240-242 OC.

FTIR (vmax, KBr):1687 (C=N), 3392 (CH_{aromatic}), 2170 (OH)3451, (CH_{ar}) 3116, (C=C), 907 cm⁻¹
 1HNMR: (DMSO): δ=9.29 ppm (s,1H, HC=N), 9.76 ppm (s,1H, OH), 6.9-7.8 ppm (m,10H, Haromatic)

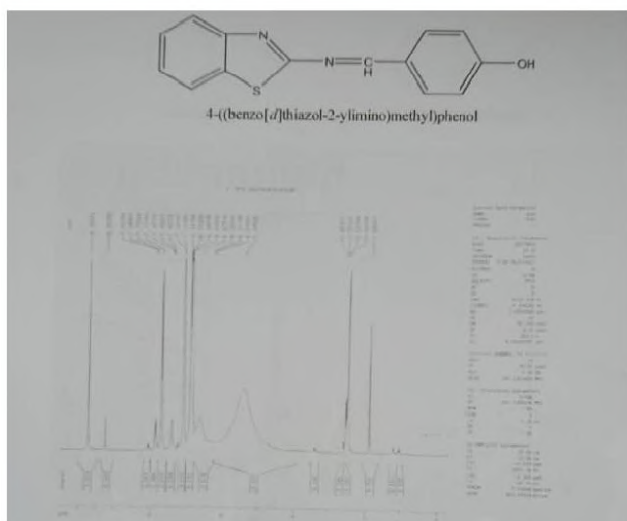


Fig. 2: 1H NMR spectra of 4-((benzo thiazol-2-ylimino)methyl)phenol

4-((benzo thiazol-2-ylimino)methyl)-N,N-dimethylaniline (a₂)

yellow solid. Yield 70%, mp 206-208 OC.

F TIR (vmax, KBr):1660 (C=N) ,1468 (C=C) ,

,1334 (CN) cm⁻¹

1HNMR: (DMSO): δ=8.08 ppm (s,1H, HC=N),

2.85ppm (s,6H, N(CH₃)),

7.02-

8.05ppm(m,8H,H aromatic)

13CNMR(DMSO):

δ=32.68,34.27,41.84,77.23,77.49,77.74,114.04,114.87,11

7.47,118.34,124.14,125.29,127.38,128.82,129.15,129.8,1

31.94,137.63,148.14,158.24,164.08ppm

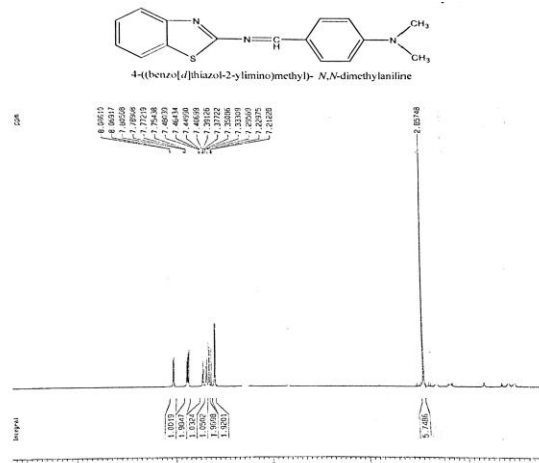


Fig. 3: 1H NMR spectra of 4-((benzo thiazol-2-ylimino)methyl)-N,N-dimethylaniline

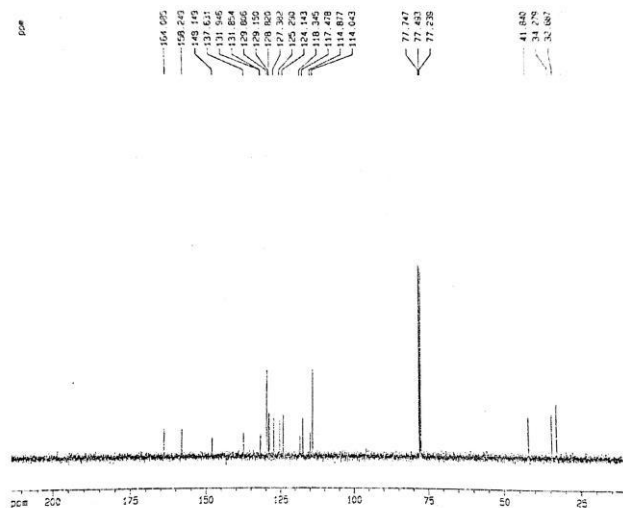


Fig. 4: 13CNMR spectra of 4-((benzo thiazol-2-ylimino)methyl)-N,N-dimethylaniline

N-(benzo thiazol-2-yl)-1-(furan-2-yl)methanimine (a₃)

black solide. Yield 75%, mp 163-1165 OC. FTIR (vmax, KBr):3333 (NH₂), 3172(CH_{aromatic}), 1738(C=C)

,1637(C=N), 1351(C-N) cm⁻¹

1HNMR:(DMSO): δ=8.36ppm(s,1H, HC=N),6.79ppm

,6.00-8.00ppm (m,8H, Haromatic)

8.37ppm (s,1H, Haromic),8.92ppm (s,1H, C=NH),
12.04 ppm (s,1H, SH).

Fig. 6: ¹H NMR spectra of N-(benzo thiazol-2-yl)-1-(4-methoxyphenyl)methanimine

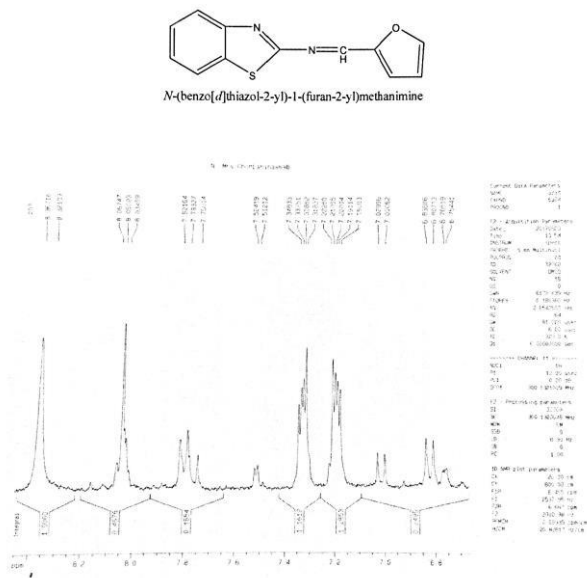


Fig. 5: ¹H NMR spectra of N-(benzo thiazol-2-yl)-1-(furan-2-yl)methanimine (a₃)

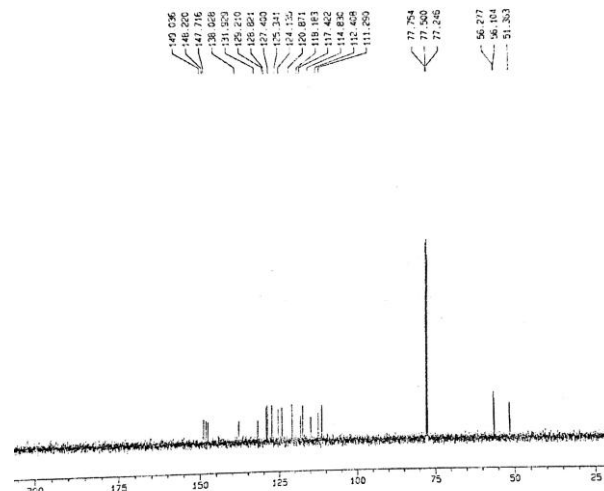


Fig. 7: ¹³C NMR spectra of N-(benzo thiazol-2-yl)-1-(4-methoxyphenyl)methanimine

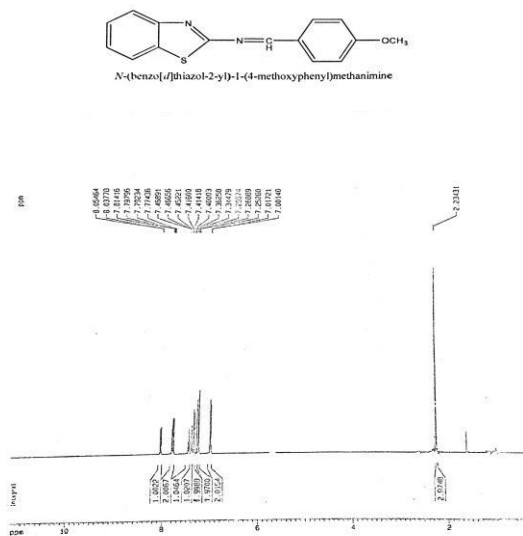
N-(benzo thiazol-2-yl)-1-(4-methoxyphenyl)methanimine (a₄)

Dark yellow. Yield 80%, mp 180-185 °C.

FTIR (ν_{max}, KBr):1727 (C=N),1125(C-O), 2852 (SH),1401 (C=C), 1609 (C=N),1513 (OCH₃),1463 (OCH₃), cm⁻¹

¹H NMR(DMSO) : δ=8.05 ppm
(s,1H,HC=N),2.23(s,1H,OCH₃),7.00-8.03(m,9H,Haromic)

¹³C NMR(DMSO): It represents 15 carbons



2.5 General procedure for synthesis of Isatin compounds

In this reaction, we dissolved (.1 mmol) 2, 4 di-nitrophenylhydrazine in a solvent of ethanol(20ml) in the presence of sulfuric acid, and then added various benzaldehyde(.1mmol) to the reaction medium, resulting in orange-colored precipitation(3).(1mmol) product No. 3 was dissolved in dichloromethane solvent. Then, dissolve the (.15 mmol)oxalyl chloride in dichloromethane and add the solution No. 3 as droplet to oxalic chloride in dichloromethane and place in reflux conditions for 4 hours. Finally, add a further amount of (.3 mmol)AlCl₃ to the reaction medium and place it in the reflux conditions for one night, then add the water and ice to the reaction. The progress of the reaction was monitored by TLC. The product was dried and recrystallized from hot alcohol to obtain the pure product. The product was characterized by melting point, ¹H NMR, IR.

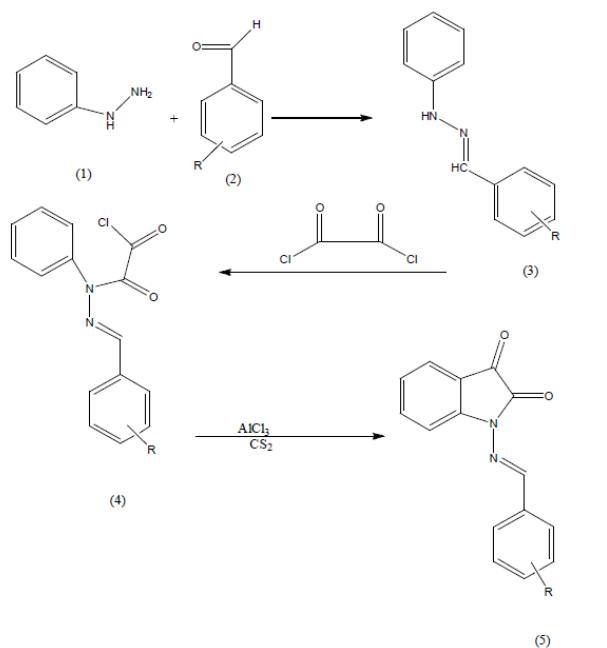


Fig. 8: Synthesis of Isatin compounds

2.6 synthesis of compound and analytical and spectral data of products

2.6.1 (E)-1-(benzylideneamino)-5,7-dinitroindoline-2,3-dione (b₁)

red solide. Yield 68%, mp 159-163 °C.

FT-IR (ν_{max}, KBr) : 3101.63 (C-H), 1728.66 (C=O), 1619.83 (C=N), 1331.11 (NO₂)

¹H-NMR (DMSO) : 8.87 (s, 1H, H between to NO₂), 8.72 (s, 1H, H Near

NO₂), 8.34 (s, 1H, CH=N) 7.81-7.82 (d, 2H, CH-Ar)

7.49 (m, 3H, CH-Ar)

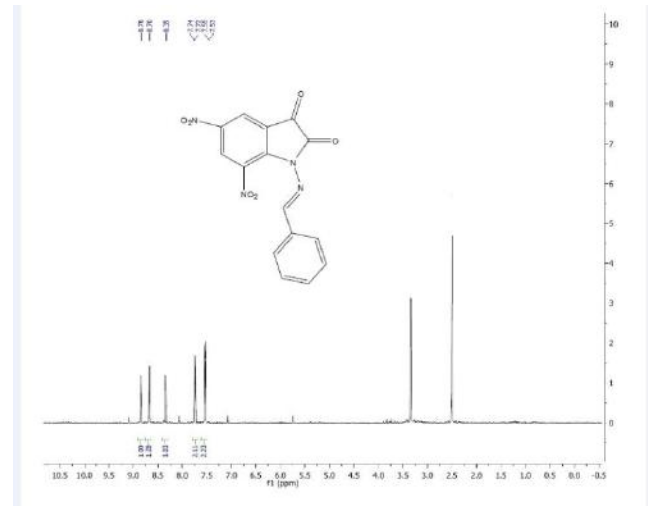


Fig.9: ¹H NMR spectra of (E)-1-(benzylideneamino)-5,7-dinitroindoline-2,3-dione (b₁)

(E)-1-(benzylideneamino)indoline-2,3-dione (b₂)

Red solid. Yield 65%, mp 179-181 °C.

FT-IR (ν_{max}, KBr) : 2811.45 (C-H), 1727.44 and 1747.66 (pair C=O),

1615.36 (C=N), 1400-1600 (Ar)

¹H-NMR (CDCl₃,

400 MHz): δ 9.69 (s, 1H, HC=N), 7.80 (d, J=7.6 Hz, 2H, indoline ring), 7.59-7.66 (m, 2H, phenyl), 7.43 (d, J=6.8 Hz,

4H, phenyl), 7.15 (t, J=15.2 Hz, 1H, indoline ring).

(E)-1-((4-methoxybenzylidene)amino)-5,7-dinitroindoline-2,3-dione (b₃)

Red solide. Yield 75%, mp 168-170 °C. FT-IR (ν_{max}, KBr) : 1705.47 and 1684.97 (pair C=O),

1334.68 (NO₂), 1273.54 (C-O), 1625.49 (C=N), 1400-1600 (Ar)

¹H-NMR (DMSO) : 3.82 (s, 3H, OCH₃), 7.03-7.05 (d, 2H, CH-Ar), 7.72-

7.74 (d, 2H, CH-Ar) 8.33 (s, 1H, CH=N) 8.88 (s, 1H, between NO₂) 8.74

(s, 1H, near NO₂)

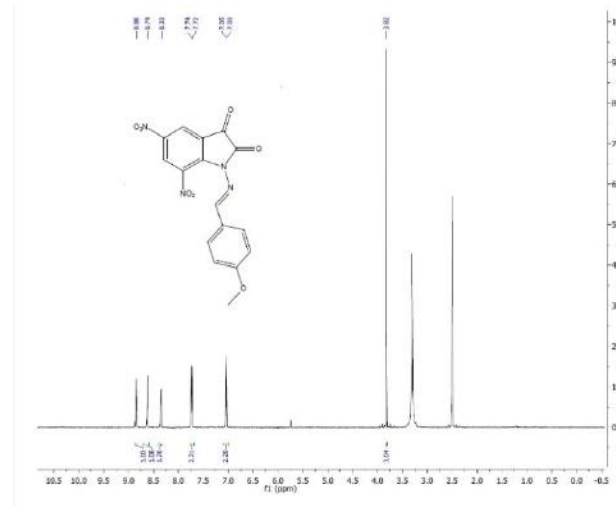


Fig. 10: ¹H NMR spectra of 1-((4-methoxybenzylidene)amino)-5,7-dinitroindoline-2,3-dione (b₃)

(E)-1-((4-methylbenzylidene)amino)-5,7-dinitroindoline-2,3-dione (b₄)

Dark red solide. Yield 72%, mp 193-195 °C.

FT-IR (ν_{max}, KBr) : 3089.30 (C-H), 2922.00 (C-H), 1719.92 (pair C=O),

1613 (C=N) 1325.98 (NO₂)

¹H-NMR (DMSO) : 2.82 (s, 3H, CH₃), 7.31-7.33 (d, 2H, CH-Ar), 7.75-

7.77 (d, 2H, CH-Ar), 8.41 (s, 1H, CH=N), 8.72 (s, 1H, near NO₂), 8.82

(s, 1H, between NO₂)

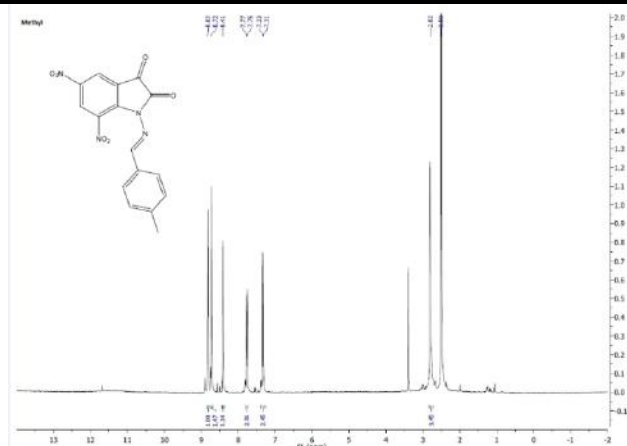


Fig. 11: ¹H NMR spectra of (E)-1-((4-methylbenzylidene)amino)-5,7-dinitroindoline-2,3-dione (b₄)

(E)-1-((4-chlorobenzylidene)amino)-5,7-dinitroindoline-2,3-dione (b₅)

Red solide. Yield 68%, mp 182-185 °C. FT-IR (ν_{max}, KBr) : 3090.71 (C-H), 1710.64 and 1689.55 (pair C=O) 1613.09 (C=N), 1402.52 and 1585.25 (NO₂), 1613.09 (C=N), 1400-1600

(CH-Ar)

¹H – NMR (DMSO) : 7.53-7.55 (d, 2 H, CH- Ar), 7.72-7.74 (d, 2H, CH- Ar),

8.35 (s, 1H, CH=N), 8.70 (s, 1H, H near NO₂), 8.78 (s, 1H, between NO₂)

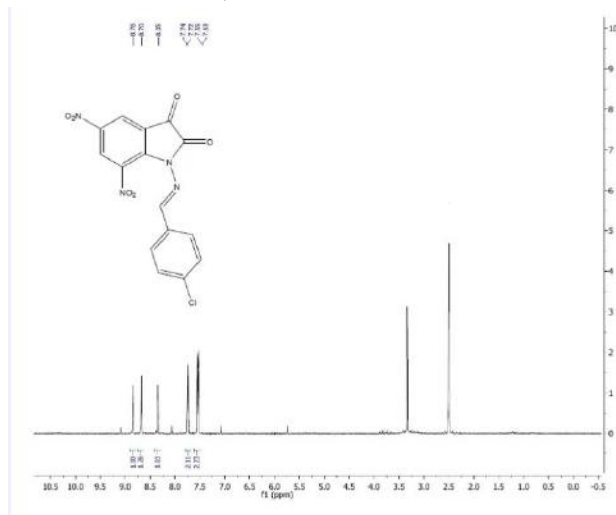


Fig. 12: ¹H NMR spectra of (E)-1-((4-chlorobenzylidene)amino)-5,7-dinitroindoline-2,3-dione (b₅)

2.7 In vitro antibacterial activity

Bacillus subtilis (ATCC: 6633) and Staphylococcus aureus (ATCC: 6838) as gram-positive bacteria Escherichia coli (ATCC: 25922), Serratia marcescens

(ATCC: 13880) as gram-negative bacteria. We used these two classes of bacteria to test the antibacterial activity of our compounds.

Microorganisms were cultured onto Muller Hinton Agar (MHA) plate and incubated for 18-24 h at 35 °C. The density of bacteria cultures required for the test was adjusted to 0.5 McFarland (1.5 × 10⁸ CFU/ml) (CFU = Colony Forming Unit). The antibacterial activity of the synthesized compounds were determined with two methods: minimum inhibitory concentration (MIC) of antibiotic for that bacteria and the disc diffusion methods. The test was repeated three times to increase precision.

2.7.1- Disc diffusion method

The disk diffusion method is a method by which the antibacterial activity of the compounds is measured. The compounds (0.04 g) were dissolved in 2 mL DMSO. A bacterial culture (which has been adjusted to 0.5 McFarland) was used to lawn Hinton agar plates using a sterile swab. The discs had been impregnated with synthesized compounds were placed on the Muller-Hinton agar surface. Tetracycline and cephadrine were used as standards for antibacterial measurements. As expected, DMSO did not show any antibacterial activity. After incubation for 18-24 h at 35 °C, the extent of non-growth of each substance was measured in millimeters. The disk diffusion method values are presented in Table 1.

Table. 1: Inhibition zone of Compounds against bacterial strains

Compounds	G (+)	
	B.sabtilis	S.aureus
E.coli	S.marcescen	
A1	12	N.A
14	10	
A2	10	15
16	13	
A3	N.A	10
N.A	14	
A4	15	12
13	10	
B1	16	15
11	N.A	
B2	N.A	13
15	14	

B3	10	21
12	9	
B4	N.A	N.A
10	N.A	
Tetracycline	10	21
12	9	
Polymixin	10	N.A
12	N.A	
DMSO	0	0
0	0	

2.7.2-Minimal Inhibitory Concentration (MIC) method

In microbiology, the minimum inhibitory concentration (MIC) is the lowest concentration of a chemical which prevents the visible growth of a bacterium. MIC is the lowest concentration of the antimicrobial compound, which inhibits the visible growth of a microorganism after overnight incubation. In this method, the various concentrations of synthesized compounds were made from 2000 to 1. 95µg/ml in a sterile tube. A 1 ml sterile Muller Hinton Broth (MHB) was poured in each sterile tube followed by addition of 1 ml test compound in tube 1. Two-fold serial dilutions were carried out from all the tubes and excess broth (1ml) was discarded from the last tube. To each tube 0. 1 ml of the standard microorganism (1. 5 ×10⁸ CFU/ml) was added. Turbidity was observed after incubating the inoculated tubes at 35 °C for 24 h. the MIC values are presented in Table 2.

Table. 2: Minimal Inhibitory Concentration, µg/ml of Compounds against bacterial strains.

Compound	G(+)		G(-)	
	B.sabtilis	S.aureus	E.coli	S.marcescens
A1	250	500	1000	17.5
A2	16.72	125	60.5	16.72
A3	15.62	125	15.62	15.62
A4	1000	1000	17.5	17.5
B1	17.5	1000	125	15.62
B2	250	500	1000	16.72
B3	16.5	125	500	17.5
B4	1000	500	125	17.5

III. CONCLUSION

In this study concentrates on the importance of fruit juice in organic transformations with biocatalyst

exclusivity and Synthesis of Isatin based structures as an active biological structure. The avail of fruit juice in organic synthesis is based on acidic properties, enzymatic activity, benign environmental nature, cheap material, and commercial usability. The benefit of synthesizing structures based on the isatin structure is that since isatin is one of the Indole derivatives and the Indole nucleus is present in many biological structures, then Isatin derivatives can have high biological properties.

The catalyst based activity is consisting of the benefit of fruit juices in various organic transformations including the formation of C-C and C-N bonds in different synthetically organic compounds that researched before. We can Forecast that in next years the chemistry of natural catalysts will continue to attract remarkable research activity. It can also be expected that in the coming years more new compounds will be synthesized based on the structure of the Isatin sciences, which can be attributed to the biological properties of these compounds.

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Strategic Management of a Work Safety Company with use of Bsc and Swot Matrix, in Macaé-RJ, Brazil

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Abstract— *The purpose of this manuscript is to evaluate the importance of the use of the SWOT matrix, the competitive strategy of differentiation and the Balanced Scorecard (BSC), in the construction of the strategic diagnosis, in a company of work safety training in Macaé-RJ, Brazil. Maintain or extend their competitive advantage. The results show that it is possible to perceive that the managers approve and consider important the use of the matrix swot the competitive strategy with a broad target in the differentiation and the Balanced Scorecard (BSC) in the elaboration of the strategic diagnosis to maintain the competitive advantage of the company studied in the market. The conclusion of the present study was that the use of the swot technique, differentiation strategy and BSC are important for the success of strategic planning and the search for competitive advantage*

Keywords— *Planning, Swot, Balanced Scorecard, Competitive Strategy.*

I. INTRODUCTION

The present study aims to develop the analysis of the strategic management adopted by a company of work safety training, which operates in Macaé-RJ, Brazil, in several distinct segments of the industry, under the SWOT approach, competitive strategies and the Balanced Scorecard (BSC), used to carry out internal and external environment analysis, aiding strategic and organizational planning. SWOT is used to position or verify the situation and strategic position of the company in the environment in which it operates (MCCREADIE, 2008).

Labor safety training companies understand that the market is becoming more competitive and their customers are more demanding, so they are looking for a variety of

strategies to stay competitive in a market where there is a high charge for quality of service and price. Through the context presented, a field research was carried out in the company, where it is demonstrated how the company implemented the SWOT and the business strategies adapting to the economic reality and the current scenario, visualizing the internal environments (strengths and weaknesses) and external (opportunities and threats) to maximize strengths and opportunities and minimize weaknesses and threats.

The overall intent of this analysis is focused on the company in the area of work safety training, uses strategic planning through the SWOT tool and business strategies, managing to identify vulnerabilities and strengths of its competitors, making it possible to improve their management decisions, always focusing on the excellence of its services through a model toyotism training with sustainable, innovative practices, at a fair price, attuned to its mission, vision and values: essential pillars for its maintenance and growth in the medium term in the national and international market.

II. REVIEW OF LITERATURE

Strategic Planning is a tool widely used by the most successful organizations, in collaborating with objectives and actions to face future situations and their commitments. All this, due to his interpretation of the environment, directing and adapting the organization in the most appropriate way for the attributes (OLIVEIRA, 2010).

It aims to reduce the chance of correcting and recovering the path to the enterprise. To the many uncertainties of market, that daily arise by means of technological and the competition, and the strategic

strategy to the staged and successful steps of the business. (SLACK et al., 2002)

When an organization has goals and objectives, the search is successful, it has the sharpness defined as what it is, what it does, and where it wants to go. (DRUCKER, 1997)

The main objective of this study was the strategic diagnosis, according to Ferreira et al. (2005), is the first step in strategic planning. It is through it that the organization will obtain the information needed to guide its strategies. The diagnosis seeks to know the relationship of the company with its internal and external environment in order to know and follow the competitive variables that affect it, being able to anticipate the changes and make the necessary decisions.

One of the tools used in the strategic diagnosis phase is the SWOT matrix and the business functions that analyze the internal (strengths and weaknesses) and external (opportunities and threats) of the company.

2.1 Swot Matrix: Environmental Analysis Technique

SWOT analysis is pointed out as a classic management tool, but its origin is not well defined. It is believed to have been created in the 1960s by professors at Stanford University. SWOT stands for Strengths, Weaknesses, Opportunities and Threats and serves to analyze the company's strengths and weaknesses as well as the opportunities and threats of the environment in which it operates. It's inserted. The diagnosis can be made by organizations of any size, since it is a tool of self-knowledge and contextual analysis, also serving as a guide in establishing a plan of action to minimize risks and increase the chances of success for the company (NAKAGAWA, 2012).

It is from this analysis that the posture is based to obtain a competitive advantage. In Porter's view (1989), competitive advantage results from the value a company can create for its buyers.

Ferrell and Hartline (2005) point out that the SWOT analysis has several advantages, such as:

(I). Simplicity: no training or technical skills required for its use;

(II). Costs: it allows the reduction of costs with areas exclusively linked to strategic planning;

(III). Flexibility: improve the quality of strategic planning even without extensive information systems;

(IV). integration and synthesis: it is possible to integrate and synthesize various information, whether quantitative or qualitative in nature;

(V). Collaboration: exchange of information and collaboration between managers in different areas in order to solve problems and eliminate possible conflicts before finalizing the strategic plan.

2.2 Generic Competitive Strategies

Strategies are decisions that are put into practice to achieve strategic objectives, be they recover a company in bad situation, maintain a good performance, reach a new level of results, grow or remain in the market. There are different ways of classifying strategies. Classifying them into generic and adaptive strategies is a way of studying how companies act in this dimension. (Porter, 1989)

Michael Porter, through studies starting from the industrial organization in economics, articulated perhaps the most important current "paradigm" in the field of business strategy, with a great diffusion of his ideas in the last 25 years. (Vasconcelos and Cyrino, 2000, Foss, 1996). The porterian theory developed on a solid theoretical structure verifiable empirically, starting from premises of economic rationality of the theory of the industrial organization that uses the models of rationality close to the neoclassical economic theory. In this perspective, the relevant factors and aspects of the industry are known and can be analyzed in a clear, structured and objective way allowing the manager to make strategic decisions that allow the economic maximization of company resources. Within this theoretical scenario, for Porter, the leader must make decisions that aim to combine products and markets generating strategies of leadership in costs, differentiation or targeting (generic strategies). According to Michael Porter (1989), business strategies can be classified into three generic categories: differentiation, cost leadership and focus (finding a niche, either product or service, consumer group or regions).

2.3 Differentiation

The first generic strategy is differentiation. In this type of strategy, a company seeks to be unique in its industry, along some dimensions widely valued by buyers. It selects one or more attributes, which many buyers in an industry consider important, positioning themselves singularly to satisfy these needs. It is rewarded for its uniqueness at a premium price. (PORTER, 1989)

For Porter (1989), the means for differentiation are peculiar to each industry. Differentiation can be based on the product itself, on the delivery system by which it is sold, on the marketing method and on a wide variety of other factors. In the field of construction equipment, for example, Caterpillar Tractor differentiation is based on product durability, service, spare parts availability, and an excellent reseller network. In cosmetics, the differentiation is usually based more on the image of the product and the positioning of the counters in the stores.

2.4 Cost Leadership

Porter (1989) shows that in the strategy that seeks leadership through cost, the goal is not to differentiate

from competitors, but to offer a cheaper product or service. This strategy is widely used by computer manufacturers, as technology takes very similar products and makes components cheaper. It was also the strategy used by Japanese car makers and digital watches, which destroyed the myth that higher quality means higher price. And whoever wears an Ironman watch, he's convinced by the same strategy, used by Texas Instruments.

2.5 Focus

According to Porter (1989), the strategy of focus is to select a niche in the market and master the resources to exploit it to the best possible way, instead of looking to confront all the competitors in the big market. The strategy, therefore, is to be the best and get the most out of narrowly selected markets or products / services.

Text item 3.2 - Generic Competitive Strategies adapted by the authors, based on the book: Entrepreneurial Strategy (Prof. Carlos Eugênio Barreto)

2.6 The Balanced Scorecard (BSC)

The strategies formulation and implementation stages are complemented by the monitoring activity, which monitors and evaluates the execution of the strategies. It is important that this activity should be done on the basis of the same indicators used to elaborate the strategic plan. However, the traditional systems that evaluate and control the company's results are biased in their emphasis on the final financial result (WRIGHT; KROLL; PARNELL, 2009).

The Balanced Scorecard (BSC) is a strategic management tool that converts the mission and strategy of organizations into various performance measures that serve as a foundation for a strategic measurement and management system. It not only includes financial goals, but also emphasizes their performance vectors. Thus, the company's performance is measured from four balanced perspectives (Kaplan, Norton, 1997):

- a) Financial perspective: it indicates if the strategy of a company, besides its implementation and execution, contribute to the improvement of financial results, whose objectives are generally related to profitability;
- b) Customer perspective: assist executives in identifying customer segments and markets where the company will compete, in addition to their performance measures in them;
- c) Internal Process Perspective: Executives identify critical internal processes, those that have the most impact on customer satisfaction and the achievement of the company's financial goals and on which the corporation must achieve excellence.
- d) Learning and growth perspective: it works on identifying the infrastructure that must be built by the

organization in order to generate improvement and growth in the long term.

III. METHODOLOGY

The methodological procedures were the exploratory research and qualitative research, which are: a) semi-structured interviews, b) observation, c) field diary and d) documentary record.

For Oliveira (2002, p. 117):

Research using the qualitative approach has the ability to describe the complexity of a particular hypothesis or problem, analyze the interaction of certain variables, understand and classify dynamic processes experienced by social groups, present contributions in the process of change, creation or formation of opinions of a certain group and to allow, in a greater degree of depth, the interpretation of the particularities of the behaviors or attitudes of the individuals.

The methodological procedure used to collect and analyze the data was research-action type, this in turn can be defined as a small-scale intervention in the real world and a very close examination of the effects of this intervention (THIOLENT, 2004). We can also say that in our studies, action research is situational, because it is concerned with the diagnosis of the problem in a specific context to try to solve it in that context.

IV. RESULTS AND DISCUSSION

4.1 SWOT matrix analysis

Through the SWOT matrix of the company, the following actions can be determined:

With regard to Opportunities:

- (A) .The Access to new content;
- (B). Access to new technology (EAD site);
- (C). Use of hotels for larger and simultaneous events;
- (D). Concurrent companies do not often use the mechanical engineer to provide training in NR-13 (Boilers and Pressure Vessels);
- (E). Concurrent companies do not often use the electrical engineer to deliver the training provided by NR-10 (Safety in Facilities and services with electricity), according to the legislation of the CONFEA / CREA-RJ system.

4.2 Regarding the Threats:

- (A). New entrants in the market;
- (B). Competitors capitalized to deal with the economic crisis;
- (C). Deterioration of economic or industry conditions;
- (D). Competitor price war;
- (E). Cultural;
- (F). The physical structure of the competitors is larger, making it possible to offer more concurrent courses;

- (G). Price of oil barrel;
- (H). Exchange rate;
- (I). Gross domestic product (GDP);
- (J). Credit and Interest;
- (K). Tax and tariff policy;
- (L). Government purchasing power and investment, for example: Petrobrás;
- (M). Costs of change.
- (N). Corruption

4.3 In relation to the Forces:

- (A). Experienced team with great technical know-how;
- (B). Privileged location (In the center of Macaé-RJ);
- (C). Good customer relationships;
- (D). Own human resources;
- (E). Inovativity
- (F). The brand is recognized in the market;
- (G). The service is quality;
- (H). We offer free courses reaching a number of 80 employees in the year, strengthening the image of the contracting company before the company or converting benefits for its own employees;
- (I). Toyotism Style (Toyotista employees must be aware of all stages of the process, performing multitasking and paying attention to the complete elimination of all wastes.);
- (J). The company studied only works with one firm at a time, not mixing the employees of the company x, y or z.

4.4 In relation to Weaknesses:

- (A). Lean structure;
- (B). Lack of partners;
- (C). Commercial poorly developed;
- (D). Lack of position and salary plan for instructors;
- (E). Does not serve the general public.

4.5 Choice of Business Strategy

According to the obtained results, the company studied, adopts the competitive scope in the Wide Target, with Differentiation. Having the company informed, it is periodically made a new analysis of its strategic planning with a new study based on the various market variables.

4.6 The BSC tool

Finally, the monitoring and control tool that will assist the company in the implementation of its strategy is represented in Figure 1. It illustrates the unfolding of the strategic planning of the company, describing the perspectives of BSC (Financial, Customer, Internal Process and Learning and Growth), informing its objectives, the respective indicators, the goals to be achieved and the initiatives to be taken, all of

fundamental importance for the achievement of the strategy.

	GOALS	INDICATORS	TARGET	INITIATIVE
FINANCIAL PERSPECTIVE	INCREASE NET BILLING	NUMBERS OF NEW SEGMENTS	INCREASE MARKET SHARE BY 35%	EXPANSION OF COURSE NETWORK
	REDUCTION OF COST	REDUCTION IN 2% OF ADMINISTRATIVE EXPENSES	REDUCE ADMINISTRATIVE EXPENSES BY 10%	WASTE REDUCTION CAMPAIGNS
CUSTOMER PERSPECTIVE	CUSTOMER ACQUISITION	NUMBER OF NEW CUSTOMERS	INCREASE THE NUMBER OF CUSTOMERS BY 20	MARKETING CAMPAIGNS
	IMPROVING CUSTOMER RELATIONSHIP	LEVEL OF SERVICE	IMPROVE THE LEVEL OF SERVICE BY 10%	DEFINE METHODS OF CUSTOMER SERVICE
INTERNAL PERSPECTIVE	INCREASE NET BILLING	NUMBERS OF NEW SEGMENTS	INCREASE MARKET SHARE BY 25%	USE IMPROVEMENT TOOL
	REDUCTION OF COST	REDUCTION IN 2% OF ADMINISTRATIVE EXPENSES	REACH 50% OF CASE STUDIES IN TRAININGS	USE DATA MINING FOR CASE STUDIES
LEARNING PERSPECTIVE	IMPROVE PRODUCTIVITY	INCREASE EMPLOYEE PRODUCTIVITY	IMPROVE 15%	PROMOTE ACCESS TO STRATEGIC INFORMATION
	TEACHER TRAINING	TRAINING EXPENSES	INCREASE THE LEVEL OF TRAINING BY 10%	ENCOURAGE TRAINING PROGRAMS
	IMPROVE LEVEL OF MOTIVATION	EMPLOYEE SATISFACTION	INCREASE SATISFACTION BY 15%	EVENT PLANNING

Figure 1: Deployment of the strategic planning of the company under the perspective of the BSC.

Source: Prepared by the Author (2018)

V. CONCLUSIONS

In the course of the research, it was verified from the introduction and the presented case that the SWOT matrix, the business functions and the BSC have a very important role in the choice of strategies and action plans, since they seek to identify the strengths and weaknesses (internal environment), opportunities and threats (external environment), taking into account the purpose of the organization. The theoretical analysis shows that the SWOT matrix is intended to understand influencing factors and to present how they can affect the organizational initiative based on the four variables, strengths, weaknesses, opportunities and threats, and the business strategies guide the way to the best competitive advantage with the help of the BSC.

It was identified that the company, located in Macaé-RJ, Brazil, uses the SWOT matrix, the generic strategy with the competitive scope in the broad target in the Differentiation strategy, as a tool within its strategic planning, together with the BSC in order to guide all sectors of the organization and their respective managers, considering points to be improved and exploring their

strengths. With the use of the SWOT matrix, the differentiation strategy and the BSC, it was possible to elaborate a plan of action in order to balance and improve the company's performance, in the analysis it was observed that the company is able to improve its internal processes. relationship with customers, suppliers and employees.

It is believed that with the subject addressed, it can be discussed in the future under other views such as: the importance of work safety training in reducing accidents and their impacts on social security. At another point we have the training as a tool to keep the employee motivated according to the concepts of maslow, thus we have a decrease of work accidents. And in another focus we have the innovation of the supervision in the area of training with respect to the Government, and lastly a correlation of the regulatory norms with their applicabilities in the current days, to exemplify we have a dubious point, as for the professionals qualified to teach training mentioned in NR-10, for example.

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Nutritional Transition of Riverine People from Puruzinho Lake in the Amazon Region. A Qualitative Study

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Abstract— *Scientific studies suggest that eating habits of traditional communities all over the world have been suffering changes as a result of gradual replacement of regional products with imported ones and also because of the increase of consumption of carbohydrates and trans fats. The nutritional state of populations, as riverine people in the Amazon region, has been widely affected by factors as changes in the eating and epidemiologic patterns. This study aims at the identification of the perception of dwellers of a riverine community the Brazilian Amazon region on their eating habits, their health and on the changes caused by development. This is a qualitative study, in which we used ethnographic semi structured interviews as a tool to collect data, conducted through a semi structured script, and applied to 16 dwellers/heads of families, in which 11 are men and 5 are women. The interviews were recorded in audio, full text transcribed and analyzed, and resulted in a descriptive system of categories and subcategories. As a result, we identified an increase of purchase capacity, greater participation in the market economy, lack of effective and continuous actions by the administrators of basic health services in the city. These joint factors contribute to the process of nutritional transition that is occurring in the community, as well as to the increase of health vulnerability of the dwellers.*

Keywords— *Riverine. Amazon. Lifestyle. Eating habits. Nutritional Transition.*

I. INTRODUCTION

The Amazon region is geographically characterized as a river basin called Amazon basin, with an area of more than 7,000,000 Km² and a population of around 25 million inhabitants, considered as a reference of biodiversity in the world since it has the biggest potamic complexes of the planet. Its inhabitants who live by the banks of rivers and streams, generally, come from mixed ethnicities (indigenous, Europeans, Africans) and are called riverine peoples [1,2,3].

The traditional riverine people in the Amazon region dwell in homes built from forest raw material, as the straw (generally used to cover their houses), the wood (processed and used in walls and floors) and lianas (used to tie the roof and to the completion of walls). The economy of family subsistence of this people is based mainly on fishing, extractivism, hunting and small-scale farming [3,4].

The riverine people's knowledge in relation to their way of life in nature, their survival management techniques, legends, beliefs and religious rites are transmitted from generation to generation [5].

Nowadays, innumerable changes have affected the daily life of most of these traditional populations. We

can attribute these changes to a greater access to urban areas, to the means of communication, to the widening of market economy and to the benefits given by the Federal Government social programs, such as “BolsaFamilia”, “SeguroDefeso” and “Luz para Todos” [6,7].

The result of these changes in the way of life of the Amazon riverine people has promoted the increase of consumption of industrialized products as canned food, sausages, trans fats, acidulants and food colorings, foods composed of a high amount of preservatives, trans fats and simple carbohydrates, which were formerly not available and that may be responsible by the loss of characteristic of their traditional customs and habits, which reveals the need of monitoring their nutritional state [7,8].

The nutritional state of traditional populations, as the Amazonian riverine peoples, has been affected by factors as noticed changes in their eating and epidemiologic patterns, characterized by the gradual replacement of natural products from their diet, such as fish, cassava flour and native fruits, with industrialized foods that are rich in preservatives and trans fats, creating the Nutritional Transition [4,9].

The Nutritional Transition (NT) may be understood as a group of changes in the diet patterns and modifications in the physical activity level [2,10,11], that impact the overweight rates and obesity and associated diseases. All of this may even lead to an Epidemiologic Transition process, which reveals cases of loss of health such as physical limitations and the increase of morbimortality by chronic non-transmissible diseases [3,4].

The worry about physiologic alterations related to health due to those changes in the nutritional state of the riverine person implies an increase of vulnerability of this population [10,12,13] and their association with a greater access to urban areas, lack of natural sources of food and/or to a higher capacity of purchase as a consequence of the increase in family income, or *per capita* [4,13,14].

This study aims to identify the perception of the dwellers of a riverine community in the Brazilian Amazon region on their relation to eating habits, perception on health and changes occurred due to development.

II. MATERIALS AND METHODS

The collection of data was conducted in the riverine community of Puruzinho Lake (located in the left banks of Madeira River, 20 kilometers downstream away from the urban area of the city of Humaitá, in the state of Amazonas). The collection occurred between February 16 and 27, 2017, through semi-structured interviews. The selection of participants was intentional. We conducted ethnographic-natured interviews [15,16] that allow us to

study more accurately environment and subject in a group or community, specifically, from different points of view, aiming a more realistic understanding of the essence of a determined phenomenon.

The interviews were conducted based on a semi-structured script with 16 dwellers/heads of families – 11 men and 5 women. When collecting data, 25 families lived in the community, and were composed of 123 members. The choice of the people to be interviewed took into consideration how much time the person has lived in the community. We identified, then, the traditional riverine dwellers who live longer in the peri-urban area [17].

The ethnographic-based interviews took into consideration that data collection also involved observation, registered in field diary, and their analysis were made according to the context in which they were carried out [18].

The interviews were conducted in the homes of the riverine people (what allowed contact privacy), and lasted from 30 to 50 minutes each. Before and after the interview, the researcher remained in the residence (kitchen) of the interviewed ones (being invited by them), and then had the opportunity to see what food products they kept, as well as the garbage that contained food packets already used by them. The scheduling and conduction of the interviews were made personally by the researcher; with authorization of the president of the community and of the administration of the city health office, according to the time and availability of the dwellers.

The number of interviewed people was outlined according to the level of saturation of data obtained. As the interviews followed a script, it was possible to guarantee the process of comparison of the collected information, which allowed the systematization of analysis categories in order to organize each interviewed person's discourse [19].

Based on the interviews scripts, we collected sociodemographic data (family and work), social life (time spent on leisure, community events as religious and cultural parties, traditional customs), practice of physical exercises, nourishment (habits, customs and changes), perception of health (main diseases in the community, hygiene habits, actions towards health) and social programs of the Federal Government for the community. The interviews were recorded and later transcribed by the researcher.

The criteria of inclusion to choose the participants of the research were: a) to have permanent residence in the community; b) to be the representative of a family unit, indicated by the members of this family, and c) to be part of the group of dwellers who have been living longer in the community.

Taking into consideration the ethical requirements, the research was submitted and approved by the Ethics on Research Committee of the Federal Institute of Rondônia (IFRO), under the register number 1.423.049. Also, all the participants signed the Free and Informed Consent Form (FICF). The names and elements that could identify the participants of the study were omitted.

III. RESULTS AND DISCUSSION

3.1. Describing the riverine people

The Amazon region has been the topic of many discussions related to environment and health. It happens because of the vast and complex estuary of the Amazon region, and also because of its great potential of environment resources. In this context of discussions on the Brazilian Amazonian scenario, the riverine dweller has appeared as one of the main actors in this epilogue. However, in reality, he/she still is still limited to a figuration that needs to be better observed and oriented due to the real situation and needs [20].

The term “riverine” is used to describe traditional populations that live in small communities by the banks of Amazonian streams, lakes and rivers. Their way of life depends, in part, on the seasonable cycles of the region. Their homes are generally built with raw material available in the local surroundings, as wood for the walls and floor, and straw from the *babaçu* tree to cover their homes. These traditional populations mainly and, sometimes, almost exclusively, subsist on small scale agriculture, extractivism and fishing [3,5].

In the Puruzinho Lake, which is composed of dark waters and is located in an area away from the urban zone, the dwellers live in a community named after the lake and that was by its banks. Their homes were built from the forest raw material, and are generally formed by a kind of attachment (semi-detached house), where the kitchen and a type of living room are located and where hammocks are hanged, so that members of the family can rest during the day (also a place to receive visitors and where the interviews occurred).

Another characteristic of the Puruzinho riverine dwellers' homes is that they are located 20 to 100m away one from another and are strategically positioned next to the water, respecting the typical seasonal characteristics (periods of “floods” and “droughts” of waters). Therefore, their homes hardly go through flooding when the rivers are full, nor are too far from the waters during the dry season; this way, it is easier for them to get to water to bathe, to collect water, and to the fish, which are kept in big Styrofoam boxes to be consumed or sold in the city later.

The rapid expansion of commercial fishing in the Amazon rivers has affected the life of people who live in

riverine communities, and it can bring harmful consequences to one of the main activities of subsistence of these people [21]. The interviews revealed that the riverine people are worried about the subsistence activities as hunt and fishing.

Fish is becoming scarcer, they come from Madeira River. But now, before they get to the lake to spawn, the owners of the big boats who live in town follow the fish by the river and then throw their giant nets from one side to the other in the entrance of the lake and we end up with the few fish that manage to go through. Last week, for example, there was a boat that caught more than one ton of fish. To have a good hunt day is difficult now. Hunters from other places are “cleaning” the area and the animals are more and more distant from here. Our hunt is only good when we go by canoe with flashlights beams along the banks of the lake. Another problem is that the young ones don't want to hunt at night. There are some things that got better for us, but others aren't that good (interviewed person 4).

Another worry told by the interviewed people is related to the educational situation in the community. We noticed, by the information collected in the interviews, that great part of the population from Puruzinho Lake is illiterate. This situation may be justified in part by the poor conditions of the school, which contribute to the low political influence and difficulty in the social community organization.

According to the testimony of an interviewed person:

There is a great worry about the kids that don't continue school, because we need teachers who do live here in the community, for we are distant from the city. Most of the teachers who come to teach here give up. We understand that because to come and back here from the city is not possible because the school boat doesn't come up here; it's too far. We have already had a meeting with some parents and talked to the woman from the city administration that takes care of schools in this entire region, but she said it's only possible to offer classes up to the 9th year. The only teacher here lives beside de school; she teaches together with her daughter who is finishing school. They divide de class in two halves and in one side stay the children from the 1st to the 5th year, and in the other side the ones from the 6th to the 9th. The only way we see for the children to continue studying is living in the city. But few of us have relatives in town, so they end up staying here (interviewed person 2).

We noticed that in many cases the riverine people are considered mistakenly as “rural workers”. This mistake causes the members of the Puruzinho Lake community, who have their own way of life, to have their needs and social context neglected. This problem may turn them into more vulnerable victims of economic, social and health problems [4,5].

Some people from the city administration think that we should enlarge the cultivated area of manioc, and plant more banana or even other things. But it's hard for us since it's not possible to get here by car on a road, and the boats that go by here are small, even when the river is high. And during the floods, the river goes up more than 10 meters and many lands get swamped; so what can we do? Just wait for the river to go down and work with what it's possible (interviewed person 5).

3.2 Food habits of the riverine people

The food habits of traditional communities around the world have been altered due to the gradual replacement of regional products with imported ones and even because of the consumption of carbohydrates and trans fats. In Brazil, we noticed that new nutritional scenario, allied to some public policies, has contributed to the prevalence of childhood malnutrition. On the other hand, we also noticed the increase of the overweight and obesity levels, which may be attributed to the great differences among social classes, to regionalism and socioeconomic contexts [4].

In the case of the traditional riverine person, the fish, the manioc flour, regional fruits and, in some more isolated communities, the game, are their staple food, being important sources of proteins, carbohydrates and vitamins. Around four decades ago (the 80's), the fishing activity of the traditional riverine person was artisanal, during the night or dawn periods, using hook and line, harpoon, bow and arrow. During those days, the amount of fish caught was enough for a family consumption and the rest was shared with neighbors [22].

The great abundance in the rivers allowed the riverine people to select the fish considered by them as nobles, as the Tambaqui (*Colossomacropomum*), Pirarucu (*Arapaima gigas*), Jatuarana (*Brycon* sp.) and Tucunaré (*Cichla* sp.), for their consumption. The amount of fish in the rivers allowed the riverine people to conduct extractive and small scale agriculture activities during the day, and they still had time for leisure as playing soccer in the community fields, and for socialization, as visiting fellows and friends at sunrise. The fish consumption associated to the manioc flour used to compose around 70% of the traditional riverine person's diet [3,20,23,24].

The manioc flour consumed by the riverine people is artisanal and is produced from the bitter manioc (*Manihotutilissima*). It is part of the staple food of the riverine people, with a daily consumption of up to 1 liter. This food is present in most of the meals, and is consumed as part of the trimmings of meat, fish and regional fruits. Riverine people usually consume the flour as a pap, *beiju* (a kind of baked cake covered by banana plant leaves), *chibé* (a mix of flour, water and sugar) and *gogó* (porridge prepared from the manioc starch, used as a complement to breastfeeding) [5,17,21,23].

As the interviews were conducted mostly in the kitchens of their homes, it was possible to identify the storing food products as: powdered milk, kitchen oil, chocolate-flavored powders, industrialized packaged snacks and soft drinks. The observation of this situation allows us to think about innumerable questions that are pointed out in the literature on the theme of nutritional transition.

Here in Puruzinho, we, the oldest ones, still prefer the good fish broth, but the youngest ones prefer the fried fish, the fried chicken, and other foods, so, what they prefer is what is done. We get worried because it's not always that we can buy different food they like. One day there was a prom at school and they threw a party with foods the saw on TV. These children invent so many things, some of these foods they like may be good, and I think they have the right to eat the good things they see on TV (interviewed person 1).

The regional native fruits that compose the traditional riverine people's diet as *açaí* (*Euterpeoleracea*), Brazil nut (*Bertholletiaexcelsa*), *tucumã* (*Astrocaryumaculeatum*), *patoá* (*Oenocarpusbataua*) and *bacaba* (*Oenocarpusbacaba*), although highly nutritious, have their consumption regulated by the seasonality offer, what causes gaps in consumption along determined periods [1,23,25].

In the community of Puruzinho Lake, the cultivation of fruits like cashew, lemon and in some cases banana, are generally made in small quantities and without any production monitoring or care. Some families have a vegetable garden near their homes where they cultivate chive, pepper and some herbs used as seasoning or medicine.

Among the factors that may be attributed to the change of eating habits of the riverine people of Puruzinho Lake, we can highlight: the increase of access to the urban areas and means of communication as the TV. The accounts below exemplify that:

Nowadays it is easier to go to town. In the past, not everybody had a motor in their boats and had

to paddle for almost a whole day in order to get to town. Now we can come and back on the same day (interviewed person 5).

The oldest children that go to school in town during the week and on the weekends come back home, bring with them a lot of fads and things they learn there. Even the prom party cake was similar to the soap opera one. They bet Cokes when they play soccer here. We still can control the small ones, but if we go out to do some work and they go and watch TV (interviewed person 7)

Considering the innumerable factors here pointed out, it is challenging to identify if the nutritional needs of the riverine people are satisfactory when compared to the essential nutrients and food security in order to allow a contribution to the prevention of health problems [21].

3.3 Public Policies to assist the riverine people

In the context of public policies, riverine communities are supported legally by the Federal Decree 6.040, from February 7th, 2007, that established the National Policy of Sustainable Development of Traditional Peoples and Communities (in Portuguese, PNPCT). In its 3rd article it defines:

Traditional Peoples and Communities: groups that are culturally different and that recognize themselves as so, that have their own forms of social organization, that inhabit and use territories and natural resources as condition for their cultural, social, religious, ancestral and economic reproduction, using knowledge, innovation and practices created and transmitted by tradition [26].

Social programs such as BolsaFamília(PBF), SeguroDefeso(SD), Luz paraTodos(LPT), are part of the public policies that bring benefits, but may also offer risks due to the changes that they may cause in the life of the riverine traditional populations. This is a situation worth of more attention and actions by the public administration.

This situation of risk can be observed through scientific studies, with the increase of purchase and consumption of industrialized products such as foods and domestic appliances [7].

The narration of the interviewed persons and the observations of this researcher allow the confirmation of what was stated before. The excerpts bellow exemplify it:

As almost every home now has a fridge and all have *rabeta* (motor canoe), the younger adults don't want to go anymore to the *castanhal* (part of the forest where there are many Brazil nut

trees) because they don't want to walk all day long carrying weight and don't want to stay awake in order to spend all night fishing. They go to the mining areas or to the city and earn more money and faster, and there is still the SeguroDefeso and BolsaFamília. When they need something they just go to the city (interviewed person 3).

...We are worried because when we are not home the younger ones only want to eat junk food, and then later get sick because of such many different things they eat (interviewed person 10).

The PBF created by the Federal Government by Decree n^o 5,209, that regulates Law n^o 10,836, from January 9th, 2004, has as its main objectives to mitigate inequalities beginning from the fight against poverty, to promote food and nutritional security and to provide more access to public services, especially to health, education and food security. Among the main conditioning factors demanded by the government is the one related to maintain children in school age regularly enrolled, guaranteeing for them at least 85 per cent of attendance [27, 28].

The SD Program is another benefit that is part of the social programs financed by the Federal Government, guaranteed by Ordinance n^o8,287, from December 1991, of the Ministry of Labor. The amount of a monthly minimum wage is paid to the professional fishers in the fishing closure period – when spawning happens, during 3 to 4 months – and the payment of this benefit comes from the Fundo de AmparoaoTrabalhador (Worker Support Fund). In order to have the right to receive the SD, the fisher must have been registered for at least one year in a fishing colony, have a Fishing General Register (RGP, in Portuguese) at IBAMA (Brazilian Institute for the Environment and Natural Resources), state not to have any monthly income above R\$ 171.38 and not be receiving any benefit from the welfare system, except accident assistance and pension for death [27,29,30].

The entrance of money changed subsistence domestic activities and life style of riverine communities [...]. Children no longer help their parents with chores and prefer to watch TV instead of practicing some activities or even play outdoors decreasing, then, their energy use. It happens the same with women, because they buy food, so housewives no longer need to make an effort so common before like, for example, to prepare manioc for the elaboration of flour [2].

The interviewed dwellers of the community say that during the months when they receive the SD their families purchase domestic appliances and furniture and

rebuild their homes and start to eat a greater variety of foods bought from town. In their perception, this is an opportunity given by the government to improve their lives and fight the poverty condition of the vulnerable population.

Life now is much better; in the past we suffered a lot, now we don't have to wake up at dawn or spend the night without sleeping in order to fish. My parents' life and mine when I was younger was very hard. The money we receive from the SD helps a lot and everyone in the community respects the period of closure so we don't catch some fish. A person who doesn't live here and says that this help from the government has to end doesn't know the reality of our daily life here, we and our children deserve to have a less suffered life (interviewed person 15).

Another social program that is part the public policies of the Federal Government destined to the poorer layers of the Brazilian population [31], and that reflects directly in the life of the riverine people in the community of Puruzinho Lake is Luz Para Todos (LPT). Created in November 2003 by the Law 10,762 and President Decree 4,873, the reflection of this government program may be noticed by the discourse of one of the interviewed people:

From the moment we started having energy here in the community things have changed a lot, for you to have an idea, families used to live in both sides of the lake, and as energy arrived only in one side, people started living only on that side. Modernity is a very good thing for the community, because life was very hard, we worked hard sunup to sundown. Now, after electric energy we can get home and have some fun, without mentioning the cold water and food that don't spoil because of the fridge (interviewed person 11).

One really good thing is to have a fan, the heat here tires us a lot, there is no way we come back to the past when we suffered before energy came here (interviewed person 16).

3.4 Health of the riverine people

Many studies have alerted for a series of changes that have been affecting the way of life of the traditional riverine people of the Amazon region [1,3,4,5,12]. One factor that is considered worrying and that reflects a worldwide problem is the Nutritional Transition [32] which is a series of changes in the eating habits mainly characterized by the dependency on processed food with high levels of preservatives, high consumption of oil in meal preparation and high consumption of carbohydrates and trans fats [33,34].

Health has been a constant cause of worry among the members of the community of Puruzinho Lake. Health

problems because of parasitosis, non-transmissible diseases like hypertension and other problems related to obesity have been a cause of complaint. For one of the interviewed people, these are problems that require a better attention from the public administration.

One thing that still worries a lot the community dwellers is the question related to people to take care of the community health. For you to have an idea, we haven't had a community health agent for more than one year. There is no kind of assistance. The community agent that used to stay here went away and we have no idea when another is coming. When we need medicine, we go to the health post in Humaitá (interviewed person 9).

When people get sick they have to be treated with the medicine we sometimes get in the nearest city, or with the teas taught by the oldest ones. And if they are too bad, the only thing to do is take them by *rabeta* (a type of motor canoe) and see if they get alive to Humaitá (AM) (interviewed person 13).

The lack of health assistance in the community is one of the many factors that, associated to the changes in eating habits, may contribute in a serious way to the increase of health problems, as is the case of the so-called modern diseases, overweight, obesity, arterial hypertension, diabetes mellitus and cardiopathies. In the last decade, it was registered that around 80% of deaths in populations of low-income countries have a straight relation to the so-called modern diseases. This situation reveals a challenge to public managers, scientists, educators and all members of the community for them to plan and execute actions directed to education and prevention [35,36].

Additionally, according to the interviewed people the health situation in the community is not worse because of the help of researchers that develop studies that contribute to health, as is the case of a project from a university that helped in the malaria control, in the drinking water treatment and in orientation for the adoption of healthy habits of nutrition and hygiene.

If the teachers weren't doing research here, the situation would have been harder. The guys from UNIR come and they bring researchers from other places to help us with blood tests, lectures and dental care. The people from the city administration say that will hire a Community Agent here, but until now nothing happened. (M 5).

There are always lectures about the kind of food we must eat in order to improve our

health, but the people here got used to eat some things and I think they won't change a lot (interviewed person 13).

Scientific investigations have revealed a continuous increase in the number of riverine people who are dependent on a great variety of consumer goods from urban markets. Therefore, frequently abandoning their subsistence activities and starting to occupy a space in the formal wage labor market, this scenario of changes has been identified in a larger scale in younger populations of riverine communities, revealing a disturbing association resulting from the relation between market economy, eating habits and health [1,37].

IV. CONCLUSION

The study conducted with the community dwellers of Puruzinho Lake identified an increase in the purchase power, due to factors as: a greater access to the benefits of the federal government social programs like BolsaFamília and SeguroDefeso, a greater participation in the market economy. This situation has contributed to a series of changes in their eating habits, among them the most worrying are the increase in the consumption of industrialized products and a greater access to a whole diversity of options and commodities offered by modern life in an accelerated speed and without any orientation and prevention monitoring.

The codification of this study was conducted through theoretical references and basic concepts of Nutritional Transition. The interviewed people have limited knowledge about the topic and its developments in relation to health and the influence of the factors here pointed out reflect what Popkin, Bing and Guo (2012) conceptualize as process of nutritional transition, identified in the population of the Puruzinho Lake.

Regarding the perception of health we noticed the concern about the lack of effective and continuous actions by the administrators of health basic services in the city. We noticed the community dwellers are conscious of their vulnerability and difficulty in adopting habits that may promote a general improvement in the community health. They are also conscious of the actions being conducted out of the public management, as is the case of the health professionals that carry out scientific studies that end up leaving a legacy well seen by the dwellers.

We believe such situation should be observed under the perspective that it is necessary to adjust posture and orientation, with the objective of mitigating negative impacts as health worsening. It is important to point out here that this challenge does not belong only to the riverine people, mas to all society influenced by its own condition of susceptibility to convenience and seduction inherent to the development process of the modern world.

Similar studies on the topic of Nutritional Transition [11,33] indicate that this is a problem with harmful perspectives that, depending on how it is treated, may be devastating for the future. Factors like market participation, environment, and government support may be influencing riverine populations due to their great impact on local practices and habits. Their relation with the economic development process needs to be investigated deeply.

Initiatives by the administrator of the Ministry of Health, Ministry of Education and acting professionals of SistemaÚnico de Saúde (a health government public program) in order to meet the demands of the community and promote a better capacity building, information and communication about the process of Nutritional Transition identified in the local population, as well as scientific studies that approach the intervenient variables in this process as: socioeconomic status, quality of life and nutritional state.

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Economic Feasibility Study of Photovoltaic Panels Installation by PVsyst 6.73 Simulator

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Abstract— *The increasing pursuit of industry modernization presenting efficiency gains, productivity and cost reduction raises the discussion about the use of new technologies that promote, simultaneously, business sustainability and productive and economic efficiency for offshore companies, which operates in the Campos Basin, located at the municipality of Macaé, Rio de Janeiro State, Brazil. This paper presents an economic feasibility evaluation to use photovoltaic panels in order to measure the project costs and highlight its benefits; to this end, a local supplier was contacted to estimate a budget. The author ran the PVsyst 6.73 simulator to calculate the energy produced by the photovoltaic system and other parameters. Taking into account the Minimum Attractive Rate (MAR) of 8.3 %, established by the board of directors, the results, by the Simple Payback and Discounted Payback (SPDP); Profitability Index (PI); Return on Investment (ROI); Net Present Value (NPV); and Internal Rate of Return (IRR) methods applied, proved the project is economically feasible and that this company has physical structure to install the equipment. As such, it is possible to have a great medium-and long-term financial economy, contributing to produce clean energy in the country.*

Keywords— *Solar Energy; Photovoltaic Panels; Economic Feasibility; PVsyst 6.73 Simulator.*

I. INTRODUCTION

It is well understood that, with the increasing importance given to sustainability, countries have shown interest in changing their energy matrices, aiming at using renewable and clean energy sources. The demand for energy has been increasing, turning it into a competitive advantage for some companies and countries, allowing the expansion of clean and renewable energy generation, such as solar energy source.

A photovoltaic system for energy generation is composed of a cluster of photovoltaic cells, which aim at capturing solar radiation and converting it into electrical

energy. These systems have photovoltaic panels as their main components (Pereira & Oliveira, 2011).

The use of the methods to study the economic feasibility of an investment project aims at establishing whether there is any potential for project implementation. That is, the purpose of this analysis is to answer the following questions: Can the project be developed successfully and achieve the results expected by the investors? Can the project satisfy the investors and generate wealth for the organization? (Abreu Filho et al., 2012). The economic feasibility methods approached by this work were Minimum Attractive Rate (MAR), Return on Investment (ROI), Net Present Value (NPV), Internal Rate of Return (IRR), Profitability Index (PI), and Simple Payback and Discounted Payback (SPDP).

They were selected as their objective is to support and demonstrate the real situation of the economic feasibility. According to Damodaran (2004), the financing of a company comprises all decisions involving financial implications.

In this context, this research aims at approaching seven financial methods to assess the economic feasibility of use of energy generation system installations through photovoltaic panels connected to the grid in a company of Macaé municipality, in Rio de Janeiro State, Brazil.

II. REVIEW OF LITERATURE

The demand for energy has been increasing worldwide, turning it into a competitive advantage for some companies and countries, allowing the growth of clean and renewable energy generation, such as solar energy source.

As stated by Fernandes and Motta (2014), the photovoltaic system is noticeable with regard to the system sustainability, since it is independent and clean, as the only energy source employed comes from the sun, and the thermoelectric power plant uses part of the energy produced for its own autonomy.

According to them, photovoltaic solar energy is considered one of the main environmentally correct

sources in the actual energy matrices. Thus, when a country invests in this type of energy production, the volume of carbon dioxide emitted into the atmosphere is lower and, in turn, less pollution is generated. The calculation of those avoided emissions is of great importance for technology identification and increase in investments and incentives for the sector (Fernandes & Motta, 2014).

The heliothermic or solar thermal energy generation is another way of using solar energy to produce electrical energy, in which solar energy generates thermal energy, and this one, electrical energy. Given the potential for use, it is clear that solar energy is at the center of discussions and definitions of energy policies in several countries, not only the developed ones but also the emerging countries. Its implications are transversal, since the use of solar energy provides some advantages, such as the reduction of fossil fuel use, reduction of greenhouse gas emissions, generation of qualified jobs, technological development, and creation of value and vectors of environmental, social, and economic sustainability (Esposito & Fuchs, 2013).

Solar energy provides many environmental benefits to the world. One of them is the ability to reduce greenhouse gas emissions. Researches conducted by the Associação Brasileira das Empresas de Serviços de Conservação de Energia – ABESCO (Brazilian Association of Energy Conservation Services Companies) in 2016 reveals that residences with photovoltaic systems are able to reduce around 1.3 tons of Carbon Dioxide (CO₂) in the atmosphere in one year, once it generates 180 kWh per month. In 25 years, which is the warranty period for photovoltaic modules, this volume can reach around 32 tons.

Nevertheless, the use of this energy source, as well as the others, has negative effects, having as the greatest concern the production and disposal of photovoltaic panels. The exponential growth of photovoltaic energy production will result in a large amount of electronic waste over the next decades and in an increasing demand for resources (energy, water, and chemicals) to produce their modules (Paiano, 2015). As such, it is believed that, by 2035, in accordance with the International Energy Agency (IEA), around one million tons of solar modules may be discarded.

As stated by Pinho and Galdino (2014), photovoltaic modules are produced in automated plants using minimal human intervention. The serial production line in large-scale photovoltaic modules has allowed a relevant fall in prices and ensured the maintenance of high-quality products.

Barbosa (2010) tells that the equipment to use photovoltaic solar energy are as follows:

Solar module – Panels designed to directly convert sunlight into electrical energy, in the form of direct current (DC).

Charge controller – Electronic device that protects batteries from overcharging and excessive discharges, extending its lifetime.

Inverter – Electronic device that converts electrical energy from direct current to alternating current, 127 volts or 220 volts, making it possible to use electrical appliances.

Battery – Used to store energy generated by solar modules to provide energy at night or on rainy days.

Among them, the main responsible for the high costs of system installation is the photovoltaic panel. However, Pinho & Galdino (2014) assert that the module price, which currently represents 50 % of cost of installing a 1 kW photovoltaic system connected to the grid in Brazil, is the main responsible for that price fall, motivated by the relevant increase in the production of photovoltaic modules in Europe, the United States, and, more recently, China.

Photovoltaic systems can be classified into three different categories: isolated, hybrid, and grid-connected category. Off-grid isolated systems do not connect to the electrical grid, since hybrids combine different energy sources, and the ones connected to the on-grid system connect to the electrical grid.

Each model is appropriate for specific goals. Gabardo & Radaskiewicz (2013) indicate that isolated systems, usually used in distant areas, are useful for a variety of applications, such as water pumping, fence electrification, light poles and so forth. Most of the time, this is the cheapest way to get electricity in these places. According to them, the energy produced in this system is stored in batteries, ensuring the supply in periods of no sun, or even in gravitational energy form, when water is pumped to tanks in supply systems.

In turn, systems connected to the grid do not need batteries for storage. In accordance with Fernandes & Motta (2014), the energy generated is directly consumed, and its surplus is transferred to the distribution grid, generating profits for the local energy concessionaire. These credits are used in times when there is not production of solar energy, such as at night. The user pays the concessionaire just the difference between the amount consumed and the amount transferred into the electrical grid.

Data given in Figure 1 show a scheme distinguishing the isolated system from the one connected to the grid.

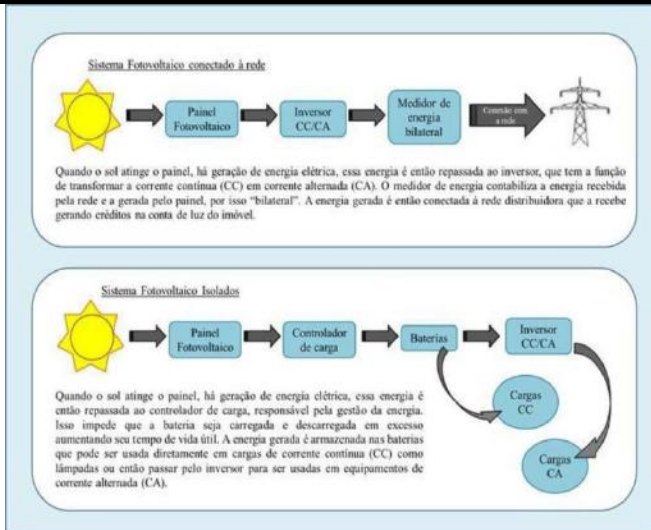


Fig.1: Example of thermal solar energy use for production of electrical energy
 Source: Machado & Miranda (2015)

By the schemes presented in Figure 1, the installation needs a bilateral power meter in the grid-connected system, as at a given time it may measure the energy transferred into the grid and at another time the energy consumed by the grid.

In Figure 2, data present the connection of a hybrid system in a simple way.

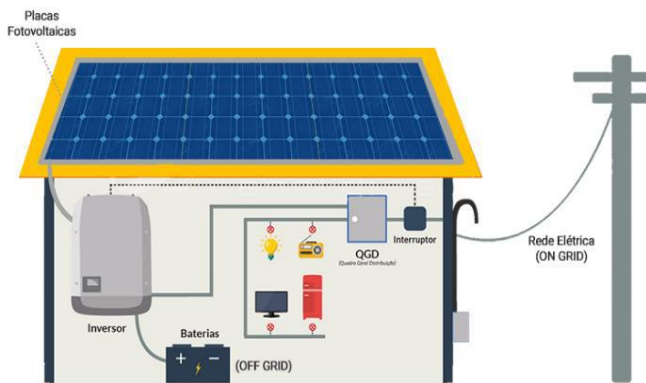


Fig.2: Example of the hybrid solar system
 Source: ESV solar vida (2018)

In accordance with Figure 2, that hybrid systems are in both batteries and bilateral energy meter, operating as an isolated system when connected to the grid.

In the words of Fernandes & Motta (2014), the most relevant legal framework for the sector of renewable energy generation is the Normative Resolution of the Agência Nacional de Energia Elétrica (482/2012 ANEEL, 2015) (Brazilian Electricity Regulatory Agency – ANEEL), subsequently updated by the Normative Resolution 687/2015 of ANEEL (ANEEL, 2015). According to it, Brazilian consumers can generate their electrical energy from renewable sources and supply the surplus to the distribution grid of their local

concessionaire. It consists of distributed micro and mini-generation of electrical energy, innovations that can combine financial economy, social and environmental awareness, and self-sustainability.

Since then, the Brazilian government has stimulated this type of generation in many ways. As stated by the Agência Nacional de Energia Elétrica (ANEEL, 2016), there is already an agreement published by the Conselho Nacional de Política Fazendária – CONFAZ (National Finance Policy Council – CONFAZ), in which, for the states that adhere to this Agreement, the Imposto sobre Circulação de Mercadorias e Serviços – ICMS (State Value Added Tax – ICMS) will be only applied on the difference between the energy consumed and the energy transferred into the concessionary grid.

Lastly, it is highlighted the development of the Programa de Desenvolvimento da Geração Distribuída de Energia Elétrica – ProGD (Distributed Electrical Energy Generation Program – ProGD), implemented by the Ordinance n. 538/2015 of the Ministry of Mines and Energy (MME), with the goal of extending, even more, the actions to stimulate distributed generation, on the basis of renewable resources, such as solar energy.

In conclusion, the high cost of photovoltaic panels is still a key factor to disseminate this technology widely in Brazil. Nevertheless, this cost tends to fall, so as tax incentives and large-scale production are implemented on a national scale.

III. METHODOLOGY

This work is considered an exploratory research performed by a case study developed in an offshore company at Macaé City, Rio de Janeiro State, Brazil.

As specified by Gil (2008), exploratory research focuses on developing, explaining, and modifying concepts and ideas, considering the development of accurate problems or hypothesis for further studies. They usually cover bibliographic and documentary data, non-standardized interviews and case studies.

This research was based on analyzing the physical feasibility for installation of the solar energy system connected to the grid within the company. For that, a photovoltaic panel installation consulting company and an electrical engineer were contacted to elaborate and dimension the project, assessing its feasibility, having as an initial condition the Minimum Attractive Rate (MAR) of 8.3 %, stipulated by the board of directors.

The annual consumption noted, when studying the accounts of the company, in 2017, was of 371.858 kWh. The solar energy system proposed has an annual production estimated at 156.370 kWh, which is the energy value produced within the first year, meaning annual savings of 42 %. Thus, it is not possible for the company, today, to achieve savings of 100 % through solar energy due to the initial capital invested.

The simulator run was the PVsyst 6.73, initially developed by the Université de Genève (University of Geneva). The PVsyst AS company currently markets it. It allows the user to operate at different levels of complexity, from an initial representation stage up to a detailed simulation system. It also presents an additional three-dimensional tool, which considers the horizon limitation and objects that may cast shadows.

The program enables to import data from the Meteornorm and TMY2, which makes it easy to compare simulated values with measured values. Besides, it has a data interface and an irradiation database of 22 locations in Switzerland and 200 locations throughout the world. It has a wide module and inverters database. This program displays the losses of the photovoltaic system and its performance rate. The PVsyst 6.73 simulator is mainly used for Grid-Connected Photovoltaic Systems, such as the study case herein presented.

If the user adds the cost of each component to the existing database, this program can project the cost of energy production in addition to a series of technical parameters provided at the end of the simulation.

The energy produced was calculated by the Meteornorm databank, which is in the PVsyst 6.73, considering irradiation and climatic conditions in the city of Rio de Janeiro.

It is known that Rio de Janeiro City is at 22° 54' 10" latitude (S) and 43° 12' 27" longitude (W).

Regarding the application of the simulator, it is of utmost importance to stress the randomness of solar radiation that, as stated by Lorenzo (2002), even when obtaining data on the radiation behavior, it cannot be guaranteed its repetition in the future, as there is an influence of factors, such as climatic changes, increase of greenhouse gas emissions, and so forth. Besides, there are different sources of information for the same location, which differ in terms of content.

The information on Figure 3 shows data used to simulate the energy produced using the PVsyst 6.73 simulator.

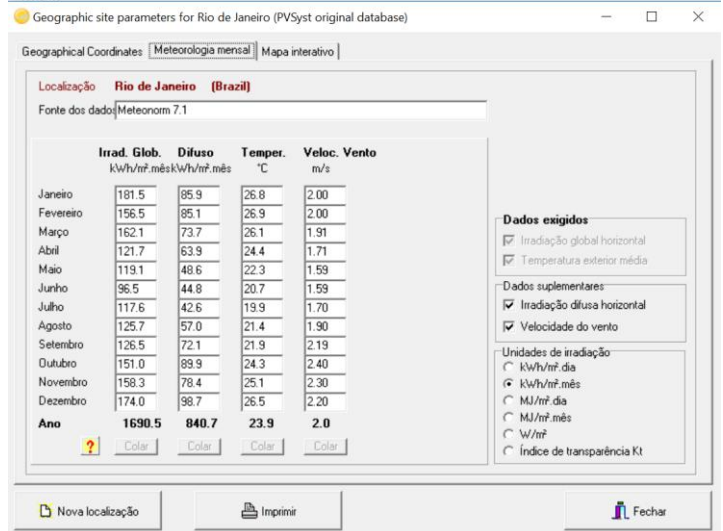


Fig.3: Data of the simulation with the PVsyst 6.73

Source: Elaborated by the author (2018)

In the previous Figure, it can be verified the data provided by the Meteornorm 7.1 database concerning the city of Rio de Janeiro, such as direct irradiation, diffuse irradiation, temperature, and wind speed, with their respective annual averages.

Data in Figure 4 show the simulation of energy produced by the solar energy system for the first year.

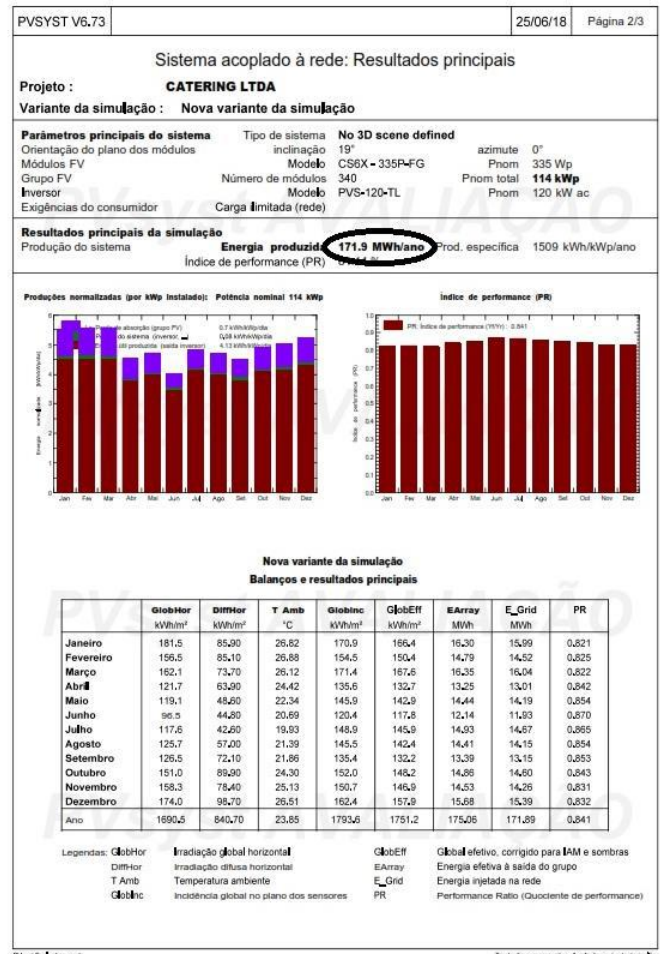


Fig.4: Simulation of the energy produced for the first year applying the PVsyst 6.73

Source: Elaborated by the author (2018)

In Figure 4, it is seen the energy prediction to be produced by the solar energy system in the amount of 171.9 MWh for the first year, in which there are three essential parameters, such as installed power, solar irradiation, and inverter performance.

Since then, a simulation with probabilistic data of climatic conditions, panel performance, and data from the power plants already operating is made. The calculation estimates the best position for the panels, facing north, where the sun sets in the South Hemisphere most of the year.

The inclination of the panels considers the latitude of the city of Macae, Rio de Janeiro State, Brazil. As Rio de Janeiro is at -22° , the panels must be tilted at 19° , in order not to have losses because of shading.

The value considered for the tariff in the first year was the highest value of the 12 invoices of the company studied in 2017.

This work has as a premise the readjustments of the energy rate from year 1 based on what Miranda states (2014, p. 41):

With regard to the energy tariff, since it depends on the Índice Geral de Preços do Mercado – IGPM (General Price Index – Market) and its readjustment is based on a coefficient called Índice de Reajuste Tarifário – IRT (Tariff Adjustment Index), it can be estimated the variation in values by means of economic studies on the variation of these indexes and factors. Also analyzing statistical studies of energy tariff variation over the last decades, reaching a value of 4.8 % of annual update (Miranda, 2014, p. 41).

It can be noted, by the statement of the researcher, that the electricity tariffs may not be well defined. Its changes can be explained in terms of appropriate policies, government interventions, and different phases of the Brazilian energy sector.

In what concerns maintenance, the photovoltaic system is reliable and of low maintenance. By a well-done installation and a frequent remote monitoring of the system, only a panel cleaning and a thermographic inspection of the electrical boxes are needed.

The power of a photovoltaic generator varies according to the manufacturer; however,

[...] usually, a minimum peak power of 90 % of the nominal power is guaranteed for the 10 to 12 first years of operation, and of 80 % for a period of 20 to 25 years. Nevertheless, there are other ways, like manufacturers, that guarantee, for 5 years, at least 95 % of the nominal power; all through 12 years, at minimum 90 %; throughout 18 years, not less than 85 %; and, during 25 years, at least 80 % (Pinho & Galdino, 2014, p. 132).

For this study, a minimum power of 90 % was used for the first 12 years and a minimum power of 80 %, for further years (13 to 25 years), as described above.

Thus, the multiplication between energy produced and energy tariff results in the revenue of this enterprise. To assess the cash flow, it is necessary to analyze the costs; for that, the maintenance costs and the part insurance are taking into account.

Maintenance cost is the cost of a four-month visit of two employees of a third-party company that provides the service. The cost of each visit is estimated at R\$ 1.264,73, totaling an annual maintenance cost of R\$ 3.794,19. How are the adjustments estimated for the following 25 years? The methodology adopted was to use approximate measures to readjust the minimum wage.

The current Brazilian rule for adjustments of a minimum wage was used as a basis. According to Teixeira and Vianna (2013), it corresponds to the variation of the Gross Domestic Product (GDP) plus inflation. The authors still state in footnote 13 that “[...] the adjustments to preserve the purchasing power of the minimum wage will correspond to the variation of the Retail Price Index – RPI (Índice Nacional de Preços ao Consumidor – INPC) [...] as a real increase, the % age corresponding to the real growth rate of the Gross Domestic Product – GPD” (p. 41) will be applied.

For this work, the growth forecasts that Teixeira and Vianna (2013) make in the most conservative and probable scenario is used: 2.0 % per year. For the Retail Price Index, it is considered the mean of the indicators between 1995 and 2017: 7.23 %.

In addition, the insurance corresponds to 3 % of the part costs. According to the budget for this research, the cost spent on equipment is R\$ 362.160,00, which results in an insurance cost of R\$ 10.864,80 for the first year. What about the adjustments for the next years? Some insurance agencies have the General Price Index – Market as a reference indicator for adjustments in Brazil. For this study, it was considered the mean of the General Price Index – Market from 1995 to 2017, which corresponds to 8.36 %, as a proxy for adjustments on the insurance values throughout the period under analysis.

It is worth mentioning that Rio de Janeiro State, by means of the Law no. 7122/2015, exempted the State Value Added Tax (ICMS) on solar energy.

The second step was to assess the economic feasibility proposed by the author in accordance with the Net Present Value (NPV), Discounted Payback, Profitability Index (PI), Return on Investment (ROI), Minimum Attractive Rate (MAR), apart from the budget made by the supplier to calculate the average time of return on investment and the financial economy to be generated.

IV. CASE STUDY

The company, located in the municipality of Macaé, Rio de Janeiro State, has 250 employees working day and

night shifts. According to the Serviço Brasileiro de Apoio às Micro e Pequenas Empresas – SEBRAE (Brazilian Micro and Small Business Support Service – SEBRAE) methodology, described by Martins, Leone & Leone (2017), with this number of people employed, the company is considered medium size.

Its structure comprises one auditorium, one laboratory for mechanical testing, one electrical workshop and various administrative sectors. All rooms use air-conditioning systems with a wide range of models and capacities. Besides, it has a large open area around 5500 m² and various light poles with metal vapor lamp installed. Thus, a large amount of energy is demanded to maintain this infrastructure.

Data in Figure 5 indicate one-year consumption in kWh and the corresponding values charged by the concessionaire.

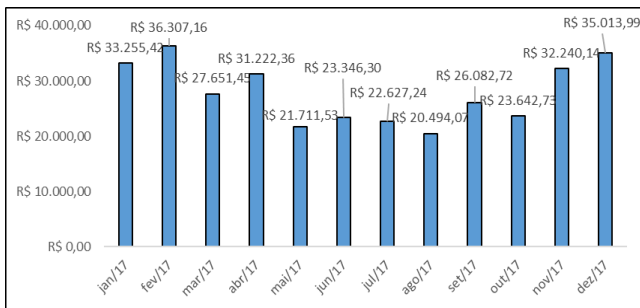


Fig.5: Consumption history of electrical energy

Source: Adapted from the PVsyst 6.73 simulator (2018)

From Figure 5, the high energy consumption showed throughout 2017 is evident. It is also noticed in this Figure that the annual costs of electrical energy of the company are R\$ 333.595,14. According to the senior administrative management of the company, the budget authorized by the Management, in 2017, to pay and maintain it was of R\$1.000.000,00. Therefore, the costs regarding electrical energy represent 33.4 % of the amount spent on the maintenance of the offshore company, a value that compromises the cost of material for new projects and investments. The data given in Table 1 present the estimated budget by the company for installing the system interconnected to the network, totaling R\$ 484.106,10.

Table.1: O Project budget

PARTS, ACCESSORIES AND INSTALLATION	
Module - Inverter - Structure	R\$ 362.160,00
Installation - Project	R\$ 121.946,10
Total :	R\$ 484.106,10

Source: Elaborated by the author (2018)

The data in Table 2 show information about equipment and photovoltaic system data.

Table.2 : Photovoltaic System Equipment and Data

Photovoltaic System	
Power (kWp)	114,00
Number of photovoltaic panels	340
Minimum area occupied by the system	664 m ²
Number of Investors	5

Source: Elaborated by the author (2018)

According to data in Figure 6, the savings made with solar energy during 2017 are shown.

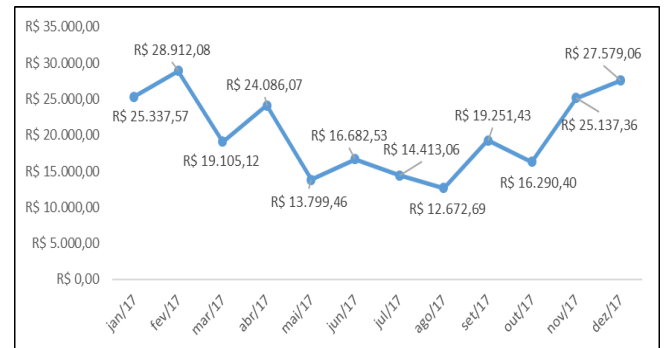


Fig.1: Savings with solar energy

Source: Adapted from the PVsyst 6.73 simulator (2018)

It is clear, from Figure 6 that, with the installation of the photovoltaic system, there is a considerable decrease in electricity bills paid in 2017.

As shown in Figure 7, it is noticed the difference in the cost of the entire photovoltaic system without solar energy and the saving generated monthly by solar energy.

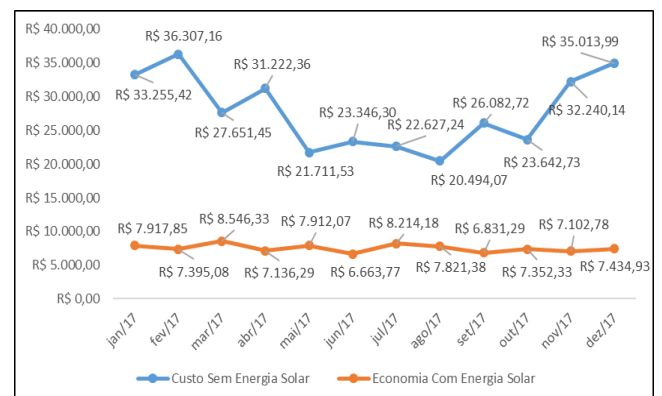


Fig.7: Cost without solar energy x savings with solar energy

Source: Adapted from the PVsyst 6.73 simulator (2018)

It is noted, from Figure 7, that with the installation of the photovoltaic system there is a projected saving of R\$ 90.328,28 for the year 2017.

Data in Figure 8 indicate a mean estimate of a monthly saving of R\$ 7.527,36.

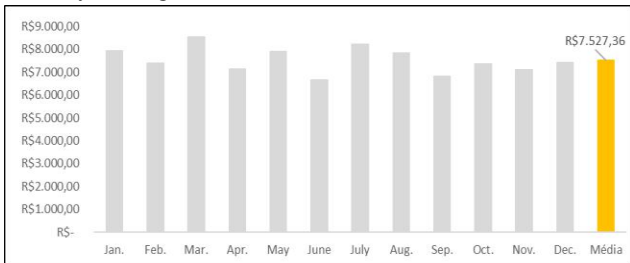


Fig.8: Estimate of Monthly Savings for 2017

Source: Adapted from the PVsyst 6.73 simulator (2018)

It can be seen in this Figure the variation of the monthly saving throughout 2017.

V. ANALYSIS AND DISCUSSION OF RESULTS

Considering the budget provided in Figure 7, the annual saving in electrical energy bills, for 2017, was estimated at R\$ 90.328,28. This way, Figure 9 and Table 3 were prepared, which indicate the mean time of return on investment and the savings generated with the project over a 25-years period.

YEAR	ENERGY PRODUCED	ELECTRIC TARIFF	REVENUE FROM ELECTRIC POWER PRODUCED	ANNUAL MAINTENANCE	ANNUAL INSURANCE	CASH FLOW	ACCUMULATED CASH FLOW
0	0,00	0,0000	R\$ 0,00	R\$ 0,00	R\$ 0,00	-R\$ 404.106,10	
1	154.710,00	0,5777	R\$ 89.375,97	R\$ 3.794,19	R\$ 10.864,80	R\$ 74.716,98	-R\$ 409.389,12
2	153.317,61	0,6068	R\$ 93.035,59	R\$ 4.144,46	R\$ 11.855,67	R\$ 77.035,46	-R\$ 332.483,42
3	151.937,75	0,6374	R\$ 96.845,06	R\$ 4.527,07	R\$ 12.936,91	R\$ 79.381,09	-R\$ 253.364,29
4	150.570,31	0,6695	R\$ 100.810,52	R\$ 4.944,99	R\$ 14.116,75	R\$ 81.748,78	-R\$ 172.011,20
5	149.215,18	0,7033	R\$ 104.938,35	R\$ 5.401,50	R\$ 15.404,20	R\$ 84.132,65	-R\$ 88.408,45
6	147.872,24	0,7387	R\$ 109.235,20	R\$ 5.900,15	R\$ 16.809,06	R\$ 86.526,98	-R\$ 2.545,82
7	146.541,39	0,7759	R\$ 113.707,98	R\$ 6.444,84	R\$ 18.342,05	R\$ 88.921,09	R\$ 85.580,71
8	145.222,52	0,8151	R\$ 118.365,92	R\$ 7.039,81	R\$ 20.014,85	R\$ 91.309,26	R\$ 175.948,11
9	143.915,52	0,8561	R\$ 123.210,49	R\$ 7.689,71	R\$ 21.840,20	R\$ 93.680,59	R\$ 268.605,45
10	142.620,28	0,8993	R\$ 128.255,52	R\$ 8.399,60	R\$ 23.832,03	R\$ 96.023,89	R\$ 363.472,89
11	141.336,69	0,9446	R\$ 133.507,12	R\$ 9.175,03	R\$ 26.005,51	R\$ 98.326,58	R\$ 460.540,59
12	140.064,66	0,9922	R\$ 138.975,76	R\$ 10.022,05	R\$ 28.377,21	R\$ 100.574,50	R\$559.767,56
13	138.944,15	1,0422	R\$ 144.810,21	R\$ 10.947,26	R\$ 30.965,21	R\$ 102.897,74	R\$ 661.242,38
14	137.832,59	1,0947	R\$ 150.891,78	R\$ 11.957,88	R\$ 33.789,24	R\$ 105.144,66	R\$ 764.908,81
15	136.729,93	1,1499	R\$ 157.228,75	R\$ 13.061,80	R\$ 36.870,82	R\$ 107.296,13	R\$ 870.695,81
16	135.636,09	1,2079	R\$ 163.851,85	R\$ 14.267,63	R\$ 40.233,43	R\$ 109.330,79	R\$ 978.515,88
17	134.551,01	1,2688	R\$ 170.712,26	R\$ 15.584,78	R\$ 43.902,72	R\$ 111.224,76	R\$ 1.088.263,19
18	133.474,60	1,3327	R\$ 177.881,63	R\$ 17.023,53	R\$ 47.906,65	R\$ 112.951,46	R\$ 1.199.811,60
19	132.406,80	1,3999	R\$ 185.352,09	R\$ 18.595,09	R\$ 52.275,74	R\$ 114.481,26	R\$ 1.313.012,44
20	131.347,55	1,4704	R\$ 193.136,29	R\$ 20.311,74	R\$ 57.043,28	R\$ 115.781,26	R\$ 1.427.692,11
21	130.296,77	1,5445	R\$ 201.247,39	R\$ 22.186,87	R\$ 62.245,63	R\$ 116.814,89	R\$ 1.543.649,41
22	129.254,39	1,6224	R\$ 209.699,14	R\$ 24.235,10	R\$ 67.922,43	R\$ 117.541,60	R\$ 1.660.652,67
23	128.220,36	1,7041	R\$ 218.505,83	R\$ 26.472,43	R\$ 74.116,96	R\$ 117.916,45	R\$ 1.778.436,59
24	127.194,59	1,7900	R\$ 227.682,38	R\$ 28.916,29	R\$ 80.876,43	R\$ 117.889,66	R\$ 1.896.698,78
25	126.177,04	1,8802	R\$ 237.244,31	R\$ 31.585,77	R\$ 88.252,34	R\$ 117.406,19	R\$ 2.015.095,98

Fig.9: Investment and Costs Analysis over 25 Years

Source: Elaborated by the author (2018)

The data in Figure 9 display the values referring to the analysis of investment and costs during 25 years, separated annually, based on the following topics: Produced Energy; Electric Tariff; Revenue from Produced Energy; Annual Insurance; Cash Flow; and Accumulated Cash Flow .

The study presents a covered area of approximately 3.000 m². It was considered that a large part of this area could be used for installation of photovoltaic panels, as it was already covered with tiles having a suitable slope, making its installation easier. Regarding the project made by the electrical engineering, it is only needed a roof of 664 m², which corresponds to the installation of 340 panels.

The data given in Figure 10 illustrate the increase in the return on investment estimated in approximately six years, using the Simple Payback method. At the end of 25 years of warranty of the photovoltaic panels, the savings generated to the company under study is of R\$ 2.015.095,98.

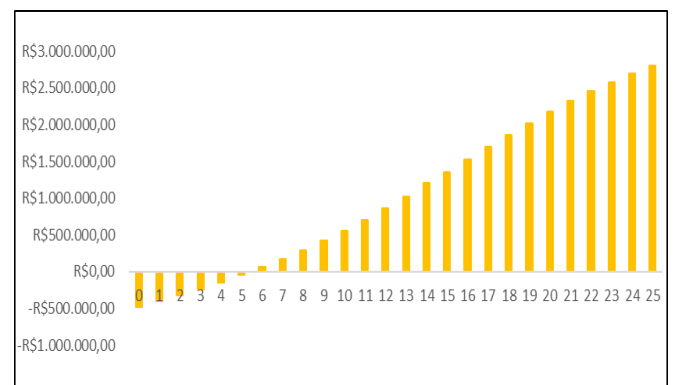


Fig.10: Time of Return on Investment

Source: Adapted from the PVsyst 6.73 simulator (2018)

From the data reported in Table 3, it was calculated the PI, which resulted in 1.99 %, higher than 1, being, thus, a favorable characteristic for the project. The ROI and the Net Present Value (NPV) were also calculated, resulting in 516.25 % and R\$ 438.835,34, respectively, which is also a positive and relevant factor for the decision making of the board of directors. As mentioned before, the MAR was 8.3 % and the IRR corresponded to 17.1 % per year, higher than the MAR. The data provided in Table 3 show these results.

Table.3: Results about Economic Indicators

Economic Indicators	Results
Profitability Index	1.99 %
Return on Investment	516.25%
Net Present Value	R\$438.835,3
Minimum Attractive Rate	8.30%
Internal Rate of Return	17.51% p.y
Simple Payback	6 years e ½ month
Discounted Payback	8 years and 5 months

Source: Elaborated by the author (2018)

On the basis of the results achieved by the economic feasibility provided, it can be stated that the project is viable, since it offers great financial savings in the medium and long term, presenting itself as one of the solutions for the reduction in the maintenance costs of the oil company, and contributes to the generation of clean energy, with no emission of carbon dioxide (CO₂).

VI. CONCLUSION

The solar energy generation system has been widely disseminated worldwide. In Brazil, after ANEEL resolution 482/2012, the photovoltaic system became largely used in residences, industries, and different organizations, with the possibility of offsetting electric generation credit.

This work aimed at assessing the possible implementation of a photovoltaic system in an offshore company in the municipality of Macaé, Rio de Janeiro State, Brazil. As observed, the company has the structural capacity to accommodate the system, and the investment will be returned in approximately six years, providing great savings in a medium and long term.

The return on investment rates was observed to be inconsistent considering the return on investment time less than or equal to five years.

Therefore, the feasibility of using photovoltaic panels is regarded as positive, providing not only financial benefits, but also contributing to sustainability, given that solar energy does not use fossil fuel, does not emit carbon dioxide into the atmosphere, and contributes to the maintenance of hydropower reservoirs, thus conserving national water resources.

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Analysis of Mercury Grouping in Soil in the Foz of the Tapajós River, Amazonia-Brazil

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Abstract— *The region of Santarém, in the state of Pará, was chosen to carry out this research because it is at the center of discussions of mercury contamination in the Amazon. The objective of this paper is the analysis of Hg and Methyl-Hg speciation in soil. The methodological procedures to determine the total mercury and methylHg were carried out by means of samples, which were submitted to acid digestion and determinations of Hg performed by Atomic Absorption Spectrophotometry with cold vapor generation. The evaluation of the concentrations of mercury in the sampled and depth points was performed with the aid of cluster analysis, using the Hierarchical clustering method. The results obtained indicate that the total mercury in soil showed very high values in the analysis of total mercury with granulometry for fine fraction and gross fraction, indicating an urgent mobilization and political action in the municipal, state and federal spheres regarding the exposure of the environment environment to the mercury detected.*

Keywords— *Atomic Absorption, Granulometry, Environment.*

I. INTRODUCTION

Amazonia is the region par excellence in the process of human environmental exposure, due to its geography and the presence of a vast hydrographic network. The monitoring and evaluation of the mercurial dynamics in the region and its consequences for local population, regional and global ecosystems are of great importance to suggest public policies and mitigate possible damages to health and the environment. An extensive literature deals with the possible effects of inorganic or methylated mercury on the local populations of the Tapajós region. The Amazonian populations, mainly riparian and

indigenous, are potentially exposed to low concentrations of total mercury throughout their lives (PINHEIRO et al., 2007), and most studies show a positive relationship between fish consumption and high levels of Hg in hair (SANTOS et al., 1999; PASSOS et al., 2007).

The highest concentrations (> 500 ppb) were found in carnivorous species, such as *Plagioscion squamosissimus* (white hake), *Pseudoplatystoma* spp. (surubim), *Brachyplatystoma filamentosum* (cub), *B. fravicans* (golden) and Cichlids *Cichla* spp. (TUCUNARÉ), among other carnivores (PINHEIRO et al., 2007), widely ingested and marketed by local communities. In this way, the commitment of the local fish will greatly affect the economic and environmental dynamics of these populations, especially the export trade that is controlled by the National Sanitary Surveillance Agency (ANVISA, 1998). Some of these studies refer to the effects on the cardiovascular system in these Amazonian populations and show that, for example, systolic and diastolic pressures are relatively low, however, there is evidence that this increases with age, and is related with high concentrations of total Hg in a population with minimal risk factors for hypertension and high environmental concentrations of Hg (FILLION et al., 2006).

On the other hand, studies on age-related cataract (ARG) conducted in the lower Tapajós River (CARUSO PROJECT, 2010) indicated that one third (n = 69; 32.7%) of the participants presented ARG, and presented individuals from this population with high levels of Hg, the cataratogenic effects of Hg can be reduced by the ingestion of selenium (Se) in their diets (LEMIRE et al., 2010). MeHg is primarily a neurotoxic agent, but its action could be antagonized by nutritional factors such as the ingestion of antioxidant vitamins present in Amazonian fruits (PASSOS et al., 2007), amino acids

(glycine, methionine, cysteine) (FARINA et al. , LEMIRE et al., 2006), and minerals such as selenium (PINHEIRO et al., 2007).

The greater or lesser impact of high concentrations of total Hg in foods ingested by local populations and the ongoing study of neural diseases underscores the importance of implementing and maintaining public health programs for local people, especially riverine and indigenous peoples. As the inhabitants perceive this problem and how it will be the relation with the chronic mercurial disease, fact to be considered, is the other issue of the study here in focus from the application of IQ-MCS.

Thus, in this article, we seek to identify and analyze the speciation of Hg and Methyl-Hg in soil and particulate matter at the mouth of the Tapajós River, and the possible impacts on the health of the surrounding populations and the perception, mobilization capacity and political action on the contamination by this metal in the population of Santarém. This analysis will be carried out through the application of Integrated Questionnaires to Measure the Social Capital Index - QI-MCS, proposed by the World Bank, in 2003.

II. MATERIALS AND METHODS

The municipality of Santarém is located in the region of the mouth of the Tapajós river, confluence with the Amazon river, mesoregion of the Lower Amazon and the microregion Santarém, in the western portion of the state, with coordinates 02° 25 '30 "S and 54° 42' 50" WG (Figure 1). According to IBGE (2015), the municipality has a population of 294,580 habitants, an area of 22,887 km² and a population density of 12.8 hab./km².

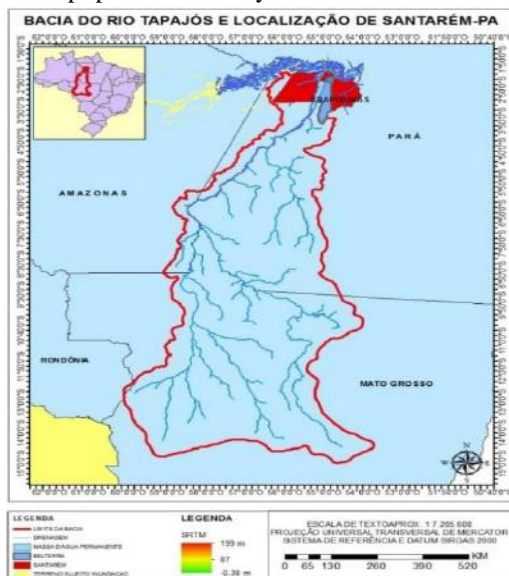


Fig. 1: Location map of the Tapajós and Santarém river basin.

The urban area of Santarém was chosen because it is the municipality directly associated to the contamination by this metal; the others were, the Village of Alter do Chão functions as an important tourist pole, in the state and national scenario and, therefore, an area directly impacted with possible dissemination of environmental contamination by Hg; The community of Arapixuna, located in the homonym hole, has its protein base in fish consumption, besides receiving seasonal influences from the waters of the Amazonas and Tapajós rivers; and communities along the Everaldo Martins Highway (Santarém-Alter-do-Chão), an area known as the Eixo Forte

For the soil sampling, the 6 points were selected, with a stratigraphic profile having 60 cm each, subdivided into fractions of 0-10, 10-20, 20-30, 30-40 and 40-60 cm, totaling 30 samples, for Fraction Grosso and 30 for Fine Fraction and collected during the dry season of the Amazon region (September and October). Samples of water and particulate material were collected at the six sampled sites.

At the end, statistical analyzes are performed by clusters (AC), which is a multivariate exploratory analysis technique that allows to separate or classify objects observed in a group or in a specific number of mutually exclusive subgroups or clusters of so that the subgroups formed have characteristics of great internal similarity and great external dissimilarity.

III. RESULTS

The dendrogram of Figure 2 shows the groups formed for the localities in relation to the concentration of Hg Total, in soil in the Fina Fina at various depths. The method of grouping the averages (Average) presented better results, that is, the best ability to evidence the data structure, indicated by the correlation between the matrix of dissimilarity, or matrix of distances between each locality and the cofenetic matrix, generated by the dendrogram. In this case, the correlation was 0.851, which characterizes a very good fit. Three homogeneous groups were formed: a group formed by the locality Alter-do-Chão (group 1), another by the localities Everaldo Martins and Lago Juá (group 2), and a third by the localities Lago Caranazal, Lake Itapari and Lago Caminho das Pedras (group 3).

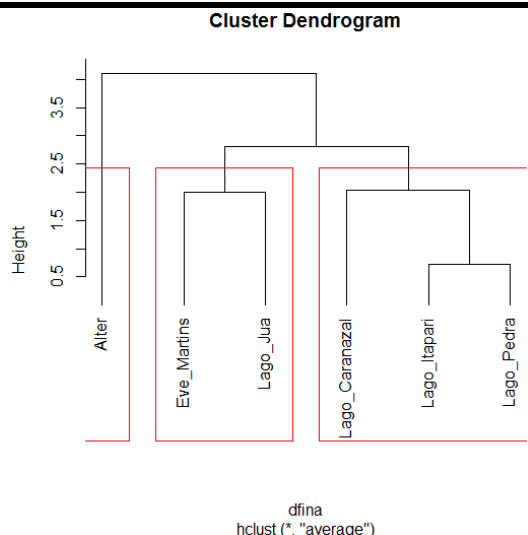


Fig. 2: Dendrogram - HgTotal Fine Fraction.

For the concentration of HgTotal, in soil at the Coarse Fraction at various depths, the dendrogram (Figure 3) showed 4 homogeneous groups: Everaldo Martins (group 1), Lake Caminho das Pedras (group 2), Itapari Lake (group 3) and Alter -do-Chão, Lago Juá and Lago Caranazal (group 4). The correlation between the distance matrix and the cofenetic matrix was 0.945, which indicates an optimal representation of the groups

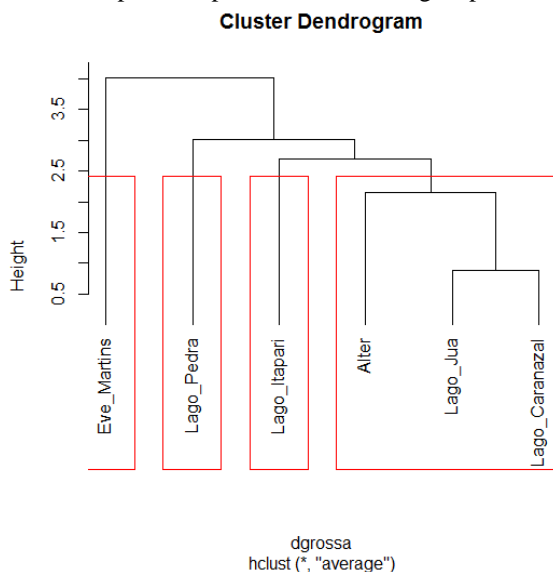


Fig. 3: Dendrogram - HgTotal Thick Fraction.

The analysis of the concentration of MeHg in soil in the fine fraction at the various depths generated the dendrogram (Figure 4). Four homogeneous groups were formed: Alter-do-Chão (group 1), Itapari Lake (group 2), Lake Caminho das Pedra (group 3) and Lake Juá, Everaldo Martins and Lago Caranazal (group 4). The correlation between the distance matrix and the cofenetic matrix was 0.945.

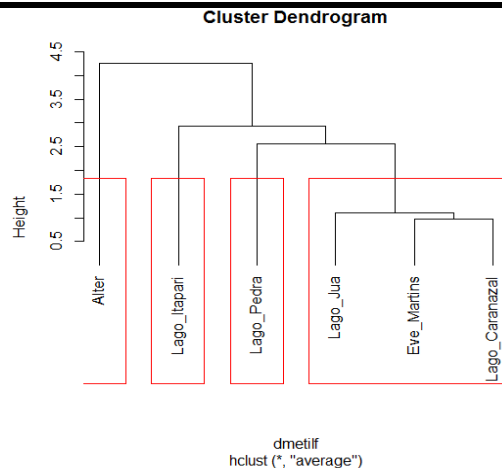


Fig. 4: Dendrogram - MeHg Fine Fraction

Considering the concentrations of MeHg and HgTotal, in soil at the Fina Fina at various depths, the dendrogram of Figure 5 was obtained and the same groups shown in the dendrogram of Figure 3 were formed, that is, Alter-do-Chão (group 1), Lake Itapari (group 2), Lake Pedra (group 3) and Lake Juá, Everaldo Martins and Lake Caranazal (group 4). The correlation between the distance matrix and the cofenetic matrix was 0.956.

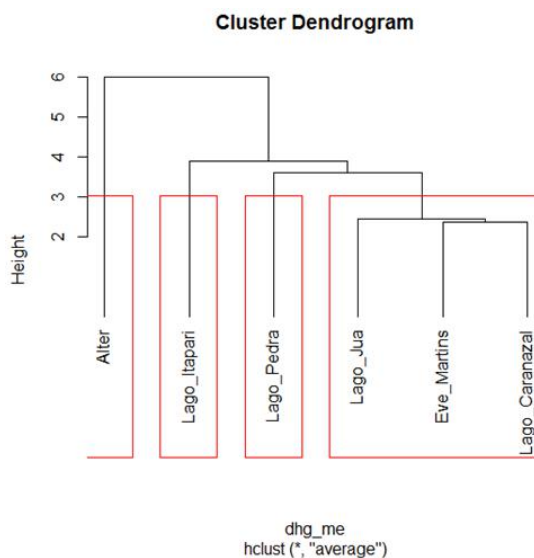


Fig. 5: Dendrogram MeHg and HgTotal Fine Fraction.

The evaluation of the depths in the various localities using the concentrations of MeHg and HgTotal in soil in the fine fraction generated the dendrogram of Figure 6. In this case, the groups formed were: 40-60 Hg (group 1), 10-20 MeHg, 40-60 MeHg, 0-10 MeOH, 20-30 MeHg (Group 2), 30-40 MeHg (Group 3) and 0-10 Hg, 10-20 Hg, 20-30 Hg, 30-40 Hg (Group 4). It is observed that the concentrations of MeHg and Total Hg were in different groups. The correlation between the distance matrix and the cofenetic matrix was 0.943.

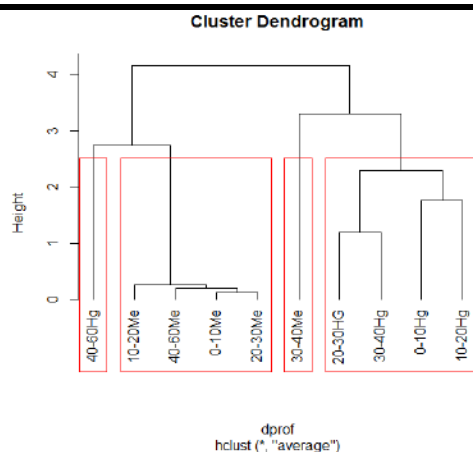


Fig. 5: Dendrogram - MeHg and Total Fine Fraction

Techniques of multivariate statistics such as cluster analysis and discriminant analysis were used in geochemical studies (Moura, 1985; Oliveira; SHORE; CRUZ et al, 1998) and interrelationships between soil characteristics and crop productivity (Correia, 1993), and presented potential for use in the establishment and proposition of reference values of metals in soils. Fadigas (2006) used clustering analysis to separate polluted areas with heavy metal contents found in a given soil, with those in natural, ie non-polluted, or reference (standard) conditions. On the basis of soil characteristics present in each group, we could propose a model to obtain the heavy metal concentrations in soil from the correlation with other metals, and establish tolerance limit threshold and reference group, it was possible to propose a model to obtain the concentrations of heavy metals in soil from the correlation with other metals, besides establishing a tolerance limit and reference limit for the most diverse types of Brazilian soil. The groups obtained in soil studies, by similarity between the samples, also are composed of soils of different pedological classes, since soils of different pedological classes can present some chemical attributes and of granulometric composition in common (EMBRAPA, 2013); thus, samples of an A, B or transitional horizon of the same soil or of different soils may be present in the same group, provided that the concentrations of some of the variables considered in the cluster analysis are close. The groups for the analysis of the concentration of MeHg, in soil in the fine fraction, in the various depths, such as Alter-do-Chão (group 1), Lake Itapari (group 2), Lago Pedra (group 3) and Lake Juá, Everaldo Martins and Lago Caranazal (group 4). Considering the concentrations of MeHg and HgTotal in soil in the fine fraction at various depths, the correlation index was 95%, with the following grouping: Alter-do-Chão (group 1), Itapari Lake (group 2), Lago Caminho das Pedra (group 3) and Lake Juá, Everaldo Martins and Lago Caranazal (group 4).

Among the groups formed for the evaluation of the depths in the concentrations of MeHg and HgTotal, in soil in the fine fraction are: 40-60 Hg (group 1), 10-20 MeHg, 40-60 MeHg, 0-10 MeHg, 20 -30 MeHg (Group 2), 30-40 MeHg (Group 3) and 0 -10 Hg, 10-20 Hg, 20-30 Hg, 30-40 Hg (Group 4). The concentrations of MeHg and Total Hg were found to be in different groups. In all cases, the correlations were significant and the correlated environments presented characteristics of landscape, environment and geographical proximity very close.

IV. CONCLUSION

With respect to contamination by Hg, were observed mean concentration values of Hg higher in the suspended particulate matter than in soil in fine fractions or crude fractions. However, most of the mercury in these waters is associated with the particulate fraction, indicating that the HgTotal in this river was derived predominantly from erosion. This particulate material rich in dissolved organic matter could be absorbing Hg⁰ and MeHg and distributing these chemical species along the biotic and abiotic compartments of the Amazonian ecosystem studied here.

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Spatial Modeling for Selection of Agricultural Potential Site

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Abstract— *The agricultural potency of Sigi Regency, Central Sulawesi, mainly consists of two types of commodities, cultivated plants, and non-food products, which are potentially developed to achieve optimal situation. Crops will support food necessity internally, i.e., local area or support inter-regional trading. Development of agriculture plays the role of material either for internal trading or export material. Potential land resources and commodity being the necessary information needed in agricultural planning. This research put forward the concept of agriculturally based on the land system and soil physical information at Sigi Regency, within 527,513 ha of area coverage. Visual interpretation from remote sensing image performed to obtain physical land data. Then, it will be integrated with land-use and land-system information for spatial analysis using Geographic Information System (GIS). Spatial data of agriculture resources potency compiled to obtain the availability of potential location at Sigi Regency including the referral became the purpose of this research. Classification of potential agriculture land reveals the potential of wetland is 45,500 ha, 21,350 ha of dry land, 93,000 ha of plantation land area, and forest area 343,400 ha.*

Keywords— *Agriculture, commodity, land-use zoning, marginal land, potential.*

I. INTRODUCTION

1.1. Background

Spatial modeling activity is intended to determine the potential of each land unit to be analyzed. Mapping the land potential focuses on the aspect of land resource inventory. Mapping of potential land is an early stage as the input of directing the spatial planning. The availability of land maps of each potency will be continued by assessing the capabilities of each land unit [1]. Provision recommendation of Land Potential Maps for agricultural land development includes numbers of information: land coverage, land suitability of paddy farming, annual cropland suitability, also road network and infrastructure availability.

The land suitability for a particular purpose is an activity of land evaluation to illustrate its suitability [2]. Land suitability assessments for certain crops are adapted to environmental conditions and its utilization by the population as high economic value commodities. Evaluation of land suitability is primarily related to evaluation for a particular use, such as for rice field, cornfield and so on [3]. Land suitability might be assessed for present conditions, or after improvement (become potential), moreover, in particular the land suitability due to its physical nature, which consists of climate, soil, topography, hydrology, and or appropriate drainage for a specific productive farming [4].

Concerning the Sigi Regency's land-use, there are rice fields, farm, coconut plantations, cocoa plantations, coffee plantations, settlements, forests and water bodies/lakes. Dominancy of dense forest is located in the central part of the hilly area. While farming, rice fields, and settlements are located along the valleys and streams. Land characteristics used in the Land Suitability Analysis is obtained from existing maps. Numbers of land characteristic data consist of the land title, climatic conditions, landform, land-use, slope, altitude, flood hazard and geological conditions [4]. At this point, the use of land has been chosen based on physically most appropriate and economically profitable [5]. This analysis will also be useful later, to boost the efforts on improving the farming system. Therefore, the land suitability of Sigi Regency is to find the appropriate area for crops and plantations to improve the economy.

1.2. Study Area

This research took place in Sigi Regency, Central Sulawesi, located at 119°38'-120°21' East and 0°52' - 2°03' South (Fig. 1). The extent of Sigi Regency is 5,196 km². The geomorphology of Sigi Regency is hilly, yet it has a variety of slope region between 0-2%, 2-15% and mostly above 45%. The region elevation is between 32 to 1,350 m above MSL. The average air temperature is 27°C with an annual mean rainfall of 71 mm/month. [6].



Fig. 1: Research location map

1.3. Materials

Topographic map scale 1:25.000 in the year of 2015, Landsat-8 acquired in 2015, DSM SRTM, Development Planning Agency Sigi Regency and statistic data were all materials for carrying agricultural land suitability analysis in Sigi Regency. Image processing and GIS tools were used for image interpretation and spatial analysis. Statistics and secondary data were collected from the Central Bureau of Statistics and Development Planning Agency of Sigi Regency, while spatial data were collected from the Indonesia Geospatial Information Agency. The software used in this study were Microsoft Office, Global Mapper, ER Mapper, Iwls and ArcGIS.

II. METHODS

Geographic Information System was used for the analysis of the land suitability (both wetland and dry land). Generally, the implementation stage of the activity was divided into preparation stage, analysis phase and map preparation (Figure 2). During the preparation stage, primary data (topographic maps and satellite imageries) and secondary data (thematic maps and tabular data of study area) were collected. Generalization method was used to put on the research results in particular sheets. DEM (Digital Elevation Model) was produced by harnessing contour map and spot heights, then we used

ArcGIS to derivate thematic maps, elevation, and slope, from the DEM. Study literature was carried on to get references about national regulation and regional policies connected with the term of land resources and forest. The land cover map was produced by the extraction of the topographic map [7]. Overlay method was utilized to carry on the spatial analysis, therefore the maps must have the same reference system on map projection, grid system, and horizontal datum. Physical analysis of agricultural resources with geomorphological approach and landform unit was used as the basis of spatial analysis. This approach could be utilized for physical conditions analysis in term of natural resource potency evaluation (i.e., agricultural land, forests).

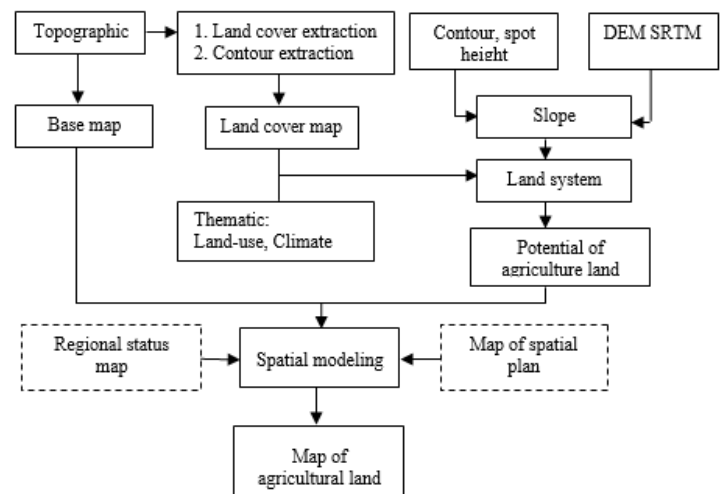


Fig. 2: Flowchart of agricultural potential site selection

The core of this research was spatial modeling, by gradually adoption of several methods with different stage conditions. The first step, spatial modeling on GIS tool was used to generate potential agricultural land data from the existing classification. The Geographical Information System tool with the overlay method was used for spatial operations [8], the scoring base was performed on the spatial analysis. Secondly, we matched potential land data with the area status to analyze and earn land availability data. At the last step, the land availability map was matched with the existing land map in order to yield the agricultural zone development [9].

Land resource elements became the main concern during process of land suitability analysis of Sigi Regency. Some elements that were used for analysis included slope, vegetation cover, landscape diversity, soil stability, and rainfall. Slope and landscape slope factors were obtained from the Digital Elevation Model (DEM), whereas vegetation cover was obtained from topographic maps and image interpretation (i.e., Landsat) [10].

Concept of sustainable development required minimum space needs and was centralized in villages to

control the growth factor. The land suitability results provided referrals for forest zoning and buffer areas, also productive agricultural areas [11]. The analytical process produced thematic maps that could be presented in the form of a printed map such as Land-cover Map, Map of Farming Areas or Land-uses map.

Agricultural land changes over time due to technology development and cultural adaptation. Technology will affect the productivity of land, while culture will determine the needs of every individual's life [12]. Agricultural potential is associated with weather and land conditions with the types of agricultural and plantation business. Agricultural development is one of the development systems that aims to cultivate agricultural enterprises in rural areas which can trigger economic activity and provide jobs to improve the community welfare. The approaches taken for this research were expected to find the most actual potency of the study area.

III. RESULTS AND DISCUSSION

Topographically, around 2/3 of Sigi Regency was hilly and mountainous, while the rest was lowland (Figure 2a). Soil and rock types found in Sigi were the combination of limestone rock and old volcanic rock causing the lowlands fertile. Land clearing or deforestation resulted in decreasing of vegetation area. Such conditions require management efforts which take account of the principles of conservation, optimization and intensification, and synergy between agriculture and plantation. Along with human needs as well as regional needs, essential commodities by local resources are served by agriculture and plantations. Community welfare can be achieved when production of various commodities is well managed, balanced and optimal. Land cover analysis showed that 75% of Sigi Regency is forest area (Fig. 3b). Table 1 shows three types of forest area based on their function and their extent. Data from Center of Statistics Bureau, 2016 for Sigi Regency stated that agricultural commodities in Sigi were defined as food and non-food commodities [6]. After this, the statistics data would then be integrated with spatial data on land use analysis results (Table 2).

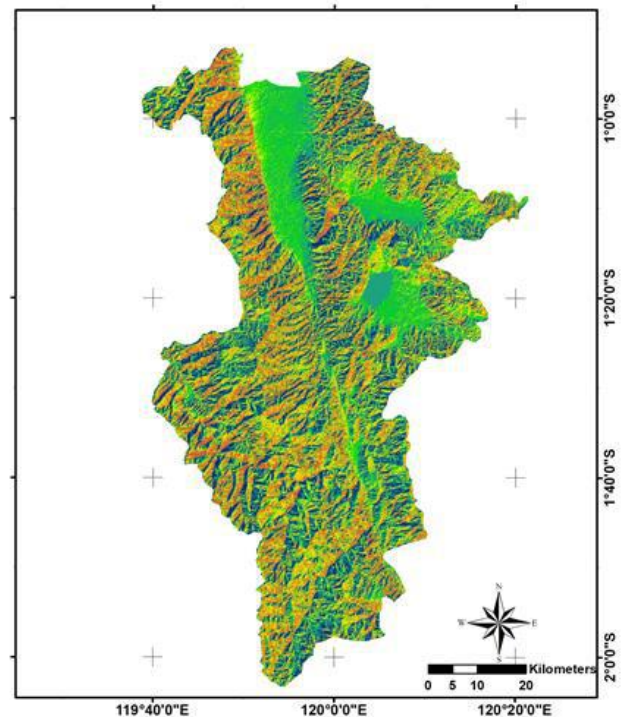
Table.1. Land cover classification

No.	Name	Area (Ha)
1.	Protected areas	249,500
2.	Plantation in forest areas	141,450
3.	Non-forest estate uses	128,650

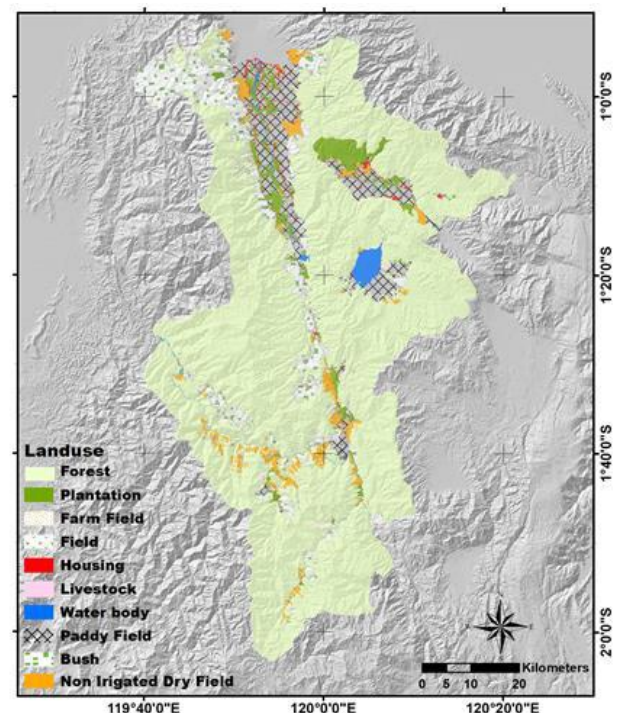
Table.2. Land-cover at Sigi Regency

No.	Types	Area (Ha)	%
1.	Settlement	32,454	6.25
2.	Non-forest estate	43,156	8.31

3.	Paddy fields	22,242	4.28
4.	Forest	343,403	66.09
5.	River/water body	22,137	4.26
6.	Dry fields	56,210	10.81
Total		519,602	



(a)



(b)

Fig. 3: DEM of Sigi Regency (a) and Land-use map (b)

Table 2 shows the results of land-use identification and the potential for agricultural site, and these results could be used to recommend direction of land availability (land potential). Distribution of potential land in a region is crucial information to do spatial management based on the alignment of the needs with the optimization of land use and environmental sustainability. Fig. 4 shows the potential of agricultural land in Sigi Regency.

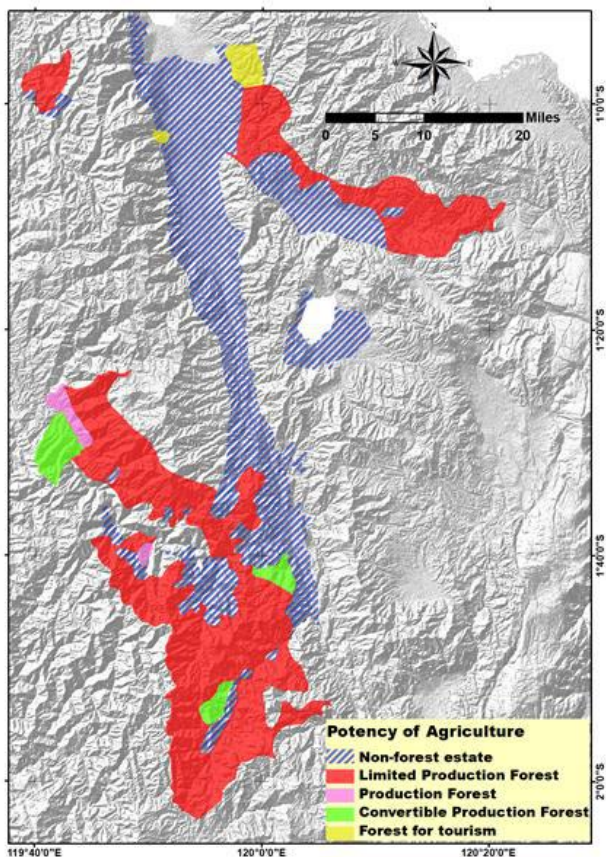


Fig. 4: Potency of agriculture

Superior commodities cultivation needs to follow topographic characteristics of the region. Since the topography of Sigi Regency is varied in slope, thus the region with a slope of 0-2% could be very potential for wetland farming and residential activities. Areas with slope of 2-15% could be potential for types of businesses, but the soil and water conservation should be wisely considered. Areas with slope range of 15 - 40% would not be feasible for plants cultivation, therefore planting in the area should be functioning as conservation. Lastly, areas with a slope of > 40% are highly threatened by erosion, so it is only suitable for being part of the protected forest.

The result as shown in Figure 5, informs the ideal potential of hilly and mountainous terrain which preserved its vegetation and could be developed as conservation-based production forests and plantation. The scale of land expansion that was feasible for the optimization of plantation potency in the forest and non-

forest estate is shown in Table 3. The expansion became an alternative for agricultural development to meet the community's need for land.

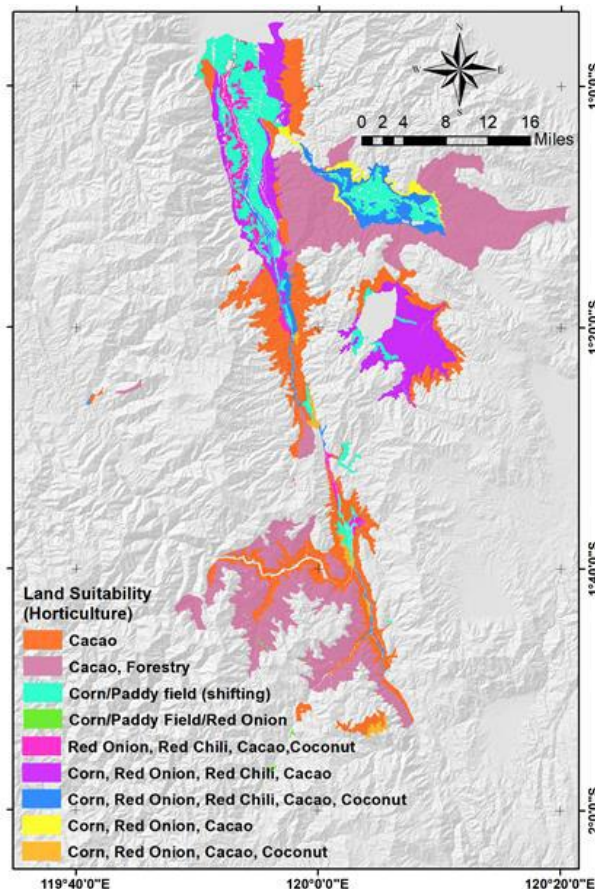


Fig. 5: Land suitability

Table.3. Potency development in non-forest estate of Sigi Regency

No.	Usage	Existing (Ha)	Expansion Plan (Ha)
1.	Plantation	37,304	55,700
2.	Paddy fields	21,805	23,700
3.	Dry fields	1,451	19,945
4.	Settlement	32,454	110,778
Total		93,014	210,123

Sources: Spatial analysis, data from BAPPEDA Sigi 2016 [13]

In average, the suitable area for plantation crops is very cramped due to domination by forests which the utilizations are restricted by law and governmental regulation. The level of land suitability is also determined by existing thematic data. With the availability of land suitability data, annual cropland development can be directed to commodities that have high economic value. Given the climatological conditions of this region, it is likely that the development of the annual crop sector can be crystallized. Physical limiting factors for annual crop

development in Sigi Regency are in fact insignificant, but more into cost and technology factors, because the agricultural business sector generally lasts for 10-25 years. The results of the study showed that non-forest estate could be used for annual crops and the suitability of cropland can be seen in Table 4 and Table 5.

Table 4. Plantation area at the non-forest estate

No.	Annual Cropland	Area (Ha)
1.	Cashew	9,376
2.	Cacao	24,381
3.	Coconut	5,953
4.	Coffee	2,567
5.	Other plantations	879
Total		43,156

Source: BPS 2016 [6]

Table 5. Land suitability for cropland

No.	Commodities	Area (Ha)
1.	Paddy fields	29,884
2.	Corn	12,370
3.	Other	1,391
Total		43,645

A rapid growth of settlements and offices has occurred in Sigi Regency. In 2011, the residential area was 32,454 ha in extent, but in 2014 it bloomed into 110,778 ha [13]. The expansion of settlements also occupied wetlands area, causing paddy fields were degraded by 3,257 ha between 2009 from 2014. This condition has been appalling since Sigi Regency was one of the food support areas in Palu City and its surrounding areas. Foremost, agriculture was the leading economic activity in Sigi Regency.

IV. CONCLUSION

The existence and quality of initial data as input in mapping method became the primary factor for the quality of the information produced. The existence of physical data related to the parameters composing land suitability evaluation in Sigi Regency were lacks and mostly were outdated. The spatial modeling classification resulted in the land suitability evaluation was still in the review scale. Thus, for implementation, ideal analysis would require more compatible spatial data.

Results of this study could be used as initial inputs for land-use planning, spatial planning directions, and policy development for the agricultural sector. Approximately, 29,800 ha area of rice farming commodities was very potential to be maintained, along with the infrastructure. The largest plantation commodities were cocoa (24,300 ha), cashew (9,300 ha), and coconut (5,900 ha). Cocoa

was the most dominant plantation product in Sigi Regency.

The best result for land suitability optimization can be achieved with ideal data. It can provide an excellent picture for decision makers in the local government as well as investment in providing spatial information data that can be used for broader needs.

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High appreciation is presented for the significant support from the local government of Central Sulawesi Province and Sigi Regency. All data provided by the local government has expedited this research, so that the result and the discussion will clarify the direction of spatial planning in Sigi Regency, deliberating the potency of agricultural sites.

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Design Templates for Some Fractional Order Control Systems

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Abstract—Time domain characteristics of first and second order systems are well known. But the same simplicity and explicitness do not exist for low order fractional order systems (FOSs). Considering the step response, the templates are developed for designing the behavior of simple FOSs with a 2-term denominator polynomial (one is unity and the other involves fractional power). Although the explicit relations between design parameters and the performance parameters such as time constant, rise time, overshoot, settling time for fractional order control systems (FOCSs) do not exist and can't be obtainable as in the ordinary integer order control systems, the obtained templates in this paper can be used for designing low order FOCSs. Hence, the drawback of non-existence of similar explicit formulas for FOCSs is eliminated by using these templates.

Keywords— Control system, fractional order, rise time, step response, time constant.

I. INTRODUCTION

FOSs have founded many applications in the last two decades and a great deal of literature has appeared for analyzing and designing these systems [1-7]. Especially fractional order proportional integral derivative (FOPID) controllers have appeared very frequently in control system design [8-10].

Focusing on some very recent literature, for example [11] proposes an adaptive FOPI control method based on enhanced virtual reference feedback tuning to meet high precision and speed requirements for controlling flexible swing arm system in the light-emitting diode (LED) packaging industry. E. Cokmez et. all have obtained and visualized stability regions based on specified gain and phase margins for a FOPI controller to control integrating processes with time delay [12]. J. R. Nayak and B. Shaw have shown how to enhance the performance of the automatic generation control by adopting cascade proportional derivative (PD) - FOPID controller in a two-

area mutually connected thermal power plant with generation rate constraint; group hunting search algorithm is adopted to explore the gain parameters of the controllers [13]. In [14], PI controller design is performed by using optimization for FOSs; first, controller parameters for a stable control are calculated by using the stability boundary locus method and then optimization is used to provide the best control. In [15], a new robust FOPID controller to stabilize a perturbed nonlinear chaotic system on one of its unstable fixed points is proposed based on the PID actions using the bifurcation diagram. In [16], fractional-order discrete synchronization of a new fourth-order memristor chaotic oscillator and the dynamic properties of the fractional-order discrete system are investigated; a new method for synchronizing is proposed and validated.

In spite of the existence of a great deal of publications about FOSs some of which have just been mentioned above, most of the present analysis and design techniques deal with sophisticated and rather special applications [17-24]. Although the step response characteristics such as rise time, settling time, delay time, overshoot and some others are well known by explicit formulas for simple integer order systems [25], such formulas are not available for FOSs. And a compact publication yielding the relations between the design parameters and the step response characteristics of even simple FOSs are not yet present. The purpose of this paper is to fulfill this vacancy and to supply some design tools for simple order FOSs.

The paper is organized as follows; in Section 2, basic definitions of time domain characteristics of first and second integer order systems are given. Section 3 introduces the FOSs that is studied and the investigation of its step responses depending on the fractional power. Section 4 gives and discusses the templates that can be used for the design of low order FOSs. Finally, Section 5 finishes with conclusions.

II. FIRST AND SECOND INTEGER ORDER SYSTEMS

Let the first order system transfer function H_1 be

$$H_1(s) = \frac{1}{p_1 s + 1}. \quad (1)$$

It is assumed that $p_1 \geq 0$ for stability. Since the study is confined to step response characteristics, it is easily obtained by applying the unit step input $u(t) = 0$ for $t < 0$, $u(t) =$

1 for $t \geq 0$, and compute the step response $y(t)$ as

$$y(t) = \begin{cases} 0, & t < 0 \\ 1 - e^{-t/p_1}, & t \geq 0 \end{cases} \quad (2)$$

The variation of the step response is shown in Fig. 1. It is an increasing exponential starting from 0 at $t = 0$, and rising to the steady-state value of 1 as $\lim t \rightarrow \infty$. The following time domain characteristics are defined for a response of the type shown in Fig. 1.

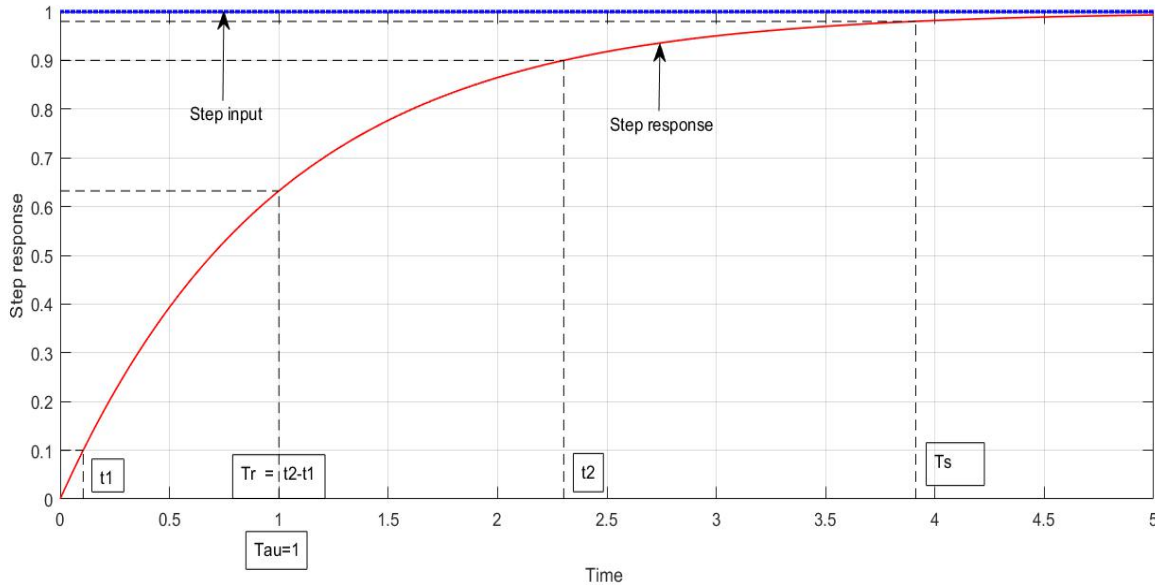


Fig.1: Step response of a first order system and some important characteristics.

Time constant τ : It is the time required for the response to reach $1 - (1/e) = 0.632121 \cong 63\%$ of its final value. For this exponential, from Eq. (2) it is true that

$$\tau = p_1. \quad (3a)$$

Rise time T_r : It is the time required for the response reach from 10% to 90% of its final value.

$$\begin{aligned} T_r &= t_2 - t_1 = 2.302585\tau - 0.105360\tau = \tau \ln 9 \\ &= 2.197225\tau \cong 2\tau. \end{aligned} \quad (3b)$$

Settling time T_s : It is the time required for the response to stay around its final value with an error less than 2%.

$$T_s = \tau \ln 50 = 3.912023\tau \cong 4\tau. \quad (3c)$$

Note that all the time characteristics depend on only the coefficient $\tau = p_1$ in Eq. (1). So, p_1 is chosen according to satisfy all the specifications on τ, T_r, T_s . Note also that for $p_1 = 0$, the system is a unity gain system which yields $y(t) = u(t)$; that is all the characteristic times τ, T_r, T_s are zero and no delay occurs at the response.

In summary, the following properties of time domain characteristics are valid: i) The response increases exponentially to its steady state value without any oscillations; ii) Rise time and settling time are some

multiples of time constant $\tau = p_1$.

It is well known that a time domain normalization with respect to τ_e corresponds to replacing t by t/τ_e which also corresponds to frequency domain normalization by writing s instead of $s\tau_e$. In Eq. (1), if we replace s by s/p_1 where $\tau_e = p_1$ is the time constant, then we have

$$H_1(s) = \frac{1}{s + 1}, \quad (4)$$

which has normalized time constant $\tau = 1$.

As the reference transfer function for a second order system

$$H_2(s) = \frac{\omega_n^2}{s^2 + 2\xi\omega_n s + \omega_n^2} \quad (5)$$

is considered [25]; obviously dc gain is equal to 1; ω_n is undamped natural frequency and $\xi \geq 0$ is the damping ratio. For $\xi > 1$ which corresponds to overdamped case, Eq. (5) yields the step response

$$y(t) = 1 - \frac{1}{\tau_2 - \tau_1} \left(\tau_2 e^{-\frac{t}{\tau_2}} - \tau_1 e^{-\frac{t}{\tau_1}} \right), \quad (6a)$$

which starts from 0 and rises to 1 monotonically as shown in Fig. 2 ($\zeta=2.0$). In this expression, there are two time constants τ_1 and τ_2 so that

$$\tau_1 = -\frac{1}{s_1} = \frac{1}{\omega_n(\xi + \sqrt{\xi^2 - 1})}, \quad \tau_2 = -\frac{1}{s_2} = \frac{1}{\omega_n(\xi - \sqrt{\xi^2 - 1})}, \quad (6b)$$

$$\tau_e = \tau_1 + \tau_2 = 2\xi\sqrt{\tau_1\tau_2} = \frac{\xi}{\pi}T_n = \frac{2\xi}{\omega_n}, \quad (6c)$$

where $T_n = 2\xi/\omega_n$ is the period of sustained oscillations of the undamped ($\xi = 0$) system.

where s_1 and s_2 are the poles of transfer function. It can be shown by using (6b) that

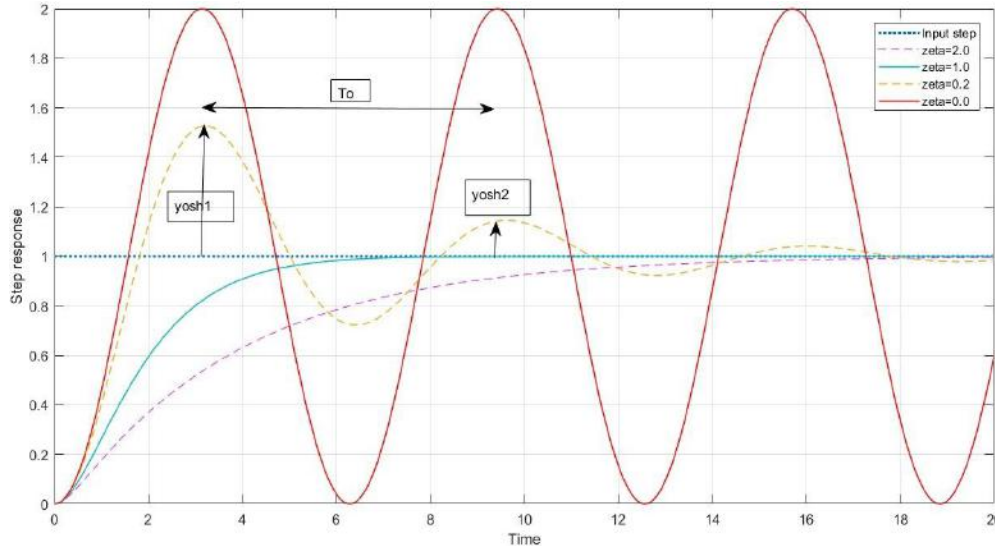


Fig.2: Step response of the second order system in Eqs. (6a), (6b) for values 2, 1, 0.2, 0 of damping ratio ξ ; $\omega_n = 1$.

For $\xi = 1$, the system in Eq. (5) is said to be critically damped; in this case there is only one time constant which is $\tau = 1/\omega_n = T_n/2\pi$. The step response is found as

$$y(t) = \mathcal{L}^{-1} \left\{ \frac{\omega_n^2}{s^2 + 2\omega_n s + \omega_n^2} \frac{1}{s} \right\} = 1 - e^{-\omega_n t}(\omega_n + 1), \quad (7)$$

which increases monotonically from 0 to the steady-state value 1 as shown in Fig. 2 (zeta=1.0).

For $0 < \xi < 1$, the system is said to be underdamped; for $\xi = 0.2$ the step response is shown in Fig. 2 (zeta=0.2). It is seen that the response is stable and approaches to the reference value 1 in a damped oscillatory manner. It is a routine process to show that the response is given by

$$y(t) = 1 - \frac{e^{-\xi\omega_n t}}{\sqrt{1-\xi^2}} \sin\left(\sqrt{1-\xi^2}\omega_n t + \sin^{-1}\sqrt{1-\xi^2}\right). \quad (8)$$

Finally, for $\xi = 0$, the system is undamped and the step response is

$$y(t) = \mathcal{L}^{-1} \left\{ \frac{1}{s} \frac{\omega_n^2}{s^2 + \omega_n^2} \right\} = 1 - \cos\omega_n t, \quad (9)$$

which represents sustained oscillations as shown in Fig. 2 (zeta=0) with undamped natural frequency $\omega_n = 1$ and undamped oscillation period $T_n = 2\pi$.

For the step responses corresponding to underdamped case two new time characteristics are defined. The oscillation period from Eq. (8) is

$$T_o = \frac{2\pi}{\sqrt{1-\xi^2}\omega_n} = \frac{\pi}{\xi\sqrt{1-\xi^2}}\tau_e. \quad (10a)$$

The settling time is approximately obtained from Eq. (8) as by equating the coefficient of sin function to $1 - 0.98 = 0.02$. The result is

$$T_s = \frac{1}{\xi\omega_n} \ln \frac{50}{\sqrt{1-\xi^2}} = \frac{\tau_e}{2\xi^2} \ln \frac{50}{\sqrt{1-\xi^2}}. \quad (10b)$$

Another time which is important is T_{max} when the first peak occurs in the response. From Eq. (8) T_{max} and $y(T_{max}) = y_{max}$ are found to be

$$T_{max} = \frac{\pi}{\omega_n\sqrt{1-\xi^2}} = \frac{\pi}{2\xi\sqrt{1-\xi^2}}\tau_e, \quad (11a)$$

$$y_{max} = 1 + \frac{e^{-\frac{\xi\pi}{\sqrt{1-\xi^2}}}}{\sqrt{1-\xi^2}}. \quad (11b)$$

The overshoot y_{osh} and percent overshoot (POSH) are defined by

$$POSH = \frac{y_{osh} = y_{max} - 1}{y_{ref}} 100 = \frac{100 e^{-\frac{\xi\pi}{\sqrt{1-\xi^2}}}}{\sqrt{1-\xi^2}}. \quad (11c)$$

For the succeeding peaks, Eqs. (12a), (12b), (12c) are modified by replacing π by $(2k - 1)\pi$ where k represents the peak numbers; for the first peak $k = 1$.

The reduction ratio (RR) is defined as the ratio of successive overshoots, and from Eq. (11c)

$$RR = e^{-\frac{2\xi\pi}{\sqrt{1-\xi^2}}}. \quad (11d)$$

For the undamped system ($\xi = 0$), Eq. (9) yields the following time domain characteristics:

$$\tau = 1 + \frac{\cos^{-1}\left(\frac{1}{e}\right)}{\omega_n}, \quad (12a)$$

$$T_r = \frac{\cos^{-1}(0.1) - \cos^{-1}(0.9)}{\omega_n}, \quad (12b)$$

$$T_{max} = \frac{\pi}{\omega_n}, \quad T_s = \infty, \quad T_o = \frac{2\pi}{\omega_n}, \quad (12c, d, e)$$

$$y_{max} = 2, \quad y_{osh} = 1, \quad (12f, g)$$

$$POSH = 100, \quad RR = 1. \quad (12h, i)$$

For $0 \leq \xi < \infty$, time domain characteristics $\tau, T_r, T_{max}, T_o, T_s$ and the overshoot y_{osh} are plotted against $\xi = \tau_e/2$.; The results are shown in Fig. 3.

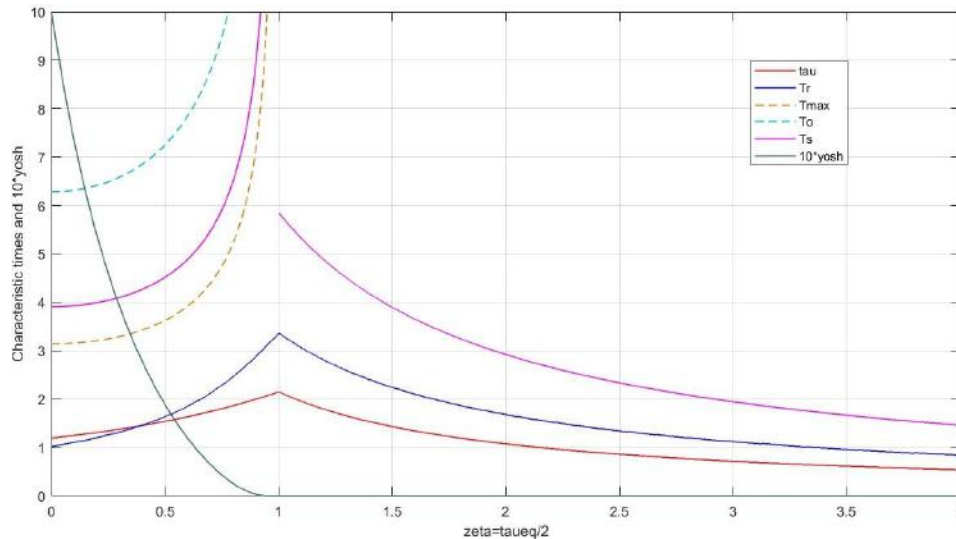


Fig.3: Variation of time domain characteristics against the damping ratio for $\xi \in [0,4]$.

III. INVESTIGATION OF 2-TERM FRACTIONAL DENOMINATOR CHARACTERISTICS

Consider the following fractional order transfer function with a constant numerator and 2-term fractional denominator:

$$H(s) = \frac{a}{bs^\alpha + c}. \quad (13a)$$

Assuming dc gain (a/c) to be 1, letting $b/c = p_1$, and

normalizing with $\tau_e = p_1^\alpha = 1$ we result with

$$H(s) = \frac{1}{s^\alpha + 1}. \quad (13b)$$

We have the following observations on the step response of the fractional transfer function in Eq. (13b); see Fig. 4 for these observations:

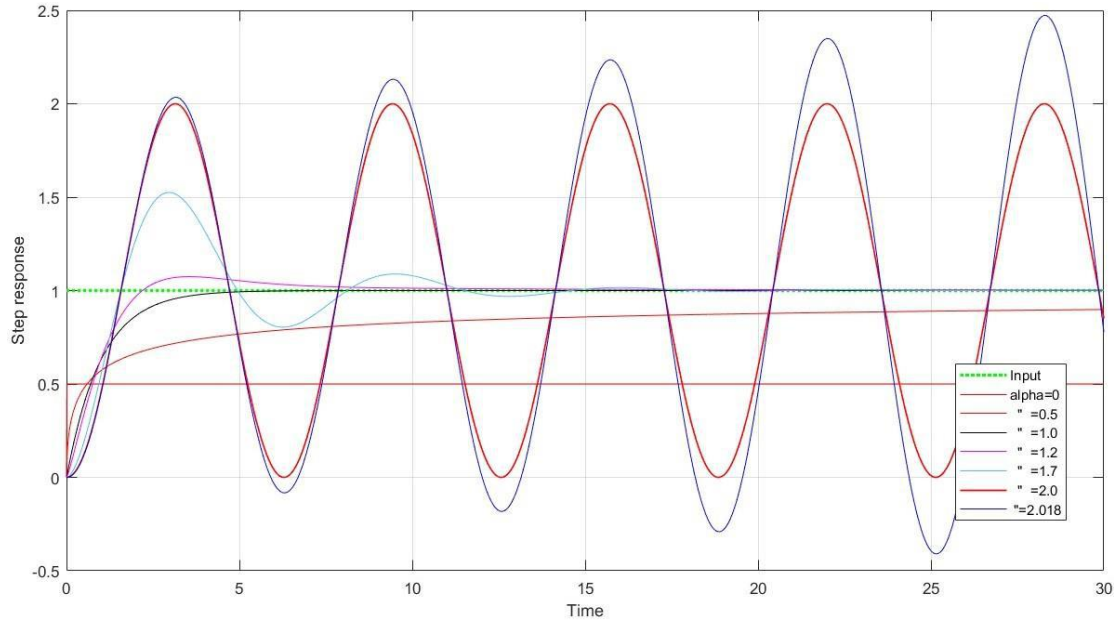


Fig.4: Step response of FOS in Eq. (14b) for different values of α .

- 1) It is obvious that dc gain of this system is 1, which results from Eq. (13b) by inserting $s = 0$ and assuming $\alpha \neq 0$. Therefore, all the step responses for stable cases will tend to 1 as $\lim t \rightarrow \infty$; ($\alpha = 0.5, 1.2, 1.7$).
- 2) For $\alpha = 0$, the transfer function will be equal to a constant gain of $1/2$, hence the step response is 0.5 ($\alpha = 0$).
- 3) For $\alpha = 1$, the transfer function is equal to a first order integer type transfer function, hence, the step response is an increasing exponential with a time constant $\tau = 1$ ($\alpha = 1$, see also Fig. 1).
- 4) For $\alpha = 2$, the fractional system in Eq. (13b) is equivalent to the second order integer type system in (5) with $\omega_n = 1, \xi = 0$; hence, the step response is sustained oscillation ($\alpha = 2$, see also Fig. 2).
- 5) For $\alpha > 2$, the system is not stable, and the step response increases exponentially (and oscillatory)-like manner ($\alpha = 2.018$).
- 6) For $1 < \alpha < 2$, the system is stable, and it has step responses ($\alpha = 1.2, \alpha = 1.7$). The first of these responses ($\alpha = 1.2$) is a decaying curve after an overshoot; and the second ($\alpha = 1.7$) is an oscillatory-like motion with exponentially-like decaying.
- 7) For $0 < \alpha < 1$, step response is a stable exponentially-like increasing behavior ($\alpha = 0.5$).

We note that those responses for $\alpha = 2.018, 1.7, 0.5$, resemble to those of a second order (for $\alpha = 2.018, 1.7$) and of a first order ($\alpha = 0.5$) integer order systems. But the

explicit formulas as in Eqs. (3,10,11,12) between the system parameter α and the step response characteristics do not exist for the considered FOSs. So, in the following section, instead of using explicit formulas, some templates are obtained to be used for designing FOSs.

IV. DEPENDENCE OF STEP RESPONSE CHARACTERISTICS ON α

In this section the dependence curves (templates) of step response characteristics, namely, duration of first oscillation period (T_o), time constant τ , rise time T_r , and settling time T_s vs $\alpha \in [0.01, 1.99]$, percent overshoot ($POSH$) vs $\beta = 2 - \alpha \in [0.01, 1.99]$ are obtained by simulations. Simulations are carried for 30 sin steps of $\Delta\alpha = 0.01$ by subprograms of FOMCON toolbox [7] integrated with MATLAB R2017 [7].

Fig. 5 shows the variation of the duration of the first oscillation against α . Numerical data show that the first peak occurs for $\alpha = 1.01$ and it is equal to 1.0014 . Then, until $\alpha = 1.34$ second peak does not appear; more elaborate numerical analysis show that, the second maximum starts exhibiting for the first time for $\alpha = 1.3396$ for which the first and second overshoots are $0.63695221, 0.011386081$, respectively; but for $\alpha = 1.34$ following the first peak of value 1.1640 , the second peak of value 1.0114 occurs. This means period of the first oscillation is defined for $\alpha \geq 1.3396$. Since there are no peaks (maximums) until $\alpha = 1.01$, the graph is started from $\alpha = 0.8$, though numerical data is obtained for all $\alpha \in [0.01, 1.99]$.

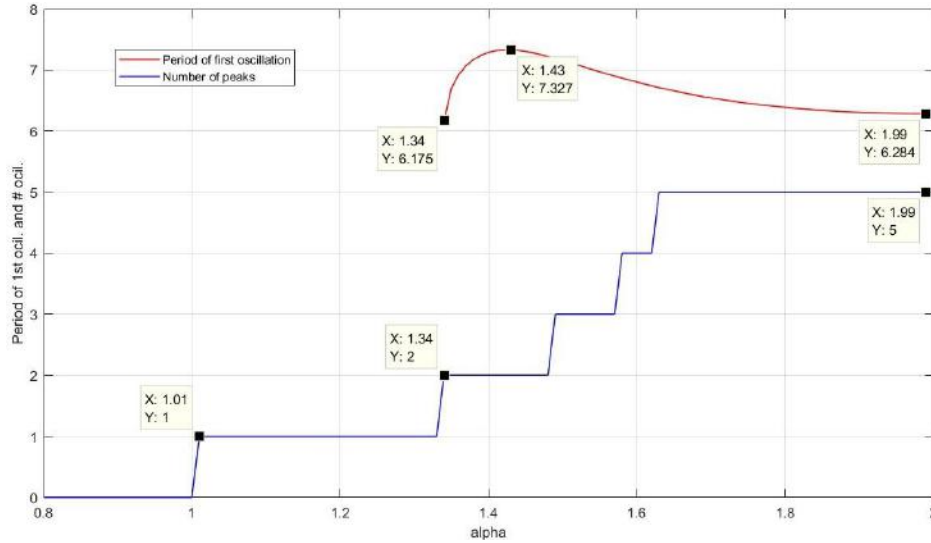


Fig.5: Duration of first oscillation against α .

Fig. 6 shows plots of time constant τ (Tau), rise time T_r , and settling time T_s . Time constant plot Tau starts from $\alpha = 0.14$, because, for smaller values of α , τ is larger than 30 s so that the response can't reach the critical value 0.632121 until 30 s; similar arguments are true for the rise time T_r which starts at $\alpha = 0.51$, and for settling time T_s which starts at $\alpha = 0.78$. Tau is obviously decreasing with increasing α , and it becomes 1.1915 for $\alpha = 1.99$. T_r also decreases with increasing α and it changes from 28.0350 at $\alpha = 1.51$ to 1.0220 at $\alpha = 1.99$. For $\alpha = 1.70$, τ is almost equal to T_r ($\tau = 1.0965$, $T_r = 1.0970$); for $\alpha \in [0.01, 1.70]$, $\tau < T_r$; and for $\alpha \in (1.70, 1.99]$, $\tau > T_r$. Settling time plot

starts from $T_s = 27.33$ for $\alpha = 0.78$ and ends at $T_s = 29.82$ for $\alpha = 1.99$. T_s decreases until $\alpha = 1.07$ and reaches to its minimum value $T_s = 2.8345$ at $\alpha = 1.07$, then it jumps up to $T_s = 5.1525$ at $\alpha = 1.08$. The plot terminates at $\alpha = 1.99$ with $T_s = 29.8215$. The irregular shape of increase of T_s for $\alpha \in [1.07, 1.99]$ is due to the dependence of T_s on discrete change of oscillations remaining in the limit $[1, \mp 0.02]$. Contrary to monotonic decrease of τ and T_s , it is true that (disregarding the irregular changes mentioned) T_s decreases monotonically for $\alpha \in [0.01, 1.07]$ and it increases for $\alpha \in [1.07, 1.99]$.

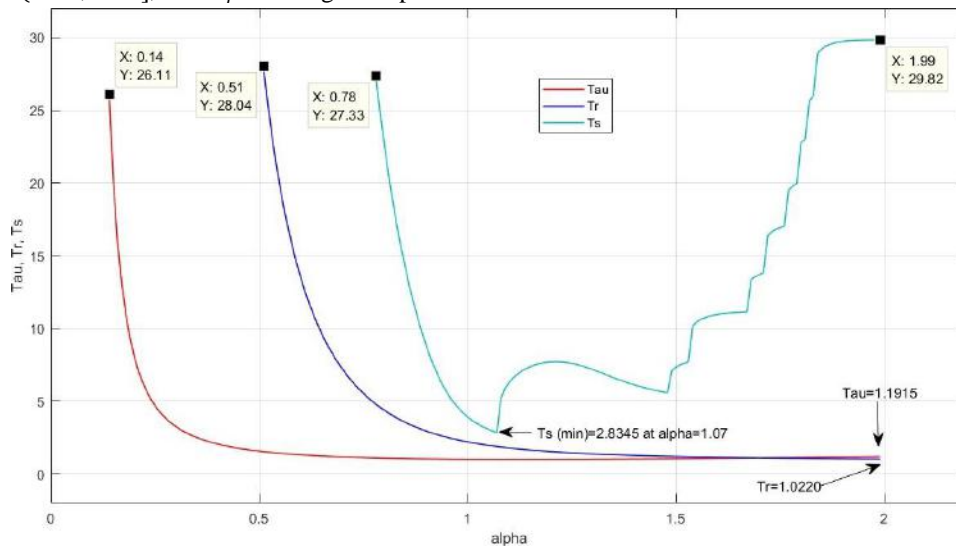


Fig.6: Time constant τ , rise time T_r , and settling time T_s vs α .

Fig. 7 shows the comparison of the variation of overshoots with $\alpha \in [1.01, 1.99]$ ($\beta = 2 - \alpha$, $\beta \in [0.01, 0.99]$) and

with the damping ratio ξ of a second order system. This plot is useful for finding the fractional order α and damping ratio

ξ for a given overshoot. For example, to achieve an overshoot of 60 %; $2 - \alpha = 0.24 \rightarrow \alpha = 1.76$ and $\xi = 0.16$

are appropriate for FOS and for a second order system, respectively.

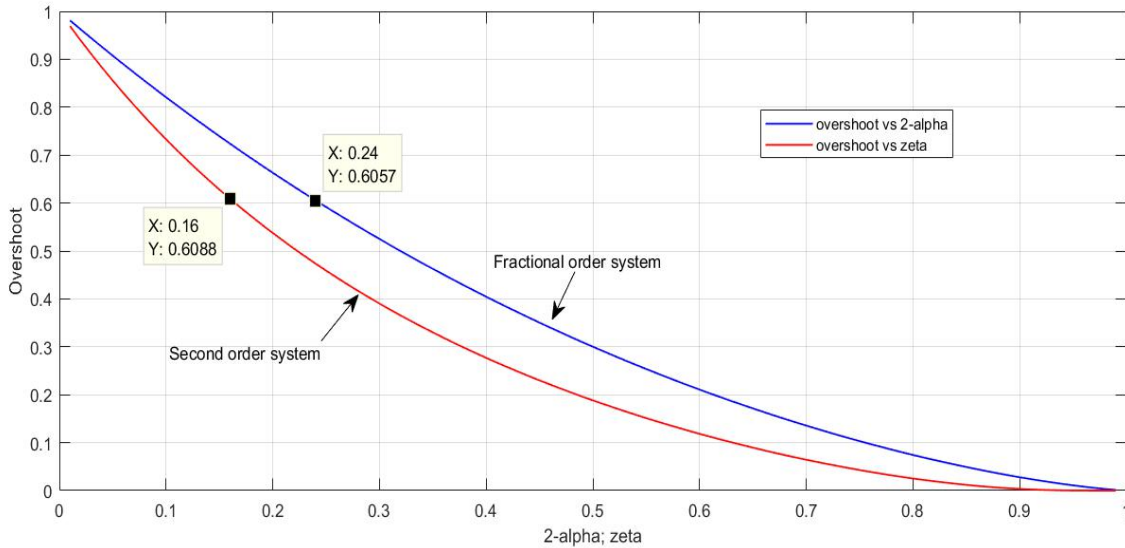


Fig.7: Overshoots versus $\beta = 2 - \alpha$ (for fractional) and ξ (for 2nd order) systems.

Fig. 8 better illustrates the relations between the overshoot and directly α (not $\beta = 2 - \alpha$) for fractional system, and ξ

for a second order system.

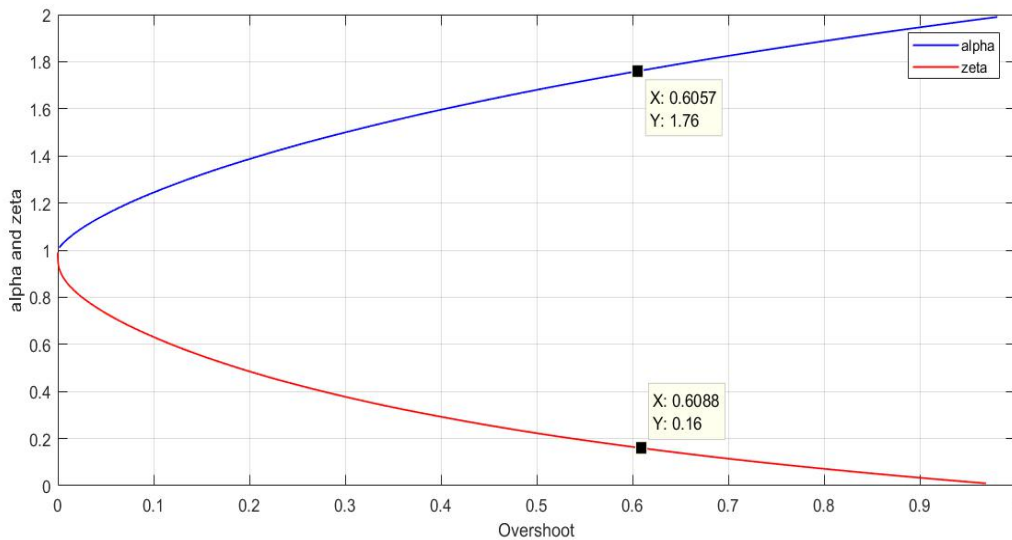


Fig.8: Variation of α for fractional order, and ξ for second order systems with the overshoot.

Fig. 9 shows the values $\beta = 2 - \alpha$ and ξ against the rise time. It is obvious that for a rise time of 4.371, β and ξ have

the same values of 1.2. This means for $\xi = 1.2$ and for $\alpha = 2 - \beta = 2 - 1.2 = 0.8$ the rise times are equal to 4.371.

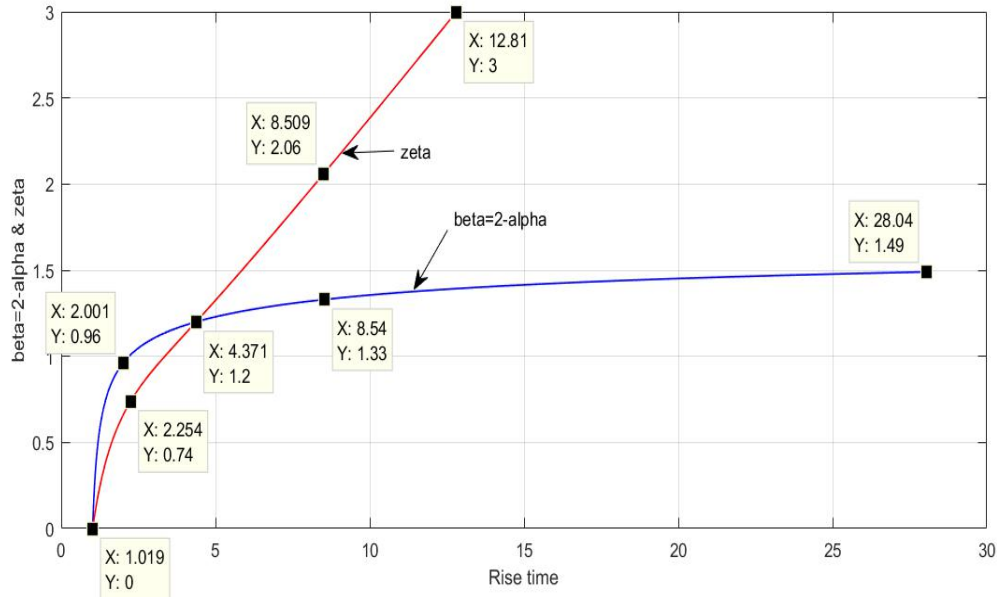


Fig. 9: $\beta = 2 - \alpha$ versus rise time and ζ versus rise time.

V. CONCLUSIONS

Time domain characteristics of the FOS with a 2-term denominator polynomial involving a single fractional power is investigated in this presentation. Dependence of important step response characteristics, namely rise time, settling time, delay time, overshoot, and oscillation period on the fractional order α are derived, and the results are presented in graphical forms that can be used as templates for design purposes. The study is conducted comparatively by considering integer order systems of 1st and 2nd order types. It is shown that the same simplicity and explicitness present for second order systems do not exist between the transfer function parameters and the step response characteristics for low order fractional systems. The results bring light for designing simple FOCSs, thus a vacancy has been fulfilled by this work.

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Environmental Turbulence, New Product Development and Innovation

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Abstract— *This study aimed to implement a systematic review of literature, in order to find theoretical support on the relationship between new product development and product innovation, moderated by environmental turbulence in the technological and market dimensions. It was used the qualitative approach, with data and information collected from published articles on the subject. The criteria researched consisted of: temporal cut from 2000 to May 2015, the article must belong to the area of Business Management or Economy, to present relationship with Environmental Turbulence, Development of New Products and product innovation. In the literature used, it was not possible found any article presenting an integrative model using New Product Development or Product Innovation moderated by environmental turbulence in its two dimensions. Based on the review accomplished, it is possible to define more four subjects to be studied in future empirical works approach these elements.*

Keywords— *New Product Development. Product Innovation. Environmental Turbulence.*

I. INTRODUCTION

The relevance of the environment is to verify critical points and favorable points to change. These changes could be different aspects: behavioral, economic, technological, market demographic and social (Gonçalves, 2011).

Historically, the environment was consider a key element in the definition of organizational strategies (Oliveira et al., 2016). In most organizations today, the prevailing perception is that the turbulent environment becomes complex and difficult to perceive and uncertainty is a constancy (Zhao; Zhu; Zuo, 2015).

In the 60's, during the post-war recovery still had observed the growth of the organizations occurred, with a tendency to diversify products. In the 1970s, the period of inflation and stagnation began, with conservative management and creation of strategic business units, while

in the 1980s a series of factors contributed to exaggerated concern about organizational effectiveness, with a Japanese economy. Research at the time focused mainly on restructuring processes. However, in the 1990s, there was rapid economic and political change. The changes that occurred in the environment required a redirection regarding uncertainty, mainly technological changes (Hamel; Prahalad, 1995; Bonjour; Micaelli, 2010).

The 21st century, accelerated changes in the economy, the market and uncertainties, it seems necessary to revise environmental concepts, especially when talking about turbulence and economics. New trends come with new impacts, new needs, arise to intra-organizational networks at various levels. As a result, the process is accelerated in search of new studies, management tools, as well as the constant need to innovate in new products, agility in the processes with the ability to predict the needs of the market and attentive to the needs (Porter, 2004; Prahalad, 1995).

The environment is everything that involves the company, also related beyond the boundaries or limits of the organization. The environment has characteristics by intense competition, economic difficulties, technological changes, uncertainties about government policies, and other factors that threaten the future of companies.

However, there is a need to interact with the economic and political system, where the companies then inserted. So that they act together to become competitive to face the adversities imposed by the system. The name of this set of adversities economic turbulence or even Environmental Turbulence (Thompson, 1967; Millillen, 1987). Zhao, Zuo, and Zillante (2015) argue that economic turbulence is a precursor to innovation and therefore to New Product Development.

The present study aimed to carry out a systematic review to find theoretical support on the relationship between New Product Development and Product Innovation, moderated by the technological and market environmental turbulence.

II. THEORETICAL REFERENCE

2.1 ENVIRONMENTAL TURBULENCE

Companies were immersion in the globalized market in order to meet the requirements and their permanence, in this way they need to adhere to the procedures and requirements of the market without frontiers. "Among these is the requirement that companies have the ability to offer quality products and services at ever more affordable prices. One of the ways to obtain competitive advantage"(Vieira, page 13, 2002).

According to Gimenez (2000), Bandeira de Mello e Cunha (2004) and Ramos (2005) there is no consensus on the definition of Environmental Turbulence. Authors like Downey, Hellriegel and Slocum Jr (1975), Miles (1978), Jauch and Kraft (1986) and Milliken (1987) consider it as synonymous with environmental uncertainty. For these authors, Environmental Turbulence refers to the difficulty of anticipating the environmental changes that the organizations are subject to, that is, the relation between them and the environment in which they are inserted (Thompson, 1967; Milliken, 1987).

The environment was recognize as the internal and external scope of organizations, under the micro and macroeconomic context. Microeconomic factors correspond to physical resources, human resources, infrastructure, scientific knowledge, organizational skills, among others. In turn, the macroeconomic aspects refer to exchange and commercial policy, fiscal and monetary policy, for example (Porter, 1999).

Under another approach, Certo and Peter (1993) establish, in addition to internal and external, the existence of the operating environment. In turn, Daft and Weick (2005) define the relevance of the social-cultural, political-legal, technological and economic environment, whereas Hitt, Ireland and Hoskisson (2005) and Johnson, Scholes and Whittington (2005) determinant of the demographic aspect.

A set of all phenomena external to the organization that have some kind of direct or potential influence on their operations. In this sense, Certo and Peter (1993) point out that through the analysis of the environment it is possible to verify the critical points of environmental pressure and identify the change bias, besides maximizing the organization's predictability and control power over external elements and development environmental impact management mechanisms.

For Rossetto and Rossetto (2005), the environment was consider as endowed with fundamental relevance for the determination of organizations' actions.

Concurrently, Jansen and Van Den Bosch and Volberda (2005) point out those turbulent environments are identify by technological changes, as well that changes in customer preferences and demand fluctuations. Thus,

these dynamic environmental conditions affect the obsolescence of current products and / or services, driving the development of new products.

It should be most impactful, that technological and marketing aspects are complementary, so that their integration based on organizational learning maximizes innovation and consequently performance (Song et al., 2005; Lane; Koka; Pathak, 2006). However, environmental turbulence is fraught with divergence, volatility, quantity of changes, and was impact by the speed with which they happen (Jauch; Kraft, 1986).

From another perspective, Gimenez (1993) elucidates that the changes are linked to the way the threats occur, with globalization being the phenomenon that causes Environmental Turbulence (Ramos; Gimenez; Ramos; Ferreira, 2005) since the environment is understood as a set (Mintzberg and Lampel, 2000). In this sense, Cochia and Machado-da-Silva (2004) emphasize the relevance of dominating and identifying the spheres of the organization in their environment.

However, Wischnevsky, Damanpour and Méndez (2011), in a study carried out in the United States during the 1970s and 1990s, found that environmental changes interfere in rates of exchange variation, as well as in products, technological and administrative processes, and consequently in the Product Gross Domestic Product (GDP). Thus, according to the authors, unpredictability is define as influencing the development of organizations and nations.

According to Zhao, Zuo and Zillante (1985) "Environmental turbulence is used to describe temporary disruptions in the organization caused by environmental factors, such disruptions often have devastating and harmful effects on organizations." It wassuppose the environment as a dynamic element of all organizational phenomena undergoes constant changes as a form of competitive survival (Zhao; Zuo; Zillante, 2015).

While the multidimensional model has been adopted to classify Environmental Turbulence, Duncan (1972) argues that this is endowed with complexity, which is complemented by Child (1972) by assigning him aspects related to diversity and by Sharfman and Dean (1991) and Rosenbush, Hong and Eastman (2007) characterizing it as unstable. However, there is no lack of standard for Environmental Turbulence dimensions. What exists are different ways of perceiving it. Under this context, in turbulent environments with uncertainty and complexity, market and technological aspects are challenging, where innovation is the highlight (Buganza, 2010).

2.2 DEVELOPMENT OF NEW PRODUCTS

It is recognize as Development of New Products, all strategy and strategic concepts of implementation of a new

process, destined to place it in the market, in order to market it (Sang; Crawford; Stuessy, 1997). The development of new products becomes an alternative to new strategies and necessary to continue in the market, with which it is possible to increase their competitiveness (Kotler, 2000; Parasuraman; Colby, 2002).

It could be accepted that Development of New Products is a process where changes happen to the characteristics of the products in order to meet the needs of the customers. New Product Development is composed of several stages, where it generates continuous knowledge (Trott, 2012).

Development of New Products can be considered as the whole process or as a total process of strategy, concept generation, product planning and marketing, as well as marketing aimed at the implementation of a new supply (Crawford, 1997). However, "experiences show that no other activity seems to take more time, more money, involves more pitfalls or more anguish than a New Products program" (Dhalla; Yuspeh, 1976, p.108)

In this sense, Clift and Vandebosh (1999) point out that the main objective of new product development is to minimize the time of the manufacturing cycle (Cooper; Kleinschmidt, 1994), as well as to maximize consumer involvement (Gruner; HOMBURG, 2000). Thus, "the key to its survival and growth lies in the continued development of new and improved products" (Kotler, 1980, p.240).

According to Cooper (1996), the Development of New Products is related to three main factors, namely: process, resources and strategies. On the other hand, Calantone, Di Benedetto and Bhoovaraghavan (1994) emphasize that most organizations generally carry out the complete cycle of technological innovation, so that it adopts a reference model for the systematic and integrated management of such process.

The New Product Development process is composed of three stages, namely: pre-development, development and post-development. The first objective is to define the relationship between the organizational objectives and the projects to be developed, as well as the individual development planning of each of these. The second, in turn, corresponds to the definition of the functional structures of the product and its technical and technological information, covering the activities of designing, constructing, testing and optimizing the product until its approval. Finally, the third step includes the systematic monitoring of information about the results of the product in the market, including its distribution and life cycle assessment (Clark; Wheelwright, 1993; Rozenfeld; Forcellini; Amaral, 2000).

However, empirical research by Rocha, Borini and Spers (2010) found that there is a negative correlation between the degree of global integration of companies and

strategic alignment with marketing autonomy in new products, which justifies the fact that certain subsidiaries have a superior advantage in relation to other corporate units. From this perspective, Sbragia and Lima (2013) elucidate that companies that have market orientation have greater integration between the functional areas related to the Development of New Products and consequently acquire high results. It is also worth noting that New Product Development indirectly affects profitability, whose relationship is intermediate by market share (Sampaio; Perin; Ferreira, 2008).

2.3 INNOVATION

The concept of innovation was born in 1911 after the publication of Economic Development Theory elaborated by Joseph Schumpeter, where under a capitalist approach; this is defined as the process of "creative destruction" that promotes the rupture with the current economic system. For this, the author bases the innovation in five assumptions (Avila Neto et al. 2016; 2017).

Namely the introduction to the market of a new good or service; introduction of a new production method; The creation of a new market in a given country; the acquisition of a new source of supply of raw materials or semi-manufactured products; the implementation of a new structure in a market (Schumpeter, 1982).

Then, innovation is endowed with economic rationality through financial returns from new products, processes and / or procedures (Freeman, 1982). Innovation can still be recognized as "the specific tool of entrepreneurs, the means by which they exploit change as an opportunity for a different business or a different service" (Drucker, 1986, p.25). Thus, while invention and creativity are associated with the individual and personal aspect of generating a new idea, innovation corresponds to an organizational process of implementing this idea (Van de Ven, 1986).

Based on the Schumpeterian assumptions, the Oslo Manual (2005, p.55) defines innovation as the "implementation of a new or significantly improved product (good or service), or a process, or a new marketing method, or a new organizational method in business practices" and thus establishes the four dimensions of innovation.

With regard to the types of innovation, there is radical and incremental innovation. The first provides a significant impact under a given market (Schumpeter, 1982), promoting its rupture (Christensen; Snyder, 1997). Incremental innovation refers to the one that subsidizes continuous technical improvement (Bessant and Tidd, 2009).

In turn, Bessant and Maher (2009) emphasize that innovation has many different forms, but we can summarize them in different dimensions: product, process,

position and paradigm innovation. For these authors, product innovation consists of the change of the product / service that a company offers, while process innovation corresponds to the transformation in the way in which the things / services are create and offered to the consumer. Consequently, paradigm innovation refers to change in the context in which product / service is introduce and, finally the paradigm of innovation relates to change in the basic mental models that guide what the company performs.

Innovation corresponds to a process whereby organizations must be attentive to market demands (Bessant and Maher, 2009). Therefore, because it is a process and not an isolated event, it is manageable (Tidd; Bessant; Pavit, 2005). Innovation requires implementation of new ways of perceiving it, as well as new markets (Bessant and Maher, 2009), especially in uncertain environments.

In the scope of innovation are the Development of New Products whose contribution refers to the maximization of the market differentiation that occurs as the competitors differentiate each other (Bessant and Maher, 2009). Therefore, it is imperative to analyze the set of elements related to the marketing, financial and technological dimension, as well as internal organizational resources (Ladders, Takekeuch, Takekeuch, 2007).

III. METHOD

For the selection of articles, which were studies, initially bibliometric search used in the Scopus, Science Direct, Emerald and Ebsco databases. As a search guideline we used the 1st Law of Bibliometrics (Law of Zipf), which consists of the occurrence of words (Bufrem; Prates, 2005), limited to the descriptors (keywords), since they strictly cover the subject treated in empirical investigations (Brandau; Monteiro; Braile, 2005). Thus, the definition and descriptions of these following terms and Booleans are "*environmental turbulence*" and "*development of new products*" and "*innovation*".

It was determined as a search filter in relation to the type of document "article", whose time cut corresponded from the year 2000 to the date of May 30, 2015. No exclusions were established regarding the language of the publications. In this way, 92 (ninety-two) articles were preliminarily obtained, of which 62 (sixty-two) were excluded after careful reading because they did not present research objectives related to the three proposed constructs (innovation, environmental turbulence and new product development).

Two papers were also exclude because they are published twice only by reversing the author's order of importance. Thus, the portfolio of articles to be analyzes was composed of twenty-eight publications that used

different types of empirical investigations. However, it was found that of these, twenty-two did not deal with the relationship between the proposed constructs, so that the final analysis was composed of six publications.

Then, the qualitative analysis of the selected articles was carried out, whose guiding question consisted of the following question: what is the relationship between Environmental Turbulence, New Product Development and Product Innovation? From this, a systematic review of the literature was carried out, which consists in the identification, selection and critical evaluation of relevant research (Clark, 2001), which provided subsidies for the preparation of prepositions and consequent of the theoretical model.

IV. ANALYSIS AND RESULTS

The convergences found that, environmental turbulence has a direct effect on the organizations, also how it operate. On the other hand, in the uncertainty aspect, organizations must be alert to new requirements, to act quickly in uncertain environments and that innovation is a success factor (Stefenon et al., 2017). However, there are also studies where organizations act on process and not product innovation, because of this process innovation has a rapid financial return, while product returns may be uncertain. They are complex questions and sometimes there is a divergence between authors, it is perceive that they deal with the same subject, but with economic bias and geographic issues. That could be one of the factors. Like the case study below.

Kam-Sing Wong (2014), reports that the success of a new product is a complex issue, Buganza (2010) also stresses that requirements and complexities are relevant factors when designing a new project. Thus, Bessant and Maher (2009, p.387) also found that "innovation does not happen simply, because we desire it, is a complex result that involves risks and needs careful and systematic management."

Pratono and Mahmood (2014) in their studies found that Environmental Turbulence has moderate and direct effects on New Product Development and business performance. Already for Zhao, Zuo and Zillante (2015), Environmental Turbulence is manage by flexibility within the context where it is insert. While for Ambridi, Li and Ren (2015), Environmental Turbulence has the moderating role between project teams and project performance. Droge, Calantone, and Harmancioglu (2008) emphasize that the Environmental Turbulence relationship has a moderating effect on intra-organizational relationships. That said the reflexes could affect organizations regardless of where they may be install. For Kam-Sing Wong (2014), Environmental Turbulence is a form of unpredictability with this having direct impact on the product. Wang et al.

(2013) reports that Environmental Turbulence has a moderating affect managerial relations, on the acquisition of resources.

Based on the premise prospects of adding a logical character of relationships between Environmental Turbulence, New Product Development and Innovation, identified in the study. It can be seen that it was not possible to verify if the Development of New Products is directly related to Environmental Turbulence and if Innovation is directly related to Environmental Turbulence. Only the study by Zhao, Zuo and Zillante (2015), emphasized that environmental turbulence has a positive effect on New Product Development.

Droge, Calantone and Harmancioglu (2008) have tested the direct and indirect effects that link the antecedents to the success of a new product. These are: (i) proactive strategic guidance along with skills; (ii) organizational structures (iii) innovation (iv) market intelligence. Emphasizes that innovation is link to intelligence and market, in turn is the success of a new product and that the background may be of intra-organizational domain. However, the relationships of intra-organizational constructs for product success are hypotheses whose moderator is environmental turbulence. While Kam-Sing Wong (2014) emphasizes that Environmental Turbulence was strategically leverage, it can play a positive role in New Product Development.

However, Buganza (2010) investigates the management of innovation in high turbulence environments, with uncertainty and complexity, market demands accompanied by technology are challenges. Recent studies in the management academy have suggested that when facing turbulent environments, companies, organizations or even nations must implement more flexible development processes (Eissmann et al., 2017; Arruda et al. 2017). The same authors carried out a case study with nine constructs in five Italian companies, the results found were that the companies studied should analyze TA as an uncertainty factor and in a specific way for each project. In addition, they may come from both changes in the market and technology.

However, having quick changes is not enough. In the case of turbulence, both market and technological, the companies studied need to wait to do the implementation of their projects. If the turbulence is only of the market, one should streamline the experiments involving clients.

In the study of Piening and Salge (2015) it was identified that Environmental Turbulence is expected positively to moderate the relationship with innovation and performance of the company. The main idea of the study was to analyze the antecedents, contingencies, and consequences of the differences between successful companies and innovation. Despite widely recognized

economic value, however, process innovation has received less conceptual and empirical attention than products. The main antecedent for innovation is focused on financial resourcefulness.

Pratono and Mahmood (2014) developed a study that aimed to determine the moderating effect of Environmental Turbulence between business performance, business orientation and business management. The study also found evidence that Environmental Turbulence is significant in relation to the performance of corporate social capital.

Yang and Huang (2016) conducted a study where the purpose was to empirically investigate a sample of projects in the construction industry of Taiwan. The results pointed out that Information Technology can improve the involvement with the owner, and later, improve the performance of the project. The results indicate a positive relationship with the team that owns the project, and organizational capacity depends on Environmental Turbulence.

Su et al. (2013) have developed a study to verify whether technological capacity and marketing capacity are complementary or supplementary capacities, and how technological and marketing capacity could be appropriately used to respond to Environmental Turbulence. Based on research in 212 Chinese companies, these authors found that technological capability and marketing ability have synergistic effects, but that technological turbulence increases the effect of performance capacity, but impedes marketing ability. Considering also that, the market turbulence advances on the effect of the marketing capacity and performance, but it impedes the technological capacity.

The study developed by Wang, Lo and Yang (2004), unlike previous studies, focuses on the decomposition of the impacts of the essential competences on the performance of the company and its moderating effects of Environmental Turbulence. With this, the studies verified that the competences influence the performance of the company and that they are moderate by Environmental Turbulence, as well as by the turbulence of market and technology.

While, Wang et al. (2013) presented a study that developed and tested a model that establishes the role of external resources as a mediation mechanism and examines the moderating role of Environmental Turbulence and also explains the impact of managerial relationships on resource acquisition. In China, this survey was conduct in 253 companies, indicating the acquisition of resources plays a partial mediating role in the relations between management and organizational performance.

Tsai and Yang (2014) studied resource-based theory, and investigated how technology turbulence and market

turmoil influence the effect of innovation on business performance. In Taiwan 452 manufacturing companies are controlled by this survey. They used moderate hierarchical regression analysis to test the hypotheses of two interaction pathways.

The results indicate that Technological Turbulence has a positive effect on innovation and New Business Development, but that Technological Turbulence, and Market Turbulence does not. They also found that when Technology Turbulence increases, Innovation has a positive effect on the success of the new business. The results suggest that managers and manufacturing companies must adopt innovation to ensure that their companies can thrive under the effect of Technology Turbulence.

Auh and Menguc (2005) report that a strategic orientation is needed that is initiated in the top management team, but very little is known about the composition of the functional diversity of the components and the effectiveness of the strategic orientations. Thus, they developed a contingency model that examines this relationship under different levels of Environmental Turbulence and cross-functional coordination. The results show that, under strong Environmental Turbulence, companies will have more difficulties to achieve greater strategic orientation due to their functional differences.

Dayan and Di Benedetto (2010) examined the mediating effects of team commitment between longevity, confidence and managerial performance, team learning and product success, under the moderating effect of Environmental Turbulence. The results show that the impact of managerial confidence is associated to the success of the product. In addition, the results show that business confidence influences team commitment.

After analysis and importance of the study in relation to Environmental Turbulence, New Product Development and innovation. It was verified that there is a need to verify critical points regarding the issue of Environmental Turbulence that organizations and managers face. With the need to identify possible changes, besides increasing proactivity of the organizations on external elements, management mechanisms to guard against the uncertainties imposed. In all these articles, it was verified absence of studies where it involved Environmental Turbulence as antecedent of the Development of New products and the innovation. Environmental Turbulence had a moderating effect on the Development of New Products, and in others, the effect was as an antecedent, only for innovation and still separately for the Development of New Products.

One factor that could be asked is when the strategies that can be adopted, as well as the defensive strategies, prospective strategies, strategies, analytics and reactive

strategies. In the case of defensive strategies, it is a process, by which the individual perceives the reality that is around them, both can be individually and collectively used (Martins, Robbini, 2012).

An analysis of mobilization by all prospective intelligence, as well as all classical analysis, and in terms of where threats and opportunities may occur, should still be considered. Looking at all the diffusion of ideas of the strategic expression prospective and verify if it is no longer applied. Companies need to be aware of any changes that occur, be they product, processes or services. The changes that the market is imposing in front of the new demands of the markets, both nationally and internationally. Mainly in exchange, political and social changes. Companies must always observe the geopolitical factor in order to face environmental turbulence.

Thus, Table 1 demonstrates how the studies define the role of Environmental Turbulence and its dimensions in the relationship between Product Innovation and New Product Development.

Table.1: Environmental Turbulence Relationships Based on Literature

Dimension of Turbulence	Relationships	Authors
Market Turbulence	Market turbulence is a precursor to innovation and therefore to New Product Development (DNP).	Zhao, Zuo e Zillante (2015)
Environmental Turbulence	It found that Environmental Turbulence has moderate effects with direct relation on New Product Development and company performance.	Pratono e Mahmood (2014)
Environmental Turbulence	Environmental Turbulence has the moderating role between project teams and project performance. That said the reflexes could affect	Afridi, Li e Ren (2015)

	organizations regardless of where they may be install.	
Environmental Turbulence	Emphasizes that the Environmental Turbulence relationship has a moderating effect on intra-organizational relationships.	Droge, Calantone e Harmancioglu (2008)
Environmental Turbulence	It is a form of unpredictability with this has direct impact on the product.	Kam-Sing Wong (2014)
Environmental Turbulence	It reports that Environmental Turbulence has a moderating impact on management relations, the acquisition of resources	Wang et al. (2013)

Source: Prepared by the authors.

Given the above, Figure 1 presents the propositions, considering the relationships between the constructs found in the literature. Such findings may serve as a basis for future research.

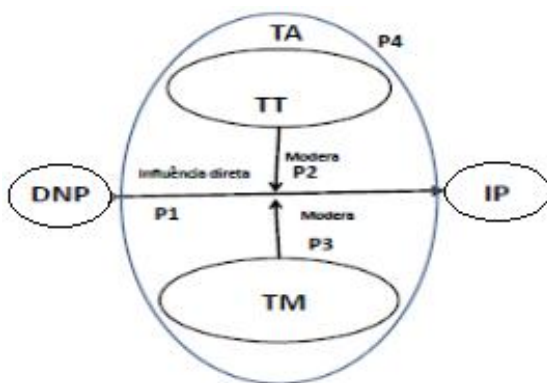


Fig.1: Research Proposals

Source: Prepared by the authors.

- P1 - Direct Influence
- P2, P3 - Moderate

The first proposition refers to the direct relationship between New Product Development and Product Innovation, where P1: New Product Development positively influences Product Innovation. In turn, the

second proposition corresponds to the relationship between New Product Development and product innovation being moderate by the Technological Turbulence variable, that is, P2: Technological Turbulence moderates the relationship between New Product Development and product innovation. In the same sense, we have the third proposition that highlights the relationship between New Product Development and product innovation being moderate by the other dimension of Environmental Turbulence, Market Turbulence, thus, P3: Market Turbulence moderates the relationship between Development of New Products and Product Innovation. Finally, the fourth proposition corresponds to Environmental Turbulence as moderator of the relationship between New Product Development and Product Innovation, equivalent to P4: Environmental Turbulence moderates the relationship between New Product Development and product innovation.

V. FINAL CONSIDERATIONS

This study aimed to carry out a systematic review to find theoretical support on the relationship between new product development and product innovation, moderated by the technological and market environmental turbulence.

These twenty-eight articles selected, only six articles reported that Environmental Turbulence has a moderating effect on Innovation and New Product Development. Pienig (2015) corroborates the proposition that Environmental Turbulence has a moderating effect on the Development of New Products and predicts the needs of consumers. It was found that most of the studies were conducted in China and recent periods. It may be due to the transition China has been going through in recent years.

In an insignificant percentage, Environmental Turbulence had a moderating effect on the Development of New Products, other the effect was as an antecedent for Innovation, and still separately with the development of new products. In that notice there is a lack of studies that prove the influence of Environmental Turbulence on New Product Development. There is no supporting data, only assumptions. This opens up a range of opportunities to develop new research with clear objectives. To meet this demand there is a need to research the three items at the same time, that is, the effects of Environmental Turbulence directly influence the Development of New Products and Innovation? But in a longitudinal period, because it is known that the effects of economic plans political crises are factors that directly affect and in this way Environmental Turbulence is present, but it is not possible to say if it can occur in a short period of time.

If there is not data, it is practically impossible to conjecture whether Environmental Turbulence has moderating or mediating influence on Development and

Innovation. This reinforces the idea that the triple alliance must act together. Each link does its part; the Government should support the academy, which is the owner of the knowledge and means of acquiring them and the government financially supporting the surveys, and organizations open to new opportunities.

A reflection in the light of the debate, there are not enough studies that prove the unanimity between the factors that affect New Product Development and Innovation (Oliveira et al., 2017a; 2017b; 2017c). We could make several conclusions, but to stick to only the reflection is already enough, because if it did so we would be concluded in a subjective way, and yet it is not object of the study. Thus, from the analysis of bibliometric research, the present study sought to understand how organizations are acting in the face of Environmental Turbulence in relation to the Development of New Products and Innovation. It would be interesting that future works would bring together studies in Eastern countries and compare them with South America.

In technical terms of these studies, it is also verified that there is a gap that needs to be studied longitudinally, which is to verify if the Environmental Turbulence affects the profitability of the organizations. Having said this, we also verify that Environmental Turbulence is a determining factor for innovation or for the Development of New Products.

In a turbulent environment where competitiveness takes on the role of globalization, the company to be competitive must assume asymmetries in the form of competitive advantage and take an innovative position in product, process, and new sources of supply and market opportunities in an organized way and without loss in quality and price. However, the competitive advantage will be maintain with continuous improvements.

We recognize the limitations of the research regarding the scarcity of empirical investigations that address the relationship between the constructs presented, together. It is a highlight, because the limitation the number of databases consulted, as the time cut used.

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Risk Assessment to the Health of Amazonian Indigenous For the Consumption of Fish, Meat of Hunts and Vegetables Containing Metylmercury

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Abstract— This study was to evaluate the exposure to methylmercury (HgMe) and the potential health risk of Tupari Indians through the consumption of their main foods. Were collection of samples of plant foods and muscle tissue from different species of fish and wild animals consumed in three villages of the Rio Branco Indigenous Land in Rondônia, in the Brazilian Amazon. The HgMe was measured in an atomic fluorescence spectrophotometer with gas chromatography. The statistical treatment of the data was performed by software R. Of the six different plant species, only sweet potato (*Ipomoea batatas*) had mean concentrations of HgMe above the limit of detection of the analytical technique for the three villages. There was a significant difference in the levels of HgMe between the species of wild animals and fish belonging to the same alimentary habit. Carnivores presented higher levels of HgMe than those obtained for non-predators, both for fish and for wild animals. The results of the assessment of the potential risk to indigenous health indicated a total HgMe of the weekly ingestion rate (WIR) of between 8.4 and 15.0 µg / kg of body weight for the villages evaluated, extrapolating all reference doses (RfD) regarding for the

Provisional Tolerable Weekly Intake (PTWI). The risk quotients (RQ) varied from 5.3 to 21.4, considerably exceeding the limit ($RQ \leq 1$), which allows to consider the impossibility of toxic effects of HgMe. The fishes accounted for the highest percentage of WIR of HgMe for all villages, with an emphasis on predatory species. Considering the nutritional value of fish meat, it is suggested the continuity of the consumption of this meat in the villages with preference for non-carnivores.

Keywords— *Indigenous Amazonian; HgMe intake rate; Risk quotient; Fish meat; wild animal meat.*

I. INTRODUCTION

The damages to human health due to the consumption of food and water contaminated by mercury, mainly methylmercury, is the most toxic form of this element are widely reported in the literature, being able to affect the central nervous system and to cause serious health problems to the population exposed to this organometal (AHMED et al., 2018; MILHOMEM FILHO et al., 2016; MOZAFFARIAN; 2009; MARQUES et al., 2007; CHEN et al., 2006; FILLION et al., 2006).

The exposure of traditional populations of the Brazilian Amazon to methylmercury has been reported as a result of the use of mercury in the gold mining (BASTOS et al., 2007), of the soybean advance in this region of Brazil (TUZEN et al., 2009; MALEKI; ZARASVAND, 2008), as well as due to the impoundments of the Amazonian rivers for the construction of hydroelectric power plants (PESTANA et al., 2016; FEARNESIDE, 2014).

According to Dórea et al. (2006) in the Amazonian lifestyle, traditional fish consumption is high, characterizing the largest route of exposure to methylmercury, and may in the Mean and long term pose a risk to the health of these people depending on the concentrations of mercury present in these fish and the amount consumed. In this sense, the health problems caused by contact or ingestion of high concentrations of mercury are potentiated when it comes to the indigenous population of the Amazon that lives in villages around the rivers and therefore has greater exposure to methylmercury, the main source of protein (BASTOS et al., 2007). In addition to fish, Amazonian indigenous peoples still have the habit of feeding meat of hunts, which can also be an important route of exposure to mercury depending on the amount consumed in the villages, as well as how polluted the environment.

Some studies have demonstrated high levels of mercury in fish (BASTOS et al., 2016; LIMA et al., 2015; BASTOS et al., 2008) in the Madeira River region of Rondonia state in the Brazilian Amazon, researchers responsible for the exposure to mercury in the Amazon. When dosing Hg in muscle tissue of different fish species from the Cassipore River basin (state of Amapá), Lima et al. (2015) observed concentrations (0.570 to 0.670 $\mu\text{g}\cdot\text{g}^{-1}$) that exceeded the limits set by the World Health Organization (WHO, 1988).

A study conducted by Santos et al. (2003) in the state of Rondonia with Wari Indians pointed out the risk of exposure to Hg contamination, since high levels of this element were identified in hair samples from this population. Barbosa et al. (1998) found average levels of Hg-T in the order of 8.30 $\mu\text{g}/\text{g}$ in the hair of 251 women and indigenous children selected along the Madeira River and Kayapo Reserve, and for 25 of them the concentration exceeded 10.0 mg/g, whereas the legislation regulates a maximum of 5.0 $\mu\text{g}/\text{g}$ (BRASIL, 1998). Santos et al. (2003) verified a high mercury exposure after analyzing mercury in the hair of 910 indigenous people (men, women and children) of TI Pacaas Novos, from different villages, including the Soterio village, with very high values of this heavy metal in children 2 to 5 years old.

Other scientific investigations carried out in the Brazilian Amazon also raised concern after observing weekly intake rates of total mercury and HgMe that

extrapolated the reference doses (RfD) established by the PTWI suggested by different international bodies related to health and human food. For example, Castilhos et al. (2001) found a weekly intake rate (WIR) of 1.33 $\mu\text{g}/\text{kg}$ body weight from the consumption of fish from the Tapajos river in Pará, as well as Mourão (2016) found a mean weekly dose of HgMe intake fish in the Madeira River region in the order of 3.4 and 3.5 $\mu\text{g}/\text{kg}$ bw for infants and juvenile riparian groups and adults in Porto Velho, Rondonia, respectively.

In view of the above, it is relevant to analyze the level of exposure to methylmercury of indigenous Tupari Amazonians living in the Rio Branco Indigenous Land, in the state of Rondonia, in the Brazilian Amazon. This is because, although there are no gold mines in that region, the area is located near a region with soybean expansion and also under the influence of seven hydroelectric plants, which may be contributing to the increase of HgMe concentrations in the soils and vegetables produced and consumed in the villages, as well as the fish and wild animals routinely present in the diet of these peoples.

II. METHODOLOGY

Sample collection

The collections were carried out in the villages of Serrinha, Trindade and Nazare, with a total of 116 indigenous, located in the Rio Branco Indigenous Land, in the state of Rondonia, Brazilian Amazon, after authorization of the Chico Mendes Institute for Biodiversity Conservation (47500-1, 47500-2, 47500-3 and 47500-4), indigenous representatives (indian chief) from the villages where the study was to be conducted by means of a signature in a letter of authorization from the National Indian Foundation (Nº 58/AAEP/PRES/2016), as well as from the Committee (approximately 150 g of the muscle tissue of 86 fish from 19 different species with carnivorous, detritivorous and preferably herbivorous dietary habits and approximately 300 g of tissue muscular of 57 wild animals from 16 different species belonging to the carnivorous, omnivorous and exclusively herbivorous trophic levels. Were collected 150 g of bark-free mass of 6 units of 6 different species of vegetal foods produced and consumed in the three villages studied, thus adding 108 vegetables samples.

Preparation and chemical digestion of samples

For the extraction of HgMe we weighed 0.05 g for fish samples, 0.5 g for meat of hunts and 1.0 g for vegetables. For the samples of fish and of the hunts was considered the wet weight whereas for the vegetables the dry weight. Samples were digested with 3.0 mL of 25 % potassium hydroxide in methanol Mean and taken to the oven at 68 °C for 6 hours for fish, hunts and vegetables with shaking every hour. At the end of the chemical

extraction, the samples were stored sheltered from light to avoid any degradation of HgMe and analyzed two days later, sufficient time for the chemical stabilization of the samples (PICHET et al., 1999).

Quantification of HgMe

The quantification of HgMe was carried out with the addition of buffer solution with 4.5 hydrogen ionic potential consisting of 300 µL of acetic acid and sodium acetate followed by the addition of 30 µL of the extract from each sample and 50 µL of sodium tetraborate 1 %. The samples were measured with Milli-Q water in inverted meniscus in the 40 mL vials. The HgMe determination was performed on the gas chromatograph coupled to the atomic fluorescence spectrophotometer (CG-AFS, Brooks Rand). The operating conditions of the equipment were: gas flow in the MERX purge trap (Ar) of

45 mL.min⁻¹, flow of the Traps (Ar) drying gas of 30 mL.min⁻¹ and flow of the GC (Ar) of 32 mL.min⁻¹ (TAYLOR et al., 2011; ALMEIDA, 2012).

Quality control of the analytical technique

The Analytical Technique Detection Limit (TDL) was calculated by averaging the standard deviation of control whites, multiplied by three, with values of 0.00000005 mg.kg⁻¹ for vegetables, 0.000001 mg.kg⁻¹ for the fish and 0.00000013 mg.kg⁻¹ for the hunts. The experimental results for the certified reference samples showed good agreement with the certified values, as well as satisfactory recovery percentages, indicating the high reproducibility of the analytical method. The experimental results for the certified reference samples are show in Frame 1.

Frame 1 - Reference values and values found for certified reference material, and percentages of recovery of HgMe for the different matrix.

Matrix	Certified sample	Reference value (mg.kg ⁻¹)	Value found (mg.kg ⁻¹)	Recovery (%)
Vegetables	IAEA 356	0.0055	0.0050	106
Fish	Tuna fish	2.85	2.58	90
Hunts				

Characterization of the health risk due to the ingestion of HgMe

The potential health risk of the populations of the three villages was estimated from the values calculated for the HgMe Weekly Intake Rate (WIR) consumption of fish, game and sweet potatoes (*Ipomoea batatas*) collected and analyze, and their comparisons with reference values (RfD) established by the Provisional Tolerable Weekly Intake (PTWI) Rate suggested by three international regulatory institutions - 1.6 µg. HgMe/kg bw/week (JECFA, 2014), 1.3 µg. HgMe/kg (EFSA, 2014) and 0.7 µg. HgMe/kg bw/week (US EPA, 2001), as well as by the calculation of the Risk Quotient (RQ). For the WIR calculation it was necessary to know the average consumption in the villages for each food analyzed, as well as the average body weight of the population of each village.

Weekly average food consumption analyzed

The estimate of the average weekly consumption of the different species of fish and wild animals analyzed, as well as for the vegetables was obtained through a questionnaire answered by a representative from each family and from each of the three villages.

Weekly Intake Rate (WIR) of HgMe

The HgMe WIR for each of the villages was calculated through Equation 1, fish and hunts, and also

for sweet potatoes (*I. batatas*), since this was the only plant that presented HgMe>TDL concentration for the three villages.

$$WIR = \text{HgMe } (\mu\text{g.kg}^{-1}) \times QW \text{ (kg) / bw} \text{ Eq.1[1]}$$

Where:

WIR = Weekly Intake Rate of HgMe in µg.kg⁻¹

HgMe = Concentration of HgMe in food in µg.kg⁻¹

QS = quantity of food consumed per week in kg

bw = Average body weight of the population in kg

The mean body weight of the populations was calculated based on data (weight in kilograms) recently collected (March 2018) and provided by the Special Secretariat of Indigenous Health, Base Base of the High Forest of the West and was therefore considered a body weight average of 66.4 kg for the Serrinha Indians, 68.3 kg for the Trindade population and 69.7 kg for the residents of the village of Nazaré. The WIR results are expressed in microgram of HgMe ingested per kilogram of body weight per week (µg. HgMe/kg bw/week) and per person in each of the villages.

Risk Quotient (RQ)

The RQ is the ratio between the weekly exposure to HgMe (WIR) and the reference dose (PTWI) for weekly intake of HgMe per kilogram of body weight.

Therefore, Equation 2 (US EPA, 2004) was used to calculate it.

$$RQ = WIR / PTWI \text{ Eq. [2]}$$

Where:

RQ = Health risk quotient by HgMe intake

WIR = HgMe weekly intake rate per kilogram of body weight

PTWI = Reference dose for tolerable weekly intake of Hg Meper kilogram of body weight

Statistical analysis

The statistical tests were performed by software R (R CORE TEAM, 2013), considering 5 % of

significance. Statistical analyzes were performed using the non-parametric Bootstrap method, with simulation of 100,000 resamples from the master sample, using the Accelerated Addition Correction (CBa) method. These methods are indicated in the case of reduced sample numbers and guarantee reliable results, mainly because they do not require any probabilistic assumptions.

III. RESULTS AND DISCUSSION

Figure 1 shows the mean concentrations of HgMe in sweet potatoes (*Ipomoea potatas*), per village studied.

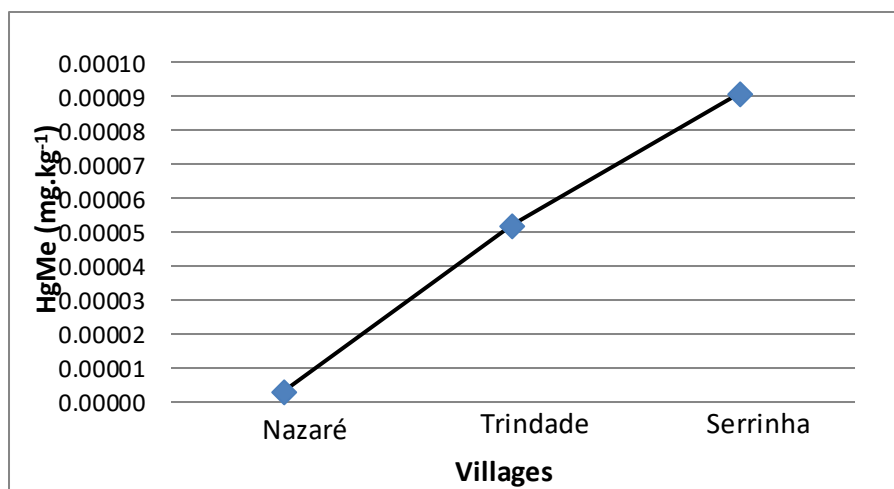


Fig. 1 - Mean concentrations of HgMe in *Ipomoea batatas* produced and consumed in the villages.

Table 1 shows the differences between the HgMe averages obtained for each species of fish per feeding habit, as well as the minimum and maximum values for each species analyzed.

Table.1 - Descriptive and discriminative statistics for HgMe concentrations in fish of different species belonging to the same food habit

CARNIVOROUS ESPECIES						
Scientific name	Popular name	N	Min.	Max.	*Mean±SD	Mean Test
<i>P. nattereri</i>	Red piranha	6	0.557	1.725	1.150±0.002	A
<i>P. corruscans</i>	Pintado	6	0.562	1.116	0.921±0.004	B
<i>P. hemioliopterus</i>	Pirarara	3	0.685	0.976	0.815±0.002	B
<i>S. marginatus</i>	White piranha	6	0.416	0.711	0.577±0.004	B
<i>P. pirinampu</i>	Barba-Chata	4	0.397	0.979	0.575±0.001	B
<i>A. brevifilis</i>	Mandubé/Palmito	8	0.106	0.620	0.389±0.023	C
<i>P. fasciatum</i>	Surubim/Cachara	4	0.312	0.404	0.364±0.002	C
<i>Z. jahu</i>	Jaú	2	0.320	0.330	0.325±0.003	C
<i>C. kelberi</i>	Tucunaré-Amarelo	4	0.179	0.357	0.265±0.003	C
<i>A. falcistrotris</i>	Dog-fish	1	-	-	0.074	-
DETRITIVOROUS SPECIES						
Scientific name	Popular name	N	Min.	Max.	*Mean±SD	Mean Test
<i>P. altamazonica</i>	Branquinha	6	0.299	1.007	0.577±0.080	A
<i>P. nigricans</i>	Curimatã	9	0.010	0.440	0.185±0.015	B
<i>L. pardalis</i>	Acari-Bodó	6	0.020	0.083	0.063±0.005	C
<i>C. callichthys</i>	Cascudo	2	0.016	0.055	0.035±0.012	C

HERBIVOROUS ESPECIES						
Scientific name	Popular name	N	Min.	Max.	*Mean±SD	Mean Test
<i>M. aureum</i>	Silver pacu	3	0.176	0.311	0.262±0.010	A
<i>P. brachypomus</i>	Pink pirapitinga	4	0.022	0.862	0.245±0.098	A
<i>A. ocellatus</i>	Cará-Açú	4	0.134	0.260	0.214±0.005	A
<i>L. freiderici</i>	Piau	4	0.031	0.058	0.048±0.003	B
<i>C. macropomum</i>	Tambaqui	4	0.025	0.039	0.031±0.002	B

*Mean concentration of HgMe expressed in mg.kg^{-1} . N: Number of samples. SD: Standard deviation of the sample. Min. And Max.: Minimum and maximum values expressed in mg.kg^{-1} . Means followed by equal letters in the same column for species of the same food habit do not differ ($p > 0.05$) from each other.

As shown in Table 1, there was a significant difference between the fish species of the different feeding habits, and no influence of the size of the species on the MeHg levels was verified. These results are not compatible with those found by Ahmad et al. (2015), who observed that total mercury (T-Hg) levels increased significantly ($p < 0.002$) in larger fish (> 20 cm in length). On the other hand, as in this research, Bastos et al. (2016) did not detect an influence of the size of omnivorous fish in their concentrations of Hg-T, when they measured this element in 3182 specimens of different dietary habits collected in the Madeira river basin in Rondônia, in the Brazilian Amazon.

The mean levels of HgMe found in this work for *C. Kelberi* (carnivorous) and *A. ocellatus* (preferably herbivorous) were higher than those found by Kehrig et al. (2008) in samples from the same species (0.245 and 0.062 mg.kg^{-1} , respectively) of the Balbina reservoir, also in the Brazilian Amazon, reinforcing the possibility of influence of the hydroelectric plants installed upstream of the studied villages in the methylation of Hg present in fish of the river Branco, consumed by the Tupari Indians. Some species of fish analyzed in this research presented MeHg levels higher than those found in samples collected in the Tapajos and Madeira river basins (BARBOSA et al., 2003), rivers known for their gold mining history, unlike the River White basin that has no history of mining and where the fish were collected for this study. This fact can be explained by the fact that the mercury associated with the Amazonian soil is released into the atmosphere and/or the river system, often favored by deforestation, or even due to natural processes and / or those from anthropic activities (ROULET et al., 1998).

According to Tuzen et al. (2009) deforestation of forest areas followed by burning is another important factor contributing to the increase of mercury levels in the environment. This is because, the burning of biomass releases the mercury into the atmosphere and facilitates the evaporation of part of the mercury contained in the soil.

Herrmann (2004) corroborated with the aforementioned authors adding that when removing the vegetation the erosion process is increased and, consequently, leaching of the mercury contained in the soil, facilitating the entry of this element in the rivers. In this sense, it is worth compensating to add that the mercurial compounds that may constitute some agricultural pesticides used in large soybean plantations in the area around Rio Branco Indigenous Land that is with a notable agricultural expansion may also have cooperated for the presence of mercury in the Branco river, where it is possible which has come through leaching during heavy rains in the region and therefore contaminated in fish and other aquatic animals such as alligators and some chelonians, such as turtles and tracajás, commonly found in Amazonian rivers.

This hypothesis reinforces the importance and the need for further investigations on the presence of Hg in areas that, without prior extraction of gold, are close to agricultural areas or downstream from hydroelectric plants.

Figure 2 shows a comparison of mean HgMe levels in fish muscle tissues by eating habits, showing a higher mean (0.604 mg.kg^{-1}) for carnivorous fish compared to detritivorous (0.250 mg.kg^{-1}) and herbivorous (0.155 mg.kg^{-1}), which did not differ significantly between them. This result is due to Oliveira et al. (2010) to the process of biomagnification in the organism of predatory fish. According to Poste et al., (2015) this is due to predatory fish feeding on other fish or aquatic animals that were already contaminated with this metal that has a cumulative effect on the organism of all living beings. Due to the high proportion of organic mercury in the total inorganic mercury present in fish meat, Dórea (2003) advised the consumption of non predatory species, since they normally present lower levels of Hg-T and also of HgMe, favoring a reduction in the exposure of the population.

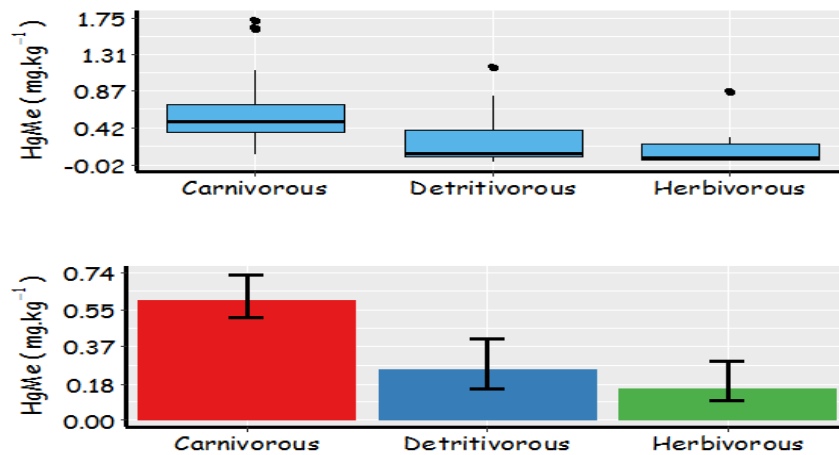


Fig. 2 - Mean concentrations of HgMe in fish muscle tissue, by dietary habit

Table 2 shows the differences between the HgMe averages obtained for each species of hunting by food habit, as well as the minimum and maximum values for each species analyzed.

Table.2 - Descriptive and discriminative statistics for the concentrations of HgMe in the hunts of different species belonging to the same food habit

CARNIVOROUS ESPECIES						
Scientific name	Popular name	N	Min.	Max.	*Mean±SD	Mean Test
<i>M. niger</i>	Alligator-açu	3	0.0009	0.3320	0.156±0.011	A
<i>C. crocodilus</i>	Jacaretinga	2	0.0019	0.1850	0.094±0.006	B
ONIVOROUS ESPECIES						
Scientific name	Popular name	N	Min.	Max.	*Mean±SD	Mean Test
<i>T. pecari</i>	Queixada	7	0.0004	0.0017	0.0008±0.012	A
<i>T. tajacu</i>	Cateto	6	0.0001	0.0016	0.0005±0.014	B
DETRITIVOROUS ESPECIES						
Scientific name	Popular name	N	Min.	Max.	*Mean±SD	Mean Test
<i>C. apela</i>	Nail monkey	2	0.0083	0.0096	0.0089±0.001	A
<i>C. parvirostris</i>	Nambu	1	-	-	0.0064	-
<i>P. unifilis</i>	Tracajá	3	0.0006	0.0085	0.0055±0.012	B
<i>P. expansa</i>	Tartaruga	8	0.0025	0.0113	0.0054±0.024	B
<i>H. hidrochaerus</i>	Capybara	3	0.0033	0.0062	0.0054±0.001	B
<i>A. paca</i>	Paca	7	0.0002	0.0065	0.0018±0.005	C
<i>D. agouti</i>	Cotia	3	0.0008	0.0018	0.0012±0.003	C
<i>A. macao</i>	Macaw	2	0.0001	0.0014	0.0008±0.005	CD
<i>M. americana</i>	Veado mateiro	2	0.0003	0.0005	0.0004±0.016	D
<i>D. novemcinctus</i>	Armadillo	2	0.0002	0.0004	0.0003±0.004	D
<i>T. terrestres</i>	Tapir	5	0.0002	0.0003	0.0002±0.012	D
<i>O. benzoarticus</i>	Pampas deer	1	-	-	0.0002	-

*Average concentration of HgMe expressed in mg.kg⁻¹. N: Number of samples. SD: Standard deviation of the sample. Min. and Max. : Minimum and maximum values expressed in mg.kg⁻¹. Means followed by equal letters in the same column for species of the same food habit do not differ (p > 0.05) from each other.

From the group of carnivorous habitats the highest average concentration of HgMe was for the larger size species (*Melanosuchus niger*) compared to *Caiman crocodilus*. The individuals representative of the species collected for this research measured between 1.84 and

3.41 meters in length and the largest specimen responded by the highest level of HgMe obtained for this species. including above the maximum value (0.5 mg.kg⁻¹) delimited by the WHO (1988) for fish with the same alimentary habit, much, although it is another type of

animal. A similar situation occurred for the species of omnivorous fighters when the average concentration of HgMe for *Tayassu tajacu* was lower than the levels found for *Tayassu pecari*, the latter with individuals around two times larger than *T. tajacu*, therefore, require a higher consumption of both plant and animal (remnants of other animals). which could have contributed to the higher levels of HgMe bioaccumulated over time in the muscle tissue of this larger species.

The results obtained for the herbivorous fighters surprised, therefore, it was expected higher concentrations of HgMe for the species *P. unifilis* and *P. expansa*, because they are chelonians that feed on algae and other vegetal proteins deposited in the sediment of the river, in the same way that a greater concentration of capybara was suspected, since this animal usually lives in regions bordering rivers and uses them as a hiding place and protection against natural predators, as well as for reproduction, thus, it has a greater contact with the sediment of rivers. This result was expected since other

studies (Almeida et al., 2014; Vergotti et al., 2009; Gomes et al. 2006; Lechler et al., 2000) showed that the bottom sediments are the abiotic accumulates mercury in the Amazonian rivers. It is suggested, therefore, the importance of conducting further research aimed at understanding the behavior of mercury in the wild animal organism.

Unlike the predatory and omnivorous species. the species *Tapirus terrestris* that reaches adulthood (as captured) between 0.9 and 1.4 meters in length and weighs up to 250 kilos was significantly different among the species that fed exclusively on plants with the lowest concentrations of HgMe obtained for this huntsing group, assuming that the highest levels found for the herbivorous species may have to do with the age of the animals (bioaccumulation) in a greater proportion than with the size.

Figure 3 shows a comparison of the mean levels of HgMe in the muscle tissues of the hunts, by alimentary habit.

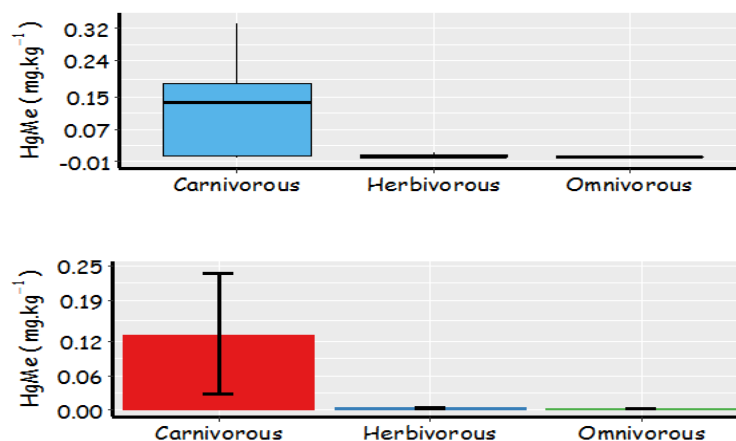


Fig. 3 - Mean concentrations of HgMe in the muscle tissue of the hunts, by food habit.

As for the fish, the carnivorous species had the highest average concentration of HgMe (0.131 mg.kg⁻¹) compared to the means found for the herbivorous and omnivorous species, which did not differ among themselves with mean levels of 0.003 and 0.001 mg.HgMe.kg⁻¹, respectively. This result can also be explained by the processes of biomagnification and/or bioaccumulation over time, as reported by Lavoie et al. (2013).

Wren et al. (1980) found percentages of HgMe in total inorganic mercury between 78.6 and 87.8 % in muscle tissues of wild beavers (herbivorous) collected in a bay in the Muskoka District, in the Canadian province of Ontario. These percentages are therefore higher than those obtained in this study for non-predatory huntsing species, even for carnivorous species.

In general, the fish presented Hg-T and HgMe concentrations more significant than the fowl and vegetal foods, being therefore the main source of food exposure to these heavy metals for the Tupari Indigenous, who have meat of fish as their main source of animal protein, if not the most consumed food in the villages, while game meat can be the second main source of mercury food exposure, followed by vegetables.

However, this hypothesis can only be confirmed by taking the quantity of these different foods consumed for each of the villages, and from there calculate the HgMe intake rate due to consumption of fish, meat of hunts and vegetables and their ratio between the reference doses for weekly ingestion per kilogram of body weight (PTWD), thus obtaining the health risk quotient (RQ) (US EPA. 2004).

Figure 4 shows the estimated average amount for weekly consumption of the analyzed fish and meat of

huntss, as well as sweet potatoes (*I. batatas*), per village.

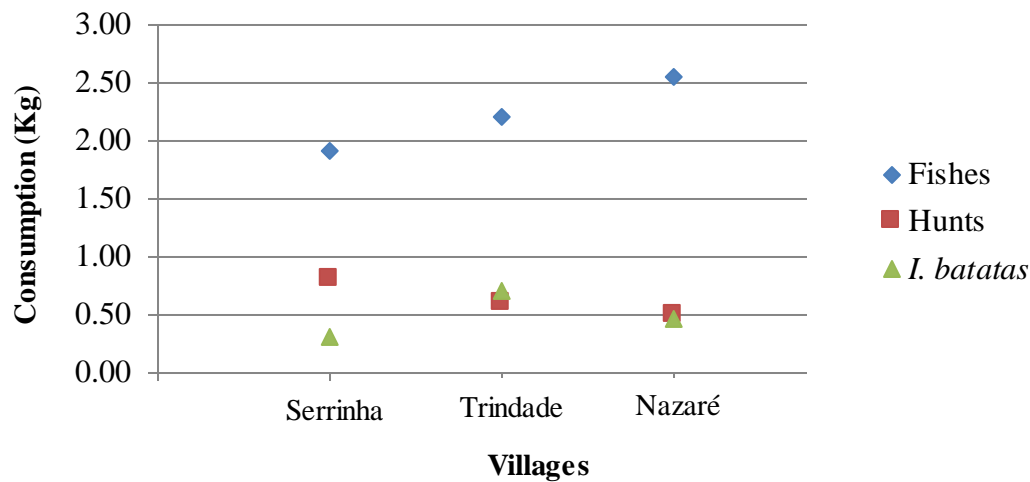


Fig. 4 - Estimated weekly average consumption of fish, game meat and sweet potatoes (*I. batatas*), per village

Several methodologies were used to collect information in studies that evaluated the consumption of fish in communities in the Brazilian Amazon region, including quantification of home consumption (OLIVEIRA et al., 2010), individual measures (PASSOS et al., 2008) and measures of consumption from the concentration of mercury in the hair (DOREA. 2003; DOREA et al., 2005). Among the studies that used the methodology of family consumption of fish with average per capita measures for fish consumption. Cerdeira et al. (1997) verified an average of 369 g/day in Monte Alegre (PA) and Boischio and Henshel (2000) of 243 g/day for the riverine population of the Madeira river (RO), values close to those verified in this research.

The Nazaré village had the highest average daily consumption (364 g/day) of fish, however, it was lower than the per capita consumption of 406 g/day found for an isolated community in Lake Puruzinho, Amazonas state (OLIVEIRA et al. 2010). On the other hand, due to the fact that 50 % of consumption in the Trindade village is of carnivorous species, this population may present a potential risk to high health, since the results showed higher concentrations of HgMe for this group of species compared to the species not predatory. This information corroborates with Ebinghaus et al. (2007), who stated that because of the biomagnification effect the carnivorous fish offer greater exposure to mercury,

The differences observed between the villages for the consumption of fish and meat of huntss can be related to the location of the villages in river Branco. In

the case of fish, for example, the lowest consumption was obtained for the Serrinha village, which has terrestrial access and is considered the point of reference and contact with the other IT villages. This is why there is a daily flow of vehicles from Funai and Sesai in the village. With a constant flow of vehicles, the indigenous residents of this village have greater access to the municipality of Alta Floresta do Oeste, where they usually hitchhike to buy other foods, which may have contributed to the reduction of fish consumption compared to the consumption in Trindade and Nazaré, the latter, is the most distant river along the studied estuaries, and perhaps because of this reason it had the highest average fish consumption.

Also due to land access, some natives of the Serrinha village have a motorcycle, which makes it easier to move to more distant forest areas within the TI where they usually go huntssing. This observation may have influenced the higher huntssing consumption observed for this village compared to Trindade and Nazaré, which were significantly the same as the average weekly meat consumption of the wild animals analyzed in this study. The greater consumption of sweet potatoes (*I. batatas*) for the village Trindade may be due to this vegetable being consumed by some families of this village with sugar after meals, therefore habitually consumed in the village as dessert. Proportional percentages and estimated amounts of fish and game consumption, by food habit and by village, are shown in Table 3.

Table.3 - Quantity (kg) and percentage proportion (%) of estimated consumption by food habit of fish and hunts analyzed, by village.

Food	Food habit	Village		
		Serrinha kg (%)	Trindade kg (%)	Nazaré kg (%)
Fishes	Carnivorous	0.475 (25)	0.660 (30)	1.275 (50)
	Detritivorous	0.475 (25)	0.660 (30)	0.765 (30)
	Herbivorous	0.950 (50)	0.880 (40)	0.510 (20)
Hunts	Carnivorous	0.040 (5)	0.030 (5)	0.025 (5)
	Detritivorous	0.320 (40)	0.210 (35)	0.150 (30)
	Herbivorous	0.440 (55)	0.360 (60)	0.325 (65)

According to the literature, mercury in the muscle of fish and other predatory animals is predominantly in the organometallic form that is the result of the bioaccumulation and biomagnification of HgMe over time and as the trophic level increases (POSTE et al., 2015; LAVOIE et al. al., 2013). Based on this assumption and the toxicity of this chemical, it is inferred that the greater the proportion of meat consumption of carnivorous animals in the diet, the greater the human exposure to HgMe. According to Dórea et al. (2006) in the Amazonian lifestyle, traditional fish consumption is

high. characterizing the greatest route of exposure to HgMe, and in the medium and long term can pose a risk to the health of these people depending on the concentrations of mercury present in these fish and the amount consumed. Table 4 shows the calculated values for the HgMe WIR through the consumption of sweet potatoes (*I. batatas*) and of the fish and wild animal analyzed by food habit, as well as their percentages in relation to the JECFA reference (PTWI) (2014), EFSA (2015) and US EPA (2001), by village.

Table 4 - Comparison between the HgMe WIR by the consumption of sweet potatoes (*I. batatas*), fish and meat of hunts and the different reference doses (PTWI), by village.

Food	Food habit and vegetable specie	WIR ($\mu\text{g}/\text{kg bw}/\text{week}$)		
		Serrinha *(66.4 kg)	Trindade *(68.3 kg)	Nazaré *(69.7 kg)
Fish	Carnivorous	4.32078	5.83660	11.04878
	Detritivorous	1.78840	2.41581	2.74390
	Herbivorous	2.21762	1.99707	1.13415
Hunts	Carnivorous	0.07892	0.05919	0.04699
	Omnivorous	0.01445	0.00949	0.00646
	Herbivorous	0.00663	0.00008	0.00466
Vegetable	<i>I. batatas</i> (Sweet potatoes)	0.00041	0.00003	0.00033
Total WIR ($\mu\text{g}/\text{kg pc}$)		8.4^c	10.3^b	15.0^a
% PTWI JECFA		525	644	937
% PTWI EFSA		646	792	1154
% PTWI US EPA		1200	1471	2143

WIR: HgMe weekly intake rate through the estimated consumption of fish, meat of hunts and sweet potatoes (*Ipomoea batatas*) analyzed. WIR Total: Sum of WIR obtained for different foods. * Average body weight of the population per village. % PTWI JECFA: Percentage of total WIR over reference dose of 1.6 $\mu\text{g}/\text{kg bw}$. % PTWI EFSA: Percentage of total WIR in relation to the reference dose of 1.3 $\mu\text{g}/\text{kg bw}$. % PTWI US EPA: Percentage of WIR over reference dose of 0.7 $\mu\text{g}/\text{kg bw}$. Means followed by equal letters in the same line do not differ from each other ($p > 0.05$) in relation to the total WIR obtained for the populations of the three villages studied.

As can be observed in Table 4, the highest ($p < 0.05$) WIR value of HgMe was obtained for the population of the Nazaré village, which is directly related to the amount of consumption of carnivorous fish species, which 73.3 % of the total WIR (11.04 $\mu\text{g.HgMe}/\text{kg bw}$) for this village. From the analyzed foods, the fish

accounted for the highest percentages of the total WIR calculated for the three villages studied, in the order of 98.8, 99.0 and 99.3 % for Serrinha, Trindade and Nazaré, respectively, followed by the answered for the second place in percentage relative to the total WIR of HgMe, for all the villages.

With a total WIR of 15.0 $\mu\text{g.HgMe/kg bw}$ the population of Nazaré village reached 937, 1154 and 2143 % reference doses (PTWI) of JECFA (2014), US EPA (2001) and EFSA (2014), respectively. After the village of Nazaré, the highest total WIR was obtained for the Trindade population (10.3 $\mu\text{g.HgMe/kg bw}$) with total WIR of 644, 792 and 1471 % in relation to the PTWI established by the different comparative same order as that for Nazaré for the reference doses used for the comparison.

Despite the fact that it presented the lowest total WIR in this study (8.4 $\mu\text{g/kg bw}$), the Serrinha population exceeded 327, 496 and 1713 times the maximum doses (PTWI) suggested by JECFA (2014), EFSA (2015) and US EPA (2001), respectively. At the same time that these results are mainly reflections of the consumption of fish they surprise and concern, therefore, they can directly imply in the increase the risk to the health of these natives due to the possibility of bioaccumulation of HgMe in the organism with the course of the years. However, it is worth adding that the bioaccumulation of mercury in the human organism is dependent on its rates of ingestion and elimination (POSTE et al., 2015).

The WIR results obtained for the fish analyzed in this study are considerably higher than those found by Castilhos et al. (2001), when they obtained a daily intake of Hg-T of 190 ng/kg bw/day. equivalent to 1.33 $\mu\text{g/kg bw/week}$ from the consumption of fish collected in areas contaminated by the gold mining of the Tapajós river, state of Pará, Amazon. In this same study the authors verified a WIR 0.56 $\mu\text{g/kg bw}$ in regions where such activity is not practiced. The difference between the studies occurred due to the quantity consumed, since the

consumption verified for the villages analyzed in this research was superior to those verified by Castilhos et al. (2001).

Mourão (2016) found a mean exposure dose of HgMe by the consumption of fish in the Madeira river region of 3.4 and 3.5 $\mu\text{g/kg bw/week}$ for the infantile-juvenile and adult groups of Porto Velho, state of Rondônia also in Amazonia, respectively, therefore, less than half of the exposure values (WIR) calculated by the intake of fish verified in this study for Serrinha (8.3 $\mu\text{g/kg bw/week}$) and lower than the exposure in Nazaré village (14.9 $\mu\text{g/kg bw week}$) at least three times. These authors concluded that even with concentrations of mercury in fish below national limits, the quantity and frequency of fish consumption in the riverine communities of the Madeira river are sufficient to maintain a high exposure dose for all age groups.

Considering that the comparison between WIR and PTWI allows only an estimation of the level of exposure to HgMe or other toxic compound due to the ingestion of contaminated foods (PASSOS et al., 2008), and not directly and directly the health risk of these, aiming to characterize the potential health risk of the populations of the three Tupari villages studied. Through the WIR of HgMe obtained for the fish, hunts and vegetal analyzed, was estimated RQ for the health of the populations of the three villages based on PTWI of 1.6, 1.3 and 0.7 $\mu\text{g.HgMe/kg bw}$, which indicate doses of chronic oral exposure of methylmercury. The results compared so that $\text{RQ} > 1$ showed a potential risk of contamination (US EPA, 2004) by HgMe in medium and long term. The values of RQ calculated according to US EPA (2004) based on the PTWI are shown in Figure 5.

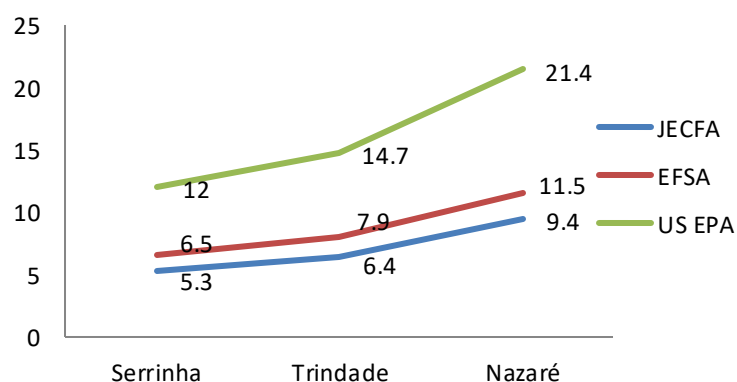


Fig. 5 - Risk quotient (RQ) from the intake of HgMe through the consumption of all foods analyzed, based on the reference doses (RfD) suggested by PTWI of JECFA (2014), EFSA (2015) and US EPA (2001).

Ranges varying between 5.3 and 21.4, the RQ values differed between the three villages studied based on the PTWI of the different regulatory institutions used as parameters for the comparison, so that the greater potential risk of health problems due to the ingestion of

HgMe was always checked for the population of Nazaré, followed by Trindade and Serrinha. Considering the proportion (50 %) of fish consumption at the top of the food chain in the village of Nazaré (Table 3), a higher weekly intake rate (WIR) of HgMe was already expected

for this population and, consequently, risk (RQ) of suffering adverse health effects compared to other villages.

Even using the reference dose of JECFA (2014), less rigorous (PTWI 1.6 $\mu\text{g}/\text{kg}$ bw) among the organizations that establish maximum tolerable values for weekly intake of HgMe, the RQ obtained for the populations of Serrinha, Trinity and Nazaré behaved higher than 4.3, 5.4 and 8.4 times, respectively, the value of RQ understood as safe limit ($\text{RQ} \leq 1$) so that health problems due to oral exposure to this organometallic compound do not occur.

When used in this study, the reference dose of US EPA (2001) to calculate the ratio between WIR and PTWI suggested, the RQ obtained in this study extrapolated between 11 and 20.4 times, which occurred as a function of the dividend (PTWI) is lower (0.7 $\mu\text{g}/\text{kg}$ bw) than PTWI (1.6 $\mu\text{g}/\text{kg}$ bw) recommended by JECFA (2014). Another important observation regarding the evaluation of the risk of exposure of these indigenous populations to HgMe is that when considering only the sum of the WIR obtained for the game and the analyzed fish, the RQ would be on the order of 0.14, 0.10 and 0.08 (<1) for the villages Serrinha, Trindade and Nazaré, respectively, even considering PTWI of 0.7 $\mu\text{g}/\text{kg}$ bw, the most rigid of them (US EPA, 2001). Thus, it can be understood that the consumption of sweet potatoes (*I. batatas*) and meat of hunts in the villages studied is not a potential source of risk to the health of the indigenous Tupari due to exposure to HgMe, with fish being the greater risk factor found for this people.

Compared with the international literature, few studies with populations of the Brazilian Amazon evaluated the health risk of diet through the calculation of RQ. These studies include Mourão (2016), who verified a RQ above 1 between 51 % and 97 %, 55 % and 87 % and 54 % and 96 %, respectively, in the groups of children and adolescents, women and adults. These results are lower than those obtained in this research, which is directly related to the higher consumption of fish in the Rio Branco Indigenous Land in comparison to the consumption of the populations studied by the author.

With weekly T-Hg ingestion rates of 31.5 to 44.8 ($\mu\text{g}/\text{kg}$ bw), Boischio and Hanshel (1996) found values of RQ between 21 and 64 for riverine infants, women of childbearing age, and children under 5 years old, living along the Madeira river, state Rondônia. The authors suggested that children in this riverbank population were taking doses of Hg that could cause neurological damage. Hacon et al. (1997) also evaluated the potential health risk of Amazonian populations using the RQ based on the ratio between the estimated intake rate and the reference dose (PTWI) selected for that study (2.1 $\mu\text{g}/\text{kg}$ bw/week),

with an estimated risk index (RQ) of 9.3 and contribution of 92 % of fish intake.

Although Santos et al. (2000) observed no signs or symptoms of mercury intoxication, the authors observed higher levels of mercury in fish from the Tapajós river region in the state of Pará, and also in the Brazilian Amazon. The authors warned that the high rates of fish consumption in that region raise concerns about the possibility of effects arising from chronic exposure, especially among children and women of childbearing age.

Still in the Brazilian Amazon, Farias (2006) observed high levels of risk for pre-school children in the Jaú National Park region in the state of Amazonas, when for many of them the T-Hg was higher than 5 $\mu\text{g}/\text{kg}$ bw/week, which was PTWI then regulated by the WHO at the time of this study.

The recent international literature is vast of studies by which the risks were estimated by the ingestion of fish containing Hg, however, the majority is marine fish. For example, the studies carried out by Anual et al. (2018) in crustaceans, cephalopods and fish from Malaysia and by Ahmed et al. (2018) on starfish species used for food in regions of the Arabian Sea coast. Although these authors evaluated the risk of eating fish and/or seafood, they found that weekly intake values were considerably lower than those obtained in this study, therefore, with a lower risk of mercury exposure compared to the consumption of fish collected in tropical rivers of the Brazilian Amazon.

Although the effects of mercury on Amazon populations are not as clear, studies in the region have evaluated the effects of mercury exposure on the neurological development of children (MARQUES et al., 2007), prenatal exposure (MARQUES et al., 2013) and adults (YOKOO et al., 2003). These studies have reported that fish consumption, maternal schooling, and nutritional status are all possible factors that may mask the relationship of exposure to mercury with effects on the central nervous system.

The scientific restlessness regarding the human exposure to different organomercurial compounds such as HgMe is mainly due to its slow elimination by the organism, and according to Ertas et al. (2014) extend for years in the brain and according to Kim et al. (2015) also in the kidneys. Several studies have demonstrated the neurotoxic effects of HgMe in populations exposed to this contaminant. The results obtained in the riverside population (HACON et al., 2008) of the Amazon basin exposed to HgMe due to high fish consumption. Through sensitive neurofunctional tests these researchers observed a decrease in visual and motor functions as the levels of mercury in the individuals' hair increased.

In addition to the health problems resulting from the high HgMe ingestion rate mentioned above this metal has also been linked to heart disease. Studies published in the New England Journal of Medicine (2002) reported a direct association between HgMe and myocardial infarction (GUALLAR et al., 2002; YOSHIZAWA et al., 2002).

Contrary to what was observed by Hacon et al. (2008), in a clinical evaluation performed by Dórea et al. (2005) in different indigenous villages of the Brazilian Amazon did not detect neurological complaints such as paraparesis, numbness, tremor and failure of balance, compatible with the exposure to mercury. These authors and their collaborators warned, however, that exposure to HgMe by ingestion fish of sweet-water is a minor problem compared to endemic infectious diseases occurring in the Amazon, such as malaria. The authors added that although fish are abundant in the indigenous diet, they have been consumed without apparent problems to the health of these Amazonian peoples.

The diet based on foods containing considerable amounts of selenium (chestnuts) and fibers (cassava meal) may be helping to avoid the occurrence of perceptible and/or other cardiotoxic effects in the riverine and indigenous populations (ROCHA et al., 2014; LEMIRE et al., 2010). As discussed in this paper and reported by Passos (2003), these compounds have antioxidant and cardioprotective effects, which aid in the production of substances with (KHAN; WANG. 2009) and thus reducing its deleterious effects on the health of these traditional populations of the Brazilian Amazon susceptible to the high RQ by fish ingestion.

IV. CONCLUSION

The results of the risk assessment using the MeHg intake rate through consumption of fish, game meat and sweet potatoes indicated that the populations of the indigenous villages studied are exposed to the risk of suffering medium and long term health problems due to the ingestion of these foods, mainly due to the consumption of carnivorous fish. However, although fish have been considered the main sources of exposure to HgMe for the indigenous studied in this research, they have also been a source of selenium in the diet of these populations, such as chestnuts and cassava, which may be improving the chronic risk to the health of the Tupari by the ingestion of foods containing HgMe.

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Spatio-temporal study of water quality in a subtropical reservoir and related water bodies in Southern Brazil

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Abstract—The importance of hydroelectricity to the world energy grid motivates the implementation of dams and formation of reservoirs. This implies changes in the ecosystem, and therefore those waters must be constantly monitored. Given the relevance of applied scientific research to monitoring data, this study aims at the spatio-temporal characterization of the water quality of Capivari-Cachoeira hydroelectric power plant reservoir located in Southern Brazil, as well as the water supplying it and the water that is restored to the river. Historical monitoring data obtained between 2005 and 2016 were used for the analysis. The factor analysis used for the study of these data resulted in two factors that explain 59.7% of the total variability. The first factor represents the influence of anthropic activities and land use, signaling the existence of polluting sources upstream of the reservoir. The second factor represents seasonality. Kruskal-Wallis tests applied in factor scores and in the variables with higher factor weights resulted in significant spatial and temporal difference. Regarding the first factor, the reservoir station and those located downstream differed spatially from those located upstream. In the reservoir, reduction in concentration of phosphorus and total solids suggests sedimentation, consequently reducing its values downstream. Considering the seasonal factor, the results obtained during winter showed the lowest temperatures and had the highest values of dissolved oxygen, with the exception of the samples from the reservoir. Thus, the control of the nutrient supply in dammed river demonstrated to be an important tool for managing water resources.

Keywords— *Hydroelectric reservoir, limnologic monitoring, multivariate statistical analysis, water resources.*

I. INTRODUCTION

Brazil is part of a group of countries where the production of electricity is massively derived from hydroelectric plants. Approximately seventy five percent of the electric energy generated comes from hydropower. This value is high when compared to other countries indexes, possibly because the country has a great number of plateau rivers, high rainfall and a significant total of watersheds. In this reality, Brazil is considered the country with the world's highest hydropower potential [1], [2].

However, dam implementation in rivers and the flooded areas caused by reservoir formation tend to trigger changes in limnological characteristics of natural area around the dam and downstream. The changes in speed and time of permanence of water can affect the physical and chemical characteristics of the ecosystem, in addition to its biological communities [3], [4].

In this way, hydroelectric reservoirs are subjected to constant monitoring of the quality of their waters, in addition to upstream and downstream areas, as a result of conditioners in environmental licenses of this kind of hydroelectric project. These monitoring programs aim to assess the ecosystem, and the data are discussed in technical reports directed to environmental agencies [1], [5].

Given this context, it is important that these data could be evaluated scientifically, as they express historical information on the behavior of that kind of ecosystem [6]. Scientific studies of the hydroelectric reservoirs and

surrounding water bodies based on long-term monitoring data allows for the observation of ecosystem evolution, in order to better understand problems that interfere with water quality. Thus, they allow the planning and the definition of management proposals for current and future use of the water body [1], [7], [8].

The scientific study of these data often occurs through multivariate statistical analyses, due the complexity of the data, which is related to the large amount of samples and variables, making it possible to find and interpret relationships [6], [8]–[13]. Multivariate statistics are also considered the most suitable for studies of historical series, since they are tools that facilitate the interpretation of spatial and temporal variable relationships related to the object of study, such as anthropogenic influence and seasonality in a specific water body [6], [8], [10].

Thus, through statistical methods, this study aimed the spatio-temporal characterization of water quality of the hydroelectric power plant (HPP) Capivari-Cachoeira reservoir, as well as the water that leads to it and the water returned to the water body, based on prior data from the monitoring program carried out by the concessionaire responsible for the powerplant.

II. MATERIAL AND METHODS

The study area comprises the reservoir of the hydroelectric powerplant Governador Pedro Viriato Parigot de Souza (also known as Capivari-Cachoeira HPP), Capivari river and the Patos river, both upstream of the reservoir, as well as the Cachoeira river, located down stream of the reservoir, where turbinated water is returned [14].

The power plant went into operation officially in 1971, being the largest underground HPP in Southern Brazil [15]. It features a reservoir with an area of 13.1 km², with a total volume of 178 million m³ and a drainage area of 1,200 km² [14], [15].

The HPP Capivari-Cachoeira produces electric power from a level drop of 740 meters diverting the Capivari river located in a plateau (Ribeira Basin) to the Cachoeira river situated in a littoral plain (Litorânea Basin). The hydroelectric plant's machine house is located in the municipality of Antonina (Litorânea Basin), and the reservoir in the municipalities of Bocaiúva do Sul and Campina Grande do Sul (Ribeira Basin), in the state of Paraná Southern Brazil [14], [15].

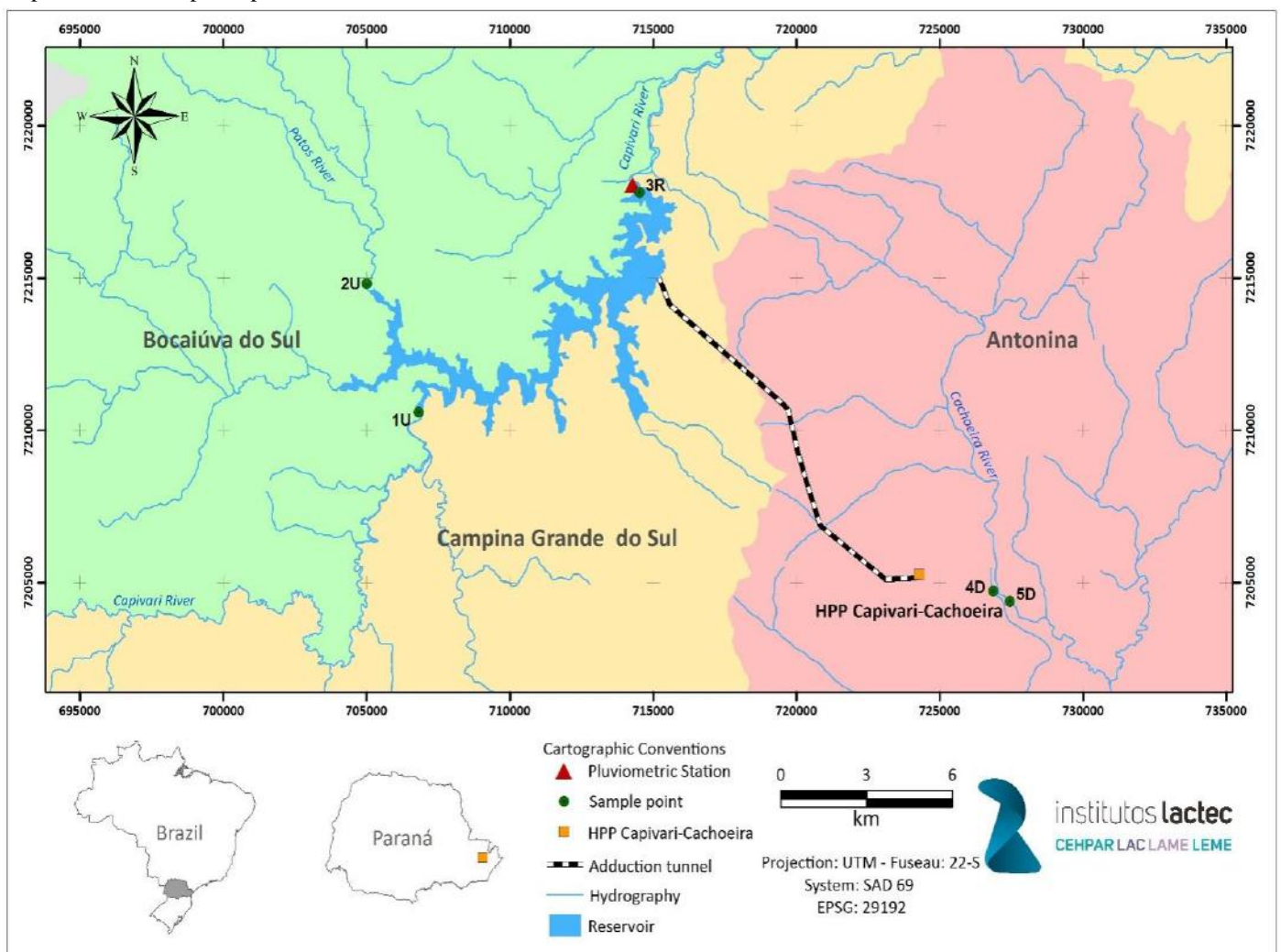


Fig. 1: Location of sampling stations.

Limnological monitoring data from the studied area were collected by from the monitoring program conducted by COPEL – Companhia Paranaense de Energia. These data were collected on a quarterly basis, between 2005 and 2016, in five sampling stations: 1U and 2U, both upstream of the HPP Capivari-Cachoeira reservoir, respectively located in Capivari river, the main river that forms the reservoir and the Patos river, an important tributary of the Capivari river. Sampling station 3R, located in the reservoir, near the dam. And two sampling stations down stream of the reservoir, 4D, located in the restitution channel of turbinated water, and 5D, in the Cachoeira river (Fig. 1).

The variables selected for this study were: water temperature ($^{\circ}\text{C}$), water transparency (m), dissolved oxygen (DO) (mg.L^{-1}), pH, electrical conductivity ($\mu\text{S.cm}^{-1}$), total phosphorus (P-Total) (mg.L^{-1}), total nitrogen (N-Total) (mg.L^{-1}), total solids (TS) (mg.L^{-1}), thermotolerant coliforms (NMP.100mL $^{-1}$) and biochemical oxygen demand (BOD) (mg.L^{-1}). The methodology used to collect the samples was the "simple" sampling type, being also based on field data collected at the moment of sampling (data recorded at the field sheet)[16].

Descriptive statistical analysis were applied in order to illustrate variable behavior per sampling station. Factor analysis (FA) was applied to the dataset in order to detect possible patterns in limnological variables and identify spatial and temporal characteristics between the analysed water bodies. This analysis identifies the most significant variables in a large dataset and synthesizes them in to factors [6], [11], [13], [17].

According to França (2009) [17], considering X a random vector with μ mean and covariance matrix Σ , in the factor model, X is linearly dependent of some non-observable random variables F_1, F_2, \dots, F_m , named common factors and " p " sources of additive variations $\varepsilon_1, \varepsilon_2, \dots, \varepsilon_p$, named errors or specific factors.

In order to eliminate the effects produced by different scales and units, data were log-transformed ($\log(x+1)$), with the exception of pH. In order to apply factor analysis, it was necessary to analyse the data previously to verify whether they were suitable for the application of this technique. Based on this, calculation of the Measure of Sample Adequacy (MSA) was applied according to the Kaiser-Meyer-Olkin (KMO) model. The result of the MSA value under the KMO model shows the proportion of variance that variables presented due to common

factors. In order for the application of factor analysis to be considered adequate for data treatment, the result should be higher than 0.5 [17], [18]. The Bartlett's Test of Sphericity, was also applied. It indicates whether the data matrix presents significant correlations between variables. As a result, p-value must be lower than 0.05[18].

In order to achieve a more suitable setting for the factor model, the MSA was also calculated individually for each variable, using the anti-image correlation matrix, in order to identify variable with MSA lower than 0.5. Those variables, with individual MSA <0.5 , were excluded from the analysis [18].

After initial assessment of the data, factor analysis was then applied, factor extraction occurred through the principal component method. Orthogonal transformation was used to facilitate the interpretation of the factors that composed the matrix. Varimax rotation was applied, distributing factor loadings so that high weights for each variable in a single factor and low or moderate weights in other factors were obtained[17]. The latent-root approaches, established by Kaiser (1958)[19] was used for factor selection, where all factors with eigenvalues higher than 1 were considered significant. For factor characterization, the variables with absolute weight higher than or equal to 0.7 were considered [18]. Thus, the factors considered significant in FA were analysed and plotted on a chart [20]–[22].

The FA was followed by the Kruskal-Wallis test, to evaluate the significance of the ordination axes (dependent variables). The Kruskal-Wallis test of the selected factors was conducted to identify the relative contribution of seasonality and the location to variations of the water quality of the different sampling stations. In this way, the axes of the factor analysis selected for interpretation were tested one at a time, using time and space as explanatory variables, and axis score as dependent variable [20]–[22].

Limnological variables that presented more explanation for the FA were also tested by Kruskal-Wallis to check the relationship space-time, being those used as explanatory variables and the empirical data as dependent variables[20]–[22]. For applying AF, the R statistical environment was used [23]. The software Statistica was used to perform the Kruskal-Wallis test and for plotting graphs[24]. The steps for performing statistical analyses previously described were summarized by flowcharts in Fig. 2.

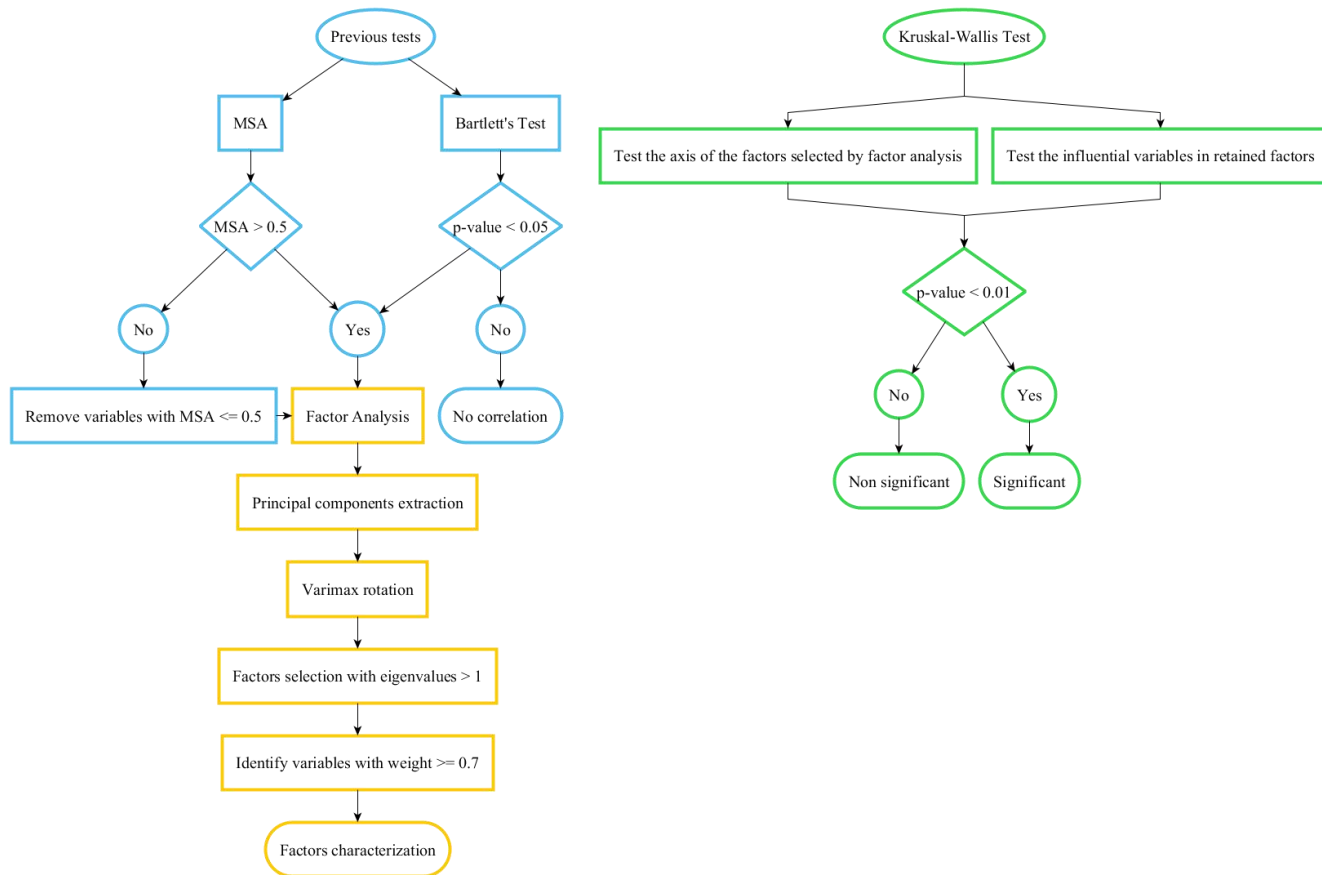


Fig. 2: Flowcharts of statistical methodology stages.

III. RESULTS AND DISCUSSION

Descriptive statistical analysis per sampling station applied in order to illustrate variable behavior is presented in Table 1.

Table 1: Descriptive statistical analysis of the water quality data studied.

	1U	2U	3R	4D	5D		1U	2U	3R	4D	5D
Watertransparency(m)						Turbidity (NTU)					
Média	0.53	0.56	1.86	0.72	0.71	Média	20.27	14.63	4.01	7.20	5.27
Mediana	0.45	0.50	1.78	0.50	0.60	Mediana	15.50	11.00	4.00	5.50	4.40
Desvio Padrão	0.30	0.29	0.70	0.35	0.33	Desvio Padrão	15.71	11.76	1.81	4.60	2.80
Máximo	1.50	1.30	3.40	1.80	1.60	Máximo	67.70	55.00	10.30	22.00	13.40
Mínimo	0.10	0.10	0.60	0.30	0.20	Mínimo	1.00	1.00	1.00	2.00	1.00
Watertemperature (°C)						Dissolvedoxygen (mg.L⁻¹)					
Média	18.24	18.05	21.91	19.23	19.43	Média	8.22	8.32	7.18	8.65	8.90
Mediana	18.60	18.80	22.25	19.70	19.85	Mediana	8.16	8.30	7.19	8.48	8.85
Desvio Padrão	3.18	3.50	3.35	2.07	2.07	Desvio Padrão	1.46	1.23	2.05	1.26	1.04
Máximo	22.60	27.60	28.30	23.30	24.00	Máximo	13.85	12.75	14.44	11.60	10.90
Mínimo	11.00	11.00	16.10	16.10	15.90	Mínimo	4.16	4.90	3.92	5.00	5.40
pH						Electricalconductivity (µS. cm⁻¹)					
Média	7.40	7.57	7.73	7.03	7.13	Média	90	51	69	71	57
Mediana	7.45	7.55	7.65	7.10	7.20	Mediana	93	47	70	72	57
Desvio Padrão	0.34	0.43	0.47	0.30	0.30	Desvio Padrão	20	12	7	9	11

Máximo	7.90	8.70	9.10	7.60	7.70	Máximo	139	96	83	90	78
Mínimo	6.50	6.70	6.80	6.10	6.20	Mínimo	47	30	54	54	39
Totalphosphorus (mg.L⁻¹)						Totalnitrogen (mg.L⁻¹)					
Média	0.072	0.057	0.023	0.024	0.030	Média	1.73	1.05	1.08	1.14	0.94
Mediana	0.060	0.039	0.020	0.020	0.030	Mediana	1.60	0.78	0.85	0.94	0.70
Desvio Padrão	0.035	0.059	0.042	0.017	0.011	Desvio Padrão	0.89	0.70	0.74	0.70	0.64
Máximo	0.150	0.300	0.290	0.110	0.070	Máximo	3.60	3.40	3.30	3.40	3.70
Mínimo	0.030	0.010	0.001	0.001	0.001	Mínimo	0.50	0.50	0.50	0.50	0.50
Total solids (mg.L⁻¹)						Thermotolerantcoliforms (NPM.100mL⁻¹)					
Média	92	74	55	60	52	Média	2021	1467	24	107	219
Mediana	87	58	54	57	51	Mediana	785	355	2	2	22
Desvio Padrão	20	49	16	13	13	Desvio Padrão	4247	2643	120	415	558
Máximo	156	316	138	115	107	Máximo	25000	13000	780	2600	3100
Mínimo	63	30	26	30	29	Mínimo	1	1	1	1	1
BOD (mg.L⁻¹)											
Média	2.60	2.43	2.14	2.19	2.26						
Mediana	2.00	2.00	2.00	2.00	2.00						
Desvio Padrão	1.97	2.09	1.24	1.44	1.37						
Máximo	10.15	12.90	7.60	9.15	6.06						
Mínimo	1.00	1.00	1.00	1.00	1.00						

The MSA (=0.58) and Bartlett sphericity (p<0.05) tests showed that the data were adequate for applying factor analysis. The adequacy to the factor model was applied more thoroughly by removing the variables with MSA lower than 0.5. In this way, electrical conductivity data, BOD and pH were excluded, whose individual MSA values were: 0.38, 0.41 and 0.43, respectively. Once those variables were removed, general MSA resulted in 0.71.

The factor analysis explained 59.7% of their total variability, retaining the first two factors. The Factor 1 (F1), explained 39.5% of the data variability, and was described by total phosphorus (+), total solids (+) and turbidity (+). Whereas Factor 2 (F2) explained 20.2% of the data variability and was represented by water temperature (+) and DO (-) (Table 2).

Table. 2: Factoranalysis result.

RotatedComponent Matrix		
	F1	F2
Watertransparency	-0.614	0.489
Watertemperature	-0.102	0.741
Dissolvedoxygen	0.122	-0.831
Total nitrogen	0.504	0.220
Total phosphorus	0.797	-0.114
Turbidity	0.866	-0.130
Total solids	0.826	-0.209
Thermotolerantcoliforms	0.673	-0.248
Eigenvalue	3.163	1.612
Variance %	39.500	20.200
Cumulativevariance%	39.500	59.700

Fig. 3 shows the graph of sample scores to analyse the spatial and seasonal behavior of the data series. Fig.4 displays the weight chart for the first two factors. Weights of the original variables in linear combination define each

factor. The relationship between variables can be observed in the weight graph. Based on these relations, it is possible to infer an interpretation for these factors [25].

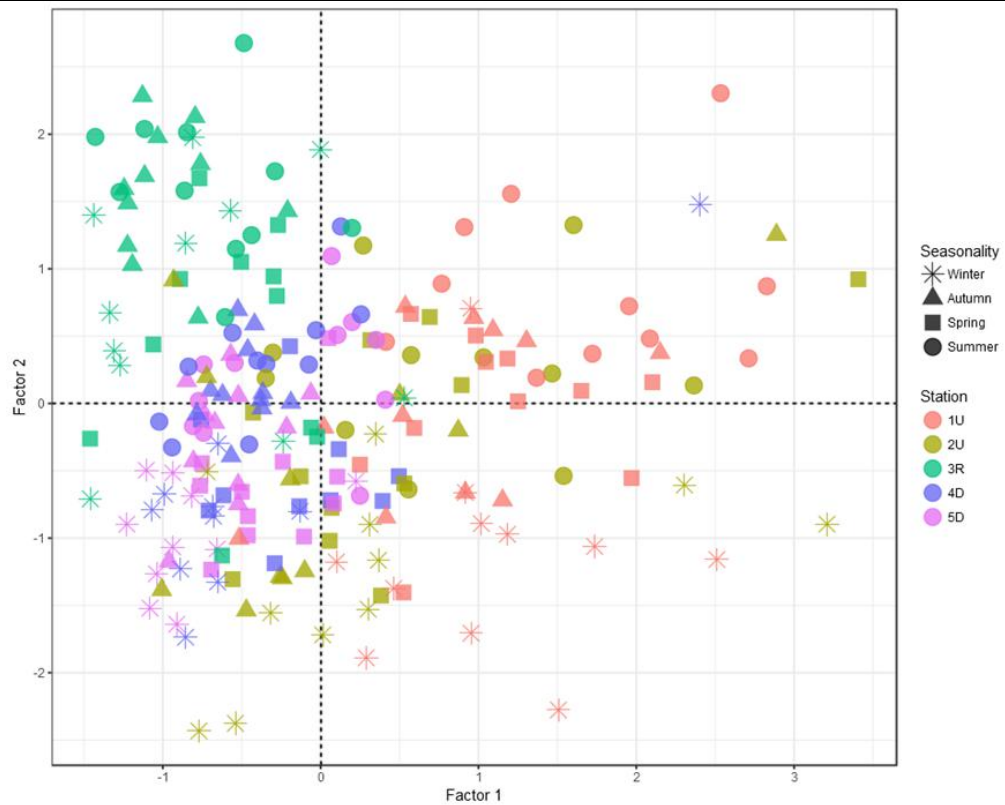


Fig. 3: Scores of the samples plotted in the plane defined by factors 1 and 2.

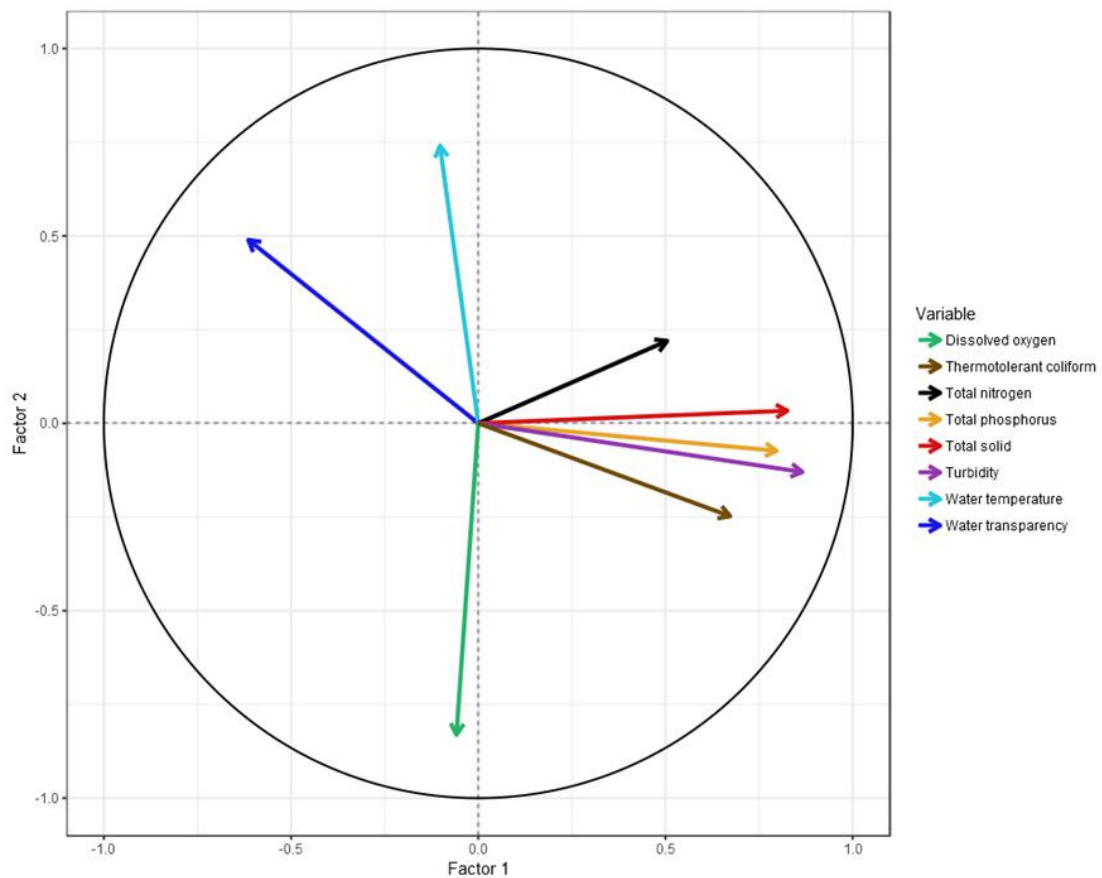


Fig. 4: Weights of the variables of the factors plotted in the factor 1 x factor 2 plan.

It is possible to identify that the variables constituting the F1 represent the influence of anthropogenic activities and land use of the surroundings, signaling the existence of polluting sources upstream of the reservoir. Over the studied years, sampling stations 1U and 2U presented the higher values for these abiotic variables (P-Total, TS and turbidity) (Table 1).

The sampling events conducted in Capivari river (1U) were more influenced by the first factor (Fig. 3). The surroundings of the Capivari river present high population density, which generates environmental pressure, such as the dumping of untreated waste, farming activities on the banks of the river, and deforestation [26],[27].

At the station of Patos river (2U), there was a higher dispersion of points (that represent samplings at this location) (Fig. 3), according to the seasons of the year and possibly due to the entry of allochthonous material originated from anthropic action in this water body. Land use in the region of Patos river is mostly rural, especially with regard to livestock, with generation of pollution loads possibly occurring due to animal waste dump in the water body [26]. Patos river, for being one of the main affluent of the Capivari river, directly interferes in its quality, and also in the quality of Capivari-Cachoeira reservoir.

This river has recently been classified from class 2, to class 4, according to its river basin committee. This reduction of class also restricts the multiplicity of uses these waters have, since the quality required for class 4 is lower than the one needed to sustain the water uses displayed for the class 2 [28], [29].

According to a study conducted using data from 2005 to 2009 of rivers and reservoirs in the state of São Paulo (southeastern Brazil), class 4 environments can be considered irrecoverable or as final, inevitable destination for domestic or industrial effluents [30].

Thus, the rivers Capivari and Patos are affected by diffuse pollution originated from the land use (industrial and rural activities), which possibly contributed to the values of phosphorus and total solids [26], [27]. It is important to note that the Capivari river lies in the expansion plan of the watersheds that supply Curitiba, being aimed for future use [31].

One of the consequences of urban growth in Brazil is the vulnerability of water resources in industrialized and densely populated regions, aggravated by changes in land use and poor sanitation infrastructure [32].

The high concentrations of phosphorus upstream to the Capivari-Cachoeira reservoir are worrisome, since it is expected that these concentrations will enrich the reservoir over time, contributing to eutrophication. This fact occurs since phosphorus is, in part, retained in the reservoir, be it due to sedimentation related to the

elevated residence time, or due to the use of phosphorus by phytoplankton.

Limnological characteristics of reservoirs make them function as accumulators of information of the drainage basin in which they are located, as well as reflecting the activities conducted in the surroundings [33].

Waste produced by anthropogenic activities, such as industrial effluents and drainage from urban areas, when discarded without proper treatment, can be a source of pollution for the river and, consequently, for the reservoir [25].

In this way, the reservoir water quality becomes an important indicator of the influences in the basin and may act as an accumulator of the changes occurring upstream.

Factor 2 (F2) retained the variable water temperature (+) and dissolved oxygen (-), representing the seasonality. Such factor demonstrates the relationship between the solubility of this dissolved gas in the water body with the temperature. Gases behavior, including dissolved oxygen, is related to temperature, since its increase makes gases less soluble [1].

Temperature is a determining factor in water quality, as it may interfere with chemical and biochemical reactions, in addition to altering biological processes that occur in the water [12], [34].

According to the results of FA (Fig. 3) it was possible to identify that the winter and summer samples at the lotic environment stations presented greater distances from each other. The increase in water temperature also provides increase in the metabolic activities of organisms, elevating their respiratory rates, triggering an increase in the consumption of dissolved oxygen in the water [13], [35].

Water samplings conducted during winter presented the lowest temperatures and had the highest DO values, at the lotic environment. In the other hand, the ones conducted in reservoir did not follow that pattern. This result may be related to stratification processes of this reservoir, as well as the dynamics of its phytoplankton community [36].

In a study conducted in the state of Paraná, in the region of the HPP Foz do Areia reservoir, the relationship between DO and water temperature in the sampling stations located upstream and downstream of the reservoir and the lack thereof in the reservoir was observed [1]. It is possible that such a relationship between DO and temperature has not been registered in the reservoir stations, due to the influence of stratification processes [1]. Thermal stratification forms a physical barrier, with significant differences in water density. This way, heat is not distributed homogeneously in the water column, as well as DO.

Samples with highest values of water temperature collected downstream of the reservoir and Patos river are similar to those collected at the reservoir (Fig. 3).

Seasonality had a higher weight in defining the similarity of water quality than spatial variation in a study conducted in the surface waters of the drainage basin of Bandeira stream, Mato Grosso do Sul state (Brazil)[12].

The Kruskal-Wallis test of the factor axes selected for interpretation resulted, for F1, insignificant differences for space ($p < 0.01$) and time ($p < 0.01$).

In general, there is a clear spatial difference between the sampling stations. The station in Capivari river, upstream from the reservoir (1U) is the site with major differences between the reservoir station (3R) and downstream (4D and 5D), also being a little more similar to 2U, a sampling station in Patos river, also upstream of the reservoir (Fig. 3 and Fig. 5).

The sampling station in Capivari river showed seasonal variation in summer compared to other seasons. In general, during summer it was recorded the highest values for the variables retained in F1 (total phosphorus, total solids and turbidity). Regarding samples from station 4D, it is possible to notice that those collected during winter were quite different from the remaining. Samples from winter 2012 had the highest values of phosphorus, total solids and turbidity (Fig. 3), making it more similar to the samples collected at Capivari river (1U) and some samples (spring 2010 and fall 2012) from Patos river (2U) (Fig. 3). The major seasonal variations for the variables retained in this factor were found, at 3R and 4D sampling stations, between fall/winter and fall/spring and for the remaining sampling stations, between summer/winter.

The Kruskal-Wallis test performed on the variables retained in FA, factor 1, resulted in spatial ($p < 0.01$) and

time ($p < 0.01$) differences for turbidity, whereas total phosphorus and solids only presented significant spatial difference ($p < 0.01$).

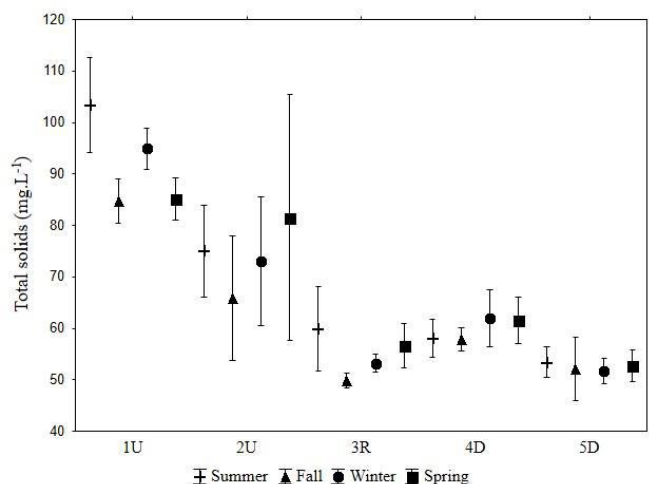
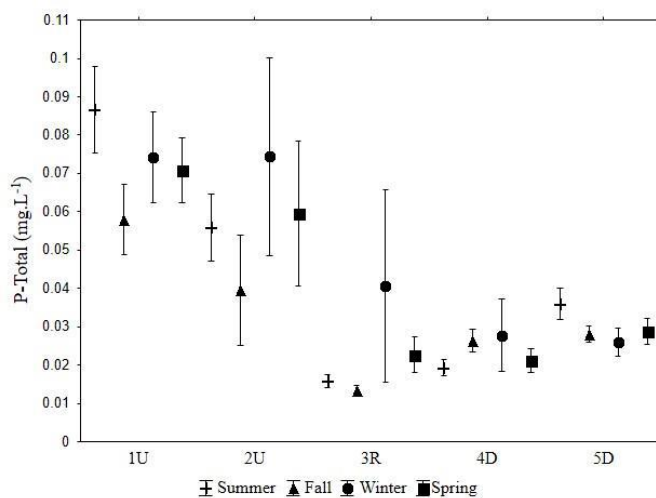
The results of these variables have shown the characteristics of the reservoir over them, since station 3R and the stations located downstream of it differed from the upstream sampling stations (Fig. 5).

In the reservoir, reduction in variable values constituting F1 seem to imply sedimentation of phosphorus and total solids, consequently also reducing its values downstream (Fig. 5). Hence, it was possible to identify that the upstream stations (1U and 2U) are more similar to each other, as well as the downstream ones (4D and 5D) (Fig. 3 e Fig. 5)

Sediments and particles can be transported from a watershed and into reservoirs, where a fraction can be retained due to the reduced flow[4]. Dams act as nutrient sinks, which may promote the accumulation of nutrients in reservoirs, consequently leading to decrease in downstream nutrient concentration [3], [4].

A study also conducted in the HPP Capivari-Cachoeira reservoir identified that the analysed nutrients, including total phosphorus and total nitrogen, presented high concentrations near the river portion with decrease in values and turbidity towards the dam, where the Capivari reservoir showed a clear longitudinal gradient[36].

A similar situation was also observed upstream of reservoirs located in Santa Maria da Vitória watershed, at Espírito Santo state (Brazil), where water quality was degraded by the presence of domestic sewage released without treatment, improving downstream water quality due to sedimentation promoted by the reservoir [37].



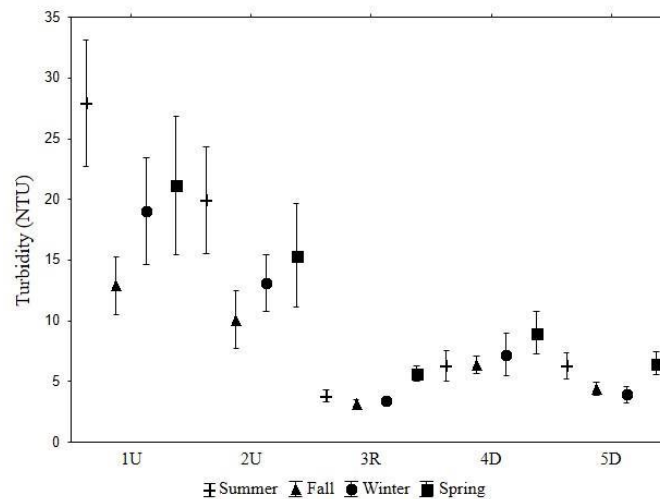


Fig. 5: Representation of the Kruskal-Wallis test result for the variables retained in F1.

Fantin-Cruz et al. (2015)[38] identified that, compared to a reference site upstream, the HPP Ponte de Pedra reservoir, located in Pantanal ecosystem (Brazil), significantly decreased the turbidity and concentrations of total solids, total phosphorus and nitrate. Similarly, to what was found in this study, the changes were not always negative. Thus, oftentimes, but not always, the reservoir caused reductions in these variables concentrations with regard to upstream stations. Also, in a study conducted in the upper Paraná river (Brazil), the large reservoirs built there were found to be responsible for the decrease in sediment load of the river downstream [39].

The study conducted by Santana et al. (2017)[22], also in the upper Paraná river, identified that the dam Porto Primavera retains more than 70% of total phosphorus of the Paraná river. Similarly, to what was found in this study, low values of total phosphorus and nitrogen

occurred, as well as high values of transparency of the water downstream of the dam.

The Kruskal-Wallis test of the factor axes selected for interpretation also resulted, for F2, into significant differences for space ($p < 0.01$) and time ($p < 0.01$).

This result demonstrates the difference in the influence of seasonality on the reservoir in relation to the upstream and downstream sampling stations located in lotic environments. As previously discussed, all the sampling stations, with the exception of the reservoir, presented the lowest temperatures and the highest values of dissolved oxygen in winter, showing the relation of the solubility of the DO with temperature. The reservoir presents distinct characteristics, such as stratification processes, a fact that may explain its distinct pattern.

Regarding to the variables retained in factor 2, dissolved oxygen presented statistically significant spatial and temporal difference ($p < 0.01$) (Fig 6).

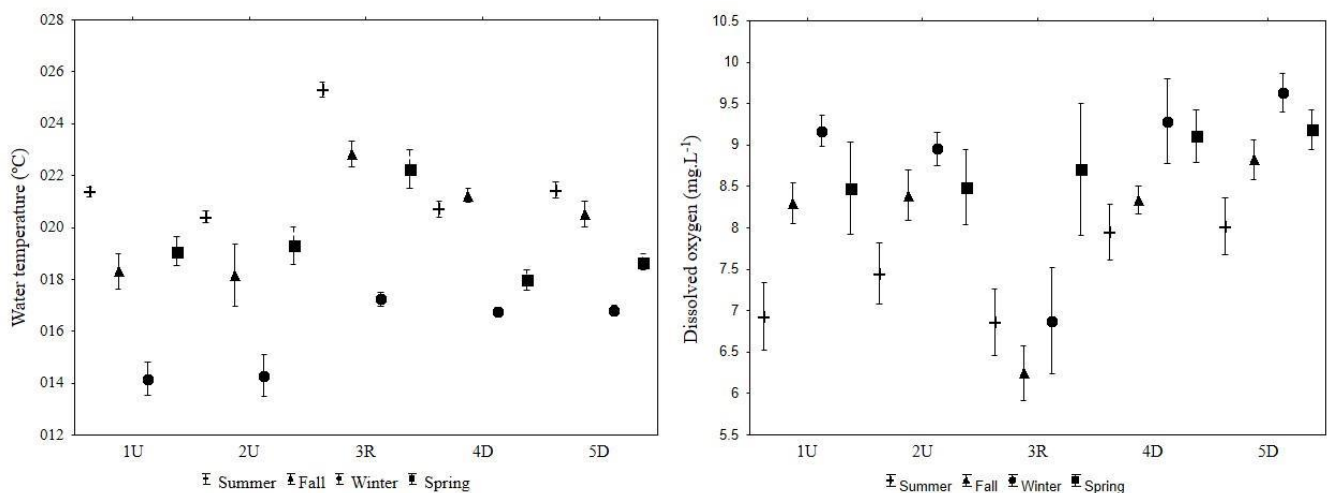


Fig. 6: Representation of the Kruskal-Wallis test result for the variables retained in F2.

The mechanisms that interfere with the balance of dissolved oxygen in aquatic environments are mainly atmospheric diffusion and photosynthesis. Organic matter oxidation, biological demand and nitrification determine the decrease in dissolved oxygen concentrations, where the first can be the main responsible for the consumption of dissolved oxygen in the water [34].

In general, the river points presented the highest values for the variable dissolved oxygen, and the reservoir presented the lowest values and highest oscillation (Fig. 6). Similar results were found in studies conducted in rivers located in Paraná (Brazil), where the high DO concentration is explained by the characteristics of the rivers, which cause greater turbulence and consequently increase oxygen transfer at the interface air-water[40], [41].

The dissolved oxygen concentrations in the reservoir station (3R) were the most diverse compared to the other locations studied, with its highest values occurring during spring. The reservoir offers more favorable conditions for the development of phytoplankton communities, in addition to the accumulation of nutrients [42]. Thus, this result is possibly related to phytoplankton communities that, due to photosynthesis and respiration processes, cause changes in DO concentrations in a seasonal or even daily basis. The widest range of values also occurred in the sampling station of the reservoir (3R), and may be related to possible events of algae blooms, which provide greater primary production and, therefore, peak increases in dissolved oxygen concentration during the day [1]. The smallest DO values of the reservoir may also be related to slower water flow compared to the sampling stations located in lotic environments.

The stations upstream of the reservoir (1U and 2U) did not present significant differences between them (Fig. 6). This result may be related to the existence of increased anthropogenic influences around these rivers, which increase labile allochthon matter and can interfere with DO values, due to decomposition processes [34].

The concentrations of DO studied by Pedrosa et al. (2015) in a section of the Paraná river were directly influenced by dumping of sewage, presenting reduced values in that portion after the sewage discharge [43]. Another study conducted in the state of Paraná, in Pitangui river, also related lower dissolved oxygen values to the influence of domestic sewage and agricultural areas[44]. This relationship was also identified in the Iguaçú river in the metropolitan region of Curitiba, Paraná, in a section with higher population density, where high deposition of unstable organic matter originated from wastewater probably caused consequent DO depletion and water quality degradation[45].

Higher dissolved oxygen values in the sampling stations downstream of the reservoir were observed (4D and 5D). This factor may be related to the flow rate being increased due to the basins diversion [46]. Physical conditions are favored in rivers that are more turbined, having therefore higher reaeration, thus influencing dissolved oxygen values [47].

The water temperature showed significant spatial-temporal differences ($p < 0.01$) (Fig. 6). The wide range of variation in the data during all monitoring seasons occurred due to the seasonality of the sampling periods (four seasons).

The sampling station located in the reservoir (3R) is the one that differed most compared to the remaining stations (Fig. 6). The seasonal pattern has shown that collections performed during summer and autumn are more similar to each other.

Variations in water temperature occur due to natural causes, such as altitude, latitude, season, time of day, flow rate, depth and solar energy, as well as by anthropogenic factors, among them, industrial dumps. Water temperature also suffers seasonal and diurnal variation, in addition to vertical stratification [35].

In a study conducted in the region of HPP São Jorge reservoir (Alagados reservoir), Paraná, results showed the influence land use and passage of water through the reservoir as well as seasonality, in which samples collected in the same season had more similar water quality[44].

Arruda, Knopik e Sottomaio (2017)[6] when using factor analysis for analysing water quality of Tibagi river, in Paraná, also found the descriptive factors of the influence of urban centers as well as that of seasonality in water quality. These factors also retained the variables total solids, total phosphorus and water transparency in opposite directions; in another factor, coliforms represented the land use, and the dissolved oxygen and water temperature, seasonality.

IV. CONCLUSION

The analyses demonstrate the significant influence of surrounding land use upstream of the reservoir, characterized by population density and farming activities.

It was possible to identify that nutrients supply from the tributaries, generates a high concentration of total solids which, due to lower flow and considerable water retention time in the reservoir, makes it function as a nutrient sink, influencing therefore the concentrations observed downstream.

Seasonality was also a significant factor for water quality as well as for differentiating the reservoir from the other sampling stations. The sampling station located in

the reservoir was the one that differed most compared to the others.

Thus, according to the analysed data, the cause of possible changes in water quality of the reservoir is related to contributions coming from upstream.

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Technology Management with Focus on Fish Transposition System (FTS)

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Abstract— Fish transposition mechanisms have been installed near hydroelectric busses in order to reconnect sections of sectioned rivers and attract fish, offering them a route for the continuity of their displacement, essential for their feeding and reproduction. In this work, a bibliographical study is developed searching for information on a model of Transportation Systems for Fishes (FTS), implemented by a hydroelectric plant located in the Madeira river on the municipality of Porto Velho - RO. It was shown that the type of STP constructed was one of successive fish ladders or basins, and its operational functioning is through monitorization of the tagged fish that pass by the channel through Telemetry and Sonar methodologies. The objectives of the Monitoring Subprogram of the Fish Transposition System (FTS) are being met according to the analyzes and technical suggestions transcribed in the EIA / RIMA, PBA and IBAMA conditioners. The monitoring results show that up to the end of 2014, some individuals of target species within the FTS and upstream of the dam, such as the Bagre Dourada species (*Brachyplatystomatus*), were not detected

suggesting that these tagged individuals were unable to climb into the system of transposition and to transpose the bus, having Madeira river as a migratory route for these species.

Keywords— Fish transposition mechanisms, Telemetry and Sonar methodologies, EIA / RIMA, PBA and IBAMA conditioners.

I. INTRODUCTION

The process of migration is the displacement of fish species to other parts of the river or basin for the purpose of feeding, reproducing and sheltering. Almost all types of migrations are in some way associated with the hydrological regime, with reproductive displacements being the most relevant for neotropical fish. Reproduction represents one of the most important aspects of a fish's biology since its existence depends on the maximum survival of offspring (AGOSTINHO & GOMES, 2007). The same authors affirm that the damming of large springs causes, among other interferences, direct impacts to fish communities, namely: isolation of populations, obstruction of migration routes and alteration in the

structure of the existing assemblies of the dammed stretch (AGOSTINHO & GOMES, 2007).

Migratory fish, also known as "piracema" in Brazil, are one of the groups most affected by dams. For these fish, the dam is an obstacle that prevents the free movement between feeding and spawning areas. In order to mitigate this negative effect, fish transposition systems (FTSs) have been implemented, which allow fish to pass through the dams.

The FTSs implanted in Brazil have been only those that provide downstream movements upstream. This is because there is still no known technology that allows the safe and effective passage upstream of the various stages from Brazilian fishes' life (AGOSTINHO & GOMES, 2007).

The Transposition System for Fishes (FTS), implemented by Santo Antônio Energia - SAE, the company responsible for the construction and operation of the Santo Antônio Hydroelectric Power Plant, on the Madeira River, Rondônia, presents the possibility of migration necessary for the spawning of several species of fish and the maintenance of fishing activity in the region, even with the plant in operation. The structure, which has been in operation since December 2011, consists of a corridor that reproduces the natural characteristics of the Madeira River waterfalls and has a proportional flow similar to the river, in order to introduce the fish to an environment as close as possible to its natural habitat (QUEIROZ et al., 2013).

A great advent was observed in the construction of hydroelectric plants and their dams in the Amazonian rivers. Such ventures have innumerable implications for environmental impacts in which we can cite the biological communities of the fauna as the main affected groups. Artificial dams damage the natural process of migrating fish, especially during the breeding season

Thus, the necessity to develop this research, aiming at a descriptive bibliographical review on the implementation of a Fish Transposition System (FTS), as a mitigating measure to minimize the environmental impacts on the fish communities of the Madeira River and their tributaries.

The descriptive review is aimed at the compilation of the presented data, through technical reports by the entrepreneurs responsible by the construction of the plant. Thus, contributing to the knowledge of the Fish Transposition Systems (FTSs), implemented by large hydroelectric projects in the rivers of the Amazon basin, as well as their functioning, feasibility and mitigation of the impacts caused by dams on the local ichthyofauna.

II. OBJECTIVES

The objective of this study is to carry out a literature review on preliminary data regarding the efficiency and

selectivity of the mechanisms of a Fish Transposition System (FTS) in the Madeira River by a Hydroelectric Plant in the municipality of Porto Velho-RO. The main objectives of this study were to identify the type of FTS installed in the Madeira River by Santo Antônio HPP and its operation (a), to highlight the main fish species of interest for evaluation of the efficiency of the monitoring of the FTS (b), and to compare analyzes of the Report of the Environmental Impact Study / Environmental Impact Report (EIR / RIMA) and the Basic Environmental Plan (BEP) with the available technical reports on FTS monitoring (c).

III. LITERATURE REVIEW

The Madeira River is one of the main rivers in Brazil and the longest and most important effluents of the Amazon River. In the world, it is one of the five most flowing rivers and the 17th most extensive (3,240 km). In addition, it is one of the major in South America; its watershed has 125 million hectares. With different denominations, the Madeira River bathes three countries: Brazil, Bolivia and Peru. In addition to environmental importance, it is essential for the economy of many regions, as it traditionally provides fishing, waterway transportation and, at its margins, the planting of various agricultural products (SAE, 2014a).

The Madeira River begins in the Andes Mountains and, after travelling 3,240 km (1,425 km in Brazil), it flows into the Amazon River, which flows towards the Atlantic Ocean. It is formed by three Andean rivers: Beni and Mamoré, in Bolivian territory, and Madre de Dios, in Peru. It arrives in Brazil by the south of the state of Rondônia and, besides bathing Rondônia, it crosses the state of Amazonas in the route until the outfall. It is called Madeira only in the Brazilian territory. On the right bank, its main tributaries are the rivers Ribeirão, Mutum-Paraná, Jacy-Paraná, Jamari and Machado. In the left bank, the rivers Abunã, Ferreiros, José Alves, São Simão and Igarapé Cuniã (AGOSTINHO & GOMES, 2007).

The Madeira River, according to Sioli and Klinge (1962), is classified as a whitewater river, due to suspended material that carries a high concentration of mineral salts in solution (electrical conductivity: 60 - 70 $\mu\text{S} / \text{cm}$ and near pH to neutral: 6.5 - 7.3). The Madeira River is the main tributary of the right bank of the Amazon River, due to the size of its hydrographic basin and the contribution in the volume of water to the Amazon Basin. In Porto Velho, the average flow of the Madeira River in the historical period (1967 to 2012) is 18,718 m^3 / s , and the registered daily maximum flow reached 48,565 m^3 / s on April 14, 1984. The minimum registered flow occurred on September 10, 2005, reaching 2,588 m^3 / s (SAE, 2014a).

3.1 HYDROELECTRIC POWER PLANT SANTO ANTÔNIO ENERGIA (SAE)

The according to the site, Santo Antônio Hydroelectric Power Plant (HPP) has 3150.4 MW of installed capacity and is located on the Madeira River, 7 km from the city of Porto Velho, Rondônia. The bulb turbine technology adopted at the plant allowed the use of the power generation potential as a function of the river flow, allowing the creation of a reservoir with an area of 354 km², not considering the backwater effect (2.5 times increment of the area), which represents a small area in relation to its power (area / power ratio = 0.11 km² / MW)

Santo Antônio Energia is the concessionaire responsible for the construction, operation and commercialization of the energy generated in the hydroelectric plant, an investment of over R \$ 16 billion, of which R \$ 1.7 billion is directed to social and environmental programs. For the implementation of a project of this size, the entire project was designed to obtain maximum use of water resources, with minimal impact on a region whose preservation is a permanent focus (Queiroz et al., 2013).

According to Queiroz et al. (2013) among the measures adopted by Santo Antônio Energia to implement the plant, is the implementation of the Ichthyofauna Conservation Program, carried out in partnership with the Federal University of Rondônia, with the National Research Institute of the Amazon and with researchers from several other institutions. Based on the consolidation of the information generated in the scope of the Program, which represents an investment of more than R60 million, associated to the knowledge of the researchers involved, generating a publication that further disseminates the knowledge acquired about the Amazon Basin so rich in its biodiversity.

3.2 ENVIRONMENTAL IMPACT STUDY / ENVIRONMENTAL IMPACT REPORT (EIS / EIR) AND BASIC ENVIRONMENTAL PLAN (BEP) FOR THE SANTO ANTÔNIO ENERGIA (SAE) HPP REGARDING THE CONSERVATION OF ICHTHYOFAUNA IN THE MADEIRA RIVER

3.2.1 Ictiofauna Conservation Program referring to the EIS / EIR report produced by LemeEngenharia Ltda.

The objective of this Program is to monitor the changes imposed on aquatic fauna and fishing activity on the Madeira River, as a result of the construction of the Power Plants, which is prolonged by its operation. It is divided into seven sets of activities, all of which must begin 12 months before the start of construction. These activities shall be carried out without interruption during the whole construction period, starting up of the

generating units and for 5 years after the last of these units starts operating. Based on the results obtained, the actions and monitoring carried out should be evaluated so that the Program can be re-dimensioned in light of the new environmental scenario that the implementation of the projects will have in the region (LEME, 2005).

According to Leme (2005), the first set of activities is related to the monitoring of fish fauna, with the following objectives:

- To record the variation in richness, diversity, community structure and abundance of fish species in the Madeira River before the works and along the five years after their completion, comparing the results.
- To record the variation in richness, diversity, community structure and abundance of fish species in the Madeira River before the works and along the five years after their completion, comparing the results.
- To monitor changes in reproductive processes and strategies, as well as variations in the reproductive activity of the main species.

For the other sets of activities according to Leme (2005) the objectives are:

- The second set of activities is related to the study of the abundance of eggs and larvae of fish along the Madeira River, whose results will provide consistent evidence on spawning season, breeding sites and natural breeding sites of this fauna.
- The third group of activities will be the genetic characterization of fish populations - a fundamental study for the implementation of strategies to manage this resource and to elucidate questions about the genetic structure of populations.
- The fourth set of activities constitutes the complementation of the fish inventory of the Madeira River and its affluents.
- The fifth set of activities is the monitoring of fishing activity, whose objective is to record the actual environmental and social effects generated by the implantation of the powerhouses on the fishing activity in the section of the Madeira river between Guajará-Mirim and Humaitá.
- The sixth set of activities consists of observing the efficiency and effectiveness of the fish transposition system to be built in the Plant.
- The seventh set of activities of this Program consists of the efforts to rescue the fish fauna, to be carried out in situations in which the operation of the Plant threatens the aquatic fauna.

3.2.2 Monitoring Subprogram of the Fish Transposition System referring to the PBA report produced by Madeira Energia S/A (MESA)

In an initial environmental diagnosis, executed by Leme (2005), important commercial migratory species were registered in the area of direct influence of the enterprise, and in the main fish landings of the Amazon.

One of the main impacts of the construction of the Santo Antônio HPP is the interruption of the migratory routes of some fish species, which may lead to the isolation between the breeding and growth areas according to Agostinho et al. (2002), especially of species of commercial interest. This isolation can severely compromise the regional fishing activity according to Agostinho et al. (1994), which depends on the abundance of these categories of fish, leading to social and economic impacts according to Agostinho et al. (2004). The EIS / EIR and discussions about the feasibility of the implementation of the Santo Antônio hydroelectric projects on the Madeira River, preceded by the Preliminary License n° 251/2007, addressed questions about the life cycle of long distances migratory, such as Siluriformes (catfish), and the great concern about the impact to be caused, by the buses, on the abundance and regional economy of this category of fish (MESA, 2008).

The Madeira River is a migratory route for many species of fish and a region of rapid rivers, more precisely the waterfall of Teotônio, which apparently represents a natural barrier to the migration of some of them (LEME, 2005).

In this case, the reproduction of some species will suffer less impact from the dam, predicted to be placed where the Santo Antônio waterfall is currently. However, for migratory species of long distances capable of transposing said waterfall, as part of the Siluriformes and Characiformes, the dam will represent an important barrier in their life cycle, which should be mitigated by a transposition system (FTS). It is believed that with the installation of an FTS, the impact on the rise of these migratory species to the spawning, and the decrease of the larvae, eggs and juveniles is mitigated allowing their population maintenance and macro-regional replenishment of fish stocks (MESA, 2008).

Regardless of the type of FTS (ladder, locks, fish lifts or artificial canal), the objective is always to provide, even partially, the transposition of the dam by the migrant shoals. The technology currently available for the construction of FTSS, often based on experience from other countries, cannot be used indiscriminately for any dam, at the risk of failure, as it has already been observed in several previous experiences in Africa, Australia and even in Brazil (MESA, 2008).

After the choice and implementation of the FTS, the efficiency of this mechanism should be monitored (number of species and number of specimens that can reach the reservoir by the time of year, etc.) so that the operating conditions of the system can be adequate and/or

corrected whenever necessary. The implementation and operation of the FTS will be subsidized by information on the ecological aspects of the migratory species obtained through the development of the subprograms of the Ichthyofauna Conservation and Rescue Program and pieces of information about the migratory route of some species obtained in the present study. The effectiveness of the FTS will be monitored by the present study, and will show successful responses during the monitoring of subprograms of the Ichthyofauna Conservation and Rescue Program, mainly from the subprograms Ecology and Biology, Ichthyoplankton and Monitoring of Fishing Activity (MESA, 2008).

Besides the efficiency of the chosen mechanism, its effectiveness should be monitored as well, that is, what happens to the specimens that can reach the reservoir. Thus, an FTS can only be considered effective if it is found through monitoring that the specimens have reached spawning areas upstream and that their offspring have survived. On the other hand, the efficacy of an FTS also involves the evaluation of the impacts that the transposition of the shoals entails in the downstream populations since the drift of eggs and larvae upstream is extremely impaired by the conditions imposed by the dam (AGOSTINHO et al., 1992).

According to Mesa (2008), the objectives proposed by the PBA for the conservation program of the ichthyofauna are:

- Define, in conjunction with engineering, the location and characteristics of the most appropriate transposition system (FTS);
- To evaluate the efficiency of the proposed FTS in the transposition of migratory species, identifying critical points for the ascension of species of interest;
- To determine the composition of the ichthyofauna in FTS, identifying the attractiveness of the system and the selectivity of its different components;
- Determine the temporal variation of the species captured in the FTS;
- Determinar os efeitos de variações na vazão e velocidade da água sobre a atratividade e a seletividade do STP;
- Evaluate the movement of eggs and larvae along the channel and determine the density of fish eggs and larvae in the FTS based on the results presented by the Ichthyoplankton Subprogram;
- Identify the migratory routes and seasonal movements of fish species.

Among the goals and expected results, according to MESA (2008), are:

- To reduce the impacts of the project on the migratory fish fauna, based on the adequacy of the FTS to the needs and characteristics of the local populations.

- To register migratory species patterns, serving as the basis for discussions on the elaboration and adequacy of the FTS.
- FTS adjusted, when necessary, from information generated in monitoring the efficiency of the mechanism.
- Upward and downward migration of adults and offspring of eggs, juveniles and larvae guaranteed, even partially, by FTS, allowing the maintenance of fish stocks upstream and downstream of the dam.

Studies must be performed by the company's engineering team and serve as the basis for discussions and determination of characteristics that must be reproduced in the FTS. It is suggested the collection of information about Teotônio waterfalls, such as depth, flow, speed and oxygen, level and other parameters that are necessary for later reproduction in the lateral artificial canal (MESA, 2008).

According to Mesa (2008), the determination of migratory patterns before the dam will be essential for the definition of structural aspects of the FTS and for the improvement of the sampling design of the FTS monitoring study. To do this, it is necessary to analyze the following aspects:

- Which species pass through the Teotônio waterfall;
- What is the periodicity of the passage of these fish?
- By what region of the TeotônioCachoeira these species are passing, considering the width of the channel, the left and right margins, surface and bottom.

The first two aspects can be evaluated based on the data of the landing of the commercial fishery in the different points of the basin, coming from the subprogram of monitoring of the fishing activity. The definition of the migration site of the species in the Teotônio waterfall should be made with the help of a mobile echo sounder, which will be fixed in a steel cable from one margin to the other of the Madeira River, one upstream and the other downstream. The equipment will be moved along the width of the studied region of the Teotônio waterfall, registering the fish that are migrating (MESA, 2008).

One of the methodologies of success verification of fish migration is the monitoring of the species that ascend the FTS at points of observation, located strategically along the artificial channel in order to allow the capture of samples periodically. In the initial stage of the project, before FTS implantation, different forms of capture and marking (first and second year) that cause minimal damage to the fish should be tested, to better dimension the equipment and to adjust the procedure to be used, as well as of the location of capture points along the FTS (MESA, 2008)

The radio telemetry technique will be used to test the efficiency of the transposition system (FTS) and can be

tested to study the behavior of migratory species along the Madeira River if its viability is confirmed by a specialist. It should be pointed out that the team responsible for the Wildlife Conservation Program, the Mammalian Monitoring Subprogram, proposes the same methodology for the monitoring of aquatic mammals and, therefore, it is suggested the joint use of the monitoring stations that will be arranged by this subprogram along the Madeira River (MESA, 2008).

Initially, the most important species in local and regional commercial fishing are indicated for this activity and, according to studies already carried out (EIA / RIMA AHES Santo Antonio and Jirau, 2005), they will be more likely to have their migratory patterns affected by the enterprise. They are:

- *Brachyplatystomarusseuxii*(dourada);
- *Brachyplatystomavaillantii*(piramutaba);
- *Brachyplatystomaplatorynema*(babão);
- *Colossomamacropomum*(tambaqui);
- *Piaractusbrachypomus*(pirapitinga).

In addition to marking specimens in FTS, specific campaigns should be carried out to capture specimens to be tagged, having a duration of 10 days, occurring in the 1st, 4th and 7th years, and covering the harvest period of each of the selected species minimum 6 months per year). The beginning and periodicity can be reviewed according to the results obtained in the first years of implementation of this subprogram. Different points of capture and marking within the system should be selected, including the reservoir and the upstream and downstream environments of the project (MESA, 2008).

According to condition 2.6 of Prior License n ° 251/2007, repopulation of both endemic species and migratory species should be promoted if their mobility is impaired and FTSs are not effective for these species. In order to meet this constraint, a technical analysis of the situation of migratory and endemic fish populations and the real need for stocking and repopulation should be carried out in the first 8 years of PBA implementation, based on data from the other subprograms of the Program of Conservation and Rescue of Ichthyofauna (MESA, 2008).

It should be emphasized that repopulating fish communities is one of several mitigating alternatives for impacts generated by large enterprises, such as the construction of dams, which in most cases constitute insurmountable obstacles for most species of migratory fish. This type of mitigation action is necessary when environmental changes such as the loss of reproduction and growth sites are observed, which may lead to several negative changes in the fish populations, and consequently in the fishing activity (AGOSTINHO et al., 1992). However, the adoption of this type of management

strategy without previous knowledge of the diversity and ecological aspects of the species, the environmental support capacity, and the relationships among the species results, in the majority of cases, in damages to the ichthyofauna or in the adoption of harmless measures (MESA, 2008).

In this sense, at the end of 8 years, the Program for Conservation and Rescue of Ichthyofauna should indicate the monitored parameters to support the decision making on the implantation of the fish breeding center, including recommendations on technical and political measures in a way that the eventual implantation of the fish breeding centre will not constitute a new source of impacts for the ichthyofauna of the Madeira River (MESA, 2008).

3.4 FISH TRANSPOSITION SYSTEMS (FTSs)

One of the consequences of dams is the interruption of the migratory flow of fish. Thus, the absence of FTSs in the dam is responsible for the depletion or even disappearance of migratory fish species, as immeasurable consequences to the ecosystem and environment. These devices are basically composed of input, body conductors and output. Under the engineering gaze, it is intended to facilitate the reproductive or trophic migration of fish by overcoming natural or non-natural obstructions by passing a volume of water upstream, favored by the hydraulic gradient, under controlled conditions respecting flow speed, flow line and structure geometry to meet the fish's intrinsic needs without causing excessive fatigue (Martins, 2000).

There are, basically, the following types of FTS: ladder, elevators, sluice, water transport and other alternatives (MARTINS, 2000).

3.4.1 Fish Stairs or Successive Basins

The international denomination for this type of FTS is "fishway", "fishpass", or "fishladder" (MARTINS, 2000).

The fish ladder is chosen more frequently for the small hydroelectric plants and dams, due to its amplitude of attending different species. It is considered the most suitable device for migratory species (SANTO, 2005).

Designed to allow upstream to downstream travel, it can also be used in the reverse direction. In addition to fish, other organisms may use this type of passage, such as some aquatic mammals (SANTO, 2005).

Its operation basically consists of dividing the unevenness created by the dam into a series of reservoirs or tanks staggered sequentially in steps, creating a channel through which the fish can swim or jump from basin to basin. The steps have the purpose of dissipating the energy in a localized way and maintaining the water level in order to favor the rise of the fish with a reduction of fatigue (MARTINS, 2000).

3.4.2 Lifts for fish

These types of FTSs are called "fish lift" or "fish elevator". It consists of tank-buckets positioned in the downstream lake in a way to attract the fish operating in phases of transposition: the opening of the bucket for access of the species, lifting of the bucket with the fish, transportation and deposition of the fish upstream (MARTINS, 2000).

The elevator operates as a conventional lift. Its operation consists in attracting the fish to a compartment located downstream of the dam that is then raised upstream by a mechanical system, and this causes the fish to transpose obstacles without any effort. When the vessel reaches the top of the dam the fish are released into the reservoir. The efficacy of this device depends on the attractiveness at the entrance to the reservoir downstream of the dam (SOARES, 2012).

Still, according to Soares (2012), it is a device that works in cycles that can be divided into three phases:

- **Attraction phase** - where water flows through the catch tank that will take them upstream of the dam.
- **Elevation phase** - in which the lifting tank rises by rails to the upper part of the dam.
- **Fish exit phase** - the tank is tilted the fish are discharged directly into the reservoir or into a channel that will take them to a safe distance upstream, where they will find the best way to continue their migration.

3.4.3 Fish lock

It is a mechanical system that works with an interconnected conductor, upstream, in an appropriate way to attract the fish, operating in phases of transposition: closing of the exit and favoring the access of the species by the entrance, closure of the entrance, consequently entrapment of the fish; opening of the exit with flood of the enclosure and the passage of the species (MARTINS, 2000).

Fish are forced to rise through the elevation of the water level of a camera to which it was attracted; then open the gate that interconnects the chamber with the bayou and the fish are thus released. The operation of the locks should take into account that the time of the operating cycle is closely related to the number and species of fish to be promoted (SOARES, 2012).

For Soares (2012), the phases of a lock are described as:

- **Attraction Phase:** where the top and bottom sluices are opened and water flows through the locking structure to attract the fish to the capture camera;
- **Filling stage:** where the inlet gate is closed and the water level in the lower chamber rises to balance with the upstream water level, forcing fish to swim to the surface;
- **Fish exit phase:** it starts when the lower sluice is partially open and the upper sluice gate manipulates

an inflow of water to provide a flow of attraction for the fish to leave the chamber;

- **Emptying Phase:** Occurs when the top door is closed, allowing the camera to empty slowly, providing a new flow of attractiveness.

3.4.4 Bypass Channels

These types of passage resemble the natural attributes of the river, seeking to return the contact between the stretches of the upstream and downstream of the dam. This is why it decreases, usually 2 and 5%, where energy is dissipated through the rapids and the cascades arranged along the course of the water (SOARES, 2012).

For Santos (2005), they are suitable for all types of barriers, as long as there is sufficient space for their construction, and generally do not require changes in the dam. Because they are highly susceptible to variations in flow rates, gates are eventually constructed to maintain it inside the device.

According to Soares (2012), the advantage is that it gets integrated into the landscape, allowing the transposition of small fish and benthic invertebrates, creating new habitats as secondary biotopes for rheophile species; it is less prone to obstructions, which reduces maintenance, it is suitable for already built dams that do not have passage for fish, because normally no changes are necessary for the dam, they make possible for the migratory species to avoid almost the whole area of the reservoir, from the foot of the dam to the limit of the reservoir. However, there is a large demand for surface area, with fairly long channels, sensitive to flow variation, deep cuts may be required in the surrounding terrain.

3.5 FTS LEGISLATION IN BRAZIL

In 1982, the General Assembly of the United Nations, in resolution 37/7, known as the World Charter for Nature, recommends principles 2 and 4 (BRAZIL, 2016)

The genetic viability of the Earth should not be compromised, the population levels of all life forms, wild and domesticated, must be at least sufficient for their survival, and for this purpose habitats need to be safeguarded.

4. Ecosystems and organisms, as well as land, and marine atmospheric resources that are used by man should achieve and maintain optimum sustainable productivity, but not in a way that jeopardizes the integrity of other ecosystems or species with which they coexisted.

The first Law that regulates fish transposition devices is the São Paulo State Law No. 2,250, of December 28, 1927, which establishes in Article 16 measures related to hunting and fishing in the territory of the State

Article 16. - *All who, for any purpose, dam the waters of the rivers, streams and streams are obliged to build ladders that allow the free rise of the fish.*

§1.º - *These ladders shall be built through projects approved by the Agriculture Secretariat, which shall supervise their construction with the Animal Industry Board of Directors.*

§ 2º - *Failure to comply with the provisions of this article shall be punished by a fine of 1: 000 \$ 000, which shall be increased to double if the delay in the construction of the stairs exceeds three months counted from the subpoena by the Secretariat of Agriculture. "The fine will be applied every three months until the stairs are built.*

This Law determines the construction of fish ladders in all the impoundments, but without the proper technical knowledge.

For Soares (2012), this was determinant for many devices to be conceived in the wrong way causing many failures and raising doubts about the effectiveness of this type of device. Because of this generalization, fish ladders were mistakenly built up to falls up to 70 meters high, as in stream dos Negros (São Carlos-SP), or in streams where the ichthyofauna was composed of only sedentary species. CONAMA Resolution No. 001 of January 23, 1986, established one of the most important instruments of the National Environmental Policy, in which Law 6.938 of August 1981 made the Environmental Impact Study and the Environmental Impact Report mandatory. with potential environmental impacts. However, article 2, point VII presents:

VII- hydraulic works for the exploitation of water resources, such as: dam for hydroelectric purposes, above 10 mw, sanitation or irrigation, opening of channels for navigation, drainage and irrigation, rectification of watercourse, opening of bars and mouths, transposition of basins, dikes;

In this resolution, it is noticed that the subject of FTS and, therefore, the ichthyofauna, were placed in the background since only the dams for the generation of power above 10MW deserve attention regarding the environmental impacts.

Article 20 of Decree 38.744 of April 10, 1997, says that the environmental licensing of new dams, reservoirs and dams for hydroelectric power plants requires the construction of elevators or ladders for fish that propitiate piracema.

In 1998, Law No. 4,630 of Minas Gerais, would make mandatory to implement ladders for fish in dams built in the waterway of the union domain; it was presented to the Chamber of Deputies and after being processed for six years it was filed (SOARES, 2012).

3.6 MIGRATION OF FISH

Numerous species of freshwater fish perform, throughout their life cycle, complex movements known as migration. The simplest migratory pattern consists of the periodic displacement of young and adult fish from one place to

another, with a subsequent return to the origin or not. The most complex migratory patterns include displacement to a third or fourth site. Reproductive migration consists of displacement between two sites for reproductive purposes, and trophic migration is for food purposes (POMPEU, 2005).

Freshwater fish are classified in potamodromous when they migrate exclusively in freshwater. Diadromes migrate between sea and fresh water. The latter can be divided into catadromous when they live in freshwater and migrate to spawn in the sea, and anadromous when they live in the sea and migrate to spawn in freshwater (POMPEU, 2005).

In Brazil, migratory fish are more important for commercial and sportive fishing, mainly comprising species of the orders Characiformes (eg. Dourado, curimatás and pias), Siluriformes (eg. surubins, mandis and jaús), all of them potamódromas (POMPEU, 2005).

Migrating fish, that practice piracema, are extremely important. Curimatá (*Prochilodus scrofa*), has more than 30 species in South America and occupies about 50% of the fish stocks of the South American rivers. The famous Dourado (*Salminus maxillosus*), an important fish in regular and sports fishing and natural heritage of the Platinum Basin, weighing 30 kg and a length of more than 1.0 m (MARTINS, 2000).

The Madeira River is one of the main migratory routes for the diverse species of migratory fish that can travel from 50 to 5 thousand km to reproduce. This trip begins in the lower Amazon River, goes through Madeira and its tributaries to the headwaters of the Andes, Bolivia (SAE, 2016)

Important migratory fish participate in the economy of Rondônia, such as Bagre (large catfish), known as leather fish, and fish of scales, are of great importance for commercial fishing. These include Jaraquis, Curimatãs, Aracus and Pacus, with distribution in different extensions of the Amazonian rivers (SAE, 2016).

The piracema coincides with the summer rains, which begin in December. At that time, the fish swim against the stream to reach the head of the river and spawn. This is because in these headwaters the chances of survival of the fingerlings are higher (SAE, 2016).

The piracema can take up to 6 months and the fish are exhausted because of the obstacles they have to face. So, they become easy prey and many dies on the way. Those who survive, finished spawning, make their way back, alongside with the fingerlings, which seek the borders and calm waters to grow (SAE, 2016).

3.7 FISH SPECIES EXISTING IN THE MADEIRA RIVER AND THEIR IMPORTANCE FOR THE REGION

With 3 thousand km of extension, between the Andes mountains, in Bolivia, and the mouth of the Amazon River, Madeira is considered the river with the greater number of described species in the world. The diversity equates the number of species known throughout Europe, Oceania and Russia combined. In addition, current studies show that, alone, the river holds almost 20% of all known fish species on the continent (SAE, 2016).

The studies developed by the team of the company Santo Antônio Energy confirmed the existence of more than 970 species, out of a total of 3,000 species estimated for the entire Amazon basin. Some are rare and at least 40 were unknown to scientists. Considering the vocation for migration, these species are divided into 3 types: those of long migration (that search the Amazon estuary and then return); those of small migration (that circulate between the meadow and the channel of the rivers) and the typical fish of meadow and igapós, that do not migrate. Of the first case, there are Piramutaba and Dourada. From the second, Tambaqui, Pacu, Jaraqui and Curimatã. Among the fish that do not migrate are Pirarucu, Aruanã, Tucunare and Piranhas (SAE, 2014).

The most common species in the Madeira River are Tambaqui (*Colossomacropomum*), which can reach 90 cm in length and reach up to 30 kg; Pirarucu (*Arapaima gigas*), typical of the Amazon basin and Brazil's largest freshwater scale fish, measuring up to 2.10 m in length; Jatuarana (*Bryconamazonicus*), much sought after at sport fishing carried out in the region, being able to reach 1.0 m in length; Pintado (*Pseudoplatystomacorruscans*), is not native to the Amazon basin, however, its importance for Rondônia stems from fish farming (SAE, 2016).

Rondônia stands out as the largest producer of freshwater fish in the country. Fish farming is the fastest growing activity in the state in recent years. In the 2014/2015 harvest, it reached around 100 thousand tons, which corresponds to an increase of 400% compared to 2010. These fish are traded locally and also exported to other states. In addition, several riverside communities practice artisanal fishing for subsistence, recreational fishing is also a typical sport in the region (SAE, 2016).

3.8 MITIGATING AND PREVENTIVE MEASURES FOR THE PRESERVATION OF ICHTHYOFAUNA IN THE MADEIRA RIVER

According to Andrades & Canellas Energy S.A (2010), one of the most sensitive points in the construction of the Madeira River hydroelectric dams is the preservation of the ichthyofauna. At the time the Santo Antônio licensing was under discussion, the catfish preservation caused a national commotion and almost made the project unfeasible under pressure from public opinion. Santo Antônio Energy and Sustainable Energy in Brazil, owner of the Jirau plant, attacked several fronts. The work

included the monitoring of the migration routes of the main fish species of the Madeira River. The idea is to measure possible changes in schools and fishing during the construction of the plant. The work included marking four thousand fish with identification tags and radio telemetry equipment.

In addition to monitoring the migratory fish routes, the Santo Antônio plant constructed a fish transposition system to prevent their death if they were sucked by the adduction channel and passed through the turbines. The transposition system allows the fish to migrate upstream, passing the hydroelectric dam without the risk of dying. In Santo Antônio, R \$ 120 million were invested in the fish transposition system. The system consists of the construction of a channel in which water velocity is regulated by gabions - a type of wire cage filled with stones - that make the water speed ideal for the passage of fish (Doria et al., 2012).

For the development of artificial reproduction and rearing techniques for the repopulation of migrating fish from the Madeira River, a contract was signed in 2013 between the Instituto Tecnológico Peixes do Brasil (ITPB), Project Pacu Aquicultura Ltda. (PP) and Santo Antonio Energy S.A. - SAE. The basic objective of the project is to research and develop breeding techniques for migratory

fish from the Santo Antônio HPP insertion area, initially for Dourada (*Brachyplatystomarusseauxii*), Babão (*Brachyplatystomaplattynemum*) and Piraíba (*Brachyplatystomafilamentosum*). There is a program for the artificial creation of fingerlings of the species of catfish mentioned (dourada, piraíba, babão) that have a greater relevance. These fish are being captured and reproduced in a tank for a later release of the fingerlings in the Madeira river (SAE, 2016).

IV. METHODOLOGY

4.1 Studyarea

The study area was focused on the Fish Transposition System (FTS) of Santo Antônio Energia HPP. The structure that is located on the Ilha Do Presídio (prison island), near the right bank of the Madeira River in Porto Velho - RO has been in operation since December 2011, after filling the reservoir, it is about 900 meters long and ten meters wide in its main channel. The structure of the FTS is a fish ladder type. Pictures 01 and 02 consist of a corridor that reproduces the natural characteristics of the Madeira River waterfalls and the proportional flow similar to the river, adapting the fish to their natural habitat.



Picture 1. Satellite image showing the FTS of the Prison Island, with the downstream observed on the right of the image. Source: Google earth (2016).



Picture 2. Picture of one of the channels showing the FTS in the operating period.

Source: Authors of the research, 2015

The FTS of Prison Island (Picture 3) is a 2.5% tilt channel with two fish entrances located on both sides of the island, and a water/fish outlet located between the Complementary Spillway and the Group Generator 04 of Santo Antônio HPP. The FTS was mostly built on excavated rocks, and the stretches close to the entrance and exit are delimited by concrete walls. The passage of water through the sinks is given by a vertical groove in each of the sinks. In the entrance porches, there is a mitre-type gate for primary attraction control, and in the

water outlet, there is a wagon-like gate that allows the channel to be drilled. The water outlet is protected by a grid of openings of 0.80 x 0.80 m which prevents the entry of logs at the same time as it allows fish out. The STP also has an additional attraction water system, consisting of two independent water intakes and a water diffuser system that will feed both intake arms (SAE, 2012)

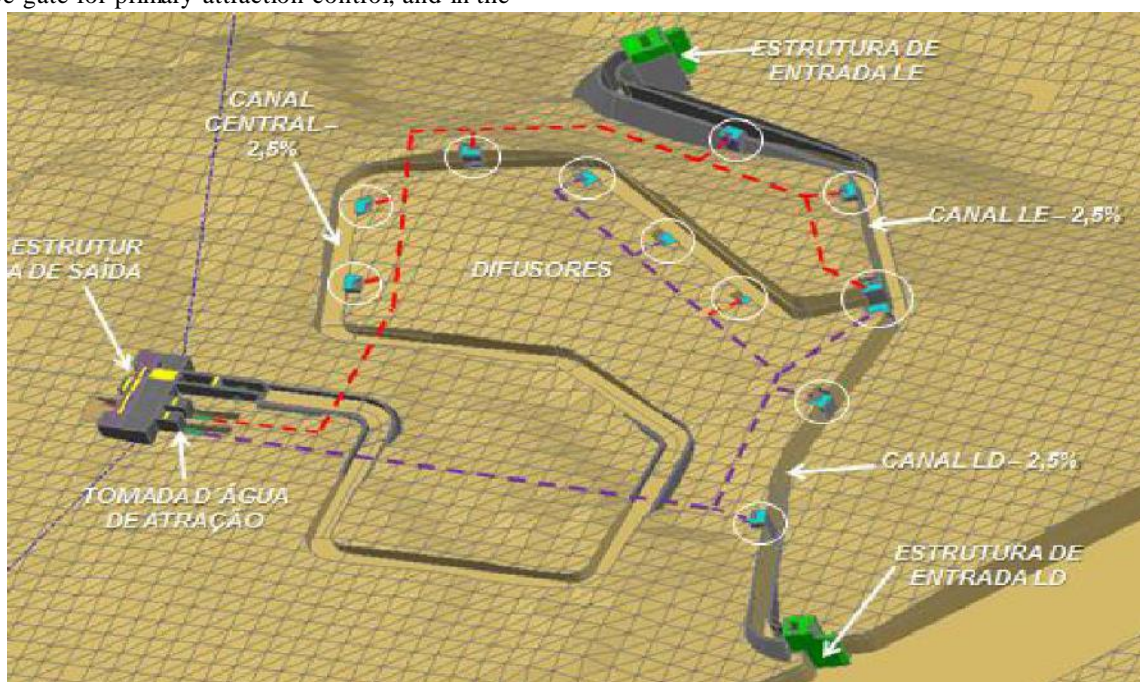


Figure 3. General arrangement of the STP of the island of Prison, in Santo Antônio HPP.

Source: SAE (2012).

4.2 Materials and procedures

The descriptive bibliographic review was defined as a methodology, since this method promotes the knowledge of the different scientific contributions about a certain theme, subsidizing support to all phases of the bibliographic research and any other type of research, helping to define the problem, determine the objectives, construct hypotheses and justify the conclusions of the surveys (MARCONI; LAKATOS, 2010).

The research consisted of a retrospective study, with the bibliographic research method, supported by a quantitative approach. Technical reports on monitoring in a FTS on the Madeira River were analyzed.

The data collection was done through the main technical reports available on the website of the entrepreneur Santo Antônio Energia S/A - SAE and the Brazilian Institute of Environment and Renewable Natural Resources - IBAMA and related to the implementation of the FTS, namely the Environmental Impact Assessment Report / Environmental Impact Report (EIAR / EIR) and the Basic Environmental Plan (BEP).

4.3 Data analysis

Based on available documents on the environmental subprogram of the FTS (environmental report), available technical reports on FTS monitoring in the periods 2011 to 2014, accounting for 07 consolidated reports between monthly, quarterly and half-yearly. The collected data will be organized through tables and analyzed individually.

V. RESULTS AND DISCUSSION

5.1 Pre-operation analysis of the fish transposition system (FTS)

According to data presented by Santo Antônio Energy (SAE, 2016) for the beginning of the filling of the reservoir, SAE performed selective manual capture and transposition of the target species, while the Fish Transposition System was not yet

in operation. The SAE submitted the final catch report from July 31 to December 5, 2011, which corresponds to the preoperative period of the Fish Transposition System (FTS) of the Prison Island. The specimens were captured 6 km downstream from the Santo Antônio dam and released upstream from the dam.

The report presents information on frequency, abundance and size class of the transposed target species. Among the orders, Characiformes abundance with 86.3% followed by Siluriformes (13.7%). The richness of Characiformes with 72.2%, Siluriformes with 27.8%. The data presented shows that the captured individuals of the order of Characiformes were adults, with more frequency in the last months of the year, whereas the Siluriformes were captured with a smaller class of sizes, being considered young specimens, mainly in the month of November / 2011 when the water level is highest on the Madeira River.

5.2 Operation analysis of the fish transposition system (FTS)

In compliance with conditions 2.27 and 2.28 of LO n° 1044/2011, the Fish Transposition System of the Santo Antônio HPP Prison Island started operating on December 1, 2011, on January 23, 2012, already operating with its normal quota (SAE, 2012).

After the starting the FTS, SAE undertook monitoring on January 12, 16 and 27, 2012, to identify which species were using the channel. The methodology used was the DIDSON sonar and a 5-meter diameter and 6.0-cm mesh between opposing nodes. The sonar identified the presence of fish in the canal, which was confirmed with the catches on the mesh. Table 1 represents 8 species of fish caught in the 4 slots during the sampling days.

Table 1. Species caught in the 4 slots during the sampling days in 01/2012.

ESPÉCIES	TOTAL
<i>Lithodoras dorsalis</i>	1
<i>Pirinampus pirinampu</i>	5
<i>Sorubim lima</i>	14
<i>Pimelodus blochii</i>	26
<i>Pimelodina flavipinnis</i>	1
<i>Sorubimichthys planiceps</i>	1
<i>Calophysus macropterus</i>	5
<i>Pseudoplatystoma fasciatum</i>	1
	54

Source: SAE (2012).

On 23/02/2012, the SAE realized a new experimental capture in the FTS. Thus according to Table 2, we obtained, as a result, the capture of 27 fish belonging to

10 species, present in the Transposition System as shown.

Table.2. Species captured in the FTS sampled in 02/2012.

ESPÉCIES	TOTAL
<i>Lithodoras dorsalis</i>	8
<i>Pinirampus pirinampu</i>	1
<i>Sorubim lima</i>	2
<i>Raphiodon vulpinus</i>	3
<i>Prochilodus nigricans</i>	1
<i>Pimelodus blochii</i>	3
<i>Pimelodina flavipinnis</i>	4
<i>Calophysus macropterus</i>	3
<i>Brachyplatystoma vailantii</i>	1
<i>Pseudoplatystoma punctifer</i>	1
	27

Source: SAE (2012).

In all, 21 species were recorded in the FTS from January to June of 2012. Of these, only the golden fish (*Brachyplatystoma orousseauxii*) was detected by radiotelemetry antennas and was not collected in the samplings.

The list of species and the months in which they were recorded in the FTS are shown in Table 1 (SAE, 2012).

Table 1. Species recorded in the FTS of the Santo Antônio HPP and its months of occurrence.

Scientific Name and Occurrence Months

January February March April May June July

Arcanthurus sp.

Brachyplatystoma platymerum

Brachyplatystoma orousseauxii

Brachyplatystoma vailantii

Calophysus macropterus

Duopalatinus peruianus

Hemisorubim platyrhynchus

Hypophthalmus marginatus

Pimelodina flavipinnis

Pimelodus blochii

Pinirampus pirinampu

Platysilurus mucosus

Prochilodus nigricans

Pseudostegophilus nemurus

Pseudoplatystoma punctifer

Pseudoplatystoma tigrinum

Pterodoras granulosus

Raphiodon vulpinus

Sorubim longatus

Sorubimichthys planiceps

Zungaro zungaro

Source: SAE (2012).

The reports presented for the first semester of 2012, demonstrated the capture methodologies used for monitoring, with nets of 5-meter diameter and 6.0cm to 6.5cm mesh between opposing nodes and waiting nets with 25 meters in length, 3 meters in height and 18 mesh. Catches with the aid of a boat, four fishing rods and natural baits, in the drowned part downstream in the FTS.

In addition to sonar use (DIDSON). Biometric and telemetric measurements were also taken.

According to the reports, during the monitoring in May / 12, trapped and dead fish were observed between baffles 17 and 32, as there are screwing points on both sides of the FTS and fast water flow. The loss of rocks from the deflectors opens space for entry and entrapment of fish. In the June / 2012 report, it was evidenced that the flow is a

variable that influences the increase or decrease of fish attraction in the FTS. The graphs suggest that at high flows, provided by the Madeira river, catches are more effective (IBAMA, 2012).

The annual consolidated report of 2012 presented by the SAE shows, in all, 49 species that have been registered in the FTS since January 2012. The species registered inside the FTS through experimental fisheries or radiotelemetry are shown in Table 2.

According to the consolidated technical report of 2012, SAE cites as main results

- All 49 species recorded in the FTS have rheophilic behaviour. Most have migratory behaviour known to the species or closely related species.
- Of the 48 species caught in the experimental fisheries, 08 were caught in all petrichor, 11 exclusively with pots and 02 with hooks. Gillnet had no exclusive species;
- From the beginning of the radiotelemetry technique tests for fish of the Madeira River, 292 individuals, most belonging to the species of Dourado (*B. rousseauxii*) and Babão (*B. platynemum*), were marked. Another 98 individuals shall be marked before the end of the high-water season. Considering that the batteries of the radio transmitters are still within the useful life, 380 individuals will be monitored by the program;
- The Dourado fish (*Brachyplatystoma rousseauxii*) was detected only by radiotelemetry antennas and was not collected in the samplings. There are monthly records of incursions of individuals of this species in the initial stretch of the FTS channel since May, being detected only by the first two antennas connected to base 0800. In recent months, however, these individuals were detected upstream by the third base antenna 0800 and approaching the antenna detection zone of base 0910; The Babão (*B. platynemum*) and piramutaba (*B. vailantii*) were not detected by radio telemetry antennas, but were

collected by the waiting nets and trays within the FTS channel near the exit. These species were also monitored with radio transmitters, but fewer individuals were tagged, compared to the golden fish (*B. rousseauxii*) and filhote (*B. filamentosum*).

- The decision to mark a lower number of individuals of the species Babão (*B. platynemum*) and piramutaba (*B. vailantii*) is due to the smaller size of these individuals, which allows them to be captured using standardized samplings (nets and pots). On the other hand, more specimens of dourada (*B. rousseauxii*) and Filhote (*B. filamentosum*) - large species that are difficult to capture in experimental fisheries - can be marked by radio telemetry monitoring. At present moment, however, the efforts of marking new individuals are concentrated in the target species of the monitoring: Golden fish (*B. rousseauxii*) and Babão (*B. platynemum*);
- In addition to the individuals detected inside the FTS, individuals of Dourada (*B. rousseauxii*) and Filhote (*B. filamentosum*) are frequently detected in the entrance of the FTS and in the Escape Channel of the Power House 01, to where the right margin entrance of the FTS is located. This indicates that individuals were able to find the way to the System;
- 02 individuals tagged with radio transmitters and 36 with hydrostatic markings (LEA) were captured by amateur or professional fishers, who returned the marks to the monitoring team along with data on the fish and capture site. Most of these recaptures occurred downstream, some more than 70 km from the release site. All fish marked during manual transposition were recaptured less than 1 year from the release date, with approximately 90% being caught less than 03 months after the release upstream.

Table 2. Species recorded in the FTS of the Santo Antônio HPP, in the Prison Island, from January to December of 2012.

Sort	Family	Species
Characiformes	Anostomidae	<i>Leporinustrifasciatus</i> <i>Rhytiodus argenteofuscus</i> <i>Schizodon fasciatus</i>
	Characidae	<i>Triporthesus angulatus</i> <i>Triporthesus elongatus</i> <i>Brycon amazonicus</i>
	Curimatidae	<i>Potamorhina altamazonica</i> <i>Potamorhina latior</i> <i>Psectrogaster</i> sp.
	Cynodontidae	<i>Cynodon gibbus</i>

		<i>Hydrolycusscomberoides</i> <i>Rhaphiodonvulpinus</i>
	Hemiodontidae	<i>Anoduselongatus</i> <i>Hemiodussp</i>
	Prochilodontidae	<i>Prochilodusnigricans</i>
	Serrasalmidae	<i>Colossomamacropomum</i> <i>Mylossomaaureum</i> <i>Mylossomaduriventre</i> <i>Piaractusbrachypomus</i> <i>Serrasalmusrhombeus</i>
Clupeiformes	Pristigasteridae	<i>Pellonacastelnaeana</i>
Perciformes	Cichlidae	<i>Chaetobranchusflavescens</i>
	Cetopsidae	<i>Cetopsis candiru</i>
	Doradidae	<i>Oxydorasniger</i> <i>Pterodorasgranulosus</i>
	Loricariidae	<i>Acanthicussp.</i> <i>Panaquecf.bathyphilus</i> <i>Squaliformaemarginata</i>
Siluriformes	Pimelodidae	<i>Brachyplatystomaplattynemum</i> <i>Brachyplatystomatigrinum</i> <i>Brachyplatystomarousseauxii</i> <i>Brachyplatystomavaillantii</i> <i>Calophysusmacropterus</i> <i>Duopalatinusperuanus</i> <i>Hemisorubimplatyrhynchus</i> <i>Hypophthalmusedentatus</i> <i>Hypophthalmusmarginatus</i> <i>Leiariusmarmoratus</i> <i>Phractocephalushemiolipterus</i> <i>Pimelodinaflavipinis</i> <i>Pimelodusblochii</i> <i>Pinirampuspirinampu</i> <i>Platynematichthysnotatus</i> <i>Pseudoplatystomapunctifer</i> <i>Sorubimelongatus</i> <i>Sorubim lima</i> <i>Sorubimmaniradii</i> <i>Zungarozungaro</i>
	Trichomycteridae	<i>Pseudostegophilusnemurus</i>

Source: SAE (2012)

According to the second consolidated report of 2012, the results of the monitoring presented makes it clear that migratory species were present throughout the FTS, although the presence of species along the PTS does not guarantee that they will complete the FTS crossing to reach the reservoir. In this sense, it will be necessary to adopt more effective monitoring measures to verify their passage to the reservoir. Another concern is the target species mentioned in the PBA and IBAMA conditions such as Dourada, Babão and Piraíba, which were not

registered in any of the monitoring campaigns in the first year of operation of the FTS.

According to the other semiannual technical reports from 2013 to 2014, SAE cites as main activities and results:

- Continuation of the telemetric monitoring of the fish movement in the surroundings of the HPP and the passage to the FTS through the fixed bases and antennas in boats;
- Evaluation of the presence of fish in the FTS and surroundings with the aid of echo sounder (DIDSON);

- Recordings of the movement of Bagres (catfish) in front of different structures of the HPP. As the mines were removed and the water reached the new structures, it was possible to observe the exploratory behaviour of the tagged fish that, after a time, began to make regular use of the area;
- Recorded tagged fish remain mostly in the downstream area, and have not left the area downstream or upstream. Most of the records occurred in the mobile tracking downstream stretch, which covers the area from 2.0 km to 10.0 km downstream of the bus;
- In the months of February and March 2014, no downstream mobile telemetry monitoring was performed due to the risks caused by the flood;
- Due to the large flood in the Madeira River that connected the lower section of the FTS to the channel of escape over the channel wall, no experiments of individuals release marked inside the channel were performed;
- There was a return of fish marks, captured by professional fishermen active in the region;
- There were fish rescues carried out in the upper section of the FTS after the preventive closing of the channel, due to the possibility of an order from the National Electric System Operator (ONS) to lower the NA of the reservoir to levels that would not allow water intake through the canal, which would eventually dry up. Aiming at the protection of the ichthyofauna that makes use of the stretch, and that would end up imprisoned in places without water if the water intake of the FTS was interrupted, controlled draining and rescue of fish was carried out (in the first 330m of the canal). From March 06 to 08, 10-15 tons of live fish were released in the stretch downstream of the FTS, where the NA of the escape channel would guarantee water supply. The drainage revealed a big number of large individuals that were not captured during monitoring due to the selection of equipment, mainly Pirarara, Jaú, Surubim and Caparari species, and it was surprising due to the virtual absence of characiforms in the stretch. After confirmation that the order to lower reservoir would not be emitted by the ONS, the normal flow of the FTS was established with the removal of the protection nets. As soon as the nets were removed, a large school of Curimatãs was sighted in the FTS, easily distinguishable due to the behaviour of jumping out of the water when meeting the fast waters in the Gabion slits.
- Due to the large flood in the Madeira River, the deflectors that make up the structure of the canal were damaged and there was a great accumulation of sediment in the canal. Therefore maintenance was scheduled for the period of least interference on fish

migration. After the recovery of the channel tests will be carried out on an experimental release of individuals, proposed in the recommendations of the report.

Fish retrieval was performed in the main FTS channel after closing and drainage for maintenance and cleaning after exceptional flooding. It is estimated that 192,900 kg of live fish were released upstream of the dam (with the exception of Piramutaba). The reduction of the attractiveness by the reduction of the flow inside the channel was aimed at reducing the quantity of fish to be rescued. This action reduced the catch of large individuals, who are not attracted by reduced flows compared to the attractiveness of the spillways. Thus mostly medium and small specimens were collected.

According to SAE (2015), the monitoring of the Fish Transposition System of the Prison Island is carried out through radiotelemetry, by experimental fisheries and through the results of rescue activities carried out to prevent the interruption of the water flow due to the exceptional flood occurred in 2014 or for maintenance of the baffles that make up the channel.

With the use of all these methodologies, from January 2012 to December 2014, 65 species of fish have been recorded in the FTS. 85% of the registered species present rheophilic behaviour, being migrators of long or short distance. Only Dourada (*Brachyplatystomatus*) was detected exclusively by radiotelemetry antennas, not being collected in the samplings nor in rescue activities (SAE, 2015).

According to SAE's Consolidated Report of 2014, the monitoring of Migratory Fish with Telemetry in the Fish Transposition System of the Prison Island and in the Madeira River downstream of Santo Antônio HPP, 266 individuals were marked with transmitters (SAE, 2015).

In the fixed bases, it was possible to register 212,815 valid detections of 28 individuals of the Dourada, Filhote, Babão, Jaú and Surubim species, downstream of the dam or at the entrance and lower section of the FTS. A total of 903 positions of 51 individuals were registered downstream of the UHESA dam with the use of mobile tracking. Of the 51 individuals detected in the mobile tracking, eleven were also detected in the fixed bases along the UHESA dam. Although there is no record of output per amount of tagged fish (other fish were recorded leaving the FTS upstream with DIDSON since 23/01/2012), the result shows that the fish were able to find the way to the FTS, despite the fact that only one of the inputs is operating (the other input will be operating from the downstream filling of the GG4 enclosure, foreseen for the second half of 2015) (SAE, 2015).

Between January and March 2015, 100 Douradas were labelled with radio transmitters and released downstream in two portions of the STP. Displacement data will be

collected by May 2015 and results will be presented in the next consolidation report (SAE, 2015).

The objectives of the Fish Transposition Sistem Monitoring Subprogram are being met according to the analyzes and technical suggestions transcribed in the EIA / RIMA, PBA and IBAMA conditions for the Santo Antônio HPP regarding the conservation of the Madeira River ichthyofauna. The monitoring results show that up to now, some individuals of target species within the FTS and upstream of the dam have not been detected, suggesting that these tagged individuals were unable to climb into the transposition system and transpose the bus, a partial inviability for migrating species of long distances as the orders Siluriformes and Characiformes, having as Madeira river migratory route for these species.

VI CONCLUSION

According to the first consolidated annual report from 2012, presented by Santo Antônio Energia (SAE), corresponding to the first year of operation of the Fish Transposition System (FTS), in all, 49 species were recorded in the FTS through experimental fisheries or by radiotelemetry. A total of 292 individuals were identified, most of them belonging to the Dourado species (*Brachyplatystomaron rousseauxii*), considered as one of the target fish cited in the Basic Environmental Program (BEP). Individuals such as Dourada (*B. rousseauxii*) and Filhote (*B. filamentosum*) were frequently detected at the entrance of the FTS, where the entrance to the right margin of the FTS is located. Some target species, such as The Babão (*B. platynemum*) and the Piramutaba (*B. vailantii*), were not detected by radio telemetry antennas but were collected with waiting nets within the FTS channel, even near the exit. The results of the first year of monitoring presented evidence of some migratory species along the FTS.

The data presented through the reports from January 2012 to December 2014 have already registered 65 species of fish in the FTS, and 85% of the registered species have a rheophilic behaviour, that is, migratory fish of long or short distance. Only the Dourada (*Brachyplatystomaron rousseauxii*) was detected exclusively by radiotelemetry antennas, not being collected in samplings nor in rescue activity as methodological forms of monitoring.

According to the technical reports consolidated by SAE, the goals for the monitoring of the FTS are being met according to the analyzes and technical suggestions transcribed in the EIA / RIMA, PBA and IBAMA conditions for the implementation of the Santo Antônio HPP in the Madeira River. However, the first results of the monitoring show that up to now, some individuals of target species within the FTS and upstream of the dam

have not been detected, concluding that these tagged individuals are not able to overcome the transposition system and transpose the bus, making this system at first a partial impossibility for species of long-distance migrating fish such as some Bagres of the Siluriform and Characiform Orders.

However, the use of hydraulic potentials for the generation of electric energy and the use of natural resources must be done in a harmonic way, in a way that one activity doesn't eliminate the possibility of the other. Nonetheless, the expansion of the hydraulic utilization of the Amazon Basin rivers in the construction of dams can change the life cycle of the ichthyofauna that uses the rivers as a migratory route for its displacement, essential for its feeding and reproduction, generating problems for the economy of the region around rivers and for the local ecological balance.

The costs of implementation, maintenance and analysis of the efficiency of installed mechanisms for the continuity of fish migration in rivers, such as FTSSs, are insignificant in relation to the value of the electric energy generated, without changing the energy viability nor the operational costs of the hydropower plants projects. Therefore, it is an instrument that, well designed, can mitigate the impacts caused by dams on the local ichthyofauna.

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Comparison of Deflection Patterns of Simply Supported and Fixed Supported Beam Structures

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Abstract— When designing a building, the most of the important component is the roof. The selection of roofs for building depends on factors like type of building, type of foundation, roofing materials, roof loads, the climate, economy, the availability of materials, and the ease of construction. This study is focused on gable roof structures with two different supported structures of the ridge beam which are known as simply supported ridge beam structure and fixed supported ridge beam structure. The simply supported structure can be defined as the ends of the ridge beam are formed to stand freely on supports and the fixed supported structure can be defined as the ends of the ridge beam are supported to restrain against rotation and vertical movement. The study is considered jack wood beams which have the same length as 198 inches (5.03m) but have different cross-sectional area; $2 \times 4 \text{ inch}^2$, $2 \times 5 \text{ inch}^2$, $2 \times 6 \text{ inch}^2$, $3 \times 4 \text{ inch}^2$, $3 \times 5 \text{ inch}^2$ and $3 \times 6 \text{ inch}^2$. Further 11 Jack wood rafters which have the length 144 inches (3.66m) and cross sectional surface area $2 \times 3 \text{ inch}^2$ are used. Two Jack wood king post trusses that have kingposts with the length 30 inches (0.7m) are used for fixed supported structure to fix the beam between two supporters. The roof pitch angle is approximately 30° . According to general fact, the deflection value of simply supported beam is higher than the deflection value of fixed supported beam.

In this study, an attempt will be made to investigate the deformation of the ridge beam when it is simply supported and fixed supported and from that observe the optimum supported structure that can be used to design a roof of a building more constructive manner. Moreover by using the results, the validity of the general fact can be also proved. The major mathematical part in this study is to generate the model to calculate deflection of the ridge beam when it is simply and fixed supported by using Euler-Bernoulli Beam theory and Fourier series.

The results showed that the deflection value of simply supported beam around 0.8-0.04 m and the deflection value of fixed supported beam around 0.008-0.001 m. According to results, the study was confirmed the general

fact of the deflection values of simply supported beam structure has higher than fixed supported beam structure.

Keywords— Euler-Bernoulli Beam theory, Simply supported, Fixed supported, Fourier Series.

I. INTRODUCTION

Nowadays there are several kinds of roofs. Each of those has advantages and disadvantages depending on the same factors like climate, durability, availability of materials and ease of the construction. In this study is focused on the gable roof that has two different supporting structures of ridge beam which is known as couple roof and closed couple roof. In the couple roofs, the ridge beam laid on the end walls and so it is considered as the simple supported structure and in the closed couple roof, the ridge beam join directly to king posts by the mortise and tenon joinery at the two ends of the ridge beam. In modern days there is a huge trend on using closed couple roof when designing buildings like hotel cabanas, summerhouses and lobbies. Results of this study are proved how the variation of those two types when considering the deformation is.

II. METHODOLOGY

The Euler- Bernoulli beam theory is the one of the best method to calculate the behavior of the beam when a load is applied on the beam. By using the Euler-Bernoulli Differential Equation and Fourier series, general expressions for following structures can be constructed respectively. Then different deflection values can be obtained by applying those constructions to the real situation as stated above.

Consider the Euler-Bernoulli Differential Equation

$$\frac{d^4 y(x)}{dx^4} = \frac{1}{EI} q(x) \quad (1)$$

where $y(x)$ - Deflection function. (m)

$q(x)$ - Deflection pressure per unit length at point x . (N)

E - Modulus of Elasticity of the beam. (Nm^{-2})

I - Moment of inertia of the beam. (m^4)

Then expand $q(x) = q$ into the Fourier sine series

$$q(x) = q = \sum_{n=1}^{\infty} q_n \sin\left(\frac{n\pi x}{L}\right) \text{ where}$$

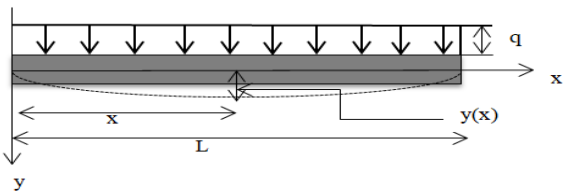
$$q_n = \frac{2}{L} \int_0^L q \sin\left(\frac{n\pi x}{L}\right) dx \quad n=1, 2, 3, \dots$$

$$q_n = \frac{2}{L} \int_0^L q \sin\left(\frac{n\pi x}{L}\right) dx = -\frac{2q}{L} \left[\frac{\cos \frac{n\pi x}{L}}{\frac{n\pi}{L}} \right] \quad (2)$$

Fig. 1

$$= -\frac{2q}{n\pi} [1 - \cos(n\pi)]$$

Note the direction of the y-axis, which was chosen to make $y(x)$ positive. It is uniformly loaded q per unit length. The axis of a beam deflects from its initial position under the action of applied forces.



As the first step this paper is focused to obtain maximum deflection values of the Jack wood beam when it is simply supported. Consider the following figure of simply supported beam.

The general expression for $y(x)$ of simply supported beam is

$$y(x) = \sum_{n=1}^{\infty} a_n \sin\left(\frac{n\pi x}{L}\right) \quad (3)$$

The fourth derivative for $y(x)$ is

$$\frac{d^4 y}{dx^4} = \sum_{n=1}^{\infty} a_n \left(\frac{n\pi}{L}\right)^4 \sin\left(\frac{n\pi x}{L}\right)$$

$$\sum_{n=1}^{\infty} a_n \left(\frac{n\pi}{L}\right)^4 \sin\left(\frac{n\pi x}{L}\right) = \frac{1}{EI} \sum_{n=1}^{\infty} q_n \sin\left(\frac{n\pi x}{L}\right)$$

When n is even, $a_n = 0$ and when n is odd,

By (1), (2) and (3),

$$a_n \left(\frac{n\pi}{L}\right)^4 = \frac{1}{EI} \frac{4q}{n\pi}$$

$$a_n = \frac{4qL^4}{EIn^5\pi^5}$$

Hence

$$y(x) = \frac{4qL^4}{EI\pi^4} \sum_{n=1,3,5,\dots}^{\infty} \frac{1}{n^4} \left(\frac{x^2}{L^2} - \frac{x}{L} + \frac{1}{n\pi} \sin\left(\frac{n\pi x}{L}\right) \right)$$

As the second step this paper is focused to obtain maximum deflection values of the Jack wood beam when it is fixed supported.

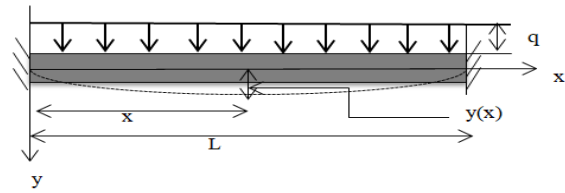


Fig. 2

The general expression for $y(x)$ of fixed supported beam is

$$y(x) = \sum_{n=1}^{\infty} a_n \left\{ -\left(\frac{x^3}{L^3} - \frac{2x^2}{L^2} + \frac{x}{L}\right) - (-1)^n \left(\frac{x^3}{L^3} - \frac{x^2}{L^2}\right) + \frac{1}{n\pi} \sin\left(\frac{n\pi x}{L}\right) \right\}$$

The fourth derivative for $y(x)$ is

$$\frac{d^4 y}{dx^4} = \sum_{n=1}^{\infty} a_n \left(\frac{n^3 \pi^3}{L^4}\right) \sin\left(\frac{n\pi x}{L}\right) \quad (4)$$

$$\sum_{n=1}^{\infty} a_n \left(\frac{n^3 \pi^3}{L^4}\right) \sin\left(\frac{n\pi x}{L}\right) = \frac{1}{EI} \sum_{n=1}^{\infty} q_n \sin\left(\frac{n\pi x}{L}\right)$$

When n is even, $a_n = 0$ and when n is odd,

By (1), (2) and (4),

$$a_n \left(\frac{n^3 \pi^3}{L^4}\right) = \frac{1}{EI} \frac{4q}{n\pi}$$

$$a_n = \frac{4qL^4}{EIn^4\pi^4}$$

$$\text{Hence } y(x) = \frac{4qL^4}{EI\pi^4} \sum_{n=1,3,5,\dots}^{\infty} \frac{1}{n^4} \left(\frac{x^2}{L^2} - \frac{x}{L} + \frac{1}{n\pi} \sin\left(\frac{n\pi x}{L}\right) \right)$$

III. RESULTS

The MATLAB software is used to get deflection values that related to different situations and from that to draw deflection curves for each situation. The results were obtained simple supported structure and fixed supported structure separately.

Results for simply supported beam:

- 1) Beam with cross-sectional area $2 \times 4 \text{ inch}^2$

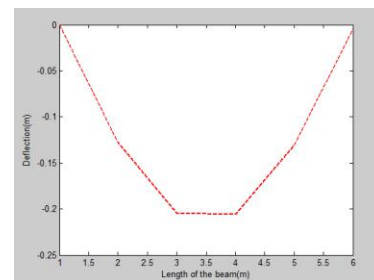


Fig.3

- 2) Beam with cross-sectional area $2 \times 5 \text{ inch}^2$

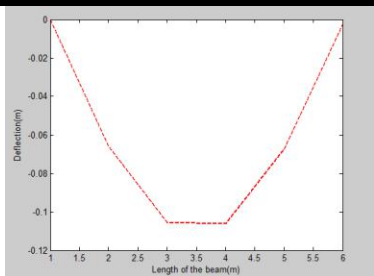


Fig.4

3) Beam with cross-sectional area $2 \times 6 \text{ inch}^2$

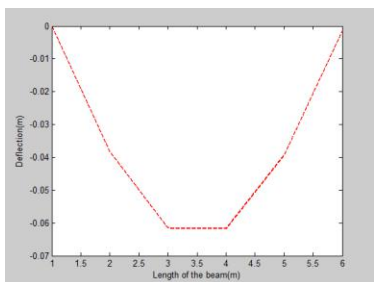


Fig.5

4) Beam with cross-sectional area $3 \times 4 \text{ inch}^2$

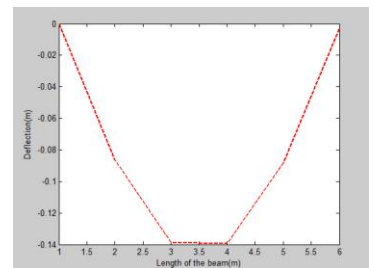


Fig.6

5) Beam with cross-sectional area $3 \times 5 \text{ inch}^2$

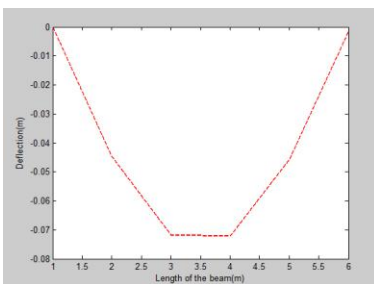


Fig.7

6) Beam with cross-sectional area $3 \times 6 \text{ inch}^2$

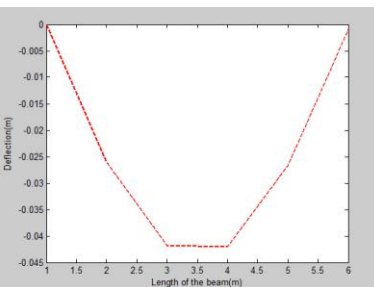


Fig. 8

Results for fixed supported beam:

1) Beam with cross-sectional area $2 \times 4 \text{ inch}^2$

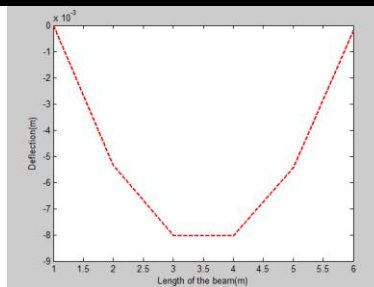


Fig. 9

2) Beam with cross-sectional area $2 \times 5 \text{ inch}^2$

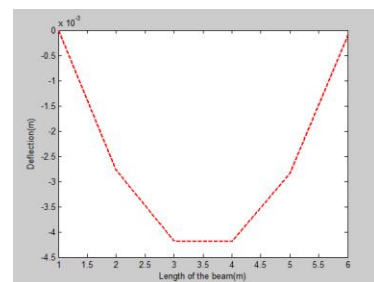


Fig. 10

3) Beam with cross-sectional area $2 \times 6 \text{ inch}^2$

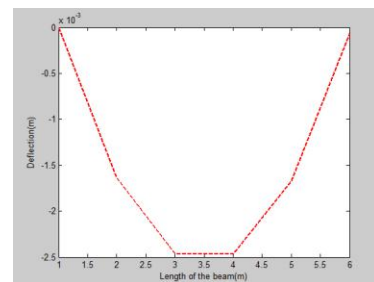


Fig. 11

4) Beam with cross-sectional area $3 \times 4 \text{ inch}^2$

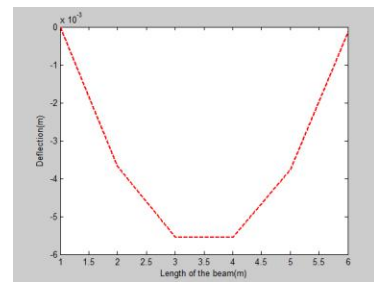


Fig. 12

5) Beam with cross-sectional area $3 \times 5 \text{ inch}^2$

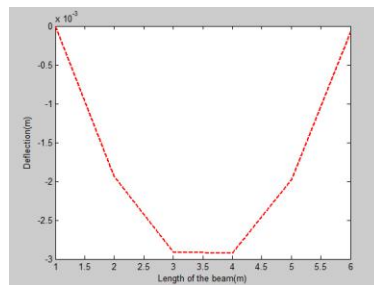


Fig. 13

By considering all graphs of deflection following tables can be constructed.

The Table 1 is represented the deflection values for simply supported beam and the Table 2 is represented the deflection values for fixed supported beam.

Table 1:

The cross-sectional area of the beam (inch ²)	The Maximum deflection (m)
2x4	0.2059
2x5	0.1062
2x6	0.6181
3x4	0.1392
3x5	0.7208
3x6	0.0421

Table 2:

The cross-sectional area of the beam (inch ²)	The Maximum deflection (m)
2x4	0.0080
2x5	0.0042
2x6	0.0025
3x4	0.0056
3x5	0.0030
3x6	0.0017

IV. CONCLUSIONS

According to above result, the maximum deflection values are occurred around 0.8-0.04 m when the beam is simply supported and the maximum deflection values are occurred around 0.008-0.001 m when the beam is fixed supported. From that the general fact which is mentioned above is proved very straightforward manner. Therefore the study shows the significance of using fixed supported structure when designing a roof.

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Trailing Boom on Fungicides Application on Wheat, Bean and Soybean

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Abstract— This study aimed to determine the influence of air-assisted and trailing boom technologies on fungicide applications to control diseases incidence and severity on wheat, bean and soybean. The experiments were conducted in three different sites in the Campos Gerais (PR) region in a completely randomized blocks design. In the wheat crop season of 2011, the treatments were: i) control (no fungicide application on the plants); fungicide spray with ii) nozzles in conventional ground boom sprayer; iii) nozzles in trailing boom; and iv) nozzles in conventional boom sprayer + trailing boom simultaneously. In the bean and soybean crop season of 2011-12, we added an extra treatment of boom with air-assisted sprayer, since the farmers had this technology available. We conclude that at the area under the disease progress curve (AUDPC), the diseases controlled with fungicides presented lower severity and incidence compared with the control treatment for all the crops evaluated. The fungicide spraying technology aggregated to air-assisted and trailing boom did not differ from the conventional boom sprayer for disease control and yield components of wheat, beans and soybeans.

Keywords— application technology; *Glycine max*; *Phaseolus vulgaris*; *Triticum aestivum*.

I. INTRODUCTION

With the constant population growth, the necessity of food production becomes each year more important. In Brazil, bean, soybean and wheat crops account for approximately 56% of the total grains produced in 2015/16. In this crop season, wheat reached a mean crop yield of 2.941 kg ha⁻¹ in the 2.1 million ha cultivated. In the same way, bean crop was cultivated in 2.8 million ha achieving a mean productivity of 907 kg ha⁻¹ while soybean was cultivated in 33.3 million ha with mean yield of 2.870 kg ha⁻¹ (CONAB, 2016).

The use of appropriate management techniques together with good genetic materials can lead to higher crop yields. However, the occurrence and incidence of

diseases stands out as one of the main limiting factors for crop productivity. In the integrated pathogens management, the use of appropriate techniques to place the pesticides in the targeted pathogen is crucial for an effective disease control (Garcia et al., 2002; Souza et al., 2014; Garcia et al. 2016).

Once the need for chemical control is determined, the success of a phytosanitary treatment program in agriculture depends fundamentally on the use of a product with proven efficacy and a technology developed for its application (Vieira et al., 2012; Cunha et al., 2014; Tackenberg et al., 2016).

Pesticide application technology is defined as the use of all scientific knowledge in order to provide the correct placement of the biologically active product in the target. This must be conducted with the appropriate amount of product, with maximum economy and with minimum environmental damage (Matthews, 2014).

Since the movement of most of the fungicides is via xylem and the initial development of most of the diseases occurs on the plant base, it is intended that the spray reach the lower third of the plants. Due to their local systemic action, some fungicides are translocated only in small distances on the plant leaf. Therefore, a good coverage is needed in order to obtain a maximum control efficiency (Cunha et al., 2011; Lehoczki-Krsjak et al., 2013; Liu et al., 2014).

Application of phytosanitary products with ground boom sprayers in association with air assistance technology are a recognized strategy to facilitate the target coverage and reduce the weather conditions influence (Matthews, 2004; Garcia et al., 2004; Guedes et al., 2012). Testing the technology in bean crop, Baesso et al. (2011) found that air assistance on the boom sprayer significantly increased the crop yields. In soybean, Aguiar Júnior et al. (2011) concluded that air-assisted spraying contributed for the control of Asian rust (*Phakopsora pachyrhizi* Syd. & Syd.), increasing in this way the crop productivity.

Another promising spraying technology is the trailing boom, commercially called "kit alvo[®]". The principle of the application technique is to couple to the conventional boom sprayer, a rod with hydraulic circuit and application nozzles to be entrained on the crop rows (Figure 1). With the plants movement by the trailing boom, it is expected to achieve a greater penetration of the droplets into the crop canopy, better coverage by the product and reduction of the weather conditions influence (Bueno et al., 2014).

In the experiment carried out by Alves and Cunha (2011), the authors verified better leaf coverage of the plants upper third and mass of thousand grains due to the use of auxiliary boom. The coverage of the bottom leaves; the droplet density and crop yield were not influenced by the use of the auxiliary boom. In soybeans, Weirich Neto et al. (2013) concluded that trailing boom spraying did not significantly affect yield components compared to the conventional boom. Also in soybean, Ozkan et al (2006) tested several spraying equipment for fungicide application and concluded that the air-assisted boom and crown opener presented better coverage and deposition in comparison to conventional boom. The objective of this study was to evaluate if the spraying of fungicides with ground boom sprayer with the aggregated technologies of air assistance and trailing boom affect the incidence and severity of diseases and yield components in wheat, soybeans and soybean crops.

II. MATERIALS AND METHODS

2.1 Wheat crop (*Triticum aestivum*L.)

The experiment was carried out in the crop season of 2011 at the farm "Paiquerê", located in the municipality of Piraí do Sul – PR (Brazil), with geographical coordinates 24°21'15"S, 50°6'8"W, Cfb climate, 910 m of altitude, with wheat cultivation conducted in no-tillage system, on a dystrophic Yellow Red Latosol (EMBRAPA, 2013).

The experimental completely randomized block design, with four treatments and five replicates. The treatments consisted of: i) control (no fungicide spraying); chemical control of leaves and spike of diseases with ii) nozzles in conventional ground boom sprayer; iii) nozzles in trailing boom; and iv) nozzles in conventional boom sprayer + trailing boom simultaneously.

The seeding of Abalone[®] wheat cultivar occurred on July 8, 2011, with an initial population of 2,300,000 ha⁻¹ plants at 15 days after emergence (15 DAE). The cultivar is susceptible to leaf rust (*Puccinia triticina* Eriks.). The following diseases occurred: yellow spot (*Drechslera tritici-repentis* Died.), leaf rust and giberela (*Gibberella zeae* Schw.), which were controlled by the five fungicides spraying treatments.

The first fungicide application was performed at the tillering stage (Large, 1954) using 0.3 L ha⁻¹ of Priori Xtra[®] (200 g L⁻¹ of Azoxistrobina and 80 g L⁻¹ of Ciproconazol), 0.7 L ha⁻¹ of Propiconazole Nortox[®] (250 g L⁻¹ of propiconazol), 0.03 L ha⁻¹ of the surfactant Aller Biw[®] and 0.3 L ha⁻¹ of mineral oil Nimbus[®].

The second spraying operation was carried out at the stage of stem elongation (Large, 1954) with 0.3 L ha⁻¹ of Priori Xtra[®], 0.03 L ha⁻¹ de Aller Biw[®] and 0.3 L ha⁻¹ de Nimbus[®]. The third spraying was performed at the stage of earing (Large, 1954) using 0.8 L ha⁻¹ of Opera[®] (50 g L⁻¹ of Epoxiconazol and 133 g L⁻¹ of Pyraclostrobin), 0.8 L ha⁻¹ of Tilt[®] (250 g L⁻¹ of propiconazol) and 0.03 L ha⁻¹ of Aller Biw[®]. The fourth spraying was applied at the stage of flowering (Large, 1954) using 0.8 L ha⁻¹ of opera[®], 0.4 L ha⁻¹ of Odin 430 sc[®] (430 g L⁻¹ of tebuconazol, sistemic) e 0.3 L ha⁻¹ de Aller biw[®]. Finally, the fifth spraying was carried out at the stage of maturation using 0.8 L ha⁻¹ of Tilt[®] and 0.03 L ha⁻¹ of Aller Biw[®].

The sprayer used was a self-propelled John Deere 4630[®], with 24-m non air-assisted spray bar, nozzles spaced in 0.5 m and spray tips LD 110 02-Hypro[®]. In the trailing boom, the tip that accompanied the equipment was the MDP 0.5 - Magno Jet[®] (130°), spaced in 0.5 m.

The speed variations were automatically corrected by the on-board computer, adjusted to maintain - in all treatments – a spraying carrier flow rate of 100 L ha⁻¹. The spray calibration for conventional treatment occurred with an average speed of 6.0 km h⁻¹, a pressure of 120 kPa and a large droplet size. When the trailing boom was used, we utilized an average displacement velocity of 4.0 km h⁻¹, working pressure 200 kPa and fine droplet size. For the conventional boom, we used an average speed of 8.5 km h⁻¹, working pressure 100 kPa, coarse drop size for spray nozzle LD 11002 (volume of the spraying carrier at 65 L ha⁻¹) and mean droplet for MDP 0.5 nozzle (35 L ha⁻¹ spraying carrier volume).

Harvesting, threshing, counting of grains per pod, mass of one thousand grains and productivity were performed manually. The determination of the mass of a thousand grains and the productivity occurred with 1.0% of impurities and with corrected humidity to 13.0% humid based.

2.2 Bean (*Phaseolus vulgaris*L.)

The experiment was carried out at the farm "Vó Anna" located in the municipality of Ventania – PR (Brazil), 2011/12 crop, coordinates 24°14' S, 50°14' W, Cfb climate, 1013 m altitude, no-tillage system, in dystrophic Dark Red Latosol soil (EMBRAPA, 2013).

A completely randomized block design with five treatments and four replicates was used. The treatments consisted of: i) control (no fungicide spraying in the

plants); fungicide application through nozzles in boom sprayer ii) with and iii) without air assistance; iv) spraying with nozzles in trailing boom; and v) nozzles in boom sprayer (not air-assisted) + trailing boom simultaneously. We added a treatment with air-assisted boom because this technology was already used at the farm routine.

The seeding of the cultivar Pérola® occurred on December 05, 2011, with about 196,000 plants ha⁻¹ (15 DAE). We conducted three applications of fungicides for the chemical control of anthracnose disease (*Colletotrichum lindemuthianum* Sacc. & Magn.), disease to which the cultivar is susceptible. We applied 0.5 l ha⁻¹ of the fungicide Mertin® (400 g L⁻¹ of Fentina hydroxide) in all the spraying operations. The phenological stages during the spraying operations were V3, R2, and R5 (Fernandez et al., 1982).

The sprayer used was the BK 3024 Vortex (Jacto®), provided with 24 m air assist spray boom, 0.5 m spaced nozzles and ADI 11002 spray tips (Jacto®). In the trailing, the spray tip used was the MDP 0.5 (Magno Jet®), which accompanied the equipment.

The speed variations were corrected automatically by the on-board computer, adjusted to maintain a spraying carrier flow rate of 150 L ha⁻¹ in all treatments. The spraying operations for the treatments with and without air assistance in the boom occurred with average speed of 6.0 km h⁻¹ and pressure of 260 kPa (medium drop for ADI tip 11002). For the trailing boom, we used an average speed of 3.0 km h⁻¹ and 320 kPa pressure (fine drop for the tip MDP 0.5 130°). For the conventional treatment + trailing boom, we used an average speed of 7.5 km h⁻¹, working pressure 200 kPa and medium droplet size ADI 11002 (volume of the spraying carrier in 100 L ha⁻¹) and fine droplet for MDP 0.5 tip (volume of the spraying carrier 50 L ha⁻¹).

Harvesting, threshing, counting of grains per pod, mass of one thousand grains and productivity were performed manually. The harvest was given on March 10, 2012. The determination of the mass of a thousand grains and the productivity occurred with 1.0% impurities and with moisture corrected to 14.0% wet basis.

2.3 Soybean (*Glycine max* L.)

The experiment was carried out at the farm “Lagoa Grande”, located in the municipality of Carambeí – PR (Brazil), 2011/12 crop, coordinates 24° 49 'S and 50 ° 12' W, Cfb climate, 980 m altitude, no-till system, in an Eutrophic Dark Red Latosol (EMBRAPA, 2013).

A completely randomized block design with five treatments and four replicates was used. The treatments consisted of: i) control (nofungicide spraying in the plants), spraying of fungicide with nozzles in boom sprayer ii) with and iii) without air-assistance, iv)

spraying with nozzles intrailing boom; and v) nozzles in boom sprayer (not air-assisted) + trailing boom simultaneously.

The sowing of Nidera® 5909 RR cultivar occurred on November 03, 2011, with about 250 thousand plants ha⁻¹ (15 DAE). The cultivar is susceptible to Asian Rust (*Phakopsora pachyrhizi* Syd. & Syd). We performed three pesticides applications for the chemical control of the following diseases: mildew (*Peronospora manshurica* Naum.) Asian rust and white mold (*Sclerotinia sclerotiorum* Lib.). The phenological stages during the spraying operations were V5, R2 and R5 (Fehr and Cavibess, 1977; Ritchie et al., 1982).

At the first spraying, we used 0.5 L ha⁻¹ of Carbomax 500 SC® (500 g L⁻¹ deccarbendazim), 0.5 L ha⁻¹ of Opera® (133 g L⁻¹ of Piraclostobine + 50 g L⁻¹ of epoxiconazol) e 0.5 L ha⁻¹ of Alterne® (200 g L⁻¹ of Tebuconazol). The products used at the second spraying operation were 0.3 L ha⁻¹ of Priori Xtra® (200 g L⁻¹ of caxoxistrobine + 80 g L⁻¹ of ciproconazol) and 0.5 L ha⁻¹ of mineral oil Nimbus®. The third application was performed with 0.3 L ha⁻¹ of the fungicide Aproach Prima® (200 g L⁻¹ of picoxystrobin + 80 g L⁻¹ of ciproconazol), 0.3 L ha⁻¹ of Ninbus® and 0.1 L ha⁻¹ of the adjuvant LI700® (surfactant lecithin and propionic acid based).

The sprayer used was BK 3024 Vortex (Jacto®), spray bar with 24 m air assist, nozzles spaced 0.5 m and spray tips ADI 11002 (Jacto®). In the trailing boom, the tip used was MDP 0.5 (Magno Jet®). With the same model of spray, we used the same spray tips, spraying carrier volume and calibration described in the bean experiment.

Harvesting, threshing, counting of grains per pod, mass of one thousand grains and productivity were performed manually. The harvest took place on March 30, 2012. The determination of the mass of a thousand grains and the productivity occurred with 1.0% impurities and with moisture corrected to 14.0% wet basis.

2.4 General characteristics

Agro-climatic conditions favored all crops. All crop treatments and phytosanitary practices were carried out in accordance with the recommendations of wheat cultivation for the region. The dimensions of the plots were 5.0 m length x by 4.0 m width, with an evaluation area of 20 m². Each plot was delimited in the center by half boom spray length in a distance of 30 m (12 x 30 = 360 m²).

We standardized the use of the flat jet tip 11002 in the conventional spraying boom, due to the higher use of this type in the region for fungicide applications. In the Trawl boom, we maintained the tip that the factory sends with the equipment. The spraying carrier volume for each

crop followed the average of fungicide applications at the farms in which the experiments were installed. The air-assisted boom has an average air speed of 38 kg h⁻¹, measured by the Kestrel 3000[®] anemone thermo-hygrometer.

Spraying operations were always performed with relative air humidity above 55%, temperature below 30°C and wind speed between 3.0 and 10.0 km h⁻¹. Climatic conditions were monitored by the Kestrel 3000[®] anemone thermo-hygrometer.

The variables evaluated were as follow: spraying carrier deposition and area under the disease progress curve (AUDPC) for incidence, severity and yield components. The spraying carrier deposition on the sprayed plants were measured with hydro sensitive cards.

The values of incidence were obtained from the percentage of sick plants. The severity was determined based in diagrammatic scales recommended for each crop. On wheat it was applied the James (1971) and Stack and McMullen (1995) scale; in beans Dalla Pria et al (2003), in soybeans Kowata et al., (2008), Godoy et al., (2006) and Napoleão et al (2005). The AUDPC was calculated for wheat bases in the evaluations performed in the phenological stages of tillering, flowering and milky grain (Large, 1954); on beans at the stages V4, R3 and R6 (Fernandez et al., (1982); and on soybeans at the stages V6, R3 and R6 (Fehr and Cavibess., 1977 and Ritchie et al., 1982). We used the entire plant for the evaluations of AUDPC and foliar diseases.

Humidity was measured using a moisture meter (G800 Gehaka[®]). The mass of one thousand grains was defined by means of a digital scale 0.1 to 500 g Diamond[®]. Productivity measurement was carried out using a Ramud[®] digital scale, with a capacity of 50 kg.

The values recorded were analyzed by the Hartley test to verify the homoscedasticity of the variances, and Shapiro-Wilk to examine the normality of the data. The measured variables were submitted to analysis of variance by the Fisher-Snedecor test and the mean values compared by the Duncan test ($p < 0.05$).

III. RESULTS AND DISCUSSION

The attempts to measure the spraying carrier deposition on the sprayed plants with hydro sensitive cards were affected by the air-assisted boom technology, which moved the cards out of the plants. Therefore, we could not measure this variable.

The Hartley test pointed to the variances homoscedasticity and the Shapiro-Wilk confirmed the data normality for all variables studied. Therefore, there was no need to transform the values for the analysis of variance. There were no differences for blocks for all the analyzed variables, which demonstrates the uniformity of the experimental conditions (Tables 1, 2 and 3).

The control plots presented significantly higher values of AUDPC disease incidence and severity for all crops evaluated when compared with the fungicides treatments. Therefore, we confirm the importance of the chemical control (Vieira et al., 2012; Cunha et al., 2014; Tackenberg, et al., 2016).

When analyzing the AUDPC of diseases incidence and severity controlled by fungicide application - with nozzles in boom and in addition to the technologies of air assistance in the boom and trailing - no significant differences were found between the treatments for wheat and soybean. Thus, the technologies added to the conventional process did not stand out in the experimental conditions.

Our results do not agree with Aguiar Júnior et al. (2011), regarding the affirmation that the air-assistance in the spraying operations can contribute for the control of Asian rust (*Phakopsora pachyrhizi* Syd. & Syd.) in soybean. In this experiment, the difference was only visible between treatments that received or not fungicide spraying.

In this way, although the air-assistance in the boom minimizes the weather influence (Guedes et al., 2012; Garcia et al, 2004) and the trailing boom improves the spray tip positioning in relation to the target (Bueno et al., 2014), they did not increase the fungicide efficiency in comparison to the conventional boom sprayer. This fact may have occurred because the ideal spray conditions were respected in the experiment for the three evaluated crops.

Regarding the wheat yield components, the significantly affected variables by the diseases were number of ears ha⁻¹, mass of thousand grains and crop yield (Table 4). In the plots that did not receive phytosanitary treatment, the diseases reduced the productive potential by 34%.

The trailing boom aggregated to the ground boom sprayer, applying fungicides isolated or in combination, did not differ from conventional technology. With a confidence degree more than 95% of probability, in the experimental conditions of the wheat crop, we do not recommend the use of trailing boom.

On bean crop, comparing the plots with and without fungicides application, we verified that the anthracnose reduced the crop yield potential by 43% (Table 5). The variables that differed significantly were grains per pod, pods per plant and productivity. Thus, we confirm the importance of chemical control, within the integrated management of diseases (Garcia et al, 2002; Vieira et al., 2012; Cunha et al., 2014; Souza et al, 2014; Garcia et al., 2016; Tackenberg, et al., 2016).

The application of fungicide with ground boom sprayer, air-assisted boom, trailing boom alone and in conjunction with the conventional boom did not

significantly differ from each other for the yield components of the bean crop. The results do not confirm the conclusions of Baesso et al. (2011), who observed increases in bean productions in response to the use of air-assisted boom.

The analysis of soybean yield components showed significant differences for final population, one thousand grain mass and crop yield (Table 6). The diseases reduced the productive potential of soybean by 25%. The results highlight the efficiency of fungicide application using appropriate technology. Therefore, we confirm the statements of Garcia et al. (2002), Vieira et al. (2012), Cunha et al. (2014), Matthews (2014), Souza et al. (2014), Garcia et al. (2016) and Tackenberg, et al. (2016).

The use of air-assisted boom aiming to facilitate the product conduction to the target and reduce the climatic influence, as observed by Garcia et al. (2004) and Guedes et al. (2012), did not result in increases of soybean yield components. The experimental data do not corroborate with the conclusions of Aguiar Júnior et al. (2011) who stated that the air assistance spraying contributed to better control of Asian rust (*Phakopsora pachyrhizi* Syd. & Syd.) increasing in this way the crop yields.

The proposal of the trailing to move the leaf canopy, to spray the spraying carrier near the target and reduce the influence of the climate (Bueno et al., 2014) did not differ significantly from the conventional system without and with air assistance, either alone or in combination. The results agree with the conclusions of Weirich Neto et al., (2013) regarding the soybean yield components and with Alves and Cunha (2011) regarding the crop yield. The superior performance of the air-assisted boom and the canopy opener highlighted by Ozkan et al (2006) in the comparison with the conventional systems for fungicide application were not observed in this experiment.

The results were similar even in different crops, properties, crop seasons, sprayers, pressures, spraying carrier volumes, spraying tips and droplets size. Therefore, the use of trailing boom did not present advantages in this experiment.

The authors observed that the angle of distribution of the baffle tip, adopted by the trailing manufacturer, was greatly affected by the trailing boom movement during spraying. Thus, evaluations with tips that generate jets with other characteristics are recommended.

Because the high investment on the crop cultivation, mainly regarding the number of fungicide sprays in crops, the yields of the properties under study were 1.3, 3.7 and 1.4 times higher than the national average for wheat, beans and soybeans, respectively (CONAB, 2016). Therefore, with appropriate crop

management strategies, it is possible to reduce the influence of pesticide application technologies.

IV. CONCLUSIONS

We conclude that at the area under the disease progress curve (AUDPC), the diseases controlled with fungicides presented lower severity and incidence compared with the control treatment for all the crops evaluated.

The fungicide spraying with the technologies of air-assisted boom and trailing boom did not differ from the conventional sprayer for disease control and yield components of wheat, soybean and beans.

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Fig.1: Trailing boom (kit alvo®) coupled to a traditional sprayer (Image: Willy Schnepfer Junior).

Table.1: Area under the disease progress curve (AUDPC) for incidence (I) and severity (S) yellow spot (*Drechslera tritici-repentis* Died.), leaf rust (*Puccinia triticina* Eriks.) and head scab (*Gibberella zeae* Schw.) on wheat crop (*Triticum aestivum* L.) - in the phenological stages of tillering, flowering and milky grain¹ - with different application techniques, cultivate Abalone®, crop 2011, farm “Paiquerê” (Pirai do Sul – PR, Brazil).

Treatments ²	Yellow spot ¹		Leaf rust		Head scab	
	I	S	I	S	I (%) ³	S (%)
Control ⁴	4,248 a ⁵	868 a	2.341a	699 a	53 a	31 a
Nozzles in boom sprayer	2,328 b	359 b	915 b	298 b	22 b	07 b
Nozzles in trailing boom	2,298 b	376 b	898 b	286 b	20 b	06 b
Nozzles in boom sprayer + trailing boom	2,322 b	395 b	869 b	278 b	22 b	06 b
Coefficient Variation(%)	3.7	9.5	2.9	11.6	50.6	28.7

(1) Phenological stages proposed by Large (1954).

(2) In all analyzed variables there were no significant differences for blocks by the Fisher-Snedecor test (P> 0.05).

(3) Since it was only possible to carry out an evaluation in the spikes, the AUDPC can not be calculated.

(4) No fungicide spraying in the plants.

(5) Means followed by the same letter in the column did not differ significantly by Duncan's test (P> 0.05).

Table.2: Area under the disease progress curve (AUDPC) for incidence (I) and severity (S) of leaf anthracnose (*Colletotrichum lindemuthianum* Sacc. & Magn.) on bean (*Phaseolus vulgaris* L.) - in the phenological stages V4, R3 and R6¹ - with different application techniques, cultivate Pérola®, crop 2011- 12, Farm Vó Anna (Ventania – PR, Brazil).

Treatments ²	Leaf anthracnose	
	I	S
Control ³	2,380 a ⁴	1,342 a
Nozzles in boom sprayer	838 b	601 b
Nozzles in boom with air-assisted sprayer	849 b	597 b

Nozzles in trailing boom	857 b	609 b
Nozzles in boom sprayer + trailing boom	835 b	589 b
Coefficient Variation (%)	13.6	16.8

(1) Phenological stages proposed by Fernandez et al. (1982).

(2) In all analyzed variables there were no significant differences for blocks by the Fisher-Snedecor test ($P > 0.05$).

(3) No fungicide spraying in the plants.

(4) Means followed by the same letter in the column did not differ significantly by Duncan's test ($P > 0.05$).

Table.3: Area under the disease progress curve (AUDPC) for incidence (I) and severity (S) of downy mildew (*Peronospora manshurica* Naum.), asian rust (*Phakopsora pachyrhizi* Syd. & Syd.) and white mold (*Sclerotinia sclerotiorum* Lib.) on soybean (*Glycine max* L.) - in the phenological stages V6, R3 and R6¹ - with different application techniques, cultivar NIDEIRA 5909 RR[®], crop 2011-12, farm "Lagoa Grande" (Carambei – PR, Brazil).

Treatments ²	Downymildew		Asian rust		White mold	
	I	S	I	S	I	S
Control ³	198a ⁴	148a	328a	91 a	87 a	77 a
Nozzles in boom sprayer	118b	64b	222b	55 b	41 b	39 b
Nozzlesinboomwithair-assistedsprayer	115b	66b	213b	51 b	40 b	39 b
Nozzles in trailing boom	125b	68b	226b	57 b	45 b	40 b
Nozzles in boom sprayer+ trailing boom	112b	60b	211b	49 b	39 b	38 b
Coefficient Variation (%)	14	19	10	26	29	30

(1) Phenological stages proposed by Fehr & Cavibess (1977) e Ritchie et al. (1982).

(2) In all analyzed variables there were no significant differences for blocks by the Fisher-Snedecor test ($P > 0.05$).

(3) No fungicide spraying in the plants.

(4) Means followed by the same letter in the column did not differ significantly by Duncan's test ($P > 0.05$).

Table.4: Yield components of the wheat (*Triticum aestivum* L.) with different application techniques, cultivate Abalone[®], crop 2011, Farm Paiquerê (Pirai do Sul - PR).

Treatments ¹	Earsha ⁻¹	Grainspe rear	Thousandgrainsmass (g)	Crop yield (kg ha ⁻¹)
Control ²	4,584,043b ³	20 a	28 b	2,687 b
Nozzles in boom sprayer	5,725,351 a	22 a	31 a	3,986 a
Nozzles in trailing boom	5,473,482 a	23 a	32 a	4,124 a
Nozzlesinboomsprayer+trailingboom	5,593,795 a	23 a	32 a	4,125 a
Coefficient Variation (%)	6.1	7.7	4.1	8.6

(1) In all analyzed variables there were no significant differences for blocks by the Fisher-Snedecor test ($P > 0.05$).

(2) No fungicide spraying.

(3) Means followed by the same letter in the column did not differ significantly by Duncan's test ($P > 0.05$).

Table.5: Yield components of the bean (*Phaseolus vulgaris* L.), with different application techniques, cultivate Pérola[®], crop 2011-12, Farm Vó Anna (Ventania - PR).

Treatments ¹	Final population (plants ha ⁻¹)	Pods per plants	Grains per pod	Thousand grains mass (g)	Crop yield (kg ha ⁻¹)
Control ²	163,000 a ³	11 b	4.4 b	269 a	2,075 b
Nozzles in boom sprayer	162,250 a	15 a	5.9 a	251 a	3,628 a
Nozzlesinboomwithair-assistedsprayer	156,750 a	15 a	5.9 a	261a	3,537 a
Nozzles in trailing boom	162,750 a	15 a	5.8 a	264 a	3,482 a
Nozzles in boom sprayer+ trailing boom	169,000 a	15 a	5.9 a	265 a	3,912 a
Coefficient Variation (%)	7.6	5.1	5.9	6.7	13.9

(1) In all analyzed variables there were no significant differences for blocks by the Fisher-Snedecor test ($P > 0.05$).

(2) No fungicide spraying.

(3) Means followed by the same letter in the column did not differ significantly by Duncan's test ($P > 0.05$).

Table.6: Yield components of the soybean (*Glycine max L.*), with different application techniques, cultivate NIDEIRA 5909 RR[®], crop 2011-12, Farm Lagoa Grande (Carambeí - PR).

Treatments ¹	Final population (plants ha ⁻¹)	Pods per plants	Grains per pod	Thousand grains mass (g)	Crop yield (kg ha ⁻¹)
Control ²	206,500 b ³	43 a	2,3 a	151 b	3,077 b
Nozzles in boom sprayer	236,132 a	44 a	2,3 a	174 a	4,137 a
Nozzles in boom with air-assisted sprayer	235,512 a	45 a	2,2 a	176 a	3,948 a
Nozzles in trailing boom	234,750 a	45 a	2,3 a	177 a	4,082 a
Nozzles in boom sprayer+ trailing boom	235,089 a	45 a	2,3 a	175 a	4,208 a
Coefficient Variation (%)	2.3	7.1	9.9	4.2	11.2

(1) In all analyzed variables there were no significant differences for blocks by the Fisher-Snedecor test ($P > 0.05$).

(2) No fungicide spraying.

(3) Means followed by the same letter in the column did not differ significantly by Duncan's test ($P > 0.05$).

Role of Triacetin additive in the performance of single cylinder D I diesel engine with COME biodiesel

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Abstract—In the present work, COME-Triacetin additive blends are experimented in lieu of the neat diesel fuel. Pure coconut oil methyl ester (COME) itself as an additive has advantages in the operation of engine. Attention is bestowed upon the reduction of HC, NO, CO₂, CO and smoke emissions, and the same is successfully achieved with the 10% Triacetin and 90% COME blend fuel. Vibration on the engine cylinder in three directions and on the foundation were measured and analyzed to elicit information about the nature of combustion. The pressure signatures are tallied with time waves eliminating the time lag in between exciter and the cylinder head vibration. Triacetin being an antiknock fuel, with 10% blend emanated as a best blend with its contribution to reduce cylinder vibration in vertical direction of the cylinder. The time wave resembles attenuated sine wave replete with pure harmonics indicating smoother combustion with lesser engine detonation. By analyzing the measured in-cylinder pressure data and the derived heat release rate, it is concluded that the addition of triacetin increases the ignition delay and the amount of heat release in the premixed combustion duration, but shortens both the diffusive burning duration and total combustion duration. On the emission side, the smoke and other emissions including NO are reduced without any cognizable trade off with other components of the emissions.

Keywords—Performance, emissions, Biodiesel, Triacetin, Additive, Blend fuels, Properties, Vibrations, Heat release rate, Blend fuel.

I. INTRODUCTION

The price hike and rapid depletion of fossil fuels make researchers to concentrate on search for alternative fuels. Methanol and ethanol are proved to be effective alternative fuels long ago for internal combustion (IC) engines. The oxygen in the methanol and ethanol molecules helps to make complete combustion when

combusted with atmospheric oxygen. Most recently noticed that DME with oxygen content of 34.7% by weight is one of the promising alternative fuels for IC engines. DME can be derived from natural gas, coal or even from biomass sources that decreases emissions including smoke, THC, carbon dioxide, NO_x, while slight increase in CO compared to those of conventional diesel fuel [1]. Lower smoke and THC emissions were reported due to higher cetane number and oxygen content of DEE. Authors also found lower CO emissions at high load condition, but higher at low load condition and lower NO_x emissions with DEE-diesel blends [2]. From the experiments with 5 % DEE found lower CO, THC and smoke emissions while a slight improvement in thermal efficiency was observed [3].

Biodiesel obtained by the transesterification of oils or fats from plants or animals, with short-chain alcohols such as methanol and ethanol can be used pure or blended with diesel [4]. Biodiesel is nonflammable, non-explosive, biodegradable, nontoxic, its usage provide reduction of many harmful exhaust emissions and nearly complete absence of sulfur oxide (SO_x) emissions, particulate and soot [5]. Reduction of CO₂, CO, HC, NO, and smoke emissions were achieved successfully with 10% Triacetin and 90% COME blend fuel. Triacetin, being an antiknock fuel with 10% blend fuel, emanated as the best blend fuel with its contribution to reduce cylinder vibration in the vertical direction. By analyzing in-cylinder pressure data and released heat rate, it is observed that the addition of Triacetin increases the ignition delay and the amount of heat release in the premixed combustion duration, but shortens both the diffusive burning duration and hence total combustion duration [6]. Knocking can be prevented by the addition of additives in biodiesel fuel. Triacetin additive can be used as an antiknock agent to reduce engine knocking, to improve cold flow and viscosity properties of biodiesel [7]. In case of biodiesel-diesel blends the performance of engine increased appreciably

with less BSFC for blend fuel and CO, HC, NOx emissions and smoke density reduces significantly but a slight increase in CO₂ as the compression ratio increases [8]. The mixture of fuel and additive provides a stable film on the metal surface and substantially reduces the wear scar on the surface area[9]. Fatty compounds possess better lubricity than hydrocarbons because of their polarity-imparting oxygen atoms [10]. A high cetane number leads to a reduction of both exhaust and NOx emission [11].

Clean combustion of diesel engines can be fulfilled only if engine development is coupled with diesel fuel reformulation or additive introduction [12]. High-pressure injection, turbo charging, and exhaust after treatments or the use of fuel additives, which are thought to be one of the most attractive solutions to reduce PM and NOx emissions [13]. The B20 blend fuel with alcohols viscosity and density, cetane number and acid values decrease as the percentage of alcohol increases. Alcohols lower the flash point slightly and reduce the viscosity and density of blend fuel marginally, with this fuel ignition can start at lower temperature and able to burn completely [14]. The fuel properties can be adjusted by blending diesel with clean biodiesel to improve performance with less pollutant emissions from engines. Biodiesel is miscible with diesel fuel and can be mixed in any proportion to burn in diesel engines with no major modifications of the engine [15]. Further the biodiesel is easily biodegradable; lubricate the engine parts, lowers greenhouse gas emissions and more efficient in combustion levels [16]. Hence, biodiesel could be a most reliable alternative fuel for emissions reduction in diesel engine applications. Vegetable oils such as rapeseed, soybean and palm oil, algae oil and animal fats which are primarily composed of triglycerides, are used to produce biodiesel, is also known as fatty acids methyl ester.

In this work Triacetin additive chosen to conduct the experiments with coconut oil methyl ester (COME) because the main advantage of this additive is easily soluble in biodiesel, suppress the knocking of engine, improve efficiency and reduce the tail pipe emissions. Triacetin additive at various percentages with COME (by volume) blends are used to study the properties of blend fuels and performance, exhaust gas analysis, smoke density and vibrations of engine.

II. PREPARATION OF BIODIESEL

Initially raw Coconut oil is filtered and heated up to 105°C temperature in order to remove solid particles and water content. In acid treatment methanol of 120ml and 2ml of concentrated highly pure H₂SO₄ per liter of oil is added and heated with magnetic stirrer at 60°C for about half an hour in a closed conical flask. The mixture is

allowed to settle down in a decanter. The settled glycerin is separated at bottom of decanter from methyl ester. Sodium Methoxide is prepared by mixing thoroughly 200ml of methanol (20% by vol.) with 6.5 grams of NaOH per liter of oil. This solution is added to the oil obtained from acid treatment, then stirred continuously at 62°C for one hour in the base treatment and allowed to settle down in decanter. The collected Coconut oil methyl ester (COME) is bubble washed with pure water in order to remove soap contents, acid and methanol. The washed COME is heated further above 100°C for some time to remove water content [17], [18] and the different stages of biodiesel making and prepared biodiesel are shown in Figs. 1 and 2. The proportions of biodiesel along with Triacetin additive blends fuels shown in table 1 were prepared to find properties and performance of diesel engine.

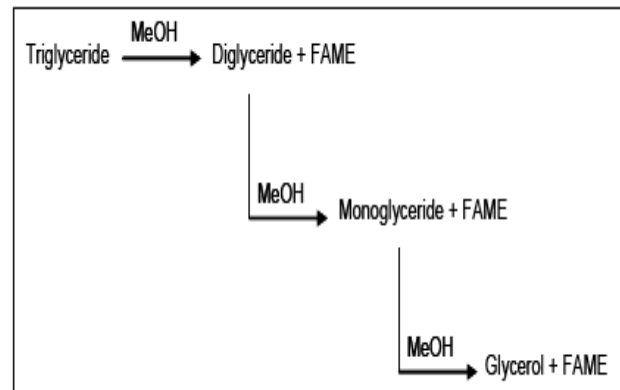


Fig.1: Stages of Biodiesel (COME) preparations

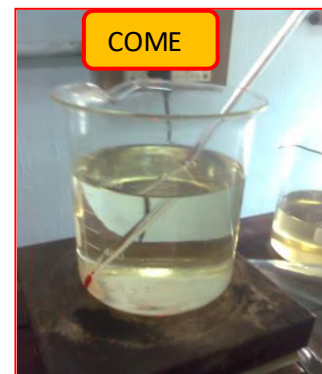


Fig. 2: Final stage of (Heating) Biodiesel

Table 1: Blend fuels for Test

S. No	Type of Fuel	Percentages in Blend Fuel
1	Diesel	100% Diesel
2	BD100	100% Biodiesel (BD)
3	BD5T	95% BD+ 5% Triacetin(T)
4	BD10T	90% BD+10% Triacetin
5	BD15T	85% BD+15% Triacetin
6	BD20T	80% BD+20% Triacetin
7	BD25T	75% BD+25% Triacetin

III. EXPERIMENTATION PROCEDURE

The experiments were conducted on a single cylinder DI diesel engine operated at normal room temperatures of

28°C to 33°C. Coconut oil methyl ester (COME) was prepared in Fuels Laboratory by transesterification process. Dual fuel (blends) operation of COME with Triacetin additive is taken up as an alternative fuel for testing at five different percentages (5%, 10%, 15%, 20%, and 25%) by volume. Neat diesel oil and pure biodiesel are also implemented at five discrete part load conditions to enable for comparison. Experimentation were carried out at various engine loads at 1500 rpm (Engine Loading device is eddy current dynamometer) to record the cylinder pressure and to compute heat release rates with respect to the crank-angle. Engine performance data is acquired to study the above mentioned parameters along with engine cylinder vibration and engine pollution parameters. Engine cylinder vibration in FFT form is monitored at each load for COME and its blends simultaneously to compare the cylinder excitation frequencies with the base line frequencies using diesel oil. Time wave forms on the cylinder head are also recorded to analyze the combustion for heat release rates. Since the combustion in the cylinder is the basic exciter, the vibration study of the engine cylinder is measured through FFT and time waveforms. These factors are the representatives of combustion propensity. The smoke values in HSU and exhaust gas analysis of different constituents of exhaust are measured and compared with diesel fuel.

IV. RESULTS AND DISCUSSIONS

Experiments were conducted with neat petro diesel, COME and COME-Triacetin [C₉H₁₄O₆] additive blends at 5%, 10%, 15%, 20% and 25% by volume on DI diesel engine without modifications in the engine operating parameters. The engine general performance, combustion, emissions and engine vibration results are compared with neat diesel and the results are summarized as follows:

4.1 FUEL PROPERTIES: The properties of fuels provide important data to further investigate and analyze the engine operation in terms of performance, combustion and emission characteristics and compare the same with diesel fuel.

4.1.1 Viscosity: Biodiesel viscosity is higher as compared to diesel fuel to use diesel engine, but it can be used as a substitute to diesel fuel at lower viscosity with minimum environmental pollution. Under low temperatures viscosity has a greater impact on fuel to flow smoothly from the storage tank into the engine. Higher viscosity causes poor atomization of the fuel spray system and inaccurate fuel injectors operation causes improper

combustion in the engine cylinder, results increased exhaust smoke and emissions. From the figure 3 it is observed that the viscosity of biodiesel is 26.5% more than diesel fuel because of free fatty acid (FFA) concentration in biodiesel. Due to higher viscosity of biodiesel and triacetin, the blend fuels of biodiesel with triacetin also at higher viscosity than diesel fuel. On other hand, small amount of triacetin addition in biodiesel increases the viscosity of blend fuels (5%, 10%, 15%, 20% and 25%) by 0.27%, 0.34%, 0.41%, 0.49% and 0.6% in comparison with biodiesel, which is within the limits of diesel fuel.

4.1.2 Heating value: The amount of heat energy released by the combustion of a unit value of fuel is known as heating value of the fuel. One of the most important constituent that vary the heating value in the fuel is moisture content. The heating value is not specified in the biodiesel standards ASTM D6751 and EN 14214 but is prescribed in EN 14213 (biodiesel for heating purpose) with a minimum of 35 MJ/kg. Figure 4 shows that the heating values of neat petro diesel, COME and COME-Triacetin [C₉H₁₄O₆] additive blends at 5%, 10%, 15%, 20% and 25% by volume are gradually decreasing. Heating value decreases as the percentage of triacetin increases in the blend fuel because the heating value of triacetin (16MJ) is much less than biodiesel (36MJ). A minimum heating value obtained for 25% of triacetin additive with biodiesel (BD25T) was 32 MJ/kg, which is 11.12% less than the heating value of biodiesel used for testing. The heating values of all blend fuels are within the requirement of standards.

4.1.3 Density: The density of biodiesel is higher than diesel fuel. Biodiesels density can be improved with the addition of additives for better performance of the engine. The density is measured by using Portable Density/Gravity Meter. High viscosity of fuel leads to problem in pumping and spray characteristics such as atomization, penetration and combustion etc. The improper mixing of fuel with air contributes to incomplete combustion that leads to low power output and exhaust with pollutants. Figure 5 shows the density of diesel, biodiesel and biodiesel with triacetin blend fuels. It is observed that the density of biodiesel is the higher at 0.892 kg/m³ and density of diesel is the lower at 0.857 kg/m³. The removal of the glycerol from vegetable oil has significantly reduced the density biodiesel fuel and it is 3.92% higher than diesel fuel. Increase in triacetin percentage in biodiesel increases the density of blend fuel, but which has very similar density values as conventional diesel fuel.

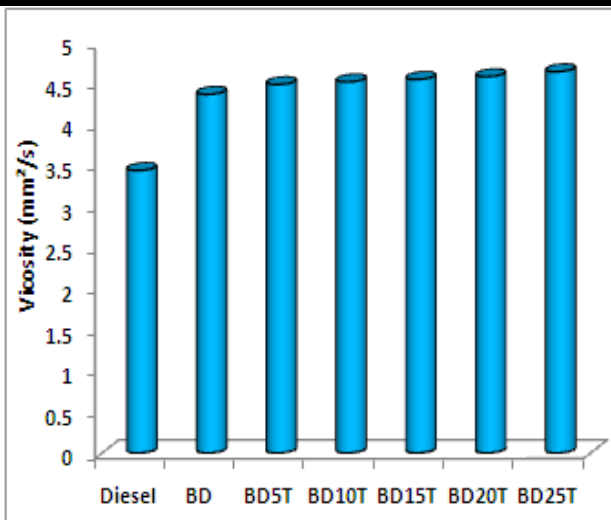


Fig.3: Viscosity values of Test fuels

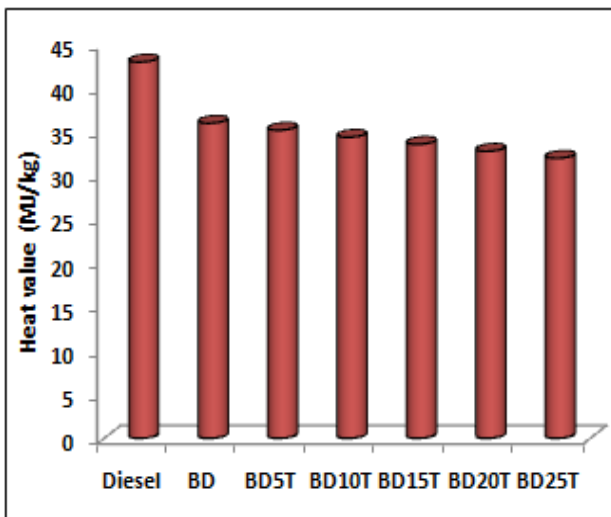


Fig.4: Heat values of Test fuels

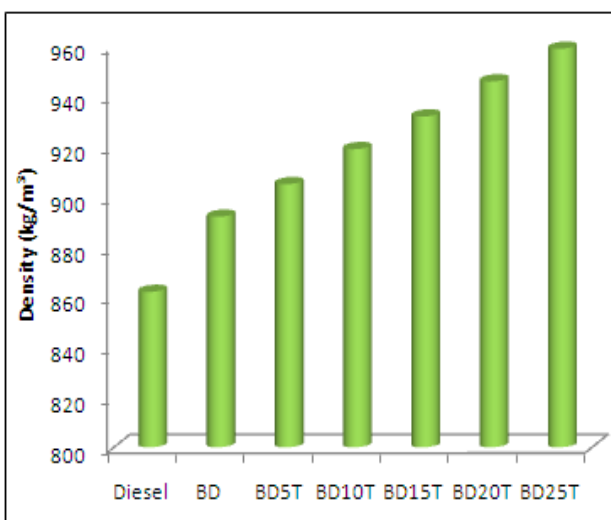


Fig.5: Density values of Test fuels

4.2 HEAT RELEASE RATE: The cumulative and net heat release rate graphs at full load are shown from figures 6 and 7. It can be observed that the net heat release rate peak is increasing with the increase of triacetin in the blend fuel. The 10% Triacetin blend falls in between the diesel and biodiesel in the net and cumulative heat release rate aspects and emerges as the best alternative to the conventional diesel fuel. The cumulative heat release rate graphs decipher consistent performance both in the premixed and diffused combustion zones for 10% triacetin blend fuel with biodiesel. The 5% triacetin joins the band wagon of 20% and 25% triacetin blend fuels with respect to the low profile diffused combustion. From the figure 8 the observation is that maximum cumulative heat released at full load and net heat release are less due to more heat transfer to cylinder surface at that load, as compared to 75% load on the engine.

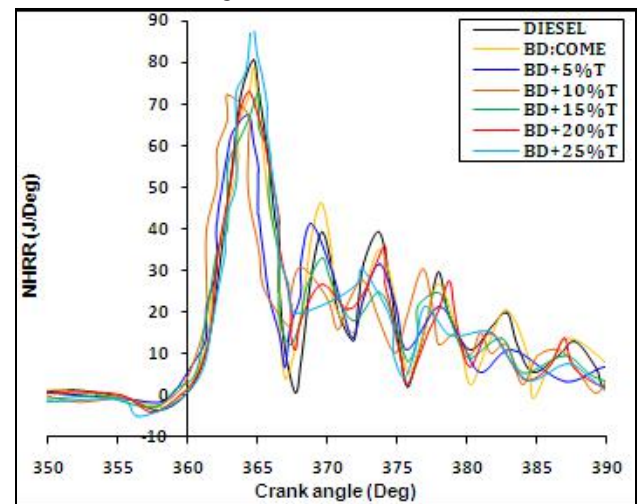


Fig. 6: NHRR vs Crank Angle at Full Load

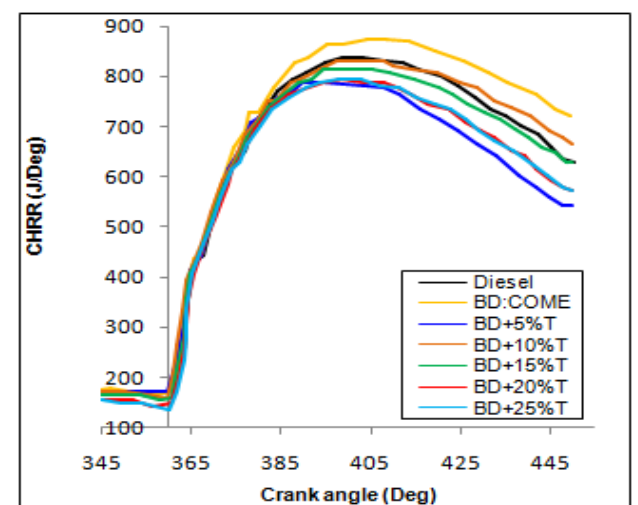


Fig. 7: CHRR vs Crank Angle at Full Load

In the case of 10% triacetin blend fuel, the ignition delay is decreased, as this blend fuel is optimal in reducing vibrations and to improve combustion quality of engine. Heat release rate curves indicates better performance in case of 10% triacetin blend fuel in premixed as well as diffused zone. With increase in triacetin quantity in the blend fuel, deterioration of diffused combustion has taken place. The 5% triacetin blend fuel could not gain sensible heat from the air - fuel mixture and converse is true for the 10% blend fuel. There is dramatic change in the process, the coefficient with percentage of triacetin mix, especially at 5% and 10% which affects the C_p and C_v values. The cumulative heat release rate curves also exhibit the same in case of 5% and 10% triacetin blend fuels with an advantage to 10% triacetin blend fuel in diffused combustion zone. There is a rapid fall of heat release rate in case of 5% triacetin additive blend fuel.

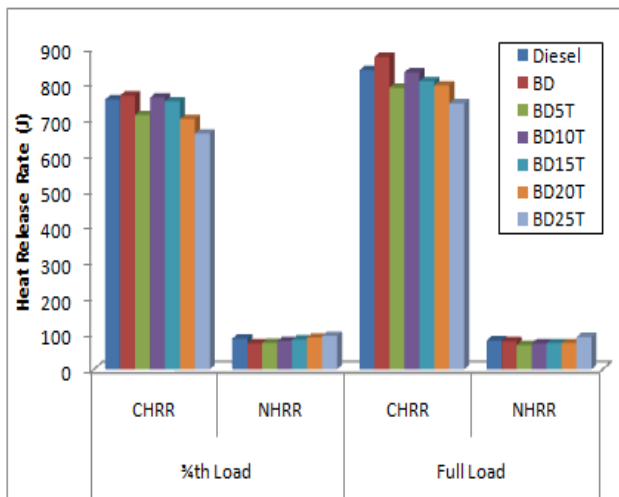


Fig. 8: Max. Values variation of CHRR and NHRR 75% and Full Load

4.3 PERFORMANCE:

4.3.1 Brake Thermal Efficiency & BSFC: Figure 9 gives the details of brake thermal efficiency and *b_{sfc}* versus percentage of load for neat fuel and the blend fuels. It can be ascertained from the figure that is increasing with the triacetin additive percentage. The load and thermal efficiency, both will increase, but are governed by different equations entailing non-synchronous increase. The implicit parameter in thermal efficiency is Calorific Value, which decreases with the increase in fuel consumption, as the calorific value of triacetin is comparatively lesser. The 10% triacetin blend fuel yielded better thermal efficiency curve at higher loads as observed. Brake Specific Fuel Consumption envisages the performance of engine with different blend fuel samples. For 10% triacetin blend, the part load performance is

observed better corroborating with the brake thermal efficiency results as described above.

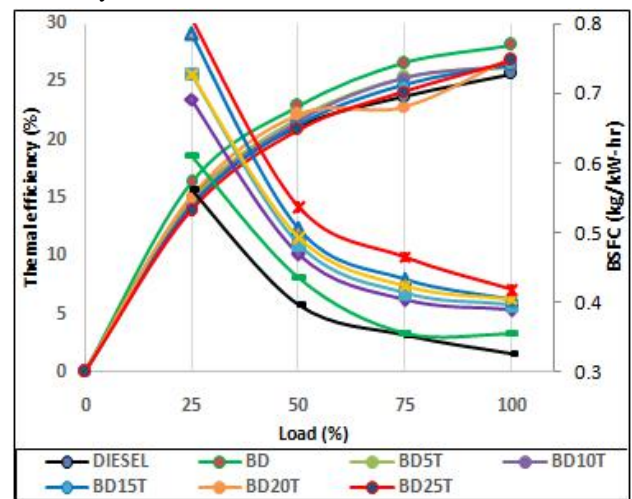


Fig. 9: Thermal Efficiency and BSFC vs. Load

4.3.2 Cylinder peak pressure and Imep: Combustion pressures in the combustion chamber have been recorded with respect to the TDC position. For specific study of the start of combustion and the specific heat of fuel mixture employed, small combustion duration from 350° to 400° which encompasses the TDC position in between at 360° has been chosen. There is relative pressure rise at the start of combustion due to temperature rise because of lower specific heat of mixture and higher convective heat transfer coefficient for various mixtures (Fig. 10). Thermal properties of the bio-fuel change with the blending of soluble triacetin. The figure 11 shows blends with Triacetin produced IMEP lesser than 6.5 bar, eliminating them from the knocking zone. The 10% triacetin blend fuel, even though produced 7.2 bar IMEP, can be regarded as safe since it is marginally below the IMEP ranges of diesel and biodiesel in the 80% burnt mass fraction zone at 1500 rpm.

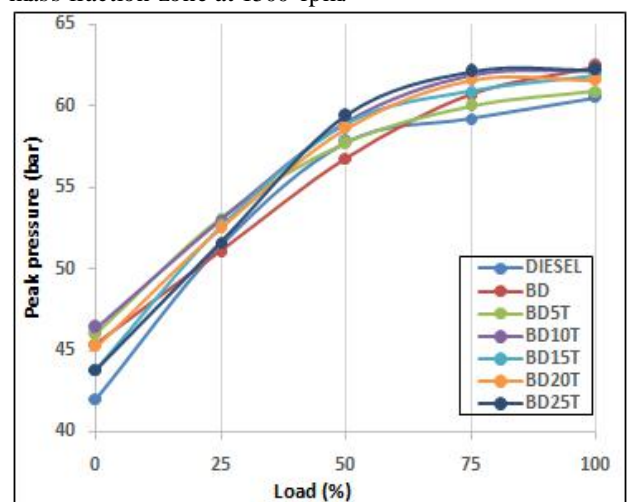


Fig. 10: Cylinder peak pressure vs. Load

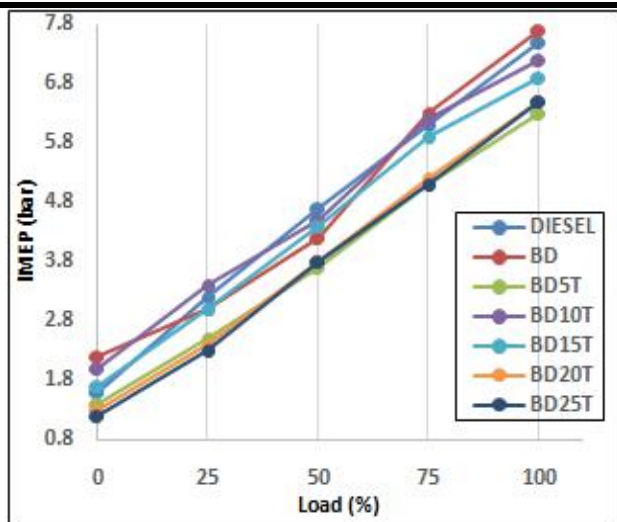


Fig. 11: IMEP vs. Load

4.3.3 Exhaust Gas Temperature: From figure 12, there is marginal fall in the exhaust gas temperatures with respect to increase in the load on engine at higher percentages of triacetin and this may be because of lower heat release rate in the diffused combustion process at lower calorific value of the blended fuel.

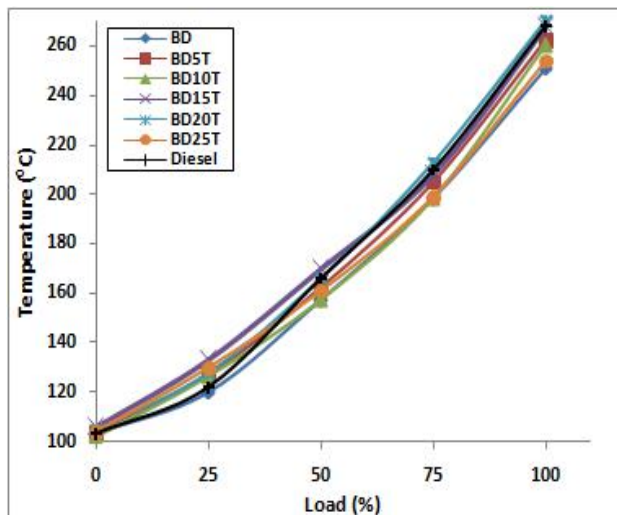


Fig. 12: Exhaust gas temperature vs. Load

4.4 EXHAUST EMISSIONS: Black color bars indicate the absolute values of the diesel fuel emissions and other negative side colored stalks indicates decrease from the absolute value of diesel. For example, in the figure 13, blue stalk indicate HC emission of biodiesel at full load then the absolute value of HC emission for the biodiesel is $132-72= 60$ ppm. The extent of decrease in that particular emission value can be easily observed in the graph.

4.4.1 Hydrocarbon (HC) Emission: Hydrocarbon emissions decrease with the loading on engine and 10% triacetin blend produced remarkable value of decrease (99

ppm). Biodiesel is known for its efficiency to reduce emissions except NOx. Triacetin blend with biodiesel further helped in the reduction of HC by 27ppm. There is 75% maximum reduction in HC emission with the triacetin blending which can be observed from the figure 13. As the load on the engine increases, the HC emission decreases at all percentages of blend fuels tested.

4.4.2 Oxides of Carbon (CO & CO₂) Emissions: Carbon monoxide emissions (figure 14) are reduced better at lower loads. It is observed that CO emission also reduced by maximum of 50% with the use of 90%BD + 10%T blend fuel and trade off with other emissions has not been observed. The CO₂ emissions reduction is nominal at all loads of the engine. From figure 15, there is a reduction of nearly maximum 10% of CO₂ emission with this blend fuel and at higher loads.

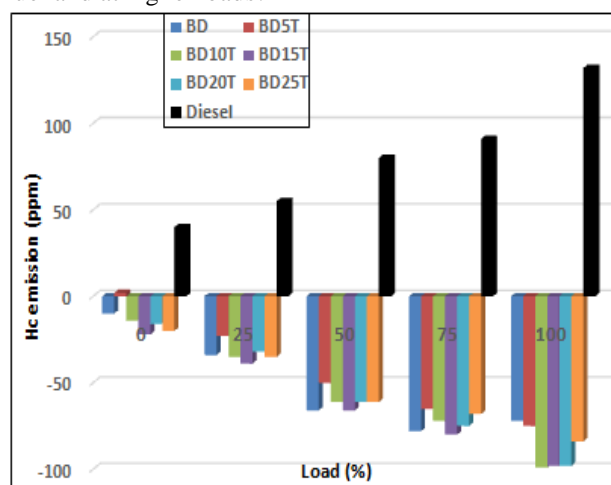


Fig.13: HC emission values vs. Load

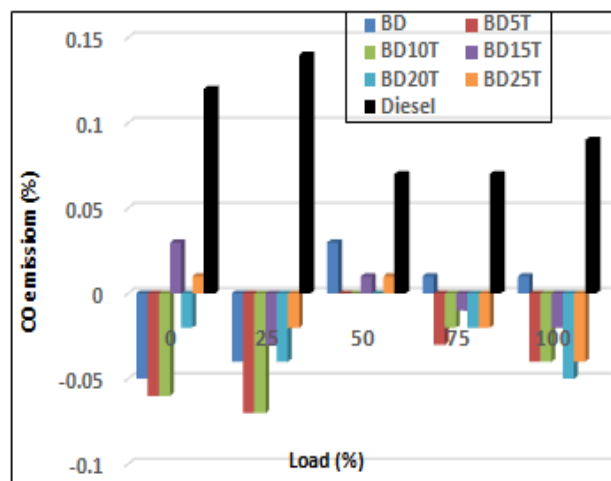


Fig. 14: CO emission values vs. Load

4.4.3 Nitrogen Oxide (NO) Emission: NO emission trade off is not observed with HC emission because the figure

16 envisage decrease of NO emission with the load and with the increase of triacetin percentage. For 10%

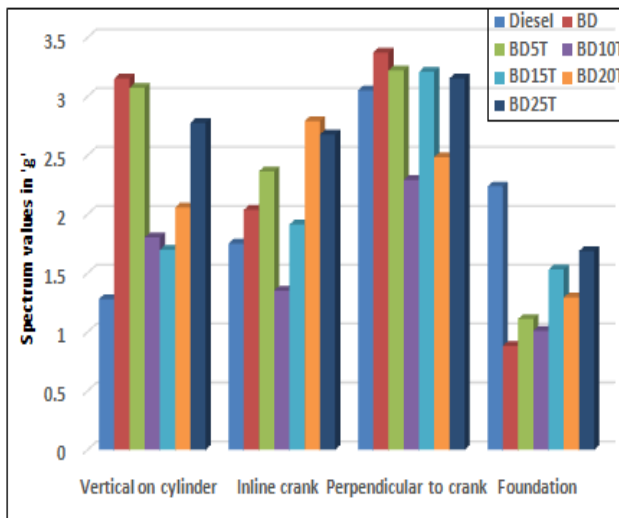


Fig. 18: Average spectrum values of the engine at full load

The FFT spectrums envisage the amplitudes of knocking frequencies with neat oils and with triacetin blends. The 10% triacetin blend fuel FFT spectrum (Figure 21) indicates the knocking amplitude is minimum for the reading obtained on the engine cylinder head, in radial direction and in line crank shaft. This direction is chosen with the view that there won't be mixed effect like piston slap in other radial direction and thrust transfer to the piston in the vertical direction and thus knocking can be fully realized in the direction inline crank. The knocking frequencies are varying by little margin around 6500Hz because of the combustion temperature variation with respect to the blend combination of triacetin.

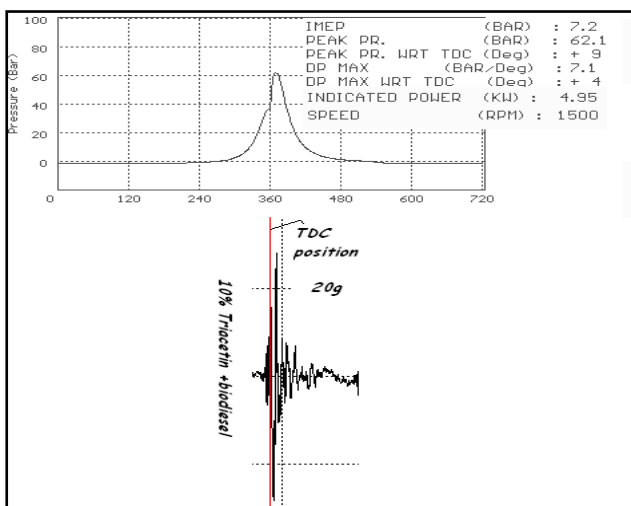


Fig. 19: Time wave recorded vertical on the cylinder head during explosion stroke at full load for 10% triacetin and 90% biodiesel

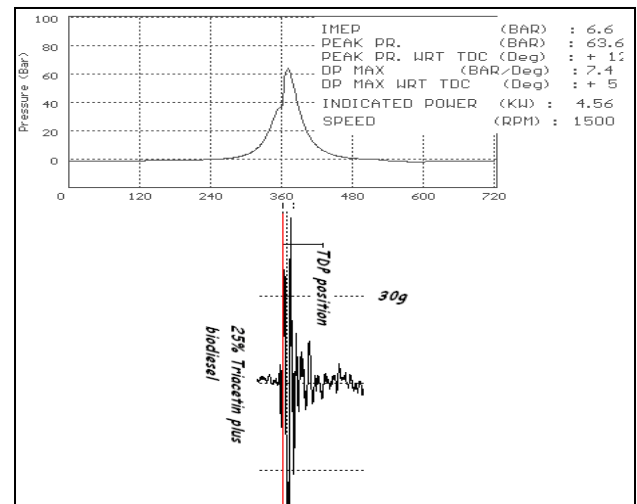


Fig. 20: Time wave recorded vertical on the cylinder head during explosion stroke at full load for 25% triacetin and 75% biodiesel

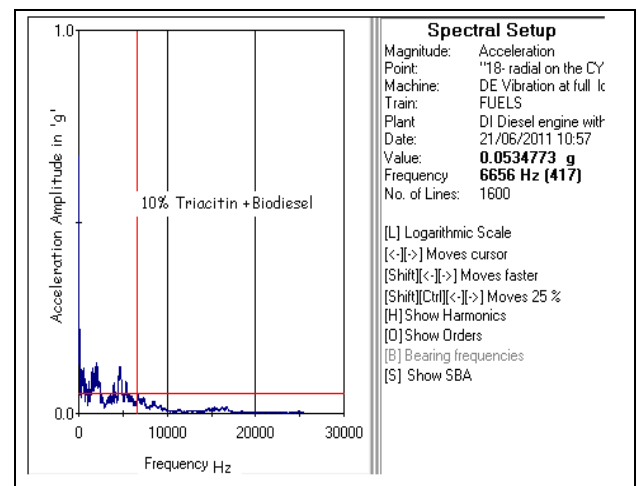


Fig. 21: FFT Spectrum Indicating Knocking Frequency and Acceleration Amplitude in Radial Direction of the Cylinder for 10% Triacetin + 90% Biodiesel Blend Fuel.

V. CONCLUSIONS

- The engine BSFC for 10% triacetin blend fuel at part load performance is better in the same way as in the case of brake thermal efficiency due the change of biodiesel properties with the addition of additive.
- The 10% triacetin blend, even though produced 7.2 bar IMEP, can be regarded as safe since it is marginally below the IMEP ranges of diesel and biodiesel in the 80% burnt mass fraction zone at 1500 rpm.
- The 10% blend of triacetin with biodiesel produced lowest amplitude at the knocking frequency

around 6,500Hz as observed from FFT graphs of the engine.

- Exhaust gas temperature reduces with increase in load at higher percentages of triacetin, because of lower heat release rates in the diffused combustion process by virtue of lower calorific value of the blended fuel.
- Maximum of 75% reduction in HC emission, 50% CO emission and 10% reduction of CO₂ emission is achieved at higher loads with 10% Triacetin additive- COME- blend fuel.
- Maximum of 28% to 29% decrease is obtained in NO emission at full load. It is obvious that there is no trade off between HC and NO, because both have decreased to cognizable extent.

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ARANEOMORPHAE: Development of an application for the identification of the taxonomic key of arachnid families in Brazil

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Abstract— *This study aimed to evaluate an application to support decision making in the identification process of taxonomic arachnids of families in Brazil. The device was developed by Ionic framework used to develop hybrid applications and with the help of Java Script programming language and the angular JS framework. With convenience, speed, easy handling and low cost maintenance, the digital system called for their Araneomorphae authors is an App (Application) and this digital system, professionals and lay people will perform clearly and dynamic identification and classification of specimens arachnids, reducing the time to research and understanding of their taxonomy. To review the application, a taxonomic key was used containing the figure of six Brazilian arachnids for identifying a period of 30 minutes. Were invited 200 students from five undergraduate classes in Biological Sciences from the Lutheran University Center Palmas - CEULP / ULBRA, Tocantins state for the key printed taxonomic, the vast majority of students (81%) took more than 30 minutes to identify the six species, whereas with application usage, 91.3% of identified species of arachnids in less than five minutes. The application proved practical, easy to understand and use, and can assist in supporting decision making to identify and rank the most common early specimens of arachnids.*

Keywords— *Araneomorphae; Digital application; Taxonomic key.*

I. INTRODUCTION

Taxonomy is the science that identifies and sorts animals and plants, according to its anatomic and

morphological structure. This theory classifies and separates the specimens in research through predetermined data from previous studies by other researchers. ARAÚJO; Bossolan, 2006; GOMES, 2007; Ferraz; BELHOT, 2010; Rapini, 2004; VASCONCELOS, 2003) According Martins (1994) and BRITO (2012) There is variety in the animal world, with more than 1 million and 500 thousand known species, and this restricts professional zoologists as to one or a few fields of interest in research.

In each animal group or type of research there are specific peculiarities in the capture or collection of material for preservation or for access to collections. To identify the specimens, the Taxonomy is the use of bases and predetermined principles by morphological anatomy of the object under study, which may be an animal or plant that has identification orders and classification based on taxonomic keys and private or public collections. Your goal is to guide the identification of a particular species (Martins & CAMPOS, 1994; GOMES, 2007).

Taxonomy comprises observing, classifying and sorting as previously established norms. These orders can be seen in the collections of museums, research materials such as taxonomic keys and references to anatomy of the study in question. Thus being able to classify - acquire information of the group or groups of objects, according to the goals you want to achieve.

The identification of an arachnid, for many researchers, requires a bibliography in text format in most of his work in the field or in the laboratory, however, not to experts, it is a difficult and often frustrating task. In

practice, arachnids identification is more complicated due to factors such as the existence of a huge number of different species; macro and microscopic variety of specimens; the lack of biological information of many species and the diversity of the Brazilian territory.

Although the preparation of identification keys comprises one among the numerous activities carried out by taxonomists, students of biological sciences and agricultural sciences or are generally not experts confronted by truly difficult to interpret key due to technical terms and the need for illustrations and images reduce the cognitive and interpretive time in a printed publication. In arachnids, biotic and abiotic factors may compromise their analysis, the most common biotic factors would be the loss of limbs such as legs, chelicerae or spinners or eyes, disputed territories, attacks by predators, abiotic factors cause influences on living organisms through physical aspects, chemical or physical chemical environment such as light, temperature, wind or weather scheme, to the action of the researcher collects as a wrongly performed, or even the preservation of these acids in liquid specimens.

The identification by means of certain keys in text format can be compromised due to these factors in the sense that the key taxonomic printed, is usually "monothetic" (Martins, 1994). When it says that the key is monotética means that it employs a unique combination of characters,

with necessary and sufficient criteria to identify a particular taxon. Or otherwise in the specimen to be identified, missing the diagnosis character, the key becomes confused and useless. This is unfortunately a very common occurrence; in insects, for example, the fall of a bristle, an antenna, or perhaps a leg, make it difficult to identify through certain keys. The expert, although to know the group, you may possibly identify him, the "gist" (Martins, 1994). In this sense, it was proposed this study aimed at evaluating a digital key named Araneomorphae, key arachnids for Families Taxonomic identification of Brazil.

II. MATERIAL AND METHODS

The digital system APP (application) was produced by making use of illustrated images of the identification key for Families spiders Brazilian Taxonomic, the Brescovit authors, Rheims and BONALDO researchers Arthropods Laboratory of the Butantan Institute, Sao Paulo capital, obtained through print the site presented in the bibliographic reference of this work. Images were separated according to their own taxonomy of specimens illustrated in print key. With short questions the researcher can identify the order of arachnids by their morphological anatomy as shown in Figure 01.

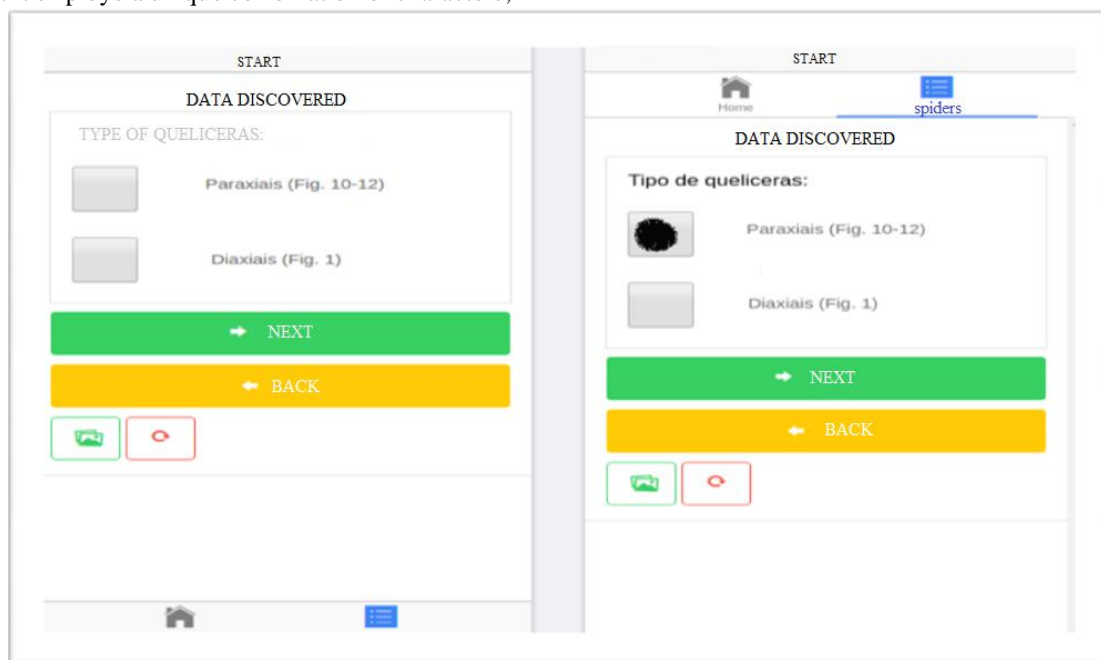


Fig.1: Alternatives to the morphological taxonomic choice of chelicerae.

When choosing the type of morphology chelicera, users have the answer of the arachnid order and up to three images listed following the pattern of a printed key. They

can compare them with the specimen under study. Having up to three options illustrated pictures to make the diagnosis as in Figure 2.

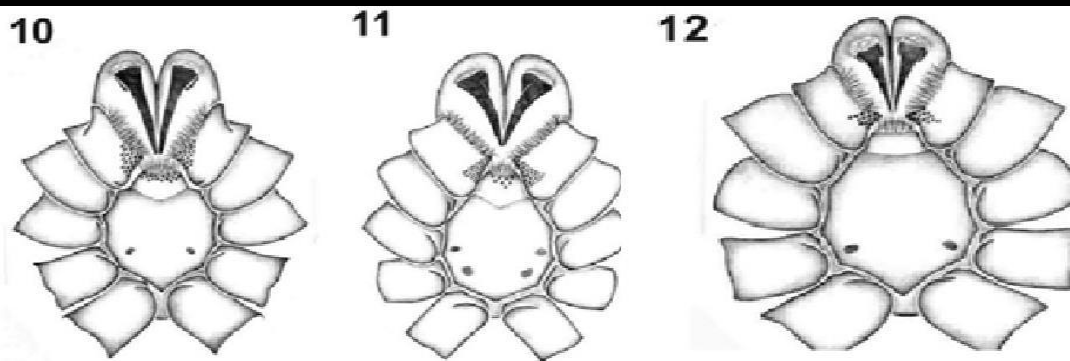


Fig.2: Orders spiders identified by morphological taxonomy of chelicerae.
Source: Key to families of spiders Brazilian Taxonomic 2018.

The nomenclature code Zoological (ASH) was used to regulate the names of taxa of the group of families, tribes, genera and species. The names of the taxa can be single-member, binomial, trinomial and tetranominal (Bernadi, 1994). Through a framework called ionic used for the development of hybrid applications. Specimens were sampled in the entomological collection represented by illustrations or photographs taken or adapted from other sources, being duly cited. They were initially developed the layout (assign software) and topics to be addressed in this. The home screen consists of the main items: Introduction, External Morphology, identification keys and credits. To develop the layout and access buttons was used HTML and CSS.

The resolution of the layout has been configured so that it suits smartphone size used, avoiding undesirable distortions in the display and arrangement of images on the screen. With the help of JavaScript programming language and the angular framework JS, it developed the system for playback and operation of identification keys and other itemized above. This was chosen due to the fact be an actual language, to be constantly updated and also work on all platforms, both browsers, but also on mobile devices.

III. RESULTS AND DISCUSSIONS

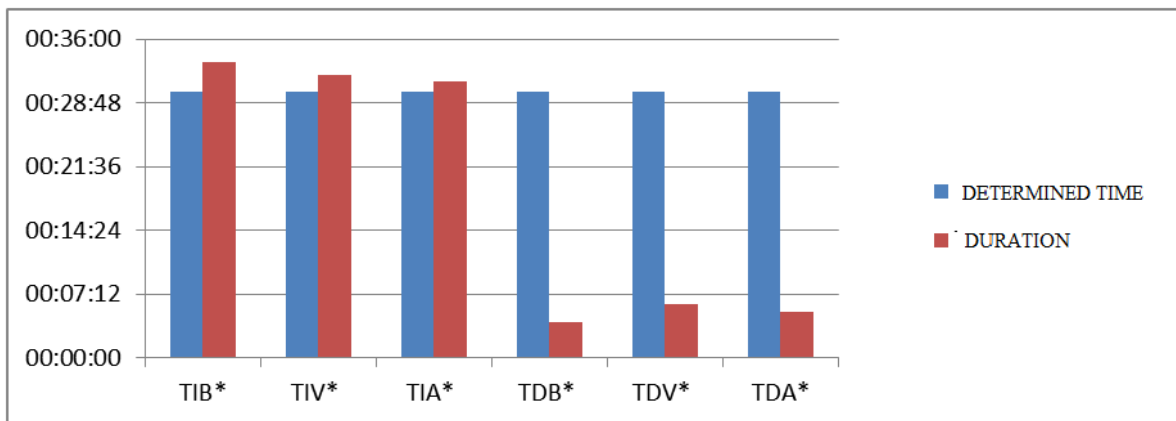
The arachnids identification digital system in Brazil presents a Brazilian and international bibliographies analysis study of spider families, select images and arachnids illustrations, already described good quality technical and visual, fast and low cost, developed a methodology agile and easy to handle for arachnids identification perfecting data of arachnids families of printed keys, for use in various off-line software platforms, with a software platform with easy upgrade and maintenance for the creation of digital identification system arachnids illustrating the taxonomic identification of arachnids of families with more common occurrence in

Brazilian ecosystems. It was used as the zoological theoretical basis for the following production of the APP (Application).

The nomenclature consists of a system of names applied to taxa animals - is governed by the International Code of Zoological Nomenclature (ICZN, 1985); by a system of rules and recommendations about the proper way to compose and apply the zoological names (Bernadi, 1994). According Bernadi (1942), the zoological nomenclature code (ASH), is intended to "promote stability and universality of the scientific names of animals, and to insure that the name of each taxon is unique and distinct." In other words, the code you want each animal taxon has a unique name, distinct, stable and universal. In this sense, the digital system reduces the possibility of the researcher to make mistakes in the investigation, at the time point of an assignment to a particular specimen, the specimen to be diagnosed.

APP (Application) was evaluated in five classes with 40 students of their undergraduate degrees in Biological Sciences, Agronomy and Veterinary totaling 200 students from the Lutheran University Center Palmas - CEULP / ULBRA, Tocantins state. It was presented to the students six specimens of Brazilian arachnids, with its morphological anatomy described. Orientou- that each of the identified mites in a given period of 30 minutes using a taxonomic key printed. With the same students at another time, we were presented six new images of Brazilian arachnids. At this point, it was requested that each student identify each arachnid using the Application.

Students who used the printed taxonomic key, identified arachnids above the appointed time of 30 minutes when performed using the application time duration to identify the animals was lower, at just 5 minutes performed the classification of arachnids. Students identified in less than 30 minutes as shown in Figure 3.



Note: TIB * Analysis time with print / Biology; TIV * Analysis time with print / Veterinary; TIA * analysis time with print / Agronomy; TDB * Analysis time with application / Biology; TDV * Analysis time with application / Veterinary; TDA * Analysis time with application / Agronomy.

Fig.3: Arachnids identification time between digital and printed methodologies.

The researcher who is in the field or in the laboratory gets a quick and reliable response to your search saving time. Avoiding capture and contain these animals to better understand through other taxonomic keys for the lack of agility and good understanding of the

technical terms of a printed key reducing the death of the majority of the specimens contained for study. For information purposes it is observed in Figure 04, the application's main menu.

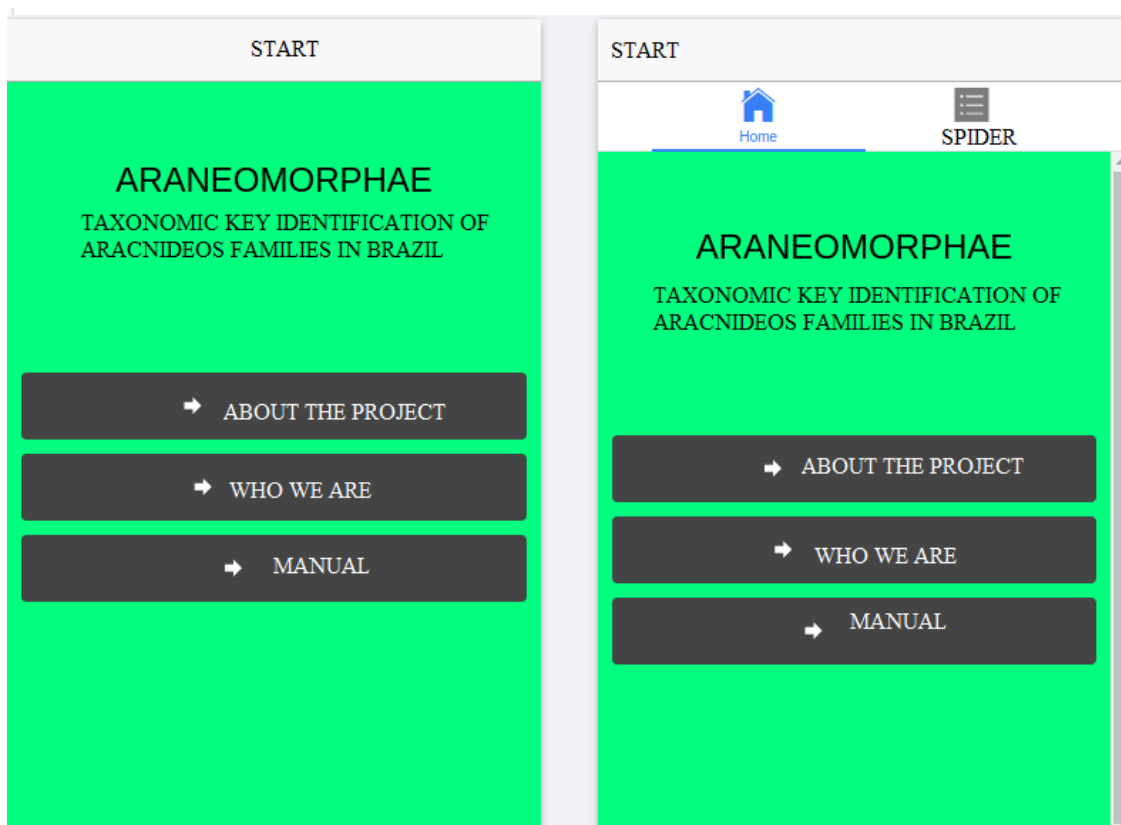


Fig.4: General data about the application.

IV. CONCLUSION

Based on research conducted, few available examples of interactive keys and taxonomic keys in printed and published in Brazil, either through the internet, or by other digital media, highlighting the

shortage of professionals, a fact that further limits development of this work.

The developed system needs some changes and corrections, but preliminary tests showed no problem of implementation and operation. Future prospects seek the

inclusion of a greater number of families together with a brief description of the same, obtaining images of the main species and other software to identify causative arachnids properly identified pests in a reference collection for availability and distribution through internet application format (still in research). Tests conducted with undergraduate students were very conclusive, demonstrating the need and the importance of technology to zoology and systematic taxonomy, as a training tool for learning and the study of knowledge and arachnids systematic taxonomy of Brazil.

It is expected that, given the scarcity of studies on identification keys for use in digital appliances in Brazil, new jobs are carried out, spreading new tools and methodologies to assist in the identification process. The digital system APP (application), proved to be easy to maintain and use and can be used by professionals and non-professionals including the areas of Life Sciences and Agricultural Sciences. It is free available its first version in Google Play.

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Coatings for saltwater pipelines

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Abstract— This paper is a literature review of coatings that aim to reduce corrosion in metallic pipelines that are in contact with saltwater. Among the existing coatings, the most common and ecologically available ones are: asphaltic enamel (AE), epoxy resin, Fusion Bonded Epoxy (FBE), Neoprene and multilayer coatings (polyethylene-PE, polypropylene-PP and polyurethane-PU). Due to the need by the industries, new technologies in this field are being developed. Carbon nanotubes, DLC (diamond type carbon), and self-recoating coating are some of the new coatings that are in evidence due to their hydrophobic property. There are many industrial applications that require high resistance to saltwater corrosion, such as coastal factories, onshore and offshore platforms, tidal power plants, and water desalination, which justify researches of new technologies in this area.

Keywords— Coating, Corrosion, Pipeline, Saltwater, Wear.

I. INTRODUCTION

According to Goucher & Walton (2011)^[1], since 1800 B.C., iron has been a widely used material for making various types of objects. With the Industrial Revolution in the 19th century, Freeman & Soete (1997)^[2] believes that cast iron and steel have gained even more importance in industry. Due to the wide use of these materials and the fact that they are susceptible to corrosion due to the action of salt water, the study of means to avoid this problem has gained relevance.

Corrosion caused by saltwater in contact with metal structure impairs industries located in coastal areas, such as the naval industry, petroleum and gas plants, desalination plants, in addition to thermoelectric and nuclear power plants. All these industries need to protect their metal structures from corrosion by saltwater. In many cases, the use of materials more resistant to corrosion, such as stainless steel, is not enough, so the use of other protection techniques is necessary.

According to the National Association of Corrosion Engineers (2007)^[3], the most appropriate and efficient technique for protection against corrosion of pipelines due

to saltwater is coating. In this work, some of the most commonly used coating materials will be presented, such as AE, coal tar, epoxy resin, FBE, Neoprene and the multilayer PE, PP and PU coating. There are also new technologies on the market, such as carbon nanotubes, DLC, nanocomposites and self-healing coatings, which are still more expensive.

Due to the wide range of options for coating, one must pay attention to the choice to be made: some of these coatings that are not ecologically correct. Also due account should be taken of the high cost of installation and maintenance of industrial plants that are subject to this environment, which justifies the choice of a suitable coating for each situation.

II. SALTWATER AND WEAR IN METALLIC STRUCTURES

1) SALTWATER

According to Lalli & Parsons (1993)^[4] and Narayan, Sharqawy, Lienhard V. & Zubair (2010)^[5], saltwater is found mainly in seas and oceans. The measurement of water salinity, according to Lerman (1986)^[6] and Libes (1992)^[7], is determined by its electrical conductivity, which is related to the amount of dissolved salts.

The salinity is not uniform. It varies between 31 kg / m³ and 39 kg / m³ of dissolved salt, with an average of about 35 kg / m³, according to the location as shown in Figure 1. This variation is due to the different rates of evaporation in the regions of the globe and the addition of fresh water from the polar ice caps. Salinity is also altered with depth: surface water is more saline than deep water, mainly due to interactions between the ocean surface and the atmosphere (Thurman & Burton, 1997)^[8].

Saltwater contains more dissolved ions than other types of water and this is the main reason why corrosion is greater in materials in contact with water (Lalli & Parsons, 1993)^[9]. Due to the difference in salinity, the composition of salt water is different in each part of the world (Pinet 1996^[10], Tavares et al., 2016^[11]). This property can be correlated to its corrosion potential.

Knowing the chemical composition of salt water is essential to define the most suitable pipeline material and coating for each region. In addition to corrosion, one must also take into account the effects of erosion caused by the presence of abrasive particles in water.

The properties of salt water (pH and salinity) and high pressure make the environment very hostile to the operation of metallic underwater equipment. (Frauches-Santos, Albuquerque, Oliveira, & Echevarria, 2014)^[12]. The combination of corrosion due to pH and salinity with erosion accelerates the wear of metal structures (Fundão et al., 2017)^[13]

2) TYPES OF SALTWATER WEAR

According to Moreno, Bonilla, Adam, Borrachero, & Soriano (2015)^[14] and Rodriguez (2018)^[15], the main type of corrosion that occurs in saltwater is electrochemical corrosion, shown in Figure 2, which is the conduction of electric current in saltwater, attracting the electrons of the external metal ions, which causes the degradation of the material. There is also anaerobic corrosion, caused by the action of bacteria.

Erosion (Figure 3), according to Anna, Castro, Silva, Franco, & Macêdo. (2008)^[16], is a type of wear caused by the repetitive impact of the abrasive fluid against the surface of a solid body. Barber & Motley (2016)^[17] also considers as erosion the implosion of bubbles formed in the fluid against the surface of the structure, i.e. cavitation. For Bhushan (2013)^[18], this type of wear is generally accelerated by the presence of suspended solid particles.

Another phenomenon that wears metal structures is cavitation, shown in figure 4, which occurs due to high-pressure levels or unstable flows, and can lead to erosion. According to Greenberg (1987)^[19] variations in the tides cause variations in the velocity of the currents, causing agitation.

In addition, the deep-sea environment is quite different from the surface. There, there is total absence of sunlight, high hydrostatic pressure and low temperature. These factors must be taken into account in the projects, since it has a great reaction to the wear of metals in contact with saltwater. (Wang, Chen, Chen, Yan, & Xue, 2012)^[20], Traverso & Canepa, 2014^[21].

III. PIPELINES IN SALTWATER

In the past, pipes were made of materials such as baked clay, wood, stone and cast iron (Antaki, 2003)^[22]. Today, there is a wide variety of materials, being the most used steel (carbon or stainless) and PVC (polyvinyl chloride). Many of the applications require resistance to abrasion, cavitation, corrosion and erosion, so often the materials need coating.

Structures in contact with salt water should be designed considering the severe corrosion to which they are subjected. According to Cooper Development Association - CDA (1986)^[23] the saltwater pipes are made mainly of stainless steels, uncovered carbon steels, galvanized steels, carbon coated steels, copper alloys, plastics and titanium. Alkazraji (2008)^[24], Krauspenhar (2012)^[25] and Bahadori (2017)^[26] explain that the material of the pipeline must be chosen from the stress and pressure that will be applied to it, since it cannot yield under stress or fail due to fracture initiation. The choice of material must also take into account the weldability and the material manufacturing process.

The pipeline manufacturing area is undergoing changes, both in relation to material and manufacturing processes, as well as in techniques to make them more resistant to the various wear mechanisms that they are exposed to.

For Abdel-Gaber, Abd-El-Nabey, Khamis, & Abd-El-Khalek. (2011)^[27] and Sun, Zhang, Liu, & Lu (2012)^[28], corrosion is costly and dangerous. The degradation of metallic ducts in contact with salt water leads to a great economic loss and can cause serious environmental accidents without mentioning the extremely toxic substances that are led by them.

IV. EXISTING AND DEVELOPING COATINGS FOR SALTWATER PIPELINES

The coating concept for Grainer & Blunt (1998)^[29] is a cover applied to the surface of an object, generally called a substrate, which seeks to alter surface properties such as adhesion, wettability, resistance to corrosion and wear or hardness.

For Byrnes (2017)^[30], coating is important in saltwater pipes to increase their corrosion resistance. A coating may be metallic, such as galvanizing, or non-metallic, such as coating with paints. Due to the various types of coating, it is necessary to know the characteristics of each one well in order to apply them when they are most suitable.

The coatings that generate the best results and are currently used most for pipes are Epoxy, FBE, Neoprene, DLC. In the future, these coatings should be replaced by emerging new technologies, such as carbon nanotubes, nanocomposites and self-healing coatings (Yasakau, Tedim, Zheludkevich, & Ferreira., 2014)^[31].

1) MOSTLY COMMON COATING TECHNOLOGIES FOR SALTWATER PIPELINES

Fusion Bonded Epoxy (FBE) is one of most common coating technology for saltwater pipelines (Wei, Zhang, & Ke, 2007)^[32] and features high performance in protecting small and large diameter pipes with moderate operating temperatures. The FBE has excellent adhesion to steel and also provides excellent resistance to cathodic dissociation

which reduces the cost with cathodic protection during the duct operation (Melot, Paugam, & Roche 2009^[33], Nguyen & Martin, 2004^[34], Amadi & Ukpaka, 2014^[35]). This coating provides physical properties that minimize damage during handling, transport, installation and operation, as well as having good chemical resistance in most soils.

Three-layer polypropylene coating (3LPP) is an anticorrosive system consisting of a high performance FBE followed by a copolymer adhesive and an outer layer of polypropylene. This combination resulted in the most durable and durable coating available on the market a few years ago (Khanna, 2008) ^[36]. This coating has a strong outer layer that protects the ducts during transportation and installation.

The two-layer PE coating combines a special butyl rubber adhesive with an outer polyethylene coating. The advantages of the coating are resistance to mechanical damage, soil contaminants and cathodic destruction. It can be applied in a temperature range of 241 K to 353 K and in tubes up to 3.5 m in diameter (Suzuki et al., 1986) ^[37]. The three-layer polyethylene (3LPE) coating is similar to that of two layers, with the addition of a copolymer adhesive, which improves shear properties (Guan, Mayes, Andrenacci, & Wong, 2007) ^[38]. The performance of the fusion-bonded epoxy coatings can be improved by advanced composite coatings reinforced with nanomaterials (Saliba, Mansur, & Mansur, 2016) ^[39]. These joint properties provide optimum protection for small and large diameter piping with low temperature flexibility, excellent handling and impact and corrosion resistance.

The neoprene rubber coating consists of a multilayer coating, with a primer bonding agent and an outer layer of polychloroprene. It is usually vulcanized in steel using a steam autoclave, but it can also be applied in place using heated electrical tapes. Provides durable and resistant protection for pipelines and risers with good resistance to absorption of water, hydrocarbons and ozone. (Long, Barnett & High, 1980^[40], Runxiu & Jian, 2014^[41]).

The modified bitumen AE coating, shown by Mirza, Rasu, & Desilva (2016) ^[42]. It has been widely used in the corrosion protection of steel pipes. It is a cheap and durable coating. Due to the properties of bitumen, the adhesion to the steel is excellent, which allows a good resistance to corrosion. The main limitation of the coating is in relation to the temperature of the fluid to be transported, which cannot exceed 363 K. AE is a safer and more environmentally friendly system than other similar coatings.

2) NEW TECHNOLOGIES FOR SALTWATER PIPELINES COATING

Vieira (2010) ^[43] made a study applying carbon nanotubes and titanium dioxide ceramic nanoparticles, added with silver. As a result, he realized that these coatings can minimize corrosion and increase the lifetime of materials submitted to high pressure and temperature during the process of oil extraction in the marine soil.

Diamond-like carbon (DLC) is a very promising coating technology for saltwater pipelines, and has been used for internal coatings in pipelines (Wang et al., 2014) ^[44]. DLC has disadvantages as a low level of adhesion on the surface of the substrate, which makes it a coat of considerable degradation (Bueno et al., 2018^[45]; Liu et al., 2018^[46]). However, it is possible to reduce this limitation by deposition of the coating by plasma immersion ionization (PIID).

Ribeiro (2013) ^[47] did some studies on nanotechnology applied to coatings, with carbon nanotubes (figure 5). The nanotubes are rolled graphene sheets to form a cylindrical structure with a diameter of 1 to 2 nm. Depending on how the graphene sheet is rolled up, the nanotubes may have semi-conductive or metallic properties. According to Ebbesen & Ajayan (1992) ^[48], these small systems have as physical properties high mechanical resistance and high flexibility, with thermal and electrical characteristics that vary according to the microscopic structure of the tube. In order to produce these nanotubes, we can use the arc discharge method and the laser ablation, under high temperature and chemical vapor deposition (CDV) under low temperature (Larrudé, 2007) ^[49].

Nanoindentations with epoxy / graphene compounds were investigated by Ribeiro et al. (2015) ^[50], and showed significant increases in Young's modulus (72%) and hardness (143%), ie the system allows simultaneous gains in the thermal and mechanical properties of the coating.

The problem with all coatings is that they are passive (Costa, Dacoreggio, Kejelin, & Comeli, 2014)^[51]. If damaged, no matter how small the damage, the corrosion process begins immediately on the part. The only possible solution to this problem is the use of self-healing material (figure 6), also known as intelligent coating.

These are materials that can partially or totally restore their original functionality after being damaged without any manual intervention (Nazeer & Madkour, 2018)^[52]. Some curing agents are isocyanate, epoxy resin, alkyd resin, organic silane and drying oil (Wang et al., 2018)^[53]. Although the self-healing coating has the curable capability for microcracks, its anti-corrosive performance is far inferior to that of the intact epoxy coating.

There are already uses of self-curing coating along with the epoxy resin. Falcón, Sawczen, & Aoki (2015)^[54] describe how to correctly apply the two materials. The self-curable material should be deposited in layers through intelligent nanoreservoirs. These tiny

molecular containers containing corrosion inhibitors are dispersed over the main coating and release the active material in a controlled manner to contain the corrosion reactions in the affected areas and heal the existing damage.

V. ECONOMIC ISSUES INVOLVING SALTWATER PIPELINES

According to Passadore (2013)^[55], the costs of corrosive processes in industry are about 3% to 4% of a nation's GDP, which shows the importance of investing in research in this area. These costs can be direct (replacement, repairs, labor, energy, etc.) or indirect costs related to accidents, efficiency, contamination, among others (Oliveira, 2016)^[56].

To choose the best type of coating to avoid corrosion, it is necessary to know the characteristics of the environment and the material to be protected (Frauches-Santos, 2013)^[57]. The cost and time required to apply the method also should be considered. The most common used solutions to prevent metal corrosion are related to their isolation. Industrial painting, with epoxy-based paints, is one of them. This coating is widely used because of ease of application and maintenance and good cost-effectiveness (Silva, Duarte, & Carvalho, 1998)^[58]. By forming a barrier between the metallic substrate and the external medium, industrial paint also results in excellent electrical and chemical behavior in the corrosive environment.

On the other hand, the use of new technologies such as DLC, carbon nanotubes and self-recoverable coating is still small, due to application complexity and cost, but in some high-value applications the investment is already justifiable. In addition, the cost of new technologies tends to fall over time, which can improve the cost-effectiveness of these new coating methods.

VI. FIGURES

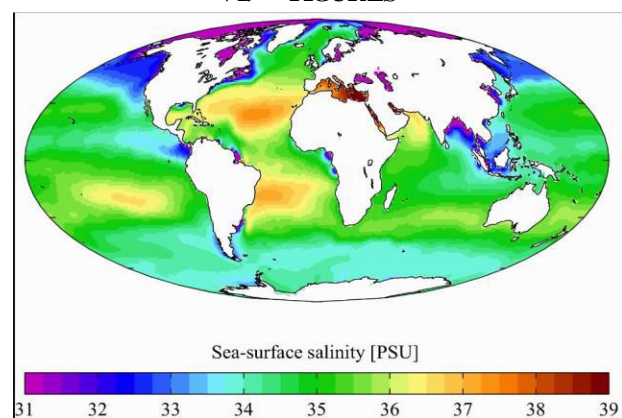


Figure 1: World map with salinity levels of seawater from Narayan et al. (2010)^[51].

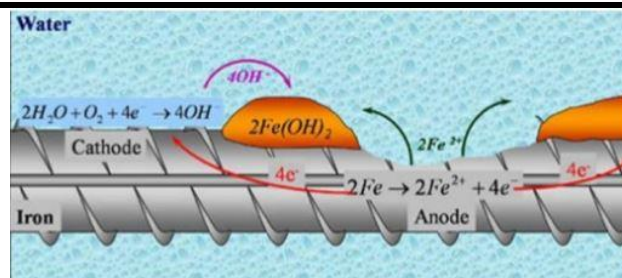


Figure 2: Corrosion mechanism of steel in the sea water. Clear, K.C., Hay, R. E. (1973)^[59]

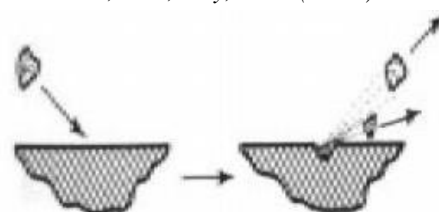


Figure 3: Erosion schema. Mecanismos de desgaste. UNIMAR

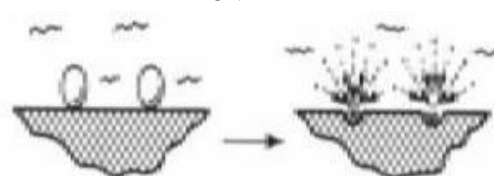


Figure 4: Cavitation schema. Mecanismos de desgaste. UNIMAR.

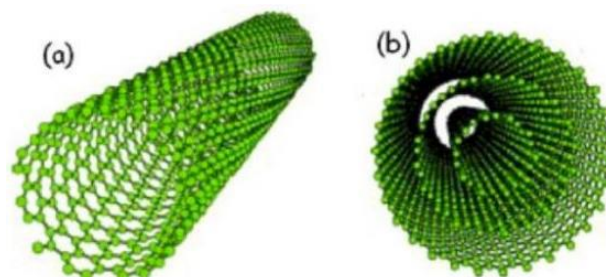


Figure 5: Schematic representation of the structure of carbon nanotubes (a) single wall nanotube, (b) multiple wall nanotube. Zarbin (2007)^[60]



Figure 6: Technical concept of self-healing coatings based on microencapsulating healing agents. Andersson, H. M., Wilson, G. (2011)^[61]

VII. CONCLUSION

Wear by corrosion on metal pipelines caused by saltwater causes many losses to the world economy. Therefore, research on ways to avoid or minimize this problem is of great importance for the industry, principally those located in coastal regions or that depend on some form of

salt water, such as onshore, offshore and pre-salt platforms, tidal power plants, nuclear and thermoelectric power plants.

The high investments necessary for the construction of these plants justify the amount spent on coatings to avoid frequent problems with corrosion. Even more technological and expensive coatings, such as DLC, carbon nanotubes, nanocomposites and autocura deserve to have their viability evaluated.

Due to this great industry need, several technologies in this area are being developed, as shown in this literature review. These advances are made to improve the properties of coatings, reducing maintenance costs and risks, and to develop ecologically correct coatings.

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Vibration Analysis of Unbalance on Axial Fan Engine 5.5 KW

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Abstract— The unbalance on an axial fan engine causes vibration and noises in a small open wind tunnel construction circuit. The unbalance is not only speeding up the damage to the engine but also disrupt the convenience surrounding the engine, especially for the engine users. In this research, measurement analysis is done to find the cause of the unbalance. Initial vibration measurement results show the amplitude exceed[s] the ISO 10816-3 standard limit (0.292 G-S equal to 15.45 mm/s). After going through the balancing process, the unbalance of the axial fan decreases by 84% with the amplitude of 0.047 G-S equal to 2.5 mm/s, so the engine vibration and the vibrations of its surrounding rope.

Keywords— Unbalance, axial fan engine, amplitude, overall vibration, ISO 10816-3.

I. INTRODUCTION

An axial fan engine is generally used to flow fluid from one place to another by changing the velocity of the fluid flow. One of the applications of axial fan engine is as a complementary tool of an open type wind tunnel construction, used to drain the fluid to the test section room.

PT. Chroma is one of the tunnel manufacturers that uses an axial fan engine. One of the wind tunnels it built has a vibrations problem at the axial fan engine with a value of 0.292 G-S \approx 15.45 mm/s, creating bad impacts on health and safety at work especially for the machine users. So the vibration must be decreased.

Generally, there are four factors of unbalance that cause damages to an engine, namely unbalance in temperature, noise, amount of oil, and vibration.

The most severe damage is caused by vibration which may be the result of miss-alignment, contaminated lubricant oil, gear mesh defect, blade defect, stator defect, component resonance, rotor defect, belt vibration, and bearing defect (see table 1).

Table 1. Main causes of engine damage^[2]

Damage to the machine-The main cause of damage										
	Unbalance	Miss-alignment	Lubrication Oil contact	Gear mesh defect	Blade defects	Stator defect	Component resonance	Rotor defect	Belt vibrations	Bearing defect
Temperature	X	X	X	X	X	X	X	X	X	X
Noise	X	X	X	X	X	X	X	X	X	X
Oil Analysis	X	X	X	X	X	X	X	X	X	X
Vibration	X	X	X	X	X	X	X	X	X	X

The axial fan engine construction that is installed in the open type wind tunnel has a direct connection between the axial fans with the engine through a coupling like a rotor connected to the stator. According to reference data the damage to direct connection machines is usually caused by an unbalance, bearing damage, and excessive aerodynamic load (see Figure 1).^[2]

Referring to the figure 1, excessive vibration on the axial fan engine 5.5 KW is estimated by the occurrences of a type of static unbalance, resulting from an engine misdeeds (such as the un-similarity in an angle between blades) or due to the imperfection in fabrications of engine components.^[2]

The measurements of vibration of the axial fan engine owned by PT. Chroma has been carried out to determines the static unbalance on the engine, and further to reduces the vibration, so it may work in a safe operation range. This may improve the health and safety of machine users.

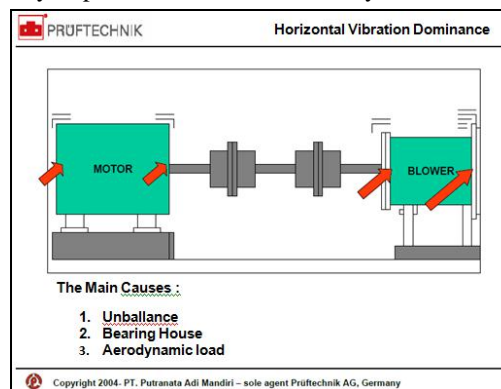


Fig.1: Dominant vibration in horizontal direction.^[2]

The main goal of measuring the unbalance carried out by PT Chroma on axial fan engines is to meet the standards of the regulations of the minister of environment of the Republic of Indonesia to keep up human health especially who works in Indonesia.

To protect Indonesia's health and safety from the effects of high vibration, the minister of environment of the Republic of Indonesia has made two rules that can be used as a law of human protection (see table 2 and table 3).^[6]

Table 2 shows the regulation of the minister of environment of the Republic of Indonesia which regulates the relationship between standardized vibrational levels with an environment friendly and health. Where type of environment friendly and health is made with 4 classifications (do not disturb, disturb, uncomfortable, painful).

Table 2. Standards of vibration for comfort and health (decree of the state minister for the environment of the Republic of Indonesia, KEP-49 / MENLH / 11/1996).^[6]

Frequency (Hz)	Vibration Rate Value, in micron (10 ⁻⁶ meter)			
	Do not disturb	Disturb	Uncomfortable	Painful
4	< 100	100 – 500	500 – 1000	> 1000
5	< 80	80 – 350	350 – 1000	> 1000
6,3	< 70	70 – 275	275 – 1000	> 1000
8	< 50	50 – 160	160 – 500	> 500
10	< 37	37 – 120	120 – 300	> 300
12,5	< 32	32 – 90	90 – 220	> 220
16	< 25	25 – 60	60 – 120	> 120
20	< 20	20 – 40	40 – 85	> 85
25	< 17	17 – 30	30 – 50	> 50
31,5	< 12	12 – 20	20 – 30	> 30
40	< 9	9 – 15	15 – 20	> 20
50	< 8	8 – 12	12 – 15	> 15
60	< 6	6 – 9	9 – 12	> 12

Table 3 shows the categories of vibration limits as regulated by the minister of environment of the Republic of Indonesia. The limit associates with damage may cause, shown in four categories (A = no damage, B = causing cracks, C = causing structural damage, D = causing damage to load-bearing walls).

Table 3. Mechanical vibration level based on impact of damage (decree of state minister of environment of Republic of Indonesia, KEP-49 / MENLH / 11/1996).^[6]

Frequency (Hz)	Vibration Velocity Limit, in mm / sec			
	Category A	Category B	Category C	Category D
4.0	< 2.0	2.0 – 27	27 – 140	> 140
5.0	< 7.5	7.5 – 25	25 – 130	> 130
6.3	< 7.0	7.0 – 21	21 – 110	> 110
8.0	< 6.0	6.0 – 19	19 – 100	> 100
10.0	< 5.2	5.2 – 16	16 – 90	> 90
12.5	< 4.8	4.8 – 15	15 – 80	> 80
16.0	< 4.0	4.0 – 14	14 – 70	> 70
20.0	< 3.8	3.8 – 12	12 – 67	> 67
25.0	< 3.2	3.2 – 10	10 – 60	> 60
31.5	< 3.0	3.0 – 9	9 – 53	> 53
40.0	< 2.0	2.0 – 8	8 – 50	> 50
50.0	< 1.0	1.0 – 7	7 – 42	> 42

II. THEORETICAL BASIS

Vibration is an alternating motion that passes through the same trajectory. This kind of movement is called periodic motions.

Between these periodic motions there is a movement called a harmonic motion. So the vibration of an object is said to be a simple harmonic function, with the following deviation equation below.

$$Y = A \cos \omega t \dots\dots\dots(1)^{[3]}$$

Where A is the amplitude, and ω is the angular frequency.

The existences of the angular frequency at harmonic function can be used to calculate the period or time of vibration of back and forth with this Equation :

$$T = 2\pi / \omega \dots\dots\dots(2)^{[3][5]}$$

The frequency that occurs can also be approached by this equation.

$$f = 1 / T = \omega / 2\pi \dots\dots\dots(3)^{[3][5]}$$

The speed of a simple harmonic moving object can be obtained from the first derivative of this deviation Equation (1).

$$v_y = - A \omega \sin \omega t \dots\dots\dots(4)^{[3]}$$

While the accelerations of simple harmonic moving objects comes from the second derivative of Equations (1).

$$a_y = - A \omega^2 \cos \omega t = - \omega^2 Y \dots\dots\dots(5)^{[3]}$$

The above formula is usually used to measure vibrations that occur on a machine, so that the unbalance in the engine due to vibration can be investigated.

The decrease in the unbalance correction ratio in a single plane balancing can be approximated using the following equation:

$$URR = 1 - U2/U1 \dots\dots\dots(6)^{[4]}$$

Where U1 initials value unbalance and U2 is the value of unbalance after correction.

III. MEASUREMENT METHOD

Usually to measure vibration on a machine, a measurement acquisition system is needed which consists of a vibration machine, trigger, and accelerometer, where the system will change the vibration signal data into electrical signal data.

The measurement acquisition system can measure vibration amplitude of a stationary or moving specimen or engine. The amplitude can be decomposed into some parameters of velocity and acceleration according to the directions of the required axis, so the placements of an accelerometer on the specimen or machine shows the direction axis of vibration measured of the specimen or machine.

Velocity parameters is one of the best indicators to know the problem of vibration at medium velocity engine.

The method of placing the accelerometer measuring instrument is determined according to the direction of the axis of the specimen or machine to be measured. To measure a vibration amplitude in the directions of the specimen or machine axis, the accelerometer is placed parallel to the x axis, and to measure a vibration amplitude in the horizontal directions of the specimen or machine axis, the accelerometer is placed parallel to the y axis, while to measure vibration amplitude in the vertical direction of the specimen or machine the accelerometer is placed parallel to the z axis.

For this axial fan engine case, the vibration data required is in the vertical direction, so the accelerometer is placed parallel to the z axis in the engine's front bearing area. While the trigger is placed on the front of an axial fan engine hub (see figure 3). Then the device is connected to the CSI-2130 analyzer as a vibration counter.

The acquisition data process of an axial fan engine is started while the accelerometer sensor receives the vibration amplitude signal data from the engine, then the vibration signal data is converted into electrical signal data, then the electrical signal data is sent to the CSI-2130 analyzer to be calculated iterative. Furthermore the CSI-2130 analyzer engine provides information simultaneously about the phase angle of the placements of the correction load positions and the value of the correction load, so that the unbalance value on an axial fan engine can be known and reduced.

SPECIFICATIONS OF SPECIMEN

Tabel 4. Technical information of the test specimen

Engine	: Axial fan
No. of blade	: 14 pieces
Power	: 5.5 KW
Speed motor	: 3000 RPM
Transmission system	: Direct
Speed balancing	: 1700 RPM
Diameter impeller	: 28.4"

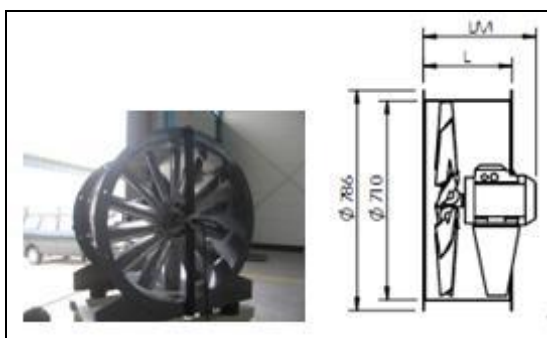


Fig.2: Construction of an axial fan engine.

IV. SETUP MEASUREMENT

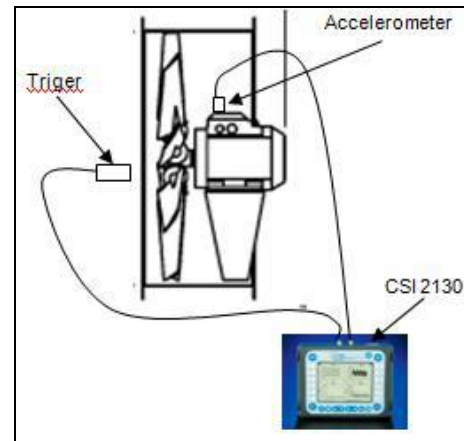


Fig.3: Setup measurement.

The measurements in this static unbalance experiment use the single plane method with several steps.

The first step, the axial fan engine is turned on, and then measures the initials unbalance to the engine by the measurement acquisition system (accelerometer, trigger, CSI 2130), the measurements were made in the front bearing positions of axial fan engine in a vertical direction only (see figures 3 and 4a).

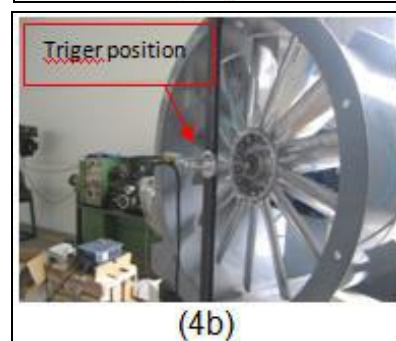
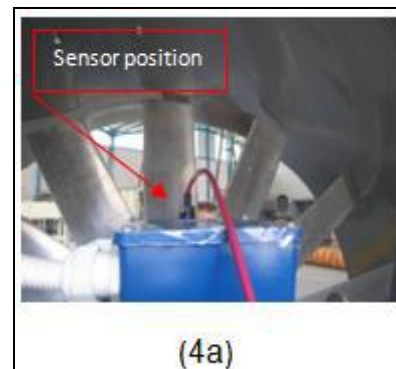


Fig.4: The locations of the vertical direction sensor on bearing no.1 of an axial fan engine (4a) and the locations of trigger (4b).

From the measurement results obtained by the value of amplitude of initials unbalance 0.2924 G-S (15.45 mm / s) at 318° phase angle (see point 1at Fig. 10a and 10c), then the engine is turned off.

The value of unbalance obtained from the measurements of 15.45 mm/sec is quite large beyond the allowable vibration limit for the axial fan engine, therefore the value must be reduced to the allowable limit.

The second step is to provides a trial weight as shown in fig. 5. This trial weight will be used to calculate the correction weight, at this moment the trial weight is used 20.1 grams at an angle of 0° on the axial fan engine hub (see first positions/ no. blade 14). Then turn on the engine again.

While the engine is running, the initials value of unbalance is measured by using a trial weight. The measurement locations is also at the front bearing positions of the axial fan engine on vertical direction.

From the measurement, it is obtained the value of initials unbalance velocity of the axial fan engine, that is 0.479 G-S (25.34 mm/s) 326° . Besides that, it is obtained the correction load phase angle and the correction load value as explained in step three, Afterward, the engine is turned off.



Fig.5: Location of trial weight on blade no. 14 at a hub axial fan engine.

The third step is to provides the correction weight, that is 25.29 grams at 231.4° (at first positions/ blade no. 6), and 5.42 grams at 205.7° (at second positions/ blade no.7) as shown in fig. 6, then put the engine on again. Then the initials unbalance of axial fan engine is re-measured at front bearing positions on vertical direction.

The result shows that the initials unbalance value decreases to 0.047 G-S (2.5 mm/s) at 31° phase angle (see point 2 - figure 10b and 10c) from the previous initials unbalance velocity value of 0.2924 G-S (15.45 mm/s). It means that the initials unbalance positions moves from the positions of point 1 to point 2. The displacements from point 1 to point 2 wants to show that visually the

change in the value of the amplitude of the unbalance vibration becomes better especially if the visual change in the value of the amplitude of the unbalance vibration approaches the point (0,0). The percentage change in the value of vibration amplitude is decreased by 84%. Judging from this, the balancing process is considered successful.

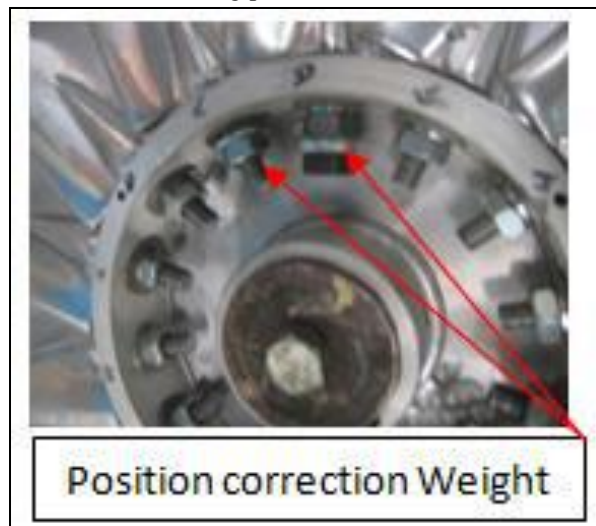


Fig.6: The locations of the correction weight in blade no. 6 and 7 at a hub of axial fan engine.

The fourth step is to measure the natural frequency and velocity vibration of the buffering of the axial fan engine by the bump test method. From the measurement found there are rapid increase in frequency from 7.81 Hz to 19.70 Hz, as well as a rapid increase of velocity from 0.0030 in / s to 0.0060 in /s. This shows that probably there is an effect of natural frequencies on the less rigid axial fan engine buffer (see table 5 and figure 11).

V. RESULTS AND DISCUSSION

Measurement and recording with FFT spectrum data curve is very helpful in conducting vibration monitoring or analyzing a problem on the machine. Therefore FFT spectrum data curve is often used by experts as a guide to quickly and accurately indicate an abnormal problem of vibration on the engine see figure 7, 8, and 11).

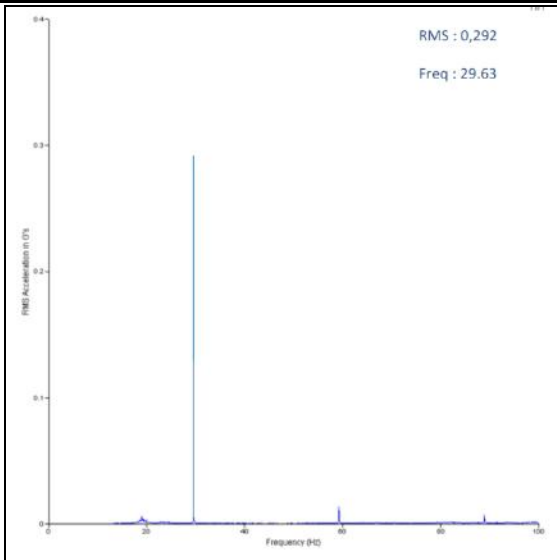


Fig.7: Axial fan engine vibration spectrum data owned by PT. Chroma before correction

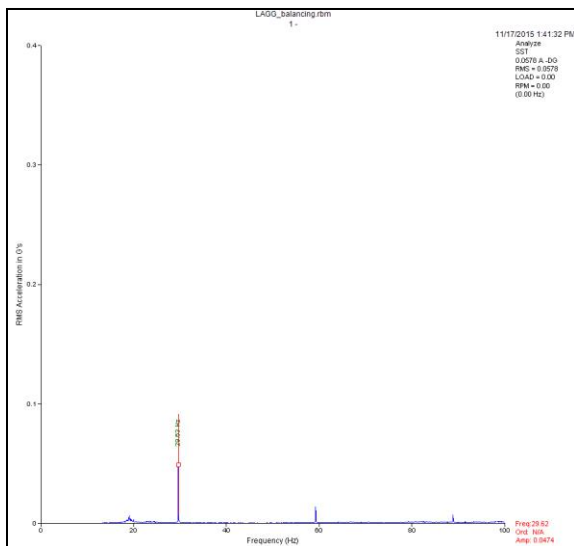


Fig.8: Axial fan engine vibration spectrum data owned by PT. Chroma after.

Evaluation of vibration and bump testing

The evaluations of measurement and correction of static unbalance of axial fan engine of PT. Chroma refers to the ISO 10816-3 and the guidance of the decree of the state minister of the environment, KEP-49/MENLH/11/1996.

Initial static unbalance velocity axial fan engine measurement results obtained value of 15.45 mm /sec, while the static correction unbalance velocity measurement results obtained a value of 2.5mm / sec. so that there is a very large decrease in the value of static unbalance velocity.

According to the ISO 10816-3, the vibration velocity value on axial fan engine with 2.5 mm/s is included in group 4 with flexible foundation classification with the allowed vibration velocity range of (0 - 4.5 mm/s),so the fan operating area of the axial engine is in a region B, (see table 6).^[7]

Meanwhile, according to the decree of the minister of environment KEP-49/ MENLH/11/1996 that the value of vibration velocity on the axial fan engine 2.5 mm/s is included in category A and does not cause damage (see table 3).^[6]

Evaluation of measurement of vibration bump test to the axial fan engine buffer, showed the increase rapidly in vibration and frequency from 7.81 Hz to 19.70 Hzwith rapid increase of the velocity from 0.0030 in/s to 0.0060 in/s. This shows the effect of natural frequencies on the less rigid axial fan engine buffer (see table 5 and figure 9).

Based on the results, it comes to consideration that the axial fan engine buffer needs to be strengthened so that the natural frequency value of the axial fan engine buffer occurs outside the engine's operation frequency (see figure 9 and 11).



Fig.9: Buffering of axial fan engine that needs to be reinforced.

Table 5. Resume data bump test results for axial fan engine owned by PT. Chroma.

Spectral Peaks			
LAGG_balancing.rbm / 1 -			
11/17/2015 3:04:15 PM			
0.00 RPM			
Units: Pk Velocity in in/sec			
Peak No.	Frequency (HZ)	Peak Value	Order Value
1	0.56	0.2942	-1.000
2	2.06	0.0415	-1.000
3	2.69	0.0247	-1.000
4	2.94	0.0201	-1.000
5	3.31	0.0161	-1.000
6	3.56	0.0140	-1.000
7	3.94	0.0115	-1.000
8	4.19	0.0101	-1.000
9	4.57	0.0084	-1.000
10	4.94	0.0075	-1.000
11	5.19	0.0068	-1.000
12	5.56	0.0059	-1.000
13	5.94	0.0054	-1.000
14	6.19	0.0050	-1.000
15	6.44	0.0043	-1.000
16	6.69	0.0040	-1.000
17	7.07	0.0040	-1.000
18	7.45	0.0035	-1.000
19	7.81	0.0030	-1.000
20	19.70	0.0060	-1.000
21	24.31	0.0094	-1.000
22	25.94	0.0054	-1.000
23	26.56	0.0058	-1.000
24	27.31	0.0048	-1.000

Range of natural frequency of engine buffer

Table.6: Vibration value based on ISO 10816-3.^[7]

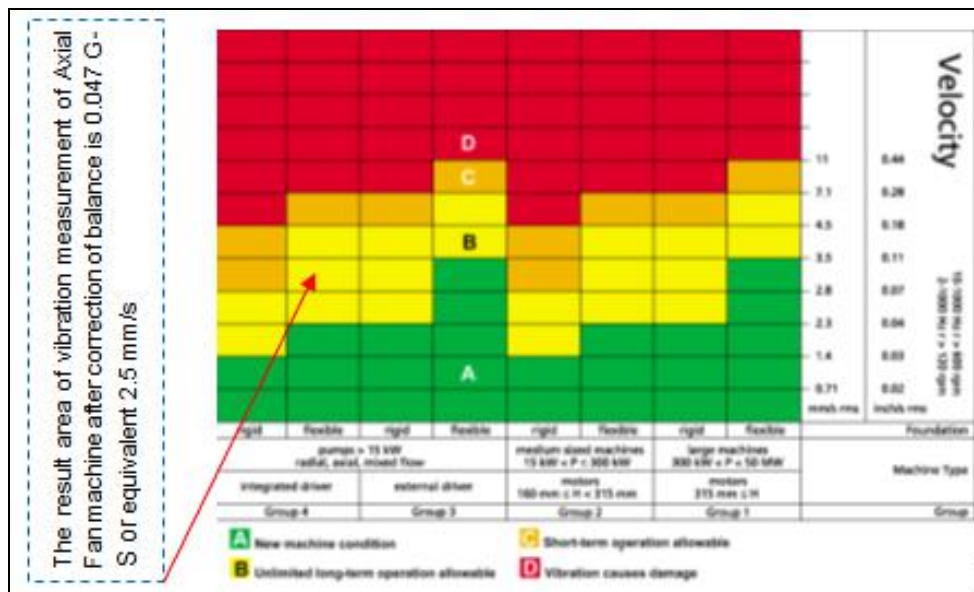


Table.7: The result of vibration data before and after the measurements of on-site balancing at bearing positions 1 of axial fan engine owned by PT. Chroma.

Sensor Location	Bearing 1		Explanation
Sensor position	Vertical		
Vibration before balancing	0.292 G-S	15.45 mm/s	Vibration causes damage
Vibration after balancing	0.047 G-S	2.5 mm/s	Operation allowable

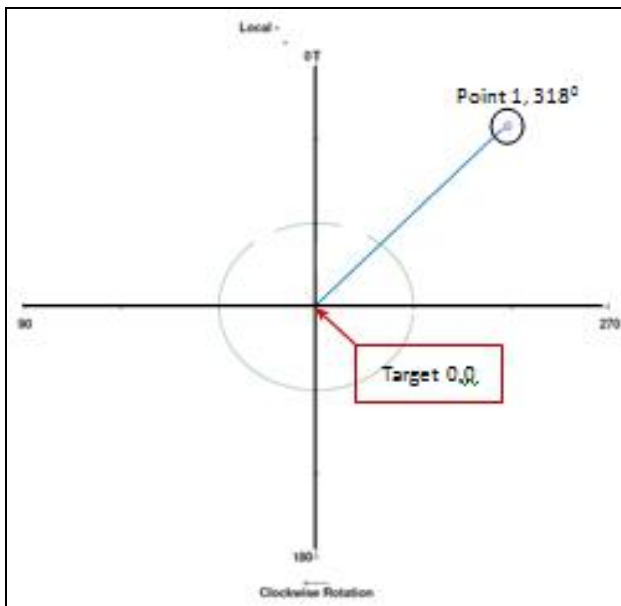


Fig.10a. Initial unbalance position

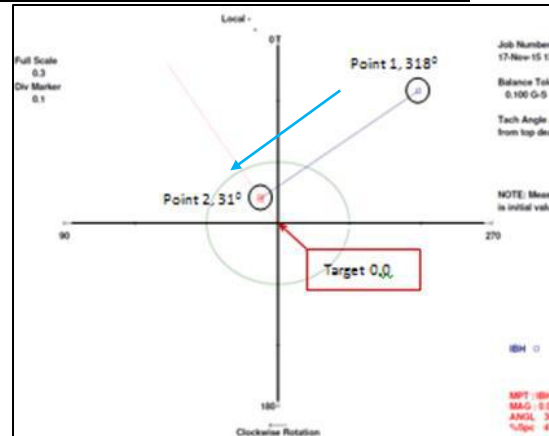


Fig.10c. Shifting of unbalance position

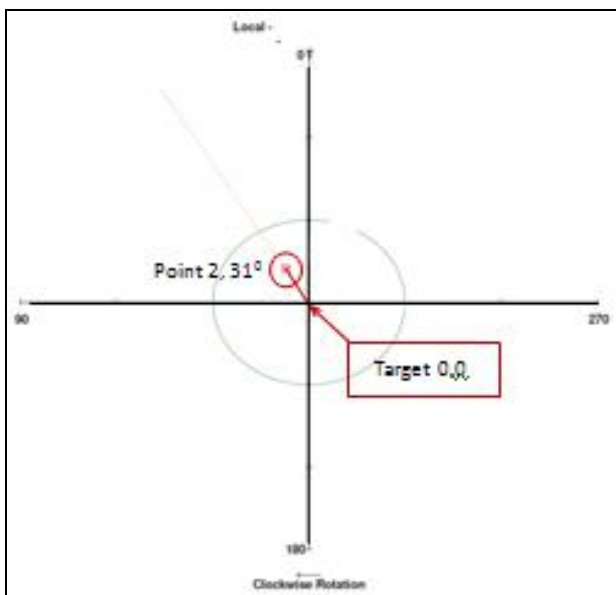


Fig.10b. Unbalance position after correction

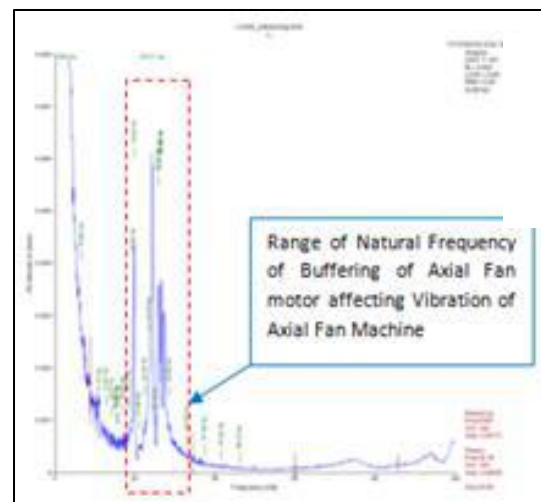


Fig.11: Resume of spectrum vibratory bump test data of buffering of axial fan engine

VI. CONCLUSIONS AND RECOMMENDATIONS

From the results of the above measurements, it can be concluded several points as follows:

1. The overall engine vibration value that occurs in the axial fan engine before is corrected by on-site balancing method is 0.292 G-S equal to 15.45 mm/s (rms);it is indicated that engine potentially speeding up the engine failure if it is not repaired immediately.
2. At the engine vibration of 0.292 G-S equal to 15.45 mm/s (rms), it indicates that the axial fan engine has

the potential not in safe range, so not comply with health and safety requirements.

3. The dominant vibration in the vertical direction is due to the unbalance in the axial fan engine blade hub.^[2]
4. After measurement and correction of unbalance with on-site static balancing method, the overall vibration of the engine decreases by 84% with a value of 0.047 G-S, equivalent to 2.5 mm/s.^[7]
5. With a vibration value 0.047 G-S equal to 2.5 mm/s, it indicates that the axial fan engine is in safe range, so it complies with health and safety requirements.^[6]
6. Referring to the ISO 10816-3 standard and the guidance of the decree of the state minister of the environment, KEP-49/ MENLH/11/1996 that the evaluations of measurement and correction of static unbalance of axial fan engine of PT. Chroma shows good results. With the decrease of the static unbalance velocity at the machine from 15.45 mm/s to 2.5 mm/s, so the axial fan engine is safely to operate because it is in category A and that it mean does not cause damage (see table 3 and table 6).^{[6][7]}
7. The existence of a less rigid buffer of the axial fan engine may affect the unbalance of the axial fan engine at a particular frequency and vibration velocity indicated by the rapid rise of the two parameters (see table 5).^[1]

RECOMMENDATION

1. The axial fan machine work activities must be monitored regularly (recommended every month) to find out the trend of engine vibration spectrum data. If the data shows a trend of increasing unsafe vibration operations, it is immediately possible to analyze the source of the bad vibration spectrum data so that identification of repairs to the machine can be known precisely, then the engine is protected from damage (see figure 7).^[1]
2. If there is a cause of vibration in the engine due to static unbalance, it is recommended to do onsite static balancing procedure as above, then the problem of unbalance on the machine can be overcome immediately, so that the engine can work again with good accuracy and the delay time of the engine is not lost too long.
3. Strengthen the buffering of axial fan engine to minimize static unbalance interference on the rotor.

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Tidal Speed Simulation of Seawater against Torque (τ) and Power (P) Produced by the Darrieus Turbine Type H

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Abstract—The depletion of fossil energy reserves and environmental issues currently play an important role in developing the concept of renewable energy, so that the search for new renewable energy is carried out very intensively. One type of renewable new energy that has the potential to be developed in Indonesia is the energy of river estuary flows, considering that Indonesia is an archipelagic country. This study, discusses renewable energy derived from the river mouth of the Bedono village of Demak Regency. The results of the observations that have been made, the tidal currents of the river which occur 2 times in 24 hours with an average current velocity at 0.953m/s. The biggest current velocity at 14.00-16.00 is 2.5 m/s and the lowest is 0.5 m/s at 06.00-08.00. Using the Computing Fluid Dynamic (CFD) model simulation and the Darrieus Type H turbine, with specifications; Diameter 1m, chord length 0.1m, turbine length 1 m, number of blade 3 and type of blade Hydrofill: NACA 0018 obtained the greatest power occurs at 14.00-16.00 at 8007.813Watt with a torque of 3540.470Nm and the lowest power of 83.726Watt with torque amounting to 14,663Nm at 04.00-06.00.

Keywords— Energy, Computing Fluid Dynamic (CFD), Darrieus Turbine Type H, Tidal, Model Simulation.

I. INTRODUCTION

The depletion of fossil energy reserves and environmental issues currently play an important role in developing the concept of renewable energy, so that the search for new renewable energy is carried out very intensively. One type of renewable new energy that has the potential to be developed in Indonesia is the energy of river estuary flows, considering that Indonesia is an archipelagic country. From the observation, the flow of the river mouth in the Bedono village of Demak Regency occurred 2 times in 24 hours with an average current speed of 0.953m / s potentially used as a power plant.

II. LITERATURE REVIEW

Darrieus Turbine

Darrieus turbine is a type of turbine that was developed by a French aeronautical engineer named Georges Jean Marie Darrieus in 1931. This darrieus turbine has advantages such as not taking too much into the flow direction because of its symmetrical shape, gravity pressure is not able to return to the blade shape, able to operate at low head and speed, while its weakness is the inability to self-starting, and high vibration. The working principle of the Darrieus turbine is due to the speed of the water flow which causes the blade to rotate with a certain rotational speed, so the resultant of the velocity will produce a hydrodynamic force [4].

Darrieus turbine is generally used as a wind power plant, but in research and trials in several places Darrieus turbines are very potential to be developed as marine currents. This turbine has various advantages including ease of manufacture, installation and maintenance. This modular and reliable turbine design can withstand high-speed currents. The darrieus turbine used in ocean currents is type H which consists of 3 blade blades, this type is divided into two types, namely straight blade type and helix blade (gorlov).

In theory, the amount of efficiency produced by wind turbines is 0.59 according to the Betz limit (Betz limit), taken from the German scientist (Albert Betz). This figure theoretically shows the maximum efficiency that can be achieved, from the curve in Figure 1, it can be seen that the efficiency of Darrieus turbine reaches 0.45%. Momentary theory in stream tube by Froude provides a simple understanding of the problem of idealized rotor modeling by assuming that:

- The acceleration of the propeller is uniform on all fluids passed.
- Flow is without friction.
- Style is distributed evenly across all profiles from stream tube.
- Inrush and outflow only have the same path

The power of the frictionless propeller was predicted by A.Betz in 1920. In accordance with Bernoulli's theory that the incoming pressure and volume equal the pressure and volume out ($P_1 = P_2$ and $V_1 = V_2$) and so that pressure is obtained [3].

$$E = p + \gamma h + \frac{\rho v^2}{2g} = \text{constant} \quad (1)$$

for horizontal flow

$$P_2 = P_1 - \frac{\rho(v_2^2 - v_1^2)}{2g} \quad (2)$$

In the momentum Froude theory, propellers are assumed to be actuator discs arising from cutting the discontinuity of the propeller field pressure. Physically the pressure in the P_1 region enters larger and when passing through the propeller the pressure will drop [3].

Sea Water Movement

• Sea current

Sea current is the movement of the mass of sea water from one place to another both vertically (upward) and horizontally (sideways movement). Examples of such movements are like the coriolis force, which is the force that turns the direction of the current from the earth's rotational power. The deflection will point to the right in the northern hemisphere and lead to the left in the southern hemisphere. This force results in a clockwise (right) gyre flow in the northern hemisphere and anticlockwise in the southern hemisphere. Changes in the direction of the current from the influence of the wind to the influence of the coriolis force are known as the ekman spiral. According to the location the current is divided into two, namely the upper and lower currents. The upper current is the current that moves on the surface of the sea. While the lower current is the current that moves below the sea surface [3].

• Tidal current.

Tidal currents are currents that occur due to changes in sea level due to tides. Characteristics of tidal currents are having a fixed period, following the tidal pattern. Therefore we know diurnal, semi-diurnal and mixed tidal currents. Tidal currents are formed by an attractive attraction between the earth and the moon's attraction. This is based on Newton's law which reads: "Two objects will be attracted to each other by forces that are inversely proportional to the square of the distance". Based on this law means that the further the distance, the less the attraction, because the distance from the earth to the sun farther than the distance to the moon, the tides of the sea level are more influenced by the moon. The tidal process is associated with periodic sea level ups and downs. The sun has a mass that is much larger than the moon, but because the moon is much closer to the earth the moon's attraction is 2.2 times greater than the sun's attraction. The

maximum current flow is generally achieved at the time of the tide and near tide, while the direction of the tidal current is strongly influenced by local environmental conditions or topography. In coastal areas, the largest tidal currents are generally parallel to the coastline [3].

Computational Fluid Dynamic (CFD)

CFD is a branch of fluid mechanics that uses numerical methods and algorithms to solve and analyze problems related to fluid flow. The purpose of CFD is to accurately predict fluid flow, heat transfer, and chemical reactions in complex systems, which involve one or all of the above phenomena.

III. RESEARCH METHODS

Survey location

The location survey is intended to find out the geographical conditions of the river covering the measurement of water depth, bridge length and tidal cycle of the area.

Measurement of current velocity

Speed measurements carried out on three sides of the bridge with the most rapid current assumption are at the place. Measurement is done every 2 hours using current drouge and stopwatch. Calculation techniques using speed formula: $v=l/t$ With v is the speed of the tidal current (m / s), l is the "current drouge" (m) mileage and t = the time taken by the current drouge (s).

Simulation of the CFD Model

In the CFD model simulation, some of the things that are done are:

- Pre Processor
- Solver
- Post Processing
- Visualization of results

IV. RESEARCH RESULTS AND DISCUSSION

Measurement of current velocity

The measurement of tidal current velocity is carried out every 2 hours with the following measurement results:

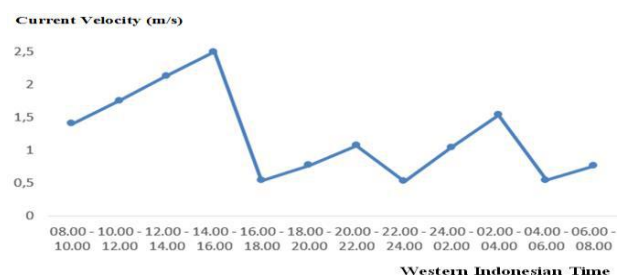


Fig. 1: Graphical Speed of Tidal Flow Against Time

Modeling of Darrius Turbine Using

Solidwork software Making a Darrius Type H turbine model Using Solidwork software where the results of 2D coordinate drawing are then redrawn using this software.

Determination of the coordinates of the blade

Determination of blade coordinates is intended to get the edge of the blade. Making point using point command with instructions in the form of x and y coordinates, in a simulation in bedono village using a Darrieus turbine with NACA 0018 blade [5].

Blade extraction

At this stage the 2-dimensional image that has been formed in the previous stage. Will be converted into 3 dimensions, this process uses the feature-ektruder command for 1000 mm. Basically, in the turbine modeling process, several parameters are needed in the turbine, including diameter, span, chord length. In this study simulated turbine specifications are; Darrieus Type H Turbine Type, Diameter 1.0 m, Chord Length 0.1 m Turbine length 1.0 m Solidity Ratio 0.6 Number of blades 3, Type of blade Hydrofill naca 0018.

Visualization of Simulation results

CFD visualization results are presented in the figure below

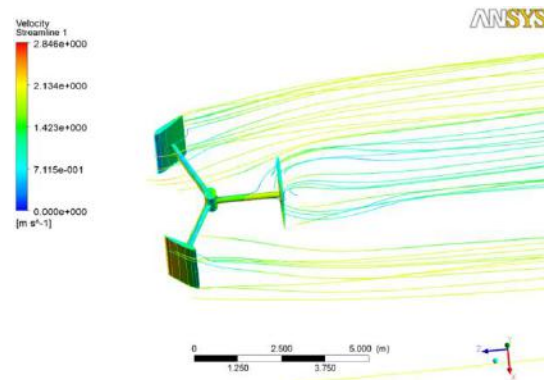


Fig. 2: Streamline Velocity in Turbines

The simulation results using CFD using tidal currents measured obtained torque (τ) and power (P) as shown below.

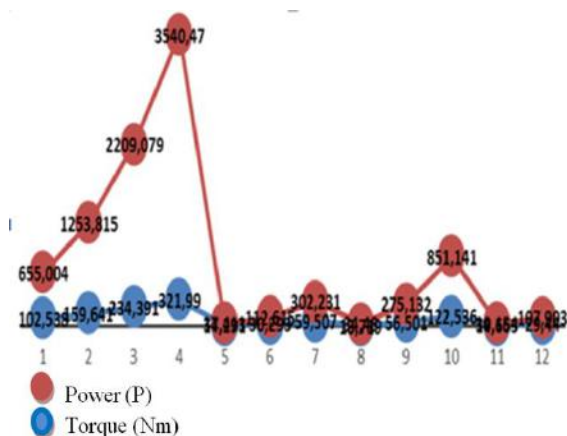


Fig.3. Torque Changes (τ) to Power (P)

It can be seen from the graph that the significant increase in power occurs when Torque (τ) reaches 321.99 Nm power (P) 3540.47W, so it can be concluded that the relationship between torque and power is not linear. The

scattering result shows that the relationship is a quadratic equation with the

$$Y=0,7712 X^{1,4586} \tag{3}$$

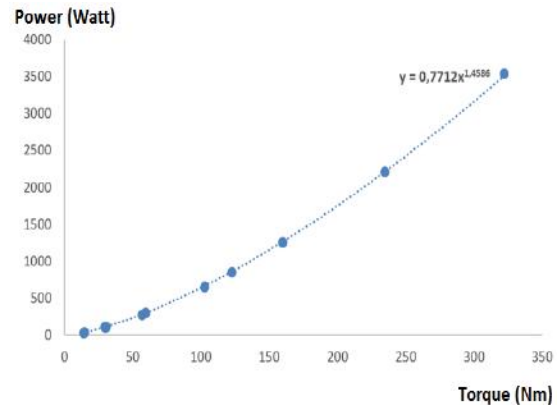


Fig.4. Torque Relationship To Power

V. CONCLUSION

From this research can be concluded several things as follows ;

- The highest speed of tidal currents occurs at 2:00 a.m - 4:00 p.m.WIB at 2.5m / s.
- The largest power of 3540.47W is generated when the torque is 321.99 Nm at 14.00-16.00.
- Torque relationship to power is a quadratic equation.

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A Review on Numerical Simulation and Comparison of Carbide and HSS Tool Wear Rate while Drilling with Difficult To Cut Super Alloy Titanium Based on Archard Model

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Abstract— A Carbide and HSS tool wear rate simulation using Archard's wear model is proposed, finite element modelling is done using commercial finite element software ABAQUS/explicit. ABAQUS interface was used to simulate the contact pressure. For measuring wear depth of tool's drilling operation is performed experimentally then wear depth is measured on profilprojecter. Comparing the wear rate, based on Archard model.

Keywords— Finite Element Analysis, Titanium Drilling, Archard's Model, Wear Rate, Carbide and HSS Tool.

I. INTRODUCTION

Titanium alloys are used extensively in aerospace, automobile and medical application because of combined high special strength (strength-to-weight ratio), fracture-resistant characteristics and exceptional resistance to corrosion. However, titanium alloys are usually considered as extremely difficult to cut material because of their low thermal conductivity and high chemical reactivity with cutting tool materials. Tool wear is major issue in dealing with titanium.

Being one of the new hole-machining methodologies, drilling is widely used machining process, which account for 40-60% of total material removal process. In the past, lot of experiments need to be conducted to obtain a series of related data during the drilling studies, which bring about huge raw material consumption. Finite Element simulation can not only save the raw material but also improves accuracy of result. Furthermore, finite element analysis can also obtain the measured data which is difficult to obtain in experiment.

II. OBJECTIVE

The objective of this review paper is to discuss the finite element modeling when drilling with Ti6Al4V alloy and use of FEM software.

III. PROPERTIES OF MATERIAL

Table.1: Material Properties.

Material properties parameters	Ti6Al4V	Carbide	HSS
Density (kg/m ³)	4420	1570	8140
Young modulus (Pascal)	122,000,000,000	669,000,000,000	207,000,000,000
Poisson ratio	0.31	0.26	0.27

IV. FINITE ELEMENT MODELING

In the area of engineering and mathematical physics Finite element modeling is used to finding out the problems. The area on which attention focuses on distribution of stress, temperature, strain, displacement, contact pressure etc. The FEM have different models using them the actual working condition is developed. The FEM gives such a result which is difficult to obtain in actual.

V. WEAR MODEL

Tool wear is major issue in production process which can be minimized up to some extent by selection of correct tool at appropriate process parameter. For predicting wear rate Archard's wear law is most commonly used which is expressed as [5]:

$$k_D = V / F_N \cdot s \quad (1)$$

Where k_D dimensional wear rate. V is the wear volume, F_N is the normal load, s is the sliding distance.

VI. LITERATURE REVIEW

Ozden Isbilira, has done the analysis for drilling of titanium alloy, the drilling tests are performed for determining the efficiency of FE model. The thrust force, torque, burr height is measured experimentally and compared with FE results for validation. The study shows that the FE model of drilling can be used as for predicting the changes in cutting force, torque and stresses with respect to drilling process parameters [4].

Xuejin Shen, has done the simulation for determining the sliding wear rate using Archard wear law. He has done the finite element modeling for predicting the wear of mechanical component. The geometry update and remeshing are taken into account in order to obtain the accurate result [5].

Yong Yang, Jie Sun introduced simulation for drilling of titanium alloy, a three-dimensional finite element model of drilling process is developed. Prediction of cutting force and comparison with experimental values are done. Study shows that finite element model is reasonable. The stresses and temperature in drilling process at initial condition increases up to its maximum value when process comes at its steady state then gradually decreases. Optimal process parameter for drilling can be determined using FEM [6].

Y. Su, D.D. Chen, L. Gong has described 3D Analysis of drilling for Ti6Al4V Alloy, using commercial finite element software DEFORM 3D. Analysis is done at different process parameters for investigating the influence of process parameters on performance of machining. The study shows that FE model can be recommended for predicting optimal process parameter for drilling of Ti6Al4V [7].

Viorel Petrariu, Dumitru Amarandei, Stelian Alaci studied about Finite element analysis of high speed drilling. The attention focused on advantages of software used for simulation of cutting process. There study showed that FEM can be used to obtain the optimum process parameters, the expensive trial and error method can be eliminated [8].

A. Attanasio, F. Fainia and J.C. Outeirob has investigated the tool wear when drilling of Inconel 718, using FEM. The tool geometry update is implemented in FEM. Investigation showed that a good agreement was obtained between the predicted and measured tool wear data [9].

Robson Cristiano Brzostek, Jose Antonio Esmerio Mazzaferro, Jorge Fernandes dos santos, Telmo Roberto

Strohaecker has, studied development of the computer model of Johnson-cook damage criterion for friction spot welding. They have developed Johnson-Cook damage criterion model for crack initiation, coalescence and the final fracture. AA 2024-T351 and alclad AA 2024-T351 aluminum alloys is used as based material. The numerical model results obtained shown good agreement with the experimental tests [10].

John M. Thomson, Mary Kathryn described, a proposal for the calculation of wear based on Archard model using FEM. In the structural analysis the effect of wear is included. Wear strain is calculated using archard model. In order to modify the elastic strain in element [11].

M. kolahdoozan, F. Azimifar, S. Rismani Yazdi investigated tool wear for drilling of nickel and analysis is done for optimization of tool wear using response surface methodology. The study deals with monitoring tool wear through the chip formations, forces, and edge temperature of drill while drilling in super alloy plate to optimize effective parameters which lead to facilitate machining process to improve tool life, and enhance productivity. Inconel 718 super alloy material and cemented coated carbide tool have selected in their study to investigate tool wear mechanism. Mathematical models were deduced by Minitab software to display the effect of the main process parameter such as cutting speed, feed rate and tool diameter on tool wear. A wear is predicted using finite element method, a 3D model of twist drill is developed, wear is compared experimentally the result recorded 95% confidence and verified by ANOVA. The simulation results were in accordance with experimental and predictive values from RSM with error rate of 4-6%, proving the ability of the tool wear model to correctly forecast it. Also the experimental results showed that cutting speed as the main parameter followed by feed rate, contribute significantly the tool wear of drill bit [12].

Hemant S. Patne, Ankit Kumar, Shyamprasad Karagadde and SuhasS. Joshi proposed the distribution of temperature while drilling of titanium work piece. They have divided the cutting edge of tool into series of independent elementary cutting tools (ECT). The cutting forces are simulated and then evaluated the distribution of temperature with consideration of heat partition factor. Also the results are validated experimentally using IR camera, simulation results are in accordance with the experimental result [13].

A.M. Abdelhafeeza, S.L. Soo, D.K. Aspinwall, A. Dowson, D. Arnold investigated, hole quality and formation of burr while drilling with aluminium and titanium alloys. Investigation shows that the interaction of

cutting speed and feed rate is statistically significant while drilling titanium and flank wear of tool is less than 30 μ m (after 60 holes) in all tests [14].

VII. PROPOSED WORK

FEM can be used for predicting the stress and temperature distribution in drilling process which is quite difficult with the actual experimental setup. From this review paper it is seen that the contact pressure distribution in drilling process can studied and compare which would be able to predict the wear rate of cutting tool.

VIII. CONCLUSION

From the recent studies for simulation of drilling process it is seen that FEM has very precise accuracy of result. The FE cutting Simulation gives good results under the boundary conditions. Which save the time and cost of manufacturing.

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Foreign Direct Investment in Tourism and Economic Growth: Panel Data of OECD Countries

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Abstract— It is debated whether foreign direct investment (FDI) exerts significant influence on economic growth. This paper aims to examine the effect of FDI in tourism on economic growth. The particular focus on tourism provides insight on possible contradictory process that previous literature have captured. This paper analyzes panel data of 18 OECD countries from 2005 to 2012 using system GMM developed by Arellano and Bover (1995) and Blundell and Bond (1998). The results show that FDI in tourism industry does not significantly affect economic growth. Furthermore, the absorptive capacities, human capital and trade openness, that are proven to work for aggregate FDI do not work for tourism-related FDI. Therefore governments are advised to take precaution against the common wisdom that FDI (in aggregate) contributes to economic growth. As this paper suggests, tourism industry, among other sectors, presents itself as an exception.

Keywords— economic growth, FDI, foreign direct investment, system GMM, tourism

I. INTRODUCTION

Despite the massive amount of literature in the field of foreign direct investment (FDI), FDI in the tourism industry has not been widely discussed. FDI is really important and crucial for developing countries since these countries are the ones that lack capital and therefore require investment from other countries to grow. Another important sector for developing countries is tourism. These countries often have unique, extensive, and breathtaking natural beauty. Therefore by utilizing these natural phenomena as well as supporting it with the right infrastructure and care, it will certainly help developing countries nourish their economy. Unfortunately developing countries lack capital, managerial skills, or both, in utilizing the resources they have into valuable tourist attractions. FDI in the tourism sector is very important not only because it brings financial resources but also technology and human capital that are crucial for the initial stage of development of these untapped tourist

sites. The locals can then maintain and further improve these destinations in the future. In the literature, this is referred to as technology and knowledge spillover. However, it is important to make sure that recipient countries benefit from it. If they do then the government should encourage more inward FDI in the tourism sector. If they do not, then the resources could be located elsewhere.

Due to these reasons, it is regrettable that FDI in the tourism sector has not received the attention it deserves. The literature has discussed this topic, however, most of them do not perform the deep quantitative analysis the question demands. Many researchers used time series data to analyze only one specific country. In the case where multiple countries were examined, the impact of FDI in tourism sector on host countries' economy are often neglected. This paper is going to analyze the effect of FDI in tourism on the economy of the recipient countries. The results of this research are going to help governments, especially the ministry of tourism, plan their strategies in order to develop their nation's tourism industry. This research employed quantitative approach by using panel data from 18 OECD countries from 2005 to 2012 as this dataset is the most comprehensive to date. The method used to analyze the data is the System Generalized Method of Moments (GMM) estimator. There is very little research in this area which have used GMM estimator although it is quite apparent that endogeneity issue exists in this case.

To conclude, 1) though research has been done on the effect of FDI on economic growth, the effect of FDI in tourism industry on economic growth is not extensively examined, 2) though research has been done on the effect of tourism industry on economic growth (tourism-led growth hypothesis), the effect of FDI in tourism industry on economic growth is less explored. Therefore this research is filling the gap in the literature. Other gaps include lack of in-depth quantitative research on the impact of FDI in tourism industry on the host country's economy, few if not no research which employed system

GMM estimator despite possible endogeneity issue, and the lack of panel data analysis encompassing many countries as previous research mainly focused on individual countries.

This paper started with an introduction which is followed by a literature review. After previous literature has been discussed, the paper discusses the materials and methods that are used in this research. The following section after that presents the results and discussion. Last but not least, the paper is concluded and closed with the limitations of the current research as well as recommendations for future research. It is hoped that this research is not only going to enrich the literature in this area but also has practical contributions for the governments. Ministry of Tourism along with the local tourism authorities should utilize empirical research as foundations of their master plan in improving their countries' tourism industry and subsequently the whole economy of the country.

II. LITERATURE REVIEW

FDI has been discussed for years. Its relationship with economic growth was explored extensively in the literature with many conflicting empirical results. There are many research which suggest that FDI significantly affects economic growth in a positive way [1-10]. On the other hand, other literature proved that the effect of FDI on economic growth is insignificant [11-16]. Many literature suggests that FDI exerts significant positive effect on economic growth when certain prerequisites have been fulfilled by the host country or the effect becomes stronger when these factors are strong enough in the host country. These variables vary from research to research but the most common factors include human capital [17-22], financial market development [18, 23-27] and trade openness [18, 20, 26].

It can be seen that literature in the area of FDI has discussed the relationship between FDI and economic growth for a long time. Unfortunately, there are no definitive results until now as many empirical studies suggest conflicting outcomes. The research have also taken into account a wide variety of data sets, starting from an individual country, developing countries, developed countries, countries in certain region and even countries all over the world. Cross-country analysis went as far as encompassing 140 countries over 39 years. This research was published quite recently [26]. They concluded that FDI significantly affects economic growth in a positive manner regardless of whether the recipient is a developing or developed country. They also stated that the variation does not occur within a country but instead between regions. Moreover, concurrent FDI is the one which affects economic growth instead of past FDI. Last but certainly not least, they also concluded that the

supporting variables inducing the positive effect of FDI on economic growth are trade openness and financial development rather than human capital. This is surprising as many researchers have proven human capital to be an important factor in the FDI-growth nexus. Unfortunately, despite comprehensive data analyses, in the end, the results cannot be generalized to all countries and all sectors. That is why this nexus has been a long-standing debate in the academic world.

In spite of country characteristic, the literature has also proven that the impact of FDI on economic growth depends on the sector in which the investment is put into. A rather comprehensive research has been done on the importance of sector in the relationship between FDI and economic growth [28]. The dataset included 47 countries over almost 2 decades from 1981 to 1999. The results showed that the aggregate effect of FDI on economic growth is not clear. The 3 different sectors which were analyzed are primary, manufacturing and service sectors. Interestingly the results of FDI-growth nexus differed in all 3 sectors, whereby it was negative for primary sector, positive for the manufacturing sector and ambiguous for the service sector. These results encourage the need for further investigation on the effect of FDI in the service sector on economic growth, in this case, FDI in the tourism industry. A similar case was found in the case of China and Vietnam [29]. They arrived at the conclusion that FDI is positively associated with economic growth only for the manufacturing industry in China and only for manufacturing and oil and gas sector in Vietnam. This shows that FDI does not necessarily benefit growth in all sectors of a country. Another research carried out in Indonesia proved that FDI only positively affects growth in the construction sector [30]. They even found that FDI brought a negative impact on growth in mining and quarrying sector. This is important to note since the government should not blindly encourage FDI in any sector of their economy. Another research used Asian countries data set [31]. She came to the conclusion that the positive effect of FDI on growth was only significant in the manufacturing sector but not in non-manufacturing sectors.

Therefore it is apparent that further research should be carried out on the effect of FDI on economic growth in sectors other than manufacturing, especially the service sector. Tourism industry as a part of the service sector has played an important role in many countries. Tourism is also an industry where both developed and developing countries can play an active role in. This is because unlike the manufacturing industry, tourism industry does not rely heavily on complex technology. Developing countries are not necessarily behind developed countries in the case of tourism since many tourists are attracted to natural beauty and cultural experience. OECD countries encompass both

developed as well as developing countries which provide a broad view of the effect of FDI on growth in tourism industry regardless of the level of economic development of the host country. Therefore this research provides significant insight for academicians and policymakers.

Literature which focused on FDI in the tourism industry is far less profound than that of the aggregate FDI. The research in tourism-related FDI used individual country or less number of countries in the analysis and also used a rather limited number of statistical methods for data analysis compared to research on aggregate effect of FDI. The number of research is also far less. A research concluded that there is two-way long-run causality between the development of tourism and FDI in the tourism-related industry, but there is no short-run relationship between the two [32]. The data set is taken from 20 developing countries. There were also research conducted in Croatia [33-34]. One proved the existence of both short-run and long-run relationship between tourism related FDI and gross value added [34]. Another one showed that there is unidirectional short-run causality from tourism-related FDI to international tourists arrival [33]. Furthermore, there was a study which specifically studied one province in Indonesia called Sumatra Utara or North Sumatra [35]. The result of their research showed that FDI in tourism does positively affect economic growth in that province. On the other hand, cross-country study which used data from 7 developed countries found that tourism development affects FDI instead of the other way around [36].

It can be seen that literature on tourism-related FDI focused on either developing countries or developed countries. As it has been mentioned before, the tourism industry is less dependent on the economic development of the host country compare to manufacturing industry, thus this research takes into account OECD countries which consist of both developed and developing countries. The research also takes into account human capital and trade openness which are seen as important absorptive capacities in the case of aggregate FDI. This is done to find out whether these two variables are also important in the specific case of FDI in the tourism industry. This is also a gap in the literature as previous research tend to analyze only FDI in the tourism industry and tourism development indicators without taking into account the other supporting variables.

Based on the literature review above, this research is going to fill the gap in the literature by analyzing the relationship between tourism related FDI and economic growth as well as tourism-related FDI and tourism development indicator, taking into account supporting variables (human capital and trade openness) in both developed and developing countries. This research helps to improve research in tourism-related FDI so that

researches in this area can gradually catch up to research on aggregate FDI. The methodology that is implemented in this research is also different than those that have been used in similar previous research. The research methodology is going to be explained in more details in the next section of this paper.

III. MATERIALS AND METHODS

There are several research methodologies which are commonly used in research of tourism-related FDI. These common methodologies are explained briefly before the methodology used in this research is introduced. These methods are frequently used in empirical or quantitative research in this area. The first is Granger Causality. Since most research in this field focused on finding out whether there is any causal relationship between FDI in tourism and economic growth or tourism development, thus many researchers used Granger Causality. Other than that, cointegration tests were also done alongside Granger Causality. The combination of these 2 methods has been used by many researchers in this area [32, 33-34, 37-40].

Many of these scholars who used the above-mentioned methodologies went through 3 steps. The first step is to test for stationarity or unit root test. The most common test used by researchers is the augmented Dickey-Fuller (ADF) test [33-34, 36-37, 40-41]. After making sure that the variables are stationary at least at the same level, the next step is to perform the cointegration test. Some researchers used Johansen cointegration test [33-34, 36, 41] or Pedroni [32, 36]. Last but not least is the Granger Causality test which determines whether there is a unidirectional or bi-directional relationship between the variables as well as short-run or long-run relationship.

Those are the common methods which are used by scholars in the area of tourism-related FDI. These tests are carried out for both time series and panel data, although more frequently used for time series data. There are certainly many qualitative research in this area as well. Most of these qualitative research focused on reviewing the literature. The method that is used in this research is different, which is the Generalized Method of Moments (GMM). GMM has previously been used in similar research which focused on Japan's inward FDI [42]. This is most probably the only research in tourism-related FDI which adopted GMM. Although the research methodology used is the same as the aforementioned research, however the variables being researched are different. The variables used were FDI as the dependent variable and the number of international tourist arrival as the main independent variable [42]. Thus the empirical research was carried out to find out whether more tourists lead to more inward FDI. This is the opposite of the objective of this research since this research is eager to find out whether more FDI in tourism industry leads to

economic growth or better tourism development of the recipient country. The results of this research impose different policy implications compared to the results drawn from the previous research [42]. Therefore, it can be seen that this research is one of the firsts to use GMM in analyzing the impact of FDI in the tourism industry on economic growth or tourism development of the host country. This is important to guide the governments with regards to the way they should administer policies and strategies around FDI in the tourism industry. There is a research which concluded that careful analyses should be done prior to attracting FDI in tourism within the overall development strategies [43].

GMM estimator itself can be applied to time series data, cross-sectional data and panel data [44]. It is a statistical methodology which combines observed economic data and information in population moment conditions in order to create estimates of the unknown parameters of the economic model [45]. GMM was introduced by Lars Peter Hansen in early eighties in the form which was practically useful for researchers and flexible since many unrealistic assumptions which existed in previous methodologies were no longer required [46]. Since then many scholars have chosen to adopt this methodology for their empirical research.

There are 3 hindrances which are overcome by the use of GMM. These 3 are the endogeneity problem, omitted variables and measurement errors [7]. GMM relaxes assumptions which are unreal and is especially useful in this case when dealing with the endogeneity problem of reverse causality. The main reason why GMM estimator is used in this research is due to reverse causality which exists between tourism related FDI and economic growth or tourism development. As proven by many researchers in this area, a bi-directional relationship exists between these variables. Furthermore, strict assumption applied in OLS whereby explanatory variables should not correlate with error term is not applicable in this case. GMM is also suitable for cases with small T large N samples [47].

There are 2 commonly used GMM estimators, which are difference GMM developed by [48] and system GMM by [49-50]. Although difference GMM was created to overcome endogeneity problem, however it may result in inefficient estimates when lagged dependent variable is included as one of the independent variables [7] as is the case in this research. Therefore system GMM is used for data analysis as it was developed to overcome the problems that might arise from using difference GMM. This research also incorporates other supporting variables such as human capital and trade openness which have been proven to help aggregate FDI exert a positive effect on economic growth [18, 20]. It is important to know what are the factors which help realize the benefits of tourism-related FDI on economic growth since tourism

related FDI, similar to aggregate FDI might not exert a significant impact on economic growth without the existence of sufficient absorptive capacities in the host country. Therefore these variables should also be taken into account in this case.

Here are the equations which are going to be tested in this paper:

$$Y_{it} = \alpha + \beta_1 Y_{it-1} + \beta_2 FDIT_{it} + \beta_3 HC_{it} + \beta_4 TRADE_{it} + \beta_5 X_{it} + \varepsilon_{it} \quad (1)$$

$$Y_{it} = \alpha + \beta_1 Y_{it-1} + \beta_2 FDIT_{it} + \beta_3 HC_{it} + \beta_4 TRADE_{it} + \beta_5 FDITHC_{it} + \beta_6 X_{it} + \varepsilon_{it} \quad (2)$$

$$Y_{it} = \alpha + \beta_1 Y_{it-1} + \beta_2 FDIT_{it} + \beta_3 HC_{it} + \beta_4 TRADE_{it} + \beta_5 FDITTR_{it} + \beta_6 X_{it} + \varepsilon_{it} \quad (3)$$

Where Y_{it} stands for economic growth, in this case represented by real GDP growth. Subscripts i denotes each country and t denotes the time dimension, in this case every year. α is a constant or the intercept. β is the corresponding coefficient of the independent variables. $FDIT$ represents the tourism-related foreign direct investment. HC is human capital or the level of educational attainment. $TRADE$ is representation of openness to trade which is an important factor in FDI growth nexus similar to human capital. X includes explanatory variables which are normally used in cross-country growth analysis. $FDITHC$ is the interaction term of tourism-related FDI and human capital, while $FDITTR$ is the interaction term of tourism-related FDI and trade openness. Lastly, ε is the idiosyncratic error term.

Another model which is also tested in this research is shown below:

$$TGDP_{it} = \alpha + \beta_1 FDIT_{it} + \beta_2 HC_{it} + \beta_3 TRADE_{it} + \beta_4 X_{it} + \varepsilon_{it} \quad (4)$$

This model intends to study the relationship between tourism related FDI and tourism contribution to GDP. This relationship is also important to be analyzed since the impact of tourism-related FDI might not be large enough to affect the whole country's economy but it should at least affect tourism contribution to the economy. These two economic models are going to be tested using the system GMM estimator.

The data which are used in this research include panel data of 18 Organisation for Economic Co-operation and Development (OECD) countries over 8 years period of time from 1994 to 2012. These 18 countries are Austria, Czech Republic, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Luxembourg, Mexico, Netherlands, Poland, Slovakia, South Korea, Spain, Turkey and the United States. Data of FDI by sector is rather scarce, thus the number of cross-sectional and time-series data available for analysis is limited. Tourism-related FDI is proxied by FDI in hotels and restaurants [32, 51]. The data are taken from OECD. Economic growth (Y) is represented by real GDP growth collected from [52]. The proxy used for human capital (HC) is

average years of education or educational attainment of 15-24 years old also taken from [52]. Trade openness (TRADE) is the sum of exports and imports divided by GDP [7, 11, 18, 23]. Data on exports, imports and GDP which are used for calculation of trade openness indicator are collected from OECD. Data on tourism contribution to GDP (TGDP) is taken from the World Travel & Tourism Council (WTTC).

Other data which are used to proxy for growth determinant factors in cross-country analysis are all taken from [52] except inflation which was taken from OECD. These explanatory variables include inflation (INFL) to proxy for macroeconomic stability, mobile cellular subscriptions per 100 people (INFR) to proxy for infrastructure and population growth (POP). These variables are indicated by X in the previously introduced equations.

IV. MATERIALS AND METHODS

The summary statistics for these variables are shown below in Table 1.

Table.1: Summary Statistics of Dependent and Independent Variables

Variables	Proxy	Source	Mean	Std. Dev.	Min	Max
FDIT	Inward FDI in hotels and restaurants (millions USD)	OECD	230.14	3126.08	-23,272	27,343
Y	Real GDP Growth	Teorell, <i>et al</i>	1.90	4.10	-14.72	11.11
HC	Average educational attainment of 15-24 years	Teorell, <i>et al</i>	11.76	1.14	8.61	13.84
TRADE	Sum of imports and exports over GDP	OECD	0.95	0.80	0.26	4.20
INFL	Inflation rate	OECD	3.12	2.01	-0.36	10.44
INFR	Mobile cellular subscriptions (per 100 people)	Teorell, <i>et al</i>	111.55	24.61	42.56	172.32
POP	Population growth	Teorell, <i>et al</i>	0.50	0.66	-1.85	2.40
TGDP	Tourism contribution to GDP	WTTC	3.41	1.46	1.63	7.01

As mentioned in the previous section, system GMM is going to be used to analyze these data according to equation (1), (2), (3) and (4). The inclusion of instrumental variables is one of the most important parts of GMM as these instrumental variables are the key to overcome the endogeneity problem. As regressors and error term correlate, instrumental variables are introduced to ensure that the regression result is not biased. However, this holds true only when the instrumental variables used are exogenous. In the case of system GMM, it is common to use lagged endogenous variables minimum by two periods as instrument variables. It is difficult to find appropriate external instruments, subsequently these instruments can be drawn from within the dataset [47]. Twice lag and above can be used since it is natural for $X_{i,t-1}$ to be instrumented by $X_{i,t-2}$ cause $X_{i,t-2}$ is related

to $X_{i,t-1}$ but not the error term as long as the error term is not serially correlated. Therefore endogenous variables lagged by two periods are used as instrumental variables in this case [42, 47]. However lagged values might be weak instruments if the prerequisites are not fulfilled, therefore there are two most widely used tests for instrumental variables to make sure that they are valid or that they are exogenous. These tests are Sargan and Hansen test [53-54]. Then again, Sargan test is inconsistent in robust GMM while Hansen test stays consistent [47]. Consequently, the result of the Hansen test of overidentifying restrictions is reported in this case. The system GMM results of all 4 equations are summed up in table 2, which is shown below. These results were calculated using `xtabond2` command in STATA 12 [47].

Table.2: Results of System GMM Estimators

Explanatory Variables	Dependent Variable: Y			Dependent Variable: TGDP
	(1)	(2)	(3)	(4)
L.Y	-.1646133 (.1213647)	-.0788524 (.1756059)	-.1637397 (.1418507)	
FDIT	.000137 (.0001125)	-.0118564 (.0114886)	.0001306 (.0003267)	-.0000905** (.0000237)
HC	.5248518 (1.975131)	-.1939754 (2.030963)	.5249426 (1.982168)	-.6695794* (.3208431)
TRADE	9.686857* (4.405844)	8.844215 (4.408282)	9.681559* (4.592384)	-1.358687* (.6494347)
INFL	1.756368** (.4333616)	1.544185** (.5245603)	1.755747** (.4458135)	-.4019304** (.1319537)
INFR	-.2797529* (.0982477)	-.2502322* (.0930645)	-.2796262* (.1012219)	.016763 (.0096647)
POP	-9.91398* (4.196383)	-9.909334* (4.070243)	-9.9122* (4.244097)	-.3279637 (.5325412)
FDITHC		.0010843 (.00104)		
FDITTR			0.00000432 (.0001729)	
Constant	18.06649 (22.16305)	24.3189 (22.91164)		12.17242** (3.515853)
AR (1)	0.170	0.130	0.164	0.060
AR (2)	0.096	0.164	0.093	0.155
Hansen Test	0.454	0.506	0.400	0.398

Heteroscedasticity-consistent standard errors in parantheses, ** denotes significant at 0.01 confidence level, * denotes significant at 5% confidence level.

The reported Hansen test above shows that it accepts the null hypothesis which suggests that the instruments are exogenous [55]. AR(1) and AR (2) in first differences are tests for autocorrelations where the null hypothesis is that there is no autocorrelation [55] and in this case, the null hypotheses are accepted for both AR (1) and AR (2). Thus the results obtained above passed all necessary tests and are robust.

The results obtained are very interesting. First of all, FDIT or tourism-related FDI has no significant effect on economic growth in any of the equations. FDIT only significantly affects tourism contribution to GDP but not economic growth. Its effect on tourism contribution to GDP is also negative and very small. This result is supported by previous findings [29-31] whereby FDI in the service sector or non-manufacturing sector has no effect on economic growth. Therefore governments should be cautious in formulating their strategies with regards to FDI. They should not waste resources or form unfavorable policies for the sake of attracting more inward FDI in the tourism industry.

A plausible explanation for this result is if the tourism industry does not provide a significant contribution to the host country's economy, thus FDI into the tourism sector

does not affect the growth of the whole economy. Therefore, equation (4) was included in the analysis. As it can be seen, even when looking at the impact of tourism-related FDI on tourism contribution to GDP instead of economic growth, the effect is still very low and negative although significant at 1% level of confidence. This should pose serious consideration for governments in their view towards encouraging inward FDI in tourism industry since it might not induce growth of its tourism industry but inhibit it instead.

Furthermore, although literature in aggregate FDI suggested that human capital and trade openness are important in realizing the benefits of FDI for the economy of the host country, however in this case, the interaction of FDIT and human capital in equation (2) and interaction of FDIT and trade openness in equation (3) show no significant results. These results both support and oppose the findings of previous research as their results showed that human capital is not an appropriate absorptive capacity but trade openness is [26]. These results also support [28] where his empirical research concluded that human capital does not help in realizing the positive growth effect of FDI in the primary and service sector.

Another interesting point is that human capital does not significantly affect economic growth in itself. A possible explanation for this result is due to the relatively high level of educational attainment of the countries included in the analysis, therefore the differences in human capital no longer explain differences in economic growth since the level of human capital does not vary and stays stable at a high level. Similar to FDIT, the effect of human capital is only significant in equation (4) where the dependent variable is tourism contribution to GDP. Interestingly the coefficient is negative and quite high. This might be due to the fact that tourism industry requires less expertise or specialized knowledge, therefore when human capital is high, more people tend to move away from the tourism industry to other industries such as manufacturing which requires higher knowledge and technical expertise, making the contribution of tourism to GDP lower.

Trade openness, inflation and infrastructure are always significant in all equations although they are significant at different level of confidence. With regards to trade openness, the coefficients are all positive in economic growth equations as expected, however it is negative in the last equation. Trade openness most likely encourages other industries more compare to the tourism industry, thus the contribution of tourism to overall GDP becomes lower as other industries dominate the GDP. Similarly, inflation is also only negative in relation to TGDP since tourists tend to look for cheap destinations, therefore it is logical that higher inflation which causes products to be more expensive is negatively related to tourism contribution to GDP. On the other hand, infrastructure is only positively related to TGDP while it is always negatively related to economic growth. It is natural that there are more tourists with better infrastructure. [7] used the same proxy for infrastructure, which is mobile cellular subscription per 100 people and obtained a similar result. Infrastructure negatively affects economic growth in the short-run (annual data) but it is positive in the long run (5 years average data). Since this research only use annual data, therefore the long run relationship cannot be determined. However, as the proxy, method (system GMM) and the short-run result of [7] were all similar to this research, it is expected that infrastructure should also positively affect economic growth in the long run as proven by [7].

Concerning population growth, its effect is significant on economic growth but not on tourism contribution to GDP. The coefficients are negative in all equations which mean that higher population growth results to lower economic growth. [3, 23-24] also acquired similar results in regards to population growth. Its effect on TGDP is insignificant which is reasonable since tourists do not necessarily put host country's population into

consideration when deciding on which tourist destination to visit.

Overall, the results obtained in this research showed both expected as well as unexpected results. Most of the control variables or common explanatory variables in growth models showed significant influence on economic growth. However, the main independent variable in this research which is tourism-related FDI does not show any significant result on economic growth. This is in line with many previous literature which suggest that the effect of FDI on economic growth is ambiguous or non-existent in the service sector or non-manufacturing sector.

V. CONCLUSION

This research uses system GMM which caters for endogeneity problem to confirm that FDI in tourism industry does not significantly affect economic growth and even negatively affects tourism contribution to GDP. The effect of FDI on the tourism industry on economic growth is also not accelerated by human capital nor trade openness. This suggests that the government, specifically ministry of tourism should not be rash or jump to conclusions in the decision of encouraging inward FDI in the tourism industry. This suggests that careful attention should be paid to the actual benefits of FDI in different industries, particularly the service industry.

There are still large gaps to be filled by future scholars. First of all, future research should tackle several limitations of this paper, such as limited number of observations, lack of external instrumental variables and imbalance number of developed and developing countries. Deeper studies regarding FDI in the tourism industry as well as other specific industries should be carried out to find out the true benefits of FDI for the recipient country despite the commonly believed advantages of FDI. There should also be further research to find out the appropriate absorptive capacities of FDI in the tourism industry. Absorptive capacities such as human capital and trade openness which are proven to work for aggregate FDI do not work for tourism-related FDI. Therefore, it is crucial to discover absorptive capacities specific to tourism FDI. This will definitely help the ministry of tourism and local authorities to focus and properly distribute their resources to those factors which are proven to help realize the benefits of tourism FDI on economic growth of the host country.

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Sweet Sorghum Establishment after Application of Residual Herbicides

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Abstract — *Imazethapyr, sulfentrazone, clomazone, diclosulam, trifloxysulfuron-sodium and trifluralin are residual herbicides commonly used for weed control in soybean or sugarcane crops. The sorghum crop implanted succeeding sugarcane, can be affected by the carryover effect of these herbicides. In this context, we aim with this work to evaluate the minimum period between application of herbicides with residual effect (imazethapyr, sulfentrazone, clomazone, diclosulam, trifluralin and trifloxysulfuron-sodium) and the planting of sorghum so that there is no impairment in growth and establishment of this crop due to the herbicide carryover effect. The experiment was installed in randomized blocks design with four replications, under field conditions. The herbicides were applied to the previously tilled soil, with sorghum being planted 0, 14, 28, 42, 56 and 70 days after herbicide application (DAA). The percentage of germination was evaluated daily from planting, and 7, 14, 21 and 28 days after emergence (DAE) of each planting, the phytotoxicity was evaluated. Thirty five DAE of each planting season, ten plants were collected per plot for measurement of leaf area, fresh and dry mass of plants, leaves and stems. The minimum time interval for planting sorghum after application of these herbicides varies, but imazethapyr is highlighted by causing high and durable toxicity to sorghum even when planting sorghum after 70 days of its application.*

Keywords — *Phytotoxicity, Sorghum bicolor, pre-emergence.*

I. INTRODUCTION

The different types of sorghum (grain, forage and saccharine) are cultivated in different regions of the world and have wide adaptability to environmental conditions, especially under water deficiency, establishing themselves in more varied environments than other commercial species (Francisco, 2016). In addition, research on sorghum in Brazil has been boosted in recent years,

mainly due to its applicability to ethanol production in situations or regions of the country where sugarcane may either not present high yields, or is not available for processing, since the entire sugarcane-based alcohol and sugar industry structure is suitable also for sorghum processing (Almodares & Hadi, 2009). Thus, sorghum has increasingly become an option for cultivation in Brazil, mainly in succession to soybeans (Dan et al., 2010).

Sugarcane makes an average of five to six successive crops, demanding a plantation reform after this period (Durães, 2011), for a new cropping cycle. Sorghum, with a short cycle – 90 - 130 days from emergence to harvest, is ideal for complementing ethanol production during the sugarcane off-season, or when sugarcane is still with low sugar concentration, allowing to extend the period of use of the ethanol production plants in up to three months (Almodares & Hadi, 2009). It should be noted that sorghum requires less fertilizer amounts, and stores sugars in its stems at different times, compared to sugarcane (Lourenço et al., 2007). In addition, it may also be suitable in an integrated system of rural property exploitation, aiming at self-sufficiency in energy, together with other activities focused on agricultural production (Souza et al., 2005).

Weed control is essential in cash crops due to competition for environmental resources such as water, light, nutrients and physical space (Silva et al., 2007). In contemporary agriculture, herbicides stand out as one of the main tools for weed control, being its use economically viable (Inoue et al., 2011). However, herbicides that have a long residual effect in soils may not be degraded during the main crop cycle, leaving residues that harm the germination and development of succeeding crops (Werle et al., 2017). Several authors report effects of residual herbicides to succeeding crops, as for rice (Avila et al., 2010; Pinto et al., 2011), cotton (Grichar et al., 2004), maize (Ulbrich et al., 2005; Artuzi e Contieiro, 2006), sunflower (Merotto Jr; Vidal, 2001; Brighenti et al., 2002),

sorghum (Silva et al., 1999; Dan et al., 2010) and millet (Dan et al., 2011).

The impact of herbicide residues (carryover effect) on crops grown succession depends on several factors, among them the natural susceptibility of the planted species, the herbicide half-life and the environmental conditions that affect the herbicide degradation rate in soil (Silva et al., 2007). Imazethapyr, sulfentrazone, clomazone, diclosulam, trifluralin and trifloxysulfuron-sodium are herbicides commonly used in soybean or sugarcane cultivation (Monquero, 2014), where sorghum can be planted in succession; all these compounds are considered at least moderately soil persistent (IUPAC, 2018). With the possibility of growing sorghum in succession to these crops, it is a priority to study the residual effect of these molecules and their potential to cause damage to the establishment of sorghum planted in succession.

II. OBJECTIVE

In this context, we aimed with this work to evaluate the minimum period between the application of the residual herbicides imazethapyr, sulfentrazone, clomazone, diclosulam, trifluralin and trifloxysulfuron-sodium, and the planting of sorghum so that there is no damage to the growth and establishment of this crop.

III. MATERIAL AND METHODS

The experiment was installed in field conditions on a Red Dystroferic Latosol with 60% clay, in the experimental area of Embrapa Agropecuária Oeste, Dourados-MS, Brazil, in the 2013/2014 cropping season. We used the strip-plot experimental design, comprising a factorial scheme 7 x 6, with four replications.

Factor A (horizontal bands) was represented by the treatments: Test (T-01); Clomazone 1.25 kg_{ai}. ha⁻¹ (T-02); Trifloxysulfuron-sodium 0.0075 kg_{ai}. ha⁻¹ (T-03); Trifluralin 2.4 kg_{ai}. ha⁻¹ (T-04); Diclosulam 0.042 kg_{ai}. ha⁻¹ (T-05); Imazethapyr 0.15 kg_{ai}. ha⁻¹ (T-06); and Sulfentrazone 0.6 kg_{ai}. ha⁻¹ (T-07). Factor B (vertical bands) was composed by sorghum planting, variety BRS 511, at intervals of 0, 14, 28, 42, 56 and 70 days after application (DAA) of the herbicides. These intervals were chosen in order to identify the minimum period required between the application of these herbicides and the implementation of the sorghum crop in a way that does not hinder its growth and development. The physico-chemical characteristics of the screened herbicides are listed in Table 1.

Table.1: physico-chemical properties of the herbicides used in the present study.

Herbicide	Solubility mg L ⁻¹	K _{oc} mL g ⁻¹	Half-life (days)	Persistence
Clomazone	1102	300	26-167	Moderated
Trifloxysulfuron sodium	25700	306	45-80	Moderated
Trifluralin	0.221	15800	81-356	Persistent
Diclosulam	6.32	90	14-80	Moderated
Imazethapyr	1400	52	14-290	Moderated
Sulfentrazone	780	43	121-302	Highly persistent

Planting was accomplished manually, where 3 cm deep furrows were opened in rows spaced at 0.45 m, and 7 seeds m⁻¹ were uniformly deposited, resulting in an approximate final density of 150,000 plants ha⁻¹ (15 plants m²). The area was tilled with plowing and harrowing, previously fertilized according to soil analysis and technical recommendations for the crop (May et al., 2012). The area had no history of application of residual herbicides for five years prior to the installation of the experiment. Soil characteristics are listed in Table 2.

Table.2: chemical soil analysis in two depths collected in the area where the experiment was installed.

Soil Depth	pH	Al	K	Ca	Mg	CTC
cm	H ₂ O	-----	cmol _c	dm ⁻³	-----	-----
0 - 5	6.50	0.07	1.16	8.23	3.35	15.9
5 - 15	5.40	0.74	0.43	4.59	2.06	15.8
Soil Depth	MO	P ¹	Fe	Mn	Zn	Cu
cm	g kg ⁻¹	-----	mg	dm ⁻³	-----	-----
0 - 5	38.9	48.5	22.2	134.2	2.9	13.6
5 - 15	26.8	30.2	28.3	69.6	1.8	17.6

Herbicide application and the first planting season were accomplished on Oct. 18, 2013. For this, we used a CO₂-pressurized backpack sprayer, connected to a bar equipped with nozzles 110.02 working at the recommended pressure, delivering 120 L ha⁻¹ of herbicide solution. The application was done at early morning, right after the planting of the first season. The soil was about 80% of field capacity by the time of the application. Basic

temperature and rain data for the period of the experiment are supplied at Figure 1.

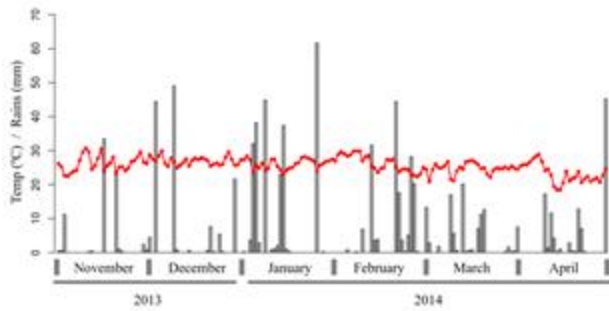


Fig.1: mean daily rainfall (mm - █) and temperature (°C - —) along the experimental period.

Phytotoxicity evaluations were performed 7, 14, 21 and 28 days after emergence (DAE), through visual symptoms measured on a scale varying from 0 to 100, where zero represents no symptoms and 100% the death of the plants. The emergence was evaluated by daily counting in a previously marked section of 3 m of planting row in each replication, daily from 0 to 14 days after planting (DAP), being considered as "emerged" seedlings with height equal or superior to 1 cm. Thirty DAE, in each planting season and for each herbicide treatment, the fresh and dry mass of shoot, leaves and stems of sorghum plants were evaluated. At 103 DAE, plant height, fresh and dry mass and density were assessed.

The data set was submitted to analysis of variance in the statistical software R (R Core Team, 2012), being explored by 3D response surfaces, and linear or non-linear regressions, according to the significances. For percentage of emergence and phytotoxicity, the Gaussian equation was used to obtain the response surfaces, as follows:

$$Z = ae^{-0.5 \left[\left(\frac{x-x_0}{b} \right)^2 + \left(\frac{y-y_0}{c} \right)^2 \right]} \quad (1)$$

IV. RESULTS AND DISCUSSION

The average daily air temperature during the conduction of the experiment ranged from 15 to 25 °C, and at least 16 rainfall events with considerable volume were observed (Figure 1), demonstrating good conditions for conducting the experiment.

The regression parameters for all treatments are summarized at Table 3. The number of emerged plants (Z axis) was modeled according to the sorghum planting interval after herbicide application (X axis) and the period in days after each planting (Y axis), by using Gaussian response surfaces (Figure 2). For all herbicide treatments the percentage of emergence increased until the eighth

day after planting, reaching the apex between the eighth and the tenth day; due to unfavorable environmental conditions and pest attacks there was a decrease in the number of plants after the tenth day. It can also be observed that all herbicides affected the number of emerged plants, and the lower the interval between herbicide application and planting, the lower the sorghum germination. When sorghum was planted at the day of the application, for example, there were 15 seeds germinated at the control plot, while for the herbicide treatments, only about 10 seedlings were present. Diclosulam was the least impacting herbicide on sorghum in concomitant planting/application, with approximately 13 seeds in a 3m row (Figure 3).

Table.3: components of the Gaussian equation (X_0 , Y_0 , a , b , c), significance (P), adjustment coefficient (R^2) and mean residual square (MRS), as function of treatment.

	Treatment						
	T01	T02	T03	T04	T05	T06	T07
X0	-6948	58,6	57,2	66,5	1580	46,8	47,5
Y0	10,1	10,1	10,1	10,4	10,3	10	10,2
a	77,5	18,1	16,2	17,1	119	17	18,4
b	3949	56,9	66,4	70,1	756	50,7	51,2
c	4,55	4,4	4,4	4,52	4,4	4,42	4,5
R2	0,67	0,66	0,66	0,71	0,74	0,68	0,67
P	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
MRS	41,76	118,5	103,1	38,82	35,2	37,04	122,4

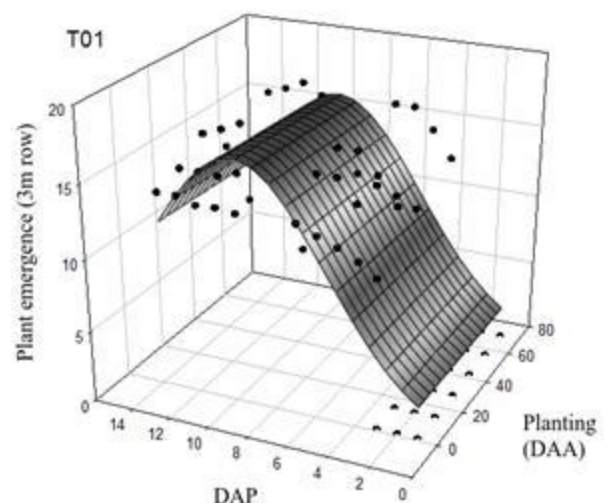


Fig.2: plant emergence in 3m in a planting row, for the control treatment with no herbicide, as function of the sorghum planting season (days after herbicide application in the other treatments – DAA), and days after each planting.

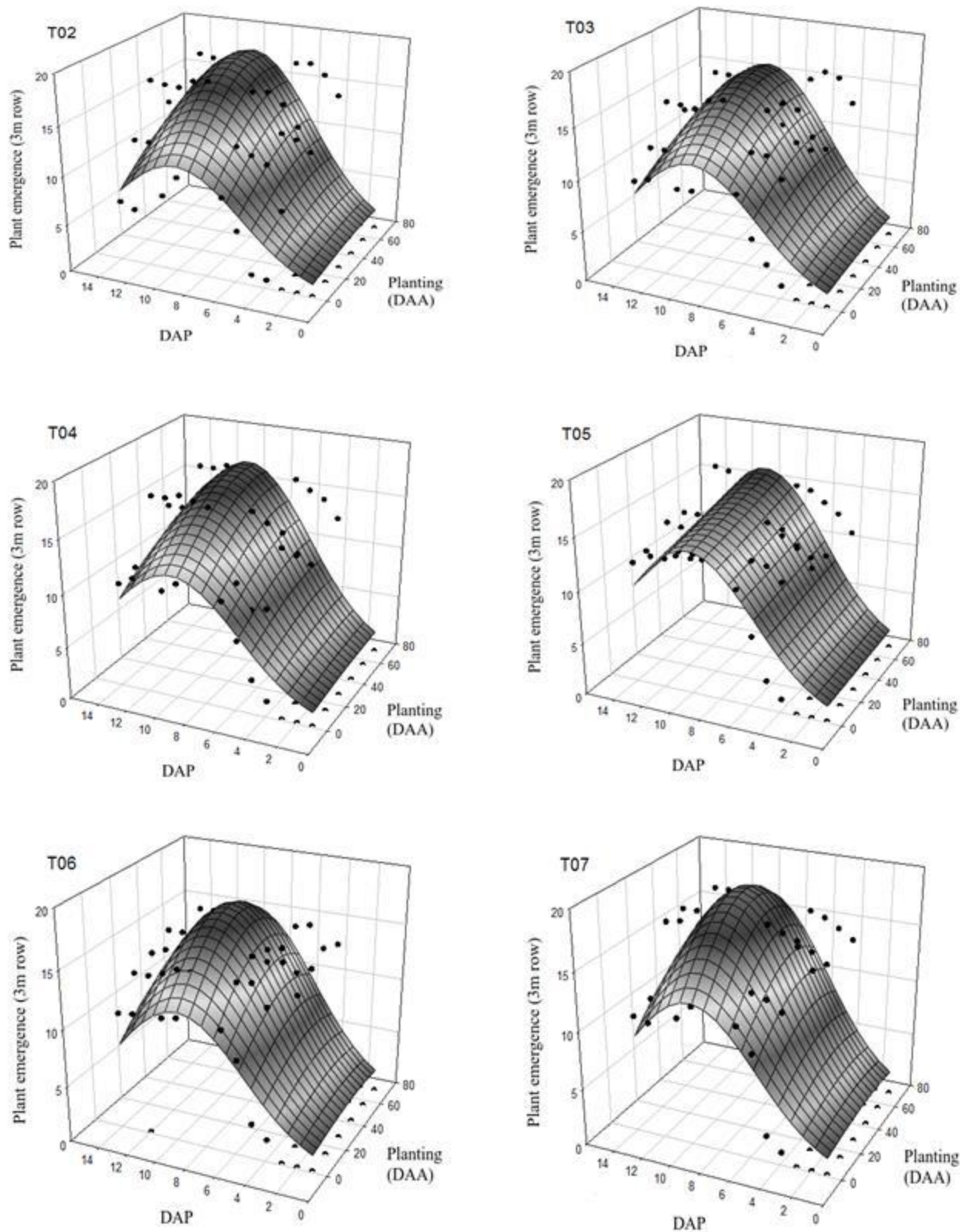


Fig.3: plant emergence in 3m in a planting row, for herbicide treatments, as function of the sorghum planting season (days after herbicide application - DAA), and days

Although all herbicides used in this experiment are considered to be at least moderately persistent in soil (Table 1), the response surfaces show that in the last planting season, 70 DAA, herbicide interference on

germination (Figure 3) decreased considerably and all treatments were similar to the control plot (Figure 2). The treatment T-02 (clomazone), T-04 (trifluralin) and T-07 (sulfentrazone) were the ones that most affected the emergence of sorghum seedlings. Maladão et al. (2013) reported that only $\frac{1}{4}$ of the commercial dose of sulfentrazone was sufficient to significantly reduce the emergence of sorghum. According to Stougaard et al. (1990) and Brighenti et al. (2002), diclosulam (T-05) and sulfentrazone (T-06) present long residual effect and they may, depending on climatic and soil conditions, cause damage to crops planted in succession. Vencill (2002) also observed that trifluralin has physical and chemical characteristics that allow it to persist in soil for a certain period of time, as observed in this work. Machado et al. (2016) verified 46% and 50% toxicity and stand reduction in sorghum planted soon after application of trifluralin and clomazone, respectively.

Although there was seed germination in treatments where the herbicides were applied, many of these plants showed toxicity symptoms, which was higher when the planting was carried out closer to the herbicide application date (Figure 3). Each herbicide presented a different percentage of toxicity in sorghum that is native to its molecule; that is, the natural differential level of tolerance to a specific treatment. Thus, 35 DAE the first planting season, all herbicides - except trifluralin (T-04), scored toxicity levels above 70%. By considering the response surfaces altogether, it can be seen that in each planting season the degree of phytotoxicity increases throughout the evaluation period.

Trifluralin also presented a shorter period of influence on sorghum development, compared to the other herbicides (Figure 3). Most of the herbicides tend not to cause significant phytotoxicity to sorghum when it is planted after 70 DAA of the herbicides (40 DAA for trifluralin). However, Imazethapyr at the end of the evaluations still presented an average 8% of phytotoxicity on sorghum plants, suggesting that the safety interval is above the range evaluated and that more studies are needed for this herbicide.

ALS-inhibiting herbicides (trifloxysulfuron-sodium, diclosulam and imazethapyr) had similar behavior, with persistent symptoms and toxicity above 80% in the first planting season, with the greatest symptoms reported 14 DAE of each planting season (Figure 4). The main symptoms were intense chlorosis, striae, followed by necrosis, reduction of growth rate and even plant death.

Similar symptoms were observed by Ulbrich et al. (2005), Dan et al. (2010) and Dan et al. (2011) when assessing the effects of imidazolinones on corn, sorghum and millet, respectively.

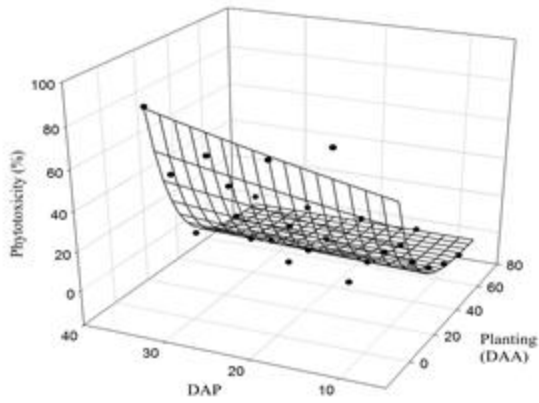
PROTOX-inhibiting (sulfentrazone) and carotenoid biosynthesis inhibiting (clomazone) herbicides, were highly harmful to sorghum; seedlings that were able to emerge already presented more than 40% phytotoxicity 7 DAE (Figure 4), in agreement with data reported by Machado et al. (2016). Maladão et al. (2013) also observed high impact of sulfentrazone in *Sorghum bicolor*.

Fresh and dry mass of the plants, leaves and stems that were able to emerge, were smaller in plantings closer to the application of the herbicides (Figures 5; 6), corroborating with the data of phytotoxicity (Figure 4). These variables are closely linked to the dissipation of herbicides from soil, which strongly affects soil persistence. Persistence corresponds to the time when a herbicide remains active in soil, which is of fundamental importance in weed management (Karam, 2005). However, more persistent herbicides, if they are not selective to the crop, can cause losses as reduced fresh and dry mass, leaf area and productivity.

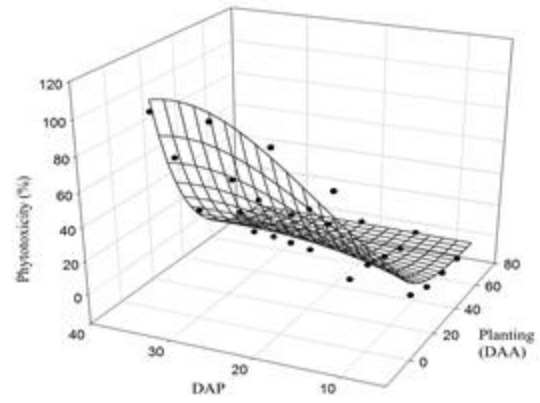
It was observed (Figures 5; 6) that all herbicides caused damage to the sorghum. For the first planting season (same day of herbicides application), the dry mass measured 35 DAE, corresponded to approximately 2 - 5 g plant⁻¹ in all treatments; for the planting performed 60 DAA, dry mass was superior to 15 g plant⁻¹, also 35 DAE.

Treatments with clomazone, trifloxysulfuron-sodium, trifluralin, diclosulam and sulfentrazone were statistically equal, so for better comprehension, they were grouped for the variables fresh and dry shoot mass, leaf and stem dry mass, and leaf area. There was reduction in all these variables, for imazethapyr at the 70 DAA planting compared to the control treatment; this corroborates the phytotoxicity data, although this herbicide did not differ statistically from the other treatments. This is also in agreement with results by Dan et al. (2012), who reported reductions in maize shoot growth when using 0.1 kg ha⁻¹ imazethapyr, even when planting it 97 DAA.

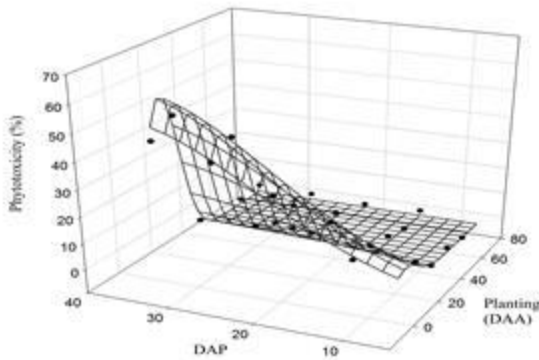
For the same variables, no differences were observed between the control and the herbicide treatments at the 70 DAA planting. However, Dan et al. (2010) found negative effects of diclosulam on sorghum plants grown in succession to soybean in the Brazilian Cerrado (savanna-like biome) region.



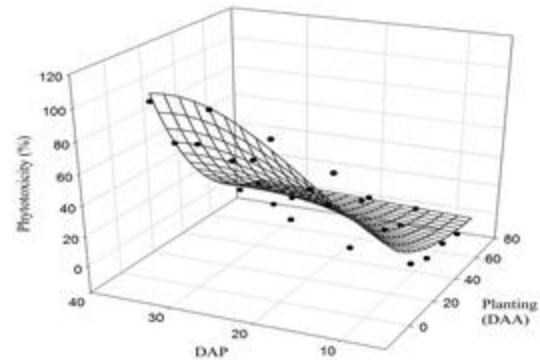
● Clomazone $Y = 170257.58e^{-.5*((x+132.53)/43.34)^2 + ((y-489.14)/189.19)^2}$ $R^2 = 0.92$



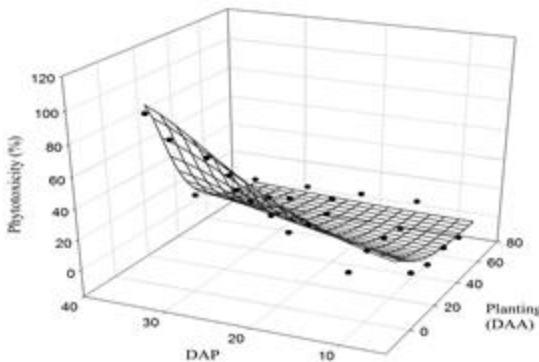
● Trifloxysulfuron-sodium $Y = 327453.72e^{-.5*((x+291.75)/73.02)^2 + ((y-32.46)/16.32)^2}$ $R^2 = 0.94$



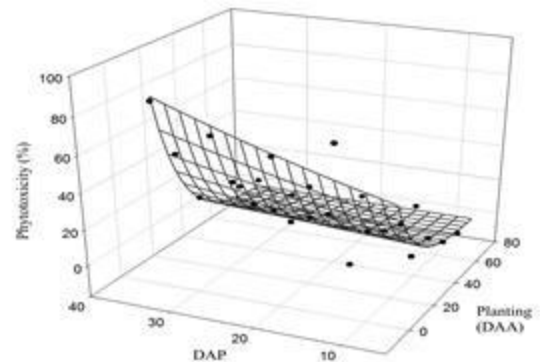
● Trifluralina $Y = 59.95e^{-.5*((x-6.94)/9.86)^2 + ((y-39.18)/16.36)^2}$ $R^2 = 0.91$



● Diclofopamil $Y = 961.70e^{-.5*((x+133.29)/63.63)^2 + ((y-32.97)/16.03)^2}$ $R^2 = 0.90$



● Imazethapyr $Y = 102.72(1+((x+1.78)/b)^2)^{-1} + ((y-38.17)/14.18)^2$ $R^2 = 0.90$



● Sulfentrazone $Y = 2940654.56e^{-.5*((x+296.73)/71.10)^2 + ((y-196.69)/91.32)^2}$ $R^2 = 0.91$

Fig.4: toxicity of sorghum plants (%), for herbicide treatments, as function of the sorghum planting season (days after herbicide application - DAA), and days after each planting (DAP).

Therefore, innumerable factors are responsible for the residual activity of a given herbicide in soil. Among these, the physico-chemical and microbiological soil traits, besides the regional edaphoclimatic conditions, are highlighted (Oliveira Jr et al., 1999). As example, one could report to results presented by Artuzi and Contiero (2006), that did not observe negative effects on maize, planted succeeding soybeans where imazethapyr (0.1 kg ha^{-1}) was applied, in Eutrophic Red Latosol. On the other hand, Dan et al. (2011) reported negative effects on the yield of millet grown succeeding soybeans, where imazethapyr (0.1 kg ha^{-1}) and diclosulam (0.035 kg ha^{-1}) were applied to Dystroferic Red Latosol. According to Cole et al. (2017), another factor to be highlighted is the great variation of sensitivity herbicides intrinsic to the genetic variability among sorghum genotypes.

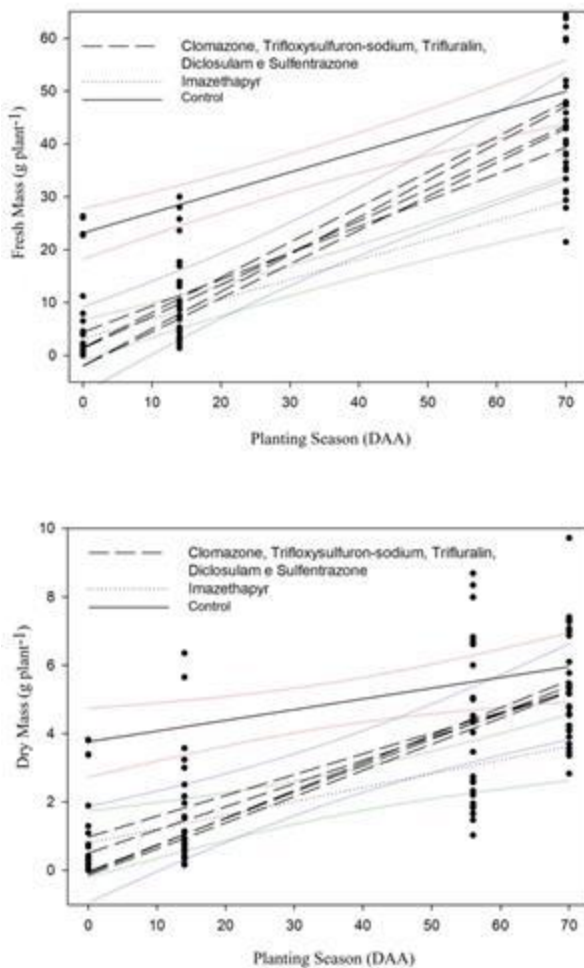


Fig.5: fresh and dry mass of saccharine sorghum plants, cv. BRS 506, as function of planting in days after application (DAA), under treatment with clomazone, trifloxysulfuron-sodium, trifluralin, diclosulam, imazethapyr or sulfentrazone.

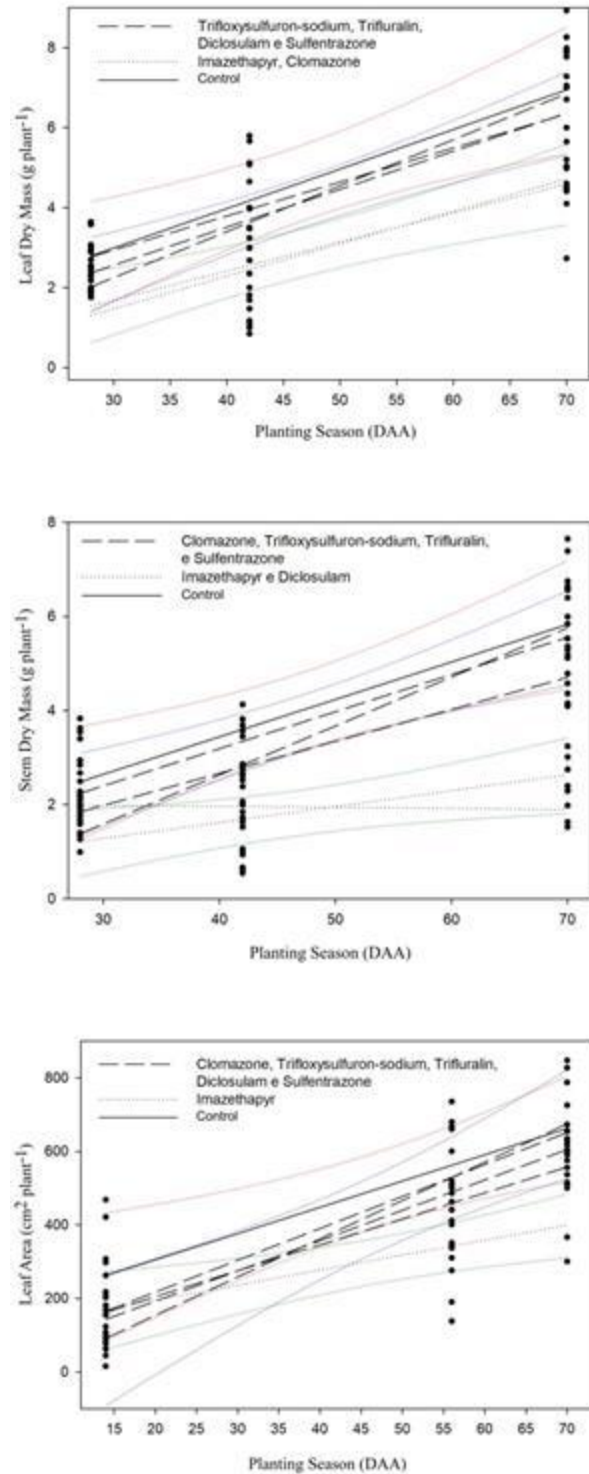


Fig.6: dry mass of leaves and stems, and leaf area, of saccharine sorghum plants, cv. BRS 506, as function of planting in days after application (DAA), under treatment with clomazone, trifloxysulfuron-sodium, trifluralin, diclosulam, imazethapyr or sulfentrazone.

The best planting time for sorghum, after application of residual herbicides, varies for each compound, being the toxicity as smaller as longer the time between the

application of such herbicides and sorghum planting. Thus, sorghum can be considered an alternative in areas previously managed with clomazone (2.5 L ha⁻¹), trifloxysulfuron-sodium (30 g ha⁻¹), trifluralin (4.0 L ha⁻¹) and sulfentrazone (1.2 L ha⁻¹) since they are applied at the beginning of the cycle of the preceding crop, conferring at least 70 days between its application and sorghum planting. On the other hand, attention should be given to areas applied with imazethapyr and diclosulam, where the carryover effect is potentially damaging even after 70 days after its application.

V. CONCLUSIONS

The best planting time for sorghum, after application of residual herbicides, varies for each compound, being the toxicity as smaller as longer the time between the application of such herbicides and sorghum planting. Thus, sorghum can be considered an alternative in areas previously managed with clomazone (2.5 L ha⁻¹), trifloxysulfuron-sodium (30 g ha⁻¹), trifluralin (4.0 L ha⁻¹) and sulfentrazone (1.2 L ha⁻¹) since they are applied at the beginning of the cycle of the preceding crop, conferring at least 70 days between its application and sorghum planting. On the other hand, attention should be given to areas applied with imazethapyr and diclosulam, where the carryover effect is potentially damaging even after 70 days after its application.

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Determination of Seismic parameters of R.C.C. Building Using Shear Core Outrigger, Wall Belt and Truss Belt Systems

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Abstract— Structural analysis has been done since decades to study the behavior of lateral load resisting systems and for that outrigger structural system has done a tremendous job in this regard. The present work is to study high-rise G+10 3D computer model RCC structure under the influence of earthquake forces. The outrigger location used according to Taranath method. Response spectrum method is used for observing the performance of total seven different cases which include regular, shear core, outrigger and wall belt and outrigger and truss belt supported system. These are studied and parameters such as Base shear, column axial forces and member shear forces were examined. Efficient cases for all the parameters have discussed in this article too.

Keywords— Seismic forces, Outrigger, Shear core, Staad Pro, Response spectrum analysis, Belt supported system, truss supported system.

I. INTRODUCTION

The examination of the seismic activities of the earth artificially via structural software reveals that whenever the R.C.C. multistory structure has located around the area of epicenter of any earthquake, the waves creates a harmful effect on it.

So, to counteract the lateral forces in the design of tall structures, the parameters to be maintained are strength, resistance against lateral deflection, stability to avoid structural and non-structural destruction. For the design requirements, structural examiners have offered new systems to maintain the above parameters are to use shear wall, truss systems, moment resisting frames, base isolation systems and one of them is outrigger and belt supported systems. In this system, when the structure rotates against lateral effects undergoes deflection and rotation. To counteract this, stiff core is provided in the middle of structure connected by stiff arms that resists the whole structure and transfer all the lateral loads around the beam-column connections. Hence the performance of

the multistory building depends upon the stiffness generated system.

II. OBJECTIVE OF THE PRESENT STUDY

The objectives of this work are as follows:

- Determination of effective case among general, shear core outrigger and belt wall supported system as well as shear core outrigger and truss supported system.
- To determine Base shear response when seismic forces are applied in X, Y and Z direction to the structure.
- To examine column Axial Forces for total seven cases with efficient case to determine minimum axial force.
- To find member Shear Forces and Bending Moment values with efficient case of all 7 cases.
- To determine and compare member Torsion values.
- To show whether truss is better or shear wall at an optimum outrigger height of structure.

III. PROCEDURE AND 3D MODELLING OF STRUCTURE

In this paper, G + 10 storey residential building with 43.26m height having 5 bays of 3 m each in X direction and 7 bays of 3 m each in Z direction for complete 7 cases that are mentioned in table 1 and figure 1 & 2. Depth of foundation taken as 3m and height of each floor is taken as 3.66m. According to several cases mentioned in table, acronym such as S1 to S7 used to represent "Structure" and T1 & T2 used to represent as "Type" were made. Indian Standard code 1893 (part 1): 2002 has used for seismic analysis of all cases, various parameters were taken presumed that the structure has located in seismic zone IV and on rested over hard soil.

Several data used in this study for modeling and loadings are as follows:

- Length and width of building = 15 m and 21 m respectively.
- Thickness of slab and Shear wall = 125 mm and 230 mm.
- Beam, bracings and column size = 600 mm x 300 mm, 230 mm x 230 mm & 500 mm x 500 mm.
- Dead load as floor finish load = 1 KN/m² (intermediate floors).
- Wall load = 17.934 KN/m and 4.9 KN/m for intermediate floors with 3.66 m wall height and for terrace periphery with 1 m height (roof).
- Water proofing and terrace finish load = 2KN/m² and 1KN/m² respectively for roof.
- Live load as per IS 875 part II = 4 KN/m² for intermediate floors and 1.5 KN/m² for roof.

Design factors for Zone IV are as follows:

- Zone factor Z=0.24 (ZONE IV)
- Response reduction factor R = 5
- Importance factor I = 1
- The fundamental natural period (Ta) for X and Z direction has taken as 1.2978 & 0.8496 seconds

3D models constructed in Staad pro, a complete software tool for analysis has used for total seven Cases and work has evaluated.

Table.1: Different Cases with respect to building configurations

S. No.	CASES	Building Configurations
1	S1	Regular building on plane ground
2	S2	Regular building with shear core
3	S3	Building with shear core and wall outriggers
4	S4	Shear Core outrigger and wall belt supported system
5	S5	Shear Core outrigger and truss belt supported system
6	S6	Shear Core outrigger and truss belt supported system optimum bracing T 1
7	S7	Shear Core outrigger and truss belt supported system optimum bracing T 2

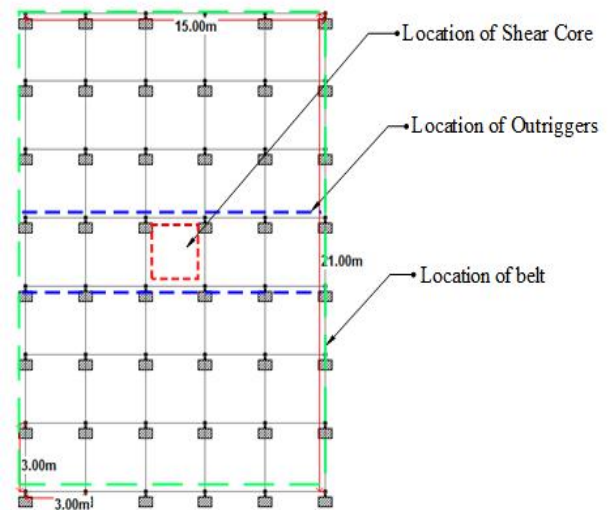
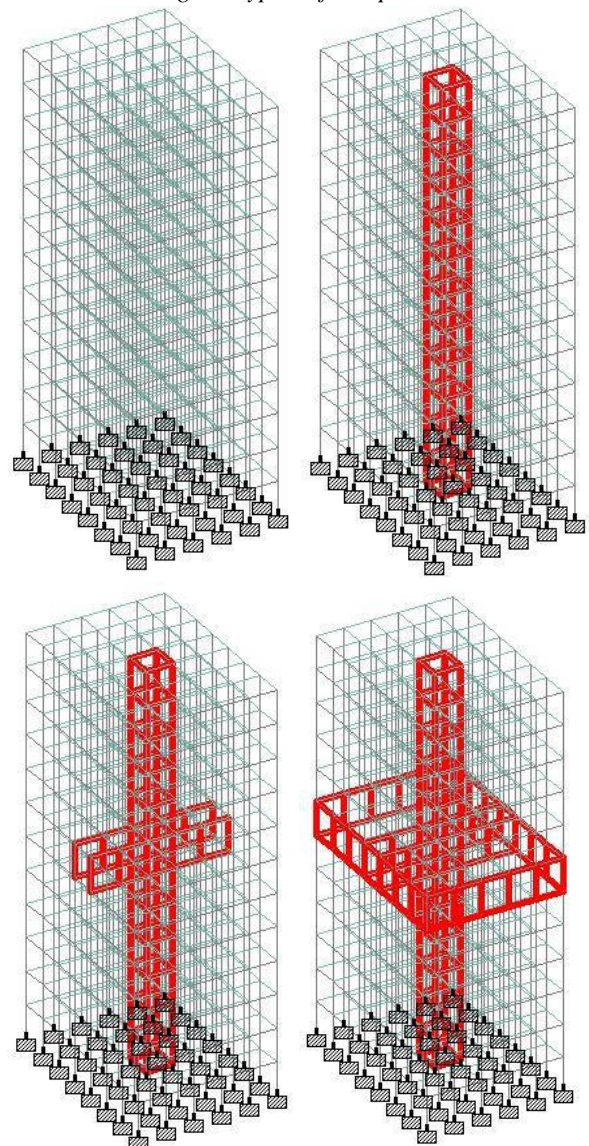


Fig. 1: Typical floor plan



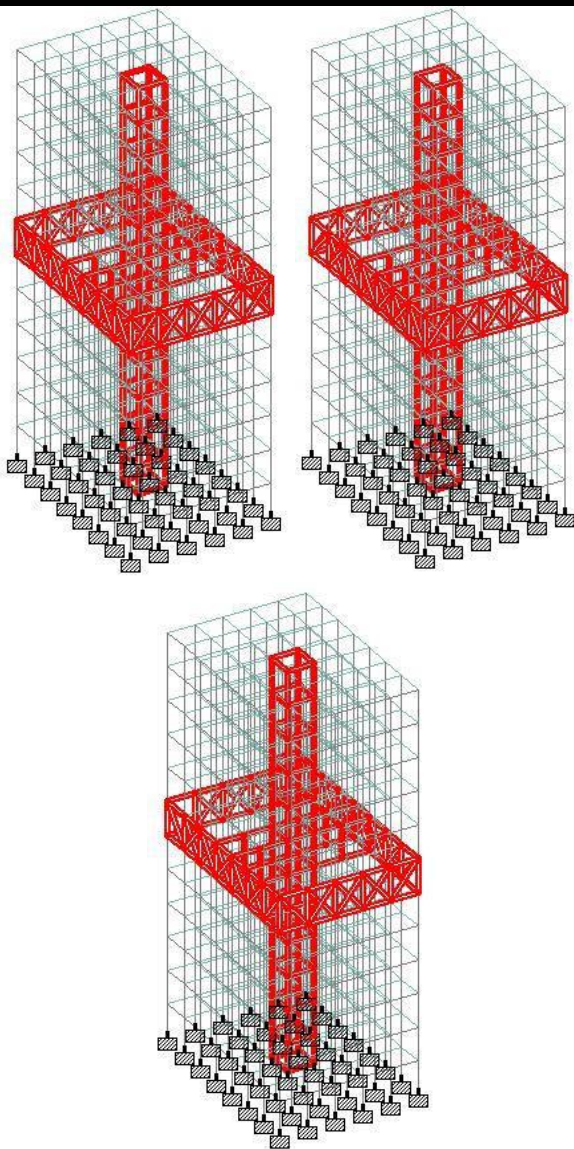


Fig. 2: 3D view of various cases of multistoried structure
Structure 1 (S1) Regular building on plane ground
Structure 2 (S2) Regular building with shear core
Structure 3 (S3) Building with shear core and wall outriggers
Structure 4 (S4) Shear Core outrigger and wall belt supported system
Structure 5 (S5) Shear Core outrigger and truss belt supported system
Structure 6 (S6) Shear Core outrigger and truss belt supported system optimum bracing T 1
Structure 7 (S7) Shear Core outrigger and truss belt supported system optimum bracing T 2

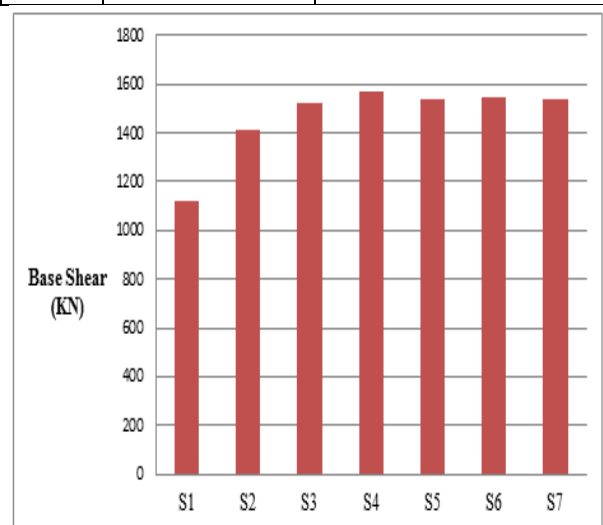
IV. RESULTS ANALYSIS

Since for the analysis of seismic effects, all the cases of the structures have been analyzed for seismic shake for longitudinal along with transverse direction. Various loads along with load combinations as per IS 456-2000 and IS 1893 – 2002 part 1, applied on all the cases and reflective result parameters have been analyzed with each

other to determine the efficient case. Results are shown both in tabular form as well as graphical form.

Table 2: Base shear

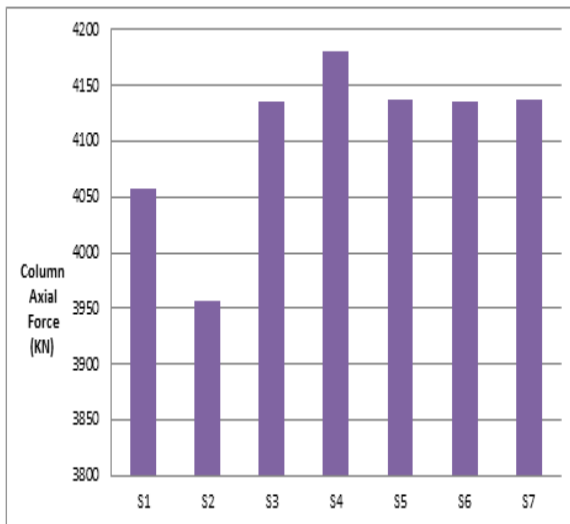
CASE S	Base Shear (KN)	EFFICIENT CASE
S1	1118.21	Other than regular building, regular building with shear core shows minimum base shear value of 1410.49 KN, so; the efficient Case for this parameter will be S 2.
S2	1410.49	
S3	1526.25	
S4	1571.74	
S5	1541.56	
S6	1545.91	
S7	1540.56	



Graph 1: Base shear comparison

Table 3: Column Axial Force comparison

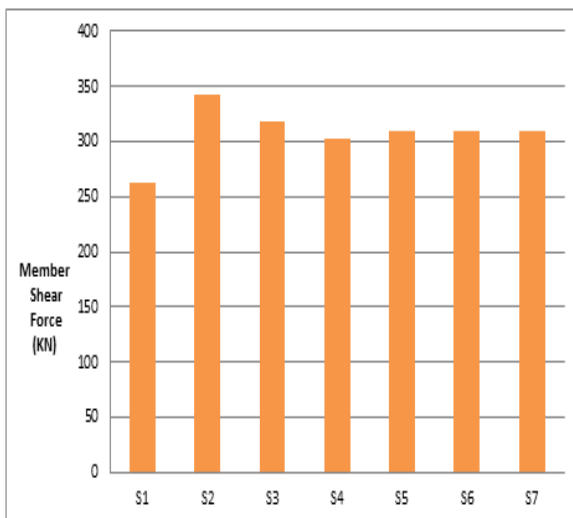
CASES	Column Axial Force (KN)	EFFICIENT CASE
S1	4058.136	Other than regular building, Case S 2 i.e. regular building with shear core shows itself an efficient case with minimum value of 3956.154 KN.
S2	3956.154	
S3	4135.927	
S4	4180.142	
S5	4137.749	
S6	4135.572	
S7	4138.083	



Graph 2: Column Axial Force comparison

Table 4: Member Shear Force comparison in Y direction

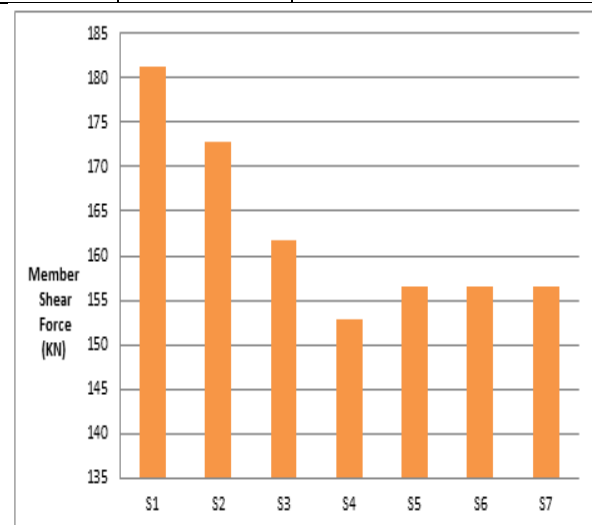
CASES	Member Shear Force (KN)	EFFICIENT CASE
S1	262.746	Other than regular building, Case S 4 shows least shear forces values among all with a value of 303.269 KN and hence Case S 4 has shown itself as an efficient case of shear forces in Y direction.
S2	343.141	
S3	317.867	
S4	303.269	
S5	310.162	
S6	310.201	
S7	310.203	



Graph 3: Member Shear Force comparison in Y direction

Table 5: Member Shear Force comparison in Z direction

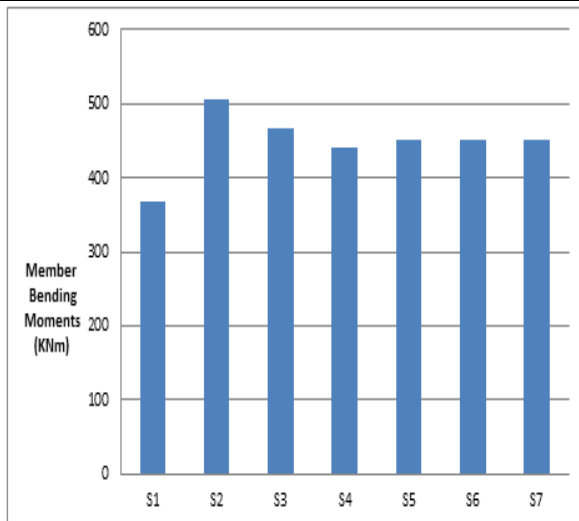
CASES	Member Shear Force (KN)	EFFICIENT CASE
S1	181.303	Other than regular building, Case S 4 shows least shear forces values among all with a value of 152.903 KN and hence Case S 4 has shown itself as an efficient case of shear forces in Z direction.
S2	172.711	
S3	161.76	
S4	152.903	
S5	156.473	
S6	156.519	
S7	156.573	



Graph 4: Member Shear Force comparison in Z direction

Table 6: Member Bending Moment comparison

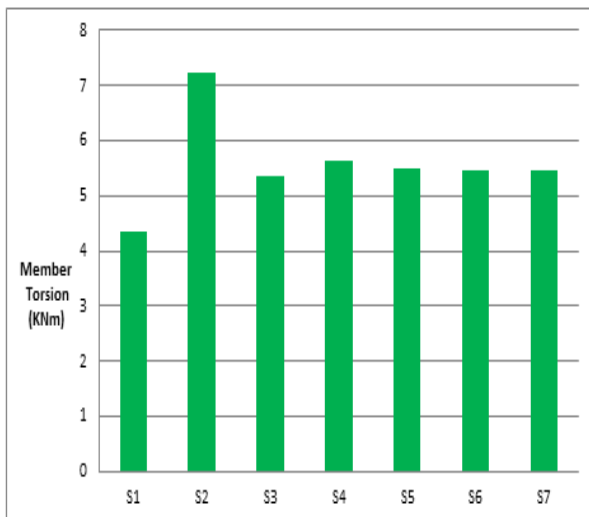
CASES	Member Bending Moments (KNm)	EFFICIENT CASE
S1	368.569	Other than regular building, Case S 4 shows least member bending moment values among all with a value of 439.536 KNm.
S2	507.066	
S3	465.636	
S4	439.536	
S5	451.977	
S6	452.113	
S7	452.156	



Graph 5: Member Bending Moment comparison

Table 7: Member Torsion value comparison

CASES	Member Torsion (KNm)	EFFICIENT CASE
S1	4.358	Other than regular building, Case S 3 shows least torsional values among all with a value of 5.349 KNm and hence Case S 3 has shown itself as an efficient case.
S2	7.241	
S3	5.349	
S4	5.642	
S5	5.496	
S6	5.475	
S7	5.468	



Graph 6: Member Torsion value comparison

V. CONCLUSION

The following conclusion has been investigated by comparing various cases are as follows:-

- Base Shear shows minimum response value other than general structure which seems very effective under seismic effect is Regular building with shear core.

- To resist moment, buildings are recommended to be designed as Shear Core outrigger and wall belt supported system shows least value among all cases.
- If column design is the main criteria, building axial forces shows a least value when only Shear Core system will be used.
- Shear Core outrigger and wall belt supported system will again be effective in shear forces for both Y and Z directions in members.
- Member torsion values have seen effective and efficient case for building with shear core and wall outriggers.
- Overall parameter controlling case among all is Shear Core outrigger and wall belt supported system.
- Wall belt system is more effective than truss belt system which has seen in this work.

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Digital Inclusion for Students with Attention Deficit Hyperactivity Disorder

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Abstract — *The Attention Deficit Hyperactivity Disorder is a syndrome characterized by distraction, impulsivity, forgetfulness and disorganization. The diagnosis requires considerable care and experience. There are multiples approaches to treatments available, which can be used in combination to meet specific needs. In the academic field, virtual learning environment emerges as a watershed in the life and destiny of students who suffer from the disorder. The objective of this study is to promote digital inclusion for students with ADHD, through a virtual learning environment, in web platform, which will provide tools able to attract attention and stimulate interest in academic activities, aiming to generate significant changes in the process of student development.*
Keywords— *Attention Deficit Hyperactivity Disorder, Digital Inclusion, Virtual Learning Environment.*

I. INTRODUCTION

Attention Deficit Hyperactivity Disorder is a neurobiological disorder, of genetic causes, that appears in the childhood of the individual and accompanies him/her throughout his/her life, being characterized mainly by symptoms of inattention, restlessness, lack of organization and impulsivity.

The conduct and inappropriate behavior of students configure one of the problems evidenced in pedagogical means and due to this situation many teachers are unprepared for the resolution of conflicts that arise in classrooms, what generates an even bigger aggravating for the developed framework [12].

The use of technological tools is increasingly part of people's lives and specially the students. Post, enjoy, comment, share files and discuss openly about any subject is a reality that students already participate, so it is

necessary that educators know this scenario and know how to use such resources in favor of education. Teachers need to adapt to the new realities of the student rather than trying to adapt them to traditionalist practices limited to blackboard and chalk.

New technologies are influencing much the way we teach and learn, inside and outside of school environments. The interest in developing this project is justified by believing that the new technological tools add numerous benefits and contributions to improve the quality of teaching in the institutions, which offer their services to the community. Currently, ADHD has been studied by scientists from diverse areas in the world, being considered by educators and researchers as a disturbing factor, mainly in the school phase. However, on the other hand, it is a subject unknown to most of the teachers of high and elementary school levels, which should be the main agents of transformation. The faculty must be attentive to the signs of ADHD to help the student, as soon as possible.

Inattention, impulsivity and hyperactivity are the main features of this disorder and we concluded that, although the majority of the students do not have enough knowledge to talk properly about ADHD, their teaching methodology allows them to observe, analyze, raise hypotheses, enabling students to adapt to the classroom and have their differences respected. And it is precisely in this change of methodology and break of paradigms that we inserted the technological tools.

Virtual learning environments have well-founded practices for school, emotional and affective development of students with ADHD. This type of system provides the power to control and manage the learning, training students, limiting the interaction and, consequently, the

construction of knowledge ,which is directly connected to the information age [3].

Due to these problems and in order to solve them, this article had as its aim to promote digital inclusion in schools and educational institutions, where there are students with attention deficit hyperactivity disorder, through a virtual environment of learning, in web platform, which will provide tools able to attract attention and stimulate interest of these students in activities aiming to increase their academic performance.

II. LITERATURE REVIEW

The development of clinical symptoms designated by ADHD makes the children with this condition to face numerous difficulties, both emotional and linguistic as in their potential intellect [14].

The bearers of attention disorders have the targets compromised and predetermined , because of the lack of learning, so that becomes evident the school failure. Given this, the student's knowledge does not internalize itself, justifying his/her bad grades , disapproval and truancy. Given this, there is a need of a prior diagnosis so that larger problems are avoided [14].

Understand the numerous situations experienced in school environments is of great relevance, because the study, the full understanding and improved ADHD cases are important to the school and the teacher have a broad view of the teaching-learning process in which the student is submitted, helping him/her in the development of learning, as well as on his/her inclusion and acceptance in the school community. On the other hand, the teacher's unpreparedness will cause even more problems and difficulties, because the teacher does not know the student's problem will be able to label him/her unjustly of lazy, inattentive or rebel, increasing failure and truancy.

There are numerous classification for attention disorders developed by students and, because of that, those who develop ADHD inattentive type are stereotyped as slow students in relation to the teaching-learning process, however the same ones are individuals with high level of intelligence, and it can be medium or above average, although the forgetfulness and disorganization are seen as signs of limitation of intellectual capacity [11].

It is necessary to remember that children with ADHD exhibit immense difficulties in completing tasks that require concentrated attention, motor agitation, difficulty controlling impulses, restlessness, excessive activity and consequently a greater number of school repetition [2].

Academic environments represent one of the major obstacles to be overcome by patients with ADHD. Most of the individuals who receive clinical treatment on ADHD frame does not develop good results in their

learning, because of poor performance and inattentive, impulsive and restless behavior in the classroom [2].

Given this, the use of new pedagogical trends help the development of teaching and learning in the student carrying ADHD is of great importance, however, nowadays the traditionalist pedagogy is still a reality of education in our country, characterized as homogeneously. This kind of pedagogical trend does not favor the ADHD students who are often characterized as restless, slow in learning teaching process and disorganized, fruit of broken families. Hence the need to work in a new pedagogical context that favors the developing of knowledge in these individuals as students. Educational institutions and health organizations have been encountered with high growth of cases of children diagnosed with attention deficit hyperactivity disorder [4]. Information is the raw material of knowledge. A society that wishes to be inserted in the Age of Knowledge needs, as a prerequisite, to be mature with the information society. For this, it is necessary that the absolute majority of those who compose it is contemplated with digital inclusion [3].

It was identified a greater motivation, on the part of the schools, to carry out the activities. Interactive ones stimulate interest in reading and learning. In the social area, qualitative changes have created higher levels of interaction, contributing to the establishment and strengthening of interpersonal relationships. In the emotional area, the increase of self-esteem led to the creation of a motivating environment, for greater perception of themselves as learners. In the school area, these new forms of exchange have awakened a desire for conversation and search for information, expressed primarily by the desire to read and write not observed earlier. With regard to the behavior, can be identified, during the activities, an increase in attention and a decrease of the turmoil at the school that presents the predominantly hyperactive/impulsive type [10].

As a result, it is of great importance the favouring of a sound childhood education, besides stimulating the parents as to the growth and development of their children, so that his/her educational base is well structured [8].

Being an educator these days is not easy, because of the devaluation of salaries, lack of resources and incentives to education. However, teachers are indispensable in the movement for the reconstruction of a new model of education that will contribute to the increase of interest and academic performance of students in general. By means of the strategies and the high teacher's commitment about learning that rises the self-esteem of ADHD students, promoting and stimulating the confidence and satisfaction with their achievements.

III. MATERIALS AND METHODS

In order to answer the objectives of the research and subsidize the information collection that resulted in this project, the option of methodological choice was exploratory and descriptive, seeking to analyze the profile and the difficulties of students with attention deficit hyperactivity disorder (ADHD).

The exploratory research aimed to get greater familiarity with the problem in order to make it more explicit or to constitute hypotheses [6]. In addition, for the deployment of the virtual environment, we used a study of technological development, whose objective is to develop a new product, program or template, with the production of a software to collect information from patients to carry out the electronic medical record [1].

The Moodle software was used as a virtual learning environment (VLE), performing itself as an online didactic teaching mechanism, which provides the student essentials tools in the learning process, such as: forums, chats, diaries, calendars, educational games, polls, online activities, in order to stimulate the ADHD bearer and develop their intellectual skills.

Moodle (Modular Object-Oriented Dynamic Learning Environment) is a free software, cross-platform and learning support, which was developed in 2011 by Australian programmer Martin Dougiamas. It will be downloaded from the platform in the website moodle.org and configured on a local machine, that can be migrated later to a production environment, hosted on a local area network or in the cloud.

The architecture used in the project was client-server, as can be seen in Figure 1, in which the processing can be distributed among costumers, which are network machines that yield information to costumers.

The technical requirements are:

- Server – Apache web Server with PHP support and technology;
- Programming Language – PHP;
- Management system database – MySQL.

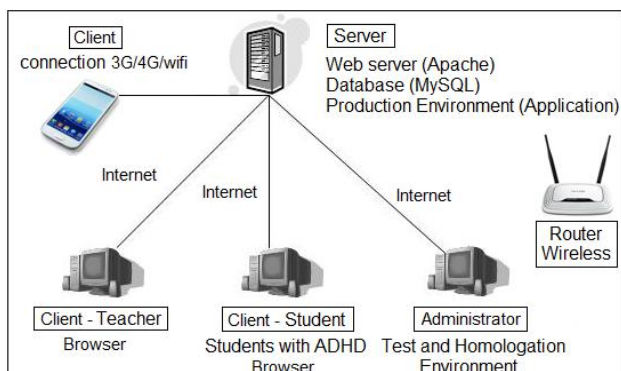


Fig. 1: Virtual Environment Architecture

IV. RESULTS AND DISCUSSIONS

4.1 IMPLEMENTATION, CONFIGURATION AND DESIGN

Installing the virtual environment occurs very simply. Simply access the website of the developer company and download the application via the link: <https://moodle.org>. After the download, simply upload the files to its server, and advancing in the settings, the database tables are automatically generated, as well as can be seen in figure 2. The virtual environment will be available, and may be offered in full for up to seventy-five (75) languages [9]. The interface design of the environment can be chosen or modified by the analyst or administrator who configures it. Simply access the manufacturer's website, choose the ideal theme, download and configure. For this project, we chose the theme named Splash..

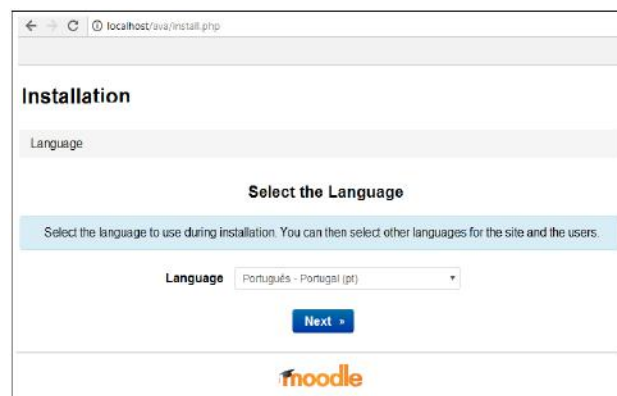


Fig. 2- Installing Moodle

4.2 AUTHENTICATION

To access the system, the student or teacher must authenticate themselves via a user name and password. In case of invalidation, the access data will be sent to the registered e-mail address. In case of first access, on screen presentation of the system there will be a message about account creation, in which the student or guardian should access, aiming at creating it, as can be shown in Figure 3:

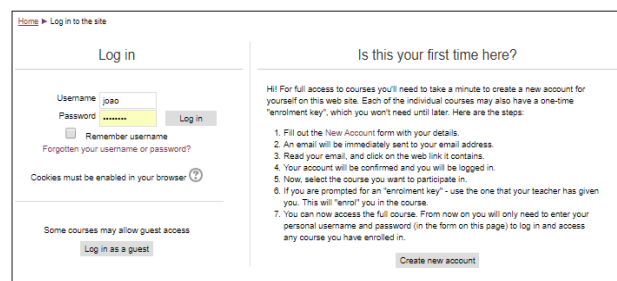


Fig. 3 - Authentication

4.3 PROFILE MANAGEMENT

Students and teachers can manage their profiles, including photos, colors for the theme, language preference,

personal data, notes, observations, presences and absences in the classroom, among several features, as shown in figure 4:



Fig. 4 – User Profile

4.4 RESOURCES

Several resources can be added seeking deepening of teaching. They are: chats, forums and online activities, meetings, glossaries, polls, games, calendars and others, as can be seen in figure 5:

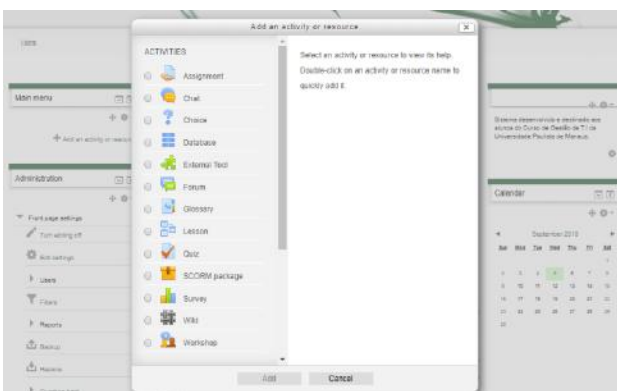


Fig. 5 - Virtual Environment Resources

4.5 MEETING AND ATTENDANCES FOR CHAT

Chats are online communication protocols, which allow conversation between members participating in the dialogue. In Moodle, it works as a liaison between teacher and student, in real time. The chats enable also the exchange of files between groups or specific individuals. Due to the grueling routine of responsible for the students, this tool would provide meetings between parents and faculty, for example, a combined schedule, common at all. In this tool, students or those responsible, can still schedule meetings with teachers or Board. For correct use it is important that the teacher specify the timetables, the day and the period in which he/she or the Board will be available in the system for this service. This schedule enables the recording of calls made during the course, as shown in figure 6:

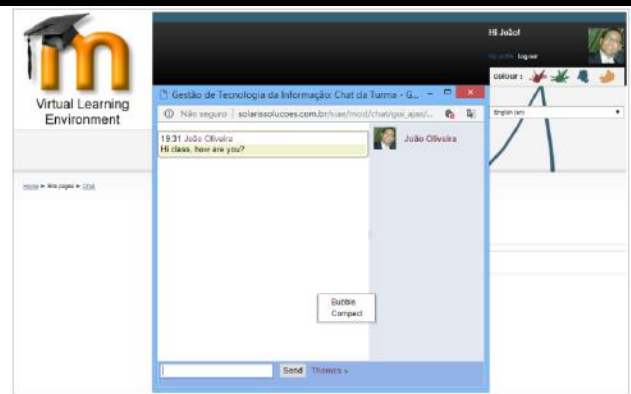


Fig. 6 - Meeting and Attendances for Chat

4.6 LIST OF COURSES

The list of subjects is organized at the discretion of the user, facilitating the visualization of activities and tasks provided by the professor responsible for each subject, as can be seen in figure 7:



Fig. 7 – List of Courses

4.7 SCHOOL CALENDAR

Within the management tasks, one of the most important is the preparation of the school calendar, which will lead the implementation of various activities throughout the year. In addition, there are several other reasons that make the definition of the calendar should be a priority. The ADHD students tend to be disorganized and forgetful [11]. As a result, the school calendar will cause the student carrying ADHD note when activities, evidences and events will occur, in a graphical, simple and intuitive way, as can be seen in figure 8:



Fig. 8 – School Calendar

Any global activity will be marked by the teacher or Board, however the student may also make his/her personal calendar markings in order to plan. Colors will be used to differentiate global and personal markings. The global events, such as holidays, events, parties, simulated and proofs, for instance, can be marked on the calendar only by the Board or coordination, no student has authorization or access. All activity has title, summary and full description of what will occur. In case of evaluation, the teacher may provide subjects within the description of the event, as shown in figure 9:

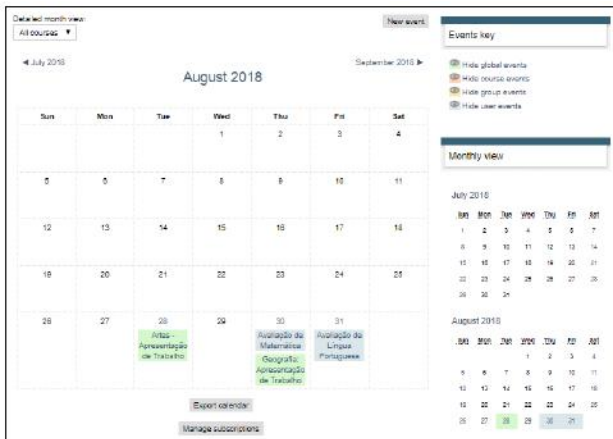


Fig. 9 – School Calendar Activities

4.8 FORUMS AND WORKSHOPS

The forum is a resource for public discussion about a particular subject, being an excellent teaching and communication strategy. When a teacher creates a forum, normally attaches a file to be studied. After attaching it, every student belonging to this class will receive an e-mail notifying that the document was made available for download, facilitating the teacher’s work and promoting a more dynamic and accessible content sharing, as can be seen in figure 10:



Fig. 10 – Forum Activity

This tool is also important to provide the content for the student who is not physically in the classroom, due to illness or a particular reason. This resource can also be

used in the evaluation of subjects using paintings, sculptures or any other specific skill.

4.9 INTERACTIVE GAMES

Digital games are teaching strategies that are already revolutionizing the way of education through entertaining and fun resources. Among several options that can be used, chess presents itself as an example of activity that develops strategy, concentration and logical reasoning, as can be seen in figure 11:



Fig. 11 – Chess Game

There is an evidence that chess is a sport that offers respect, discipline and integration. In addition, it instigates thoughts and stimulates organization, planning, non-violence and logic [7].

In our system, we will provide logical reasoning games, chess, crossword puzzles, anagrams and questions about history, literature, geography and puzzle, as can be shown in figure 12:

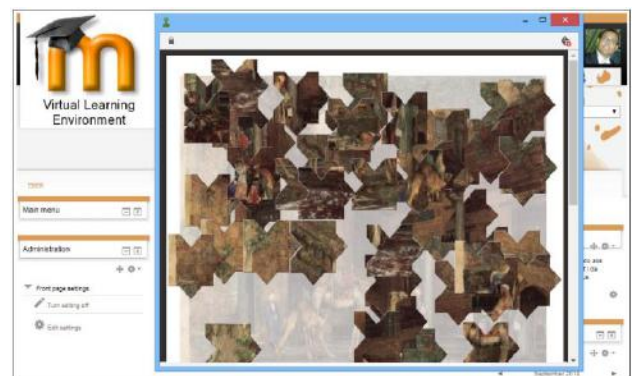


Fig. 12 – Puzzle Game

4.10 DATA DICTIONARY

The glossary is a tool that lists terms in alphabetical order, facilitating the understanding of texts and formulas provided by the teacher to the students, during the whole course. In Moodle, students have permission to add terms with dictionary definitions and links that contain explanations for each term, as can be shown in Figure 13:

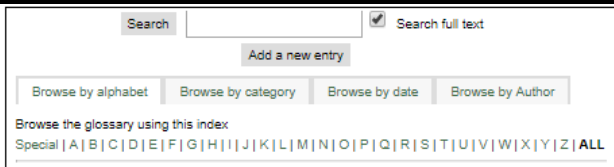


Fig. 13 – Data Dictionary

4.11 POLL

The poll is very important to store and total data that will be used for decision-making based on the common denominator. Polls can be conducted for any type of subject and the actual percentage of choices may or may not be made available to students, as shown in figure 14:

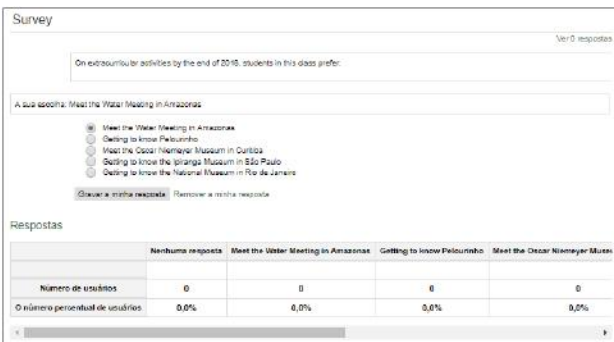


Figure 14 – Poll

4.12 ONLINE TESTS

Online tests are always made by the teachers of each subject. The questions can be associative, discourse, multiple choice or true and false. The teacher elaborates the questions and answers, indicating which is the correct one, as well as its score. However, in Moodle platform, all questions elaborated for a subject are kept in a database and can be reused by teachers or tutors for other questions, as can be shown in figure 15:

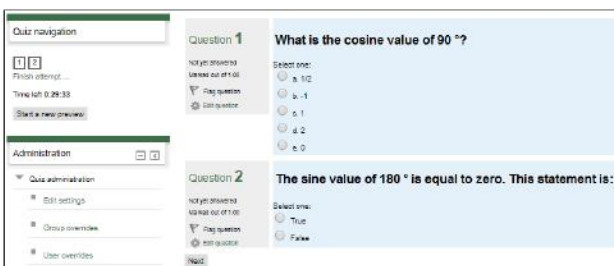


Fig. 15 – Online Test

The duration of the test is also set by the teacher, as can be seen in figure 16. The number of attempts for each question can also be set. It is quite common for the teacher to define that students are entitled to a second chance or attempt a simulated proof or test.

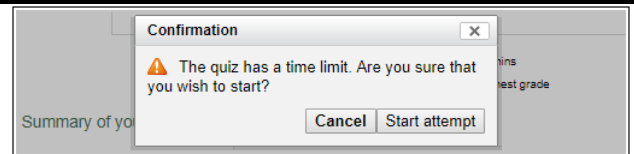


Fig. 16 – Test Duration Time

At the end of set time, the test automatically closes, computing and displaying the note in real time, after the test review. A report with the amount of right and wrong questions, such as the final grade, is displayed to the student, as can be seen in figure 17:

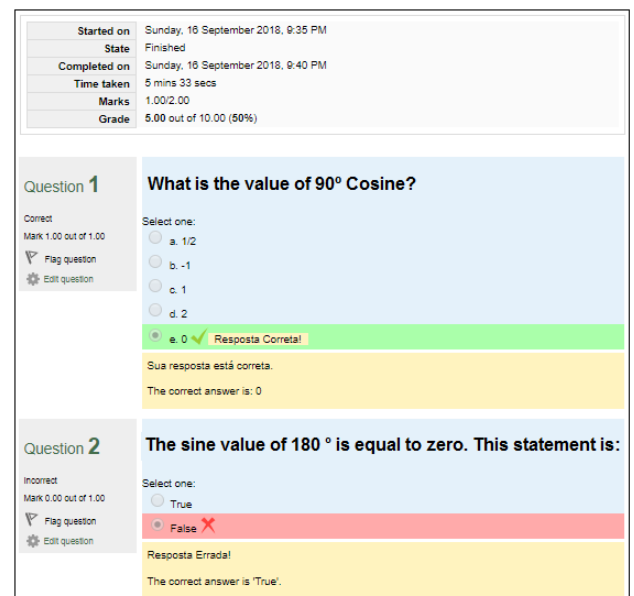


Fig. 17 – Final Test Report

4.13 TASK WITH FILE UPLOAD

The task is a simple and interesting resource. It is an activity that is passed on to the student in order to prepare and send, via file upload, the activity in any format or even compacted, as can be shown in figure 18:

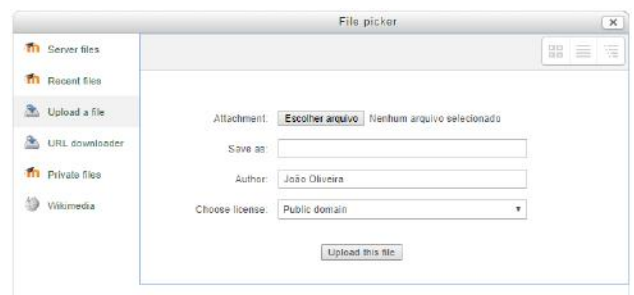


Fig.18 – File Upload Task

The teacher should provide the activity with a scheduled start and end date. After submitting it, the activity will be available for the teacher to analyze and give the grade, as

can be seen in figure 19. Another interesting resource of this activity is that every time a student submits an activity, the teacher responsible for the subject receives a message in his/her email. In addition, students will also be able to evaluate the work of their colleagues, i.e., there is an apprenticeship by the exchange of information among students.



Fig. 19 – Upload File

V. CONCLUSION

The inclusion of digital resources in classrooms, using AVA, generates a significant change in student development process, which increase communication between students and teachers, and encourage them to participate even more in school activities that provide benefits in learning.

Through the virtual environment, it becomes possible to purpose tasks, discussions, reports, games, research sources and other tools that encourage students to interact and work as a team. In addition, the student with ADHD will have the option to manage with autonomy his/her time and place of study, according to his/her needs, having full access to all content taught in classroom, besides interacting and socializing with other students and being able to organize through a simple and intuitive academic calendar.

In the observations made using the virtual learning environment (VLE), changes in the development process of students with ADHD were highlighted. Among several positive results, it was identified a greater motivation to perform the activities. Interactivity has stimulated interest in reading and writing. In the social field, qualitative exchanges have created higher levels of interaction, contributing the establishment and strengthening of interpersonal relationships. In emotional and affective area, the increase of self-esteem led to the creation of a motivated environment. In the school context, these new

forms of exchange awakened a desire for conversation and the search for information, expressed mainly by the desire to read and write not observed earlier. With the regard to behavior, an increase in attention and a decrease in agitation can be identified during activities [10].

The scientific community got to prove that computers and the internet are associated with better student performance in skills that must be developed at school, such as reading and math. This is the study carried out by the OECD, the Organization for Economic Cooperation and Development [13].

The use of technological tools is increasingly part of people's lives, especially the students. Posting, enjoying, commenting, sharing, sharing files and discussing openly any subject is a reality that students already participate, and it is necessary that educators know that scenario and know how to use such resources in favor of education. Teachers need to adapt to the new realities of the student instead of trying to adapt them to traditionalist practices of blackboard and chalk. The virtual learning environment has informed practices for school, emotional and affective development of students with ADHD. This type of system provides the power to control and manage the learning, training students, limiting the interaction and, consequently, the construction of knowledge, which is directly connected to the information age [3].

We concluded that the use of computers, internet, laptops, cellphones in class, games, data show, chats, polls, virtual learning environments and their various resources increase interactivity in classrooms and make the student set his/her own pattern of learning, research, organization and autonomy. In addition, the virtual learning environment has been excelling increasingly in helping educators, arousing more and more attention and mainly students, being a differential in the life and fate of students with ADHD, assisting positively in their evolution as a student and citizen.

ACKNOWLEDGEMENTS

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THE USE OF LOGISTICS AS A COMPETITIVE ADVANTAGE THROUGH AGB-SYSTEM SOFTWARE - BRAZIL .

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Abstract— *The present study aims to make an analysis of the logistic management of an offshore company, regarding a stock of materials through the same service provision for Petrobrás and the response time (logistic indicator) is a fundamental factor, even of because it implies contractual issues.*

There are many offshore companies that use Logistica to become more competitive, such as those in the Campos Basin. This company in question undertook a deployment of a stocking process and a system such as AGB-SYSTEM to assist in the management of product storage, thus increasing its productivity.

Using the AGB-SYSTEM, a more specific procedure was received the result of a 32.25% increase over a period of 12 months, since the business already had the procedure and no software was used to manage product storage.

Keywords— *procedure, AGB-SYSTEM, logistics, management, storage*

I. INTRODUCTION

The present study has as a way to develop the analysis of the logistics management of an offshore company in the offshore area, regarding material storage since we know that it provides service to Petrobrás and the response time (logistic indicator) is a fundamental factor, even of survival, as it implies contractual issues.

Before the study the company did not have a procedure in the area of Logistics that aimed at the storage and importance of the stocking process as a competitive

advantage. After the study the company came to realize the importance and to have this procedure to increase its competitive advantage.

Since biblical times, military leaders have used logistics. The wars were long and often distant, large and constant displacements of resources were necessary. In order to transport troops, armaments and heavy war chariots to combat sites where planning, organization and execution of logistical tasks were necessary, involving the definition of a route, not always the shortest, since it was necessary to have a source of water drinking, transportation, storage and distribution of equipment and supplies. (DIAS, 2009, p.27)

Faced with a scenario and in constant socioeconomic variations and highly competitive, in which the organizations are inserted, the concern of the companies in offering better performance and quality in the products offered appears. One way to efficiently and effectively meet customer expectations and satisfaction is through the logistics process, which encompasses a chain whose mission is to put the right products or services in the right place at the right time and in the desired conditions, thus avoiding the waste. In this context the logistic process of storage studied in the company in question becomes an essential factor for a company that wants to continue in the market, since it is new and had in the document that would guide the logistics management of storage.

According to LAROUSSE (2001, p.610), "Logistics is part of the art of war that aims to guarantee provisions, transportation, accommodation, hospitalization for the military personnel in operation." In this way, it can be seen that over the centuries, logistics already showed its importance, even if in an auxiliary way, without the perception on the part of its leaders that it could be used in a strategic way.

Supply Logistics is directly linked to the process of purchasing materials, inventory control, warehousing and transportation from the supply source to the company responsible for the production process or distribution. The internal is responsible for moving, packaging and moving the finished products within the company premises or interplants, so that they are available for distribution logistics that will make the products available at the access points for the final consumer.

II. REVIEW OF LITERATURE

Logistics began with military operations, as generals had the need for armament replacement, food, medical help at just the right time on the battlefield.

Movement and storage activities that facilitate the flow of products from the point of purchase of the raw material to the point of final consumption, as well as the information flows that put the products in motion, in order to provide adequate levels of service to the customers. customers at a reasonable cost. (BALLOU, 2012).

The evolution of business logistics is divided into three eras, which will be discussed below.

Before 1950: to date, logistics within companies was taken care of by different sectors. It was common for transportation to be commanded by production;

stocks through marketing, finance and production; processing orders for sales or finances. In this way, it resulted in a conflict of objectives and responsibilities in logistics activities.

According to Ballou (2012, p. 28): "Until about 1950, the camp remained dormant. Companies fragmented the management of key logistics activities. "

Soon after World War II, many logistical concepts were generated and began to be used today. This influence lasted only a few years, but by 1945 companies began to put transport and storage under the responsibility of a single manager. According to Pozo (2010, p.04): "The armed forces of America were the first to use this concept of logistics in World War II and successfully [...] in the early 1950s." Between 1950 and 1970 - development: between the early 1950s and the 1960s there was a very great evolution of theory and practice of logistics. With this evolution of theory, marketing and management professors were upset because companies paid more attention to buying and selling than to physical distribution.

After 1970 - years of growth: business logistics began to reap the benefits of using them, but companies appeared

to be more concerned with profits than with cost control. Often this evolution was masked by the inefficiency of the market, both in distribution and in production. According to Bowersox and Closs (2001), "Business logistics, as a field of business administration, entered the 1970s in a state described as semimaturity."

Some events were fundamental to this evolution, such as the oil industries, which since 1973 increased oil prices over the next seven years, influencing the market decline and rising inflation.

Logistic Strategic Planning is a tool widely used by the most successful organizations, collaborating in setting goals and actions to face future situations and achieve their goals. All this, due to his interpretation of the environment, directing and adapting the organization in the most appropriate way to reach them (OLIVEIRA, 2010).

It aims to reduce the chance of errors and change the path traced by the company, to consider the necessary resources and feasibility of the enterprise. Due to the market's many difficulties, which arise daily due to technological advances and competition, strategic planning has become one of the first steps for business continuity and success. (SLACK et al., 2002)

The logistics processes, within an organization, correspond to all the activities necessary for the delivery of a product or service to the clients, since it is constituted by several activities that through a good management can be characterized as a competitive advantage for the company, besides the search for internal and external integration, seeking to meet the needs of moving information, products and materials more quickly, reliably and safely.

Supply logistics can be seen as the set of activities used by companies related to the acquisition of materials from suppliers, seeking the integration between transport and suppliers with the objective of obtaining greater efficiency in resupply, as well as the strengthening of purchasing power and reducing costs for the administration of goods and services. However, for better interaction between stakeholders, communication is of fundamental importance in order to have a supply effectively. Thus, for Moura (1997, p.9):

According to Ballou (2006), supply logistics encompasses all the activities carried out in the acquisition of materials necessary for the production or distribution of products, using methods such as storage, handling, storage, transportation and information flow. In this way, the logistics of supply has as subprocesses the storage and transportation.

For Porter (1989), apud Souza (2012), internal logistics are considered as activities associated to the receipt, storage and distribution of inputs in the product, such as material handling, warehousing, inventory

control, fleet scheduling, vehicles and return to Providers. For Silva (2012), the internal logistics includes all the activities carried out in the logistical support for the production, involving all the flow of materials and components in the acquisition of the inputs until the delivery of the finished products to the distribution logistics. Souza (2012) argues that internal logistics refers to the whole process of receiving, storing, controlling and distributing materials used within an organization.

Logistics is considered to be one of the most important areas within an organization, as it has enabled companies to stand out from their competitors through competitive strategies.

Still for Souza (2012), the main characteristics of the internal logistics are: a) Attendance to the employees - responsible for attending the material resources used within the organization; b) Task Optimization - allows the reduction of the time between the tasks performed by the organization's employees through the elimination of spaces and delivery in the ideal quantity; and c) Integration of the other sectors of the organization - Once the material resources used in each of the sectors of the organization need to be surveyed, providing within the limits the standardization of these resources, the internal logistics approach the sectors discussing the application and the use of their products in the execution of their tasks.

According to Moura (2005), the movement of materials involves the entire process from the entry of goods into the organization, location, positioning and distribution of materials, facilitating the movement, until the storage and exit of the goods.

Ballou (2006) argues that the stock for companies is indispensable for a good performance of the activities, since if there is a stock within the organization, the risk of not attending to a customer is minimal, since the stock is a good of the company that will be used to meet future demands, and the company is protected from any unforeseen events that may occur with the process or the demand for the products.

The movement of materials is inserted within any organizational process becoming a key point, since besides being representative in the total cost of the products has a direct connection with the quality of the products. Therefore, when well managed, it will bring great competitiveness to the company (MOURA, 2005).

In order to have a good use of movement and the optimization of spaces, it is also necessary that the layout is well planned, taking into consideration the type of process and the characteristics of the company.

According to Ballou (2012, p.24), "The extensive use of inventories results in the fact that, on average, they account for approximately one to two thirds of logistical costs, making stockkeeping a key logistics". For a

dynamic value aggregation to inventory, it must be positioned close to the consumers or to the vessel ports. Maintaining multiple stock points generates a high cost, causing the stored products to have added to their market value of approximately 33% per year.

III. METHODOLOGY

The present research was guided by a set of techniques and procedure, through which the reality of the process in question was studied and analyzed: "The logistic process of storage as business strategy: case study in an industry in the offshore area.

Its objectives were achieved through an exploratory approach, since, according to Gil (2002, p.41), exploratory research aims to provide greater familiarity with the problem, with a view to making it more explicit or to constitute hypotheses.

Under this idea, information was collected through a semi-structured interview and questionnaire about the process: stock logistics saving throughout 2017.

IV. RESULTS

As a result of the interviews and questionnaire responses we suggested the following procedure implementation together with the AGB-SYSTEM.

Direct Benefits of AGB-SYSTEM software deployment.

1 – Inventory Control
2– Purchasing Administration
3 – Receiving Materials
4 – Product Control
5- Forecast of Demand
6 - Cost Accounting
7 – Tax Accounting
8 – Product Control

Chart 1 : Benefits of AGB-SYSTEM software
 Source : Elaborated by the author (2018)

PROCEDURE

• PURPOSE

Define the Rules and Procedures for the receipt and movement of Materials and Products from purchases made by the company, as well as materials moved between the warehouse and the production process, in order to optimize activities and ensure the most adequate conditions for reliability the process.

• SCOPE

From the arrival of the materials and / or products through the logistics area, raw material output for the manufacturing, receipt of intermediate materials or finished from the factory and output of the finished products for assembly or sale.

• APPLICATION FIELD

All areas of the company with processes related to receiving and moving materials and / or products.

• ENJOYING NO FOUNTAIN

• RESPONSIBILITIES

The Logistics Area is responsible for all necessary support and guidance to the Material Receipts sector for the fulfillment of its activities, in accordance with this Policy, as well as to support the Receipt Receipt sector, guaranteeing the write-off of purchase orders and receipt of the notes in the AGB-SYSTEM.

It is the responsibility of the Logistics (Warehouse) sector to receive the materials and / or products delivered by the suppliers, only when they are in accordance with the specifications in the respective purchase orders, as well as to ensure that the materials comply with the receipt generated by the AGB-SYSTEM, based on the invoice of the supplier. It is the responsibility of the controlling sector to guarantee the tax receipt of the materials and / or products in the AGB-SYSTEM, generating their entry and accounting in the stock.

At the time of preparation and issuance of the receipt, the corresponding purchase requests will be downloaded, generating the tax deeds and the respective payments to the suppliers.

The IT Area is responsible for maintaining the AGB-SYSTEM, as well as all necessary adjustments to the implementation of this Procedure.

• POLICIES

The Logistics Area of the company has authority and responsibility for the management of the Receiving of Materials (Warehouse) sector located in Rio de Janeiro / RJ.

The Procurement Area, together with the Logistics area, shall keep track of all deliveries of goods and / or products in order to correct distortions and, in particular, identify the reasons why they occurred.

The Logistics Area - Material Receipts Sector together with the Controllershship Area - Receipt Receipts Sector, shall maintain strict control over all goods and / or products received as well as the Receipts received in the AGB-SYSTEM.

The Logistics Area must elect an employee of the company to be responsible for coordinating the work done in the Warehouse, for the physical receipt of the goods and / or products in the AGB-SYSTEM.

All goods and / or products delivered to the warehouse must be checked before being unloaded and must be supported by Receipt Notes generated by the AGB-SYSTEM. The original invoice of the supplier and his approved purchase order will be retained in the entry order at the time of the tax receipt that will be given before the physical receipt of the material. Materials and / or products in disagreement with the Purchase Order or without their respective Invoices, can not be received and must be returned to the supplier for appropriate measures.

The AGB-SYSTEM must be configured to accept the receipt of materials, with differences in their quantities, within the tolerance levels accepted by the system and authorized by the Company.

All returns must be approved by the supervisor of the Quality Area and must be immediately notified to the requesting area of the material and / or product, the reasons for which they have generated the return.

In case of return of material and / or product to the supplier, the Purchasing Area must negotiate new deadlines, having as basic premise the urgency of the new receipt.

All occurrences involving returns of materials or correctness in the process due to errors in billing, should be included in the performance monitoring report of the suppliers.

The quality tests carried out on some Raw Materials shall comply with the technical criteria applied by the responsible area and the lead time foreseen for its accomplishment. Once the Raw Material has been refused, all of its process of receipt and payment to the supplier must be immediately reversed, avoiding greater inconvenience in the process.

• Warehouse Ordinance

All delivery of material and / or product, must be accompanied by the respective Tax Notes and the

Knowledge of Transportation, when applicable, that must be presented by the carrier in the Ordinance before its release for delivery in the warehouse.

The official of the tax receipt should check the documents and pay attention to the data of the Invoice, verifying the correct existence of the data required for acceptance of the same, such as: Corporate Ratio, Address, Material Description, Purchase Order N° and Contact Person in the company.

The invoice must be checked with the purchase order, if everything is correct, the tax receipt will be formalized and the Receipt Note will be issued, which will be the mirror of the vendor's NF, as well as the basis for the physical conference to be carried out by the Area of Logistics. With the Receipt Note, as well as the left-hander of the NF that has been detached, the vehicle will continue to the physical receiving sector (Warehouse), for physical and material quality and / or product conference. If NF is in disagreement with the Purchase Order, it will be up to the Purchasing Department to solve such problem, including, to return the merchandise, if it is the case.

The materials and / or products to be used directly in the Production and in the Maintenance sectors, as well as the fixed assets will follow the same process above.

Any Technical Reports that accompany some Raw Materials, whose presentation by the supplier of the material is mandatory, should be sent to the Quality Control department for analysis and approval of the quality of the material being delivered.

- **Physical Receipt of Materials and / or Products**

The responsible official in the Warehouse must check all goods with the respective Receipt Notes before they are unloaded. The goods must have their weight or confirmed quantities for their acceptance.

If there is disagreement in the process (Merchandise vs. Receipt) outside the tolerance levels, the warehouse supervisor must notify the supervisor of the Purchasing Area and arrange for the return of the material to the supplier, if applicable.

Materials and / or products that need to be unloaded directly in the Production or in the Maintenance sectors should be checked prior to their unloading by the responsible ones in those areas, through the Receipt Note that can be delivered to the responsible ones through the own drivers of the carriers.

Note: Checking the goods and / or products delivered to the Production and Maintenance sectors must be checked by checking the respective quantities and

accepting differences within the tolerance limits set in the system.

Subsequent to the conference of the materials, if approved, those responsible must legibly sign and stamp the note of the invoice and the Receipt Note and advise the driver that before leaving the company the driver must return the Receipt Note to be attached to the note and forwarded to the accounting for registration and filing.

If there are distortions in the process, outside the limits of tolerance configured in the system, those responsible in the areas should communicate to the Material Receiving department, so that it can take the appropriate measures, and even return the materials to the suppliers, if applicable.

- **Receipt of Invoices (Fiscal)**

The official responsible for receiving the Notes in the AGB-SYSTEM must do so in accordance with the respective Purchase Orders, taking into account the following items: material code, material description, quantity, place and deadline, prices unit / total, incidence of taxes and payment terms.

Fiscal Notes diverging from their respective Purchase Orders must be returned to suppliers for regularization. For this, the responsible in the Receipt of Invoices field, should obtain the approval of the Supervisor of the Purchasing Area and of the Controllership area.

All Material Purchasing Tax Notes must be inserted in the AGB-SYSTEM, obeying the legal deadline of up to 05 (five) business days from the date of entry of the document in the company premises, for its fiscal books and, later sent to Area of Controllership for due diligence on your custody.

The taxpayer should pay attention to the receipt of materials that may be benefiting from the tax credit (ICMS, IPI, PIS and COFINS), which will be determined upon receipt of the invoice. Any discrepancies should be corrected and immediately notified to the Purchasing Department.

The second copies of the Invoices relating to the deliveries of Computer and Telephony Equipment shall be delivered to the IT area for custody and control. Such copies may be used when sending the equipment for repair still under warranty period.

- **Letters of Correction and Complementary Fiscal Notes**

In cases where there is a need and the possibility of obtaining a letter of correction, the person responsible for receiving the tax must formally communicate to the

Controllership Area, which in turn must approve and request its issuance to the supplier.

In cases where there is a need to issue an invoice supplementary to the price, the person responsible for receiving the tax must formally communicate to the Purchasing department, which shall approve and request its issuance from the supplier.

In case of approval in the issuance of an additional invoice of price, all criteria for the approval of a new Purchase Order must be observed, canceling the previously issued request.

GROOVING MOVEMENT

• RESPONSIBILITIES

The warehouse is responsible for the physical custody of all material classified as Raw Material, Intermediate Product and Finished after assembly.

The Logistics Area is responsible for all necessary support and guidance to the Warehouse sector for the fulfillment of its activities, in accordance with this Policy, as well as to support this sector with regard to all movement of warehouse material, ensuring, including maintenance of this movement in the AGB-SYSTEM .

It is the responsibility of the Logistics (Warehouse) sector, to receive the materials, as above, as well as the control of the permanence of these materials in the inventories and their outputs for production, consumption and maintenance and sales.

The IT Area is responsible for maintaining the AGB-SYSTEM, as well as all necessary adjustments to the implementation of this Procedure.

• POLICIES

The COMPANY Logistics Area has authority and responsibility for the management of the Warehousing sector located in Rio de Janeiro / RJ

The Controllership Area, in conjunction with the Logistics area, shall maintain a "follow-up" on all the physical movements of the warehouse, in the sense of financial control, for subsequent valuation and accounting of inventories.

The Logistics Area shall promote rotating inventories in the Warehouse, in periods not exceeding 7 (seven) days, always maintaining updated information, in order to guarantee the accuracy of the data obtained with the physical materials; the physical adjustments to the AGB-SYSTEM will be carried out by the Controller, after the appropriate analysis of the reasons for the differences identified.

The AGB-SYSTEM must be configured to control any and all movements of the stocks, indicating their origin and destination.

All output of material from the warehouse must be supported by the document "Order Reserve" - which is issued by the OF - Order of Manufacture - which in turn must be referenced to a PO - Purchase Order -

There can be no duplication of material withdrawal for the same Order of Manufacture. If material in excess of the reserve is required, it must be justified by the production control planning (PCP). It is up to the PCP industry to control the materials in the factory.

In the case of return / return of partial or total material, the return values to the inventory must be the same as those of the exits and will be given to the inventory by the warehouse sector.

All occurrences involving returns / returns of materials or correctness of the process due to errors in the requisition and must be included in the material handling accompaniment report.

All material / product shall maintain a standardization of its unit of measurement. To do so, it is up to the Purchasing Department to create the standardization of these materials, however, it is up to the Warehouse Area to pay attention to the inventory in the appropriate and standardized unit of measurement.

• PROCEDURES

The Warehouse, based on the Receipt Note will proceed in the input of the material in the inventory, paying attention to the standard unit of measure of the company. This entry will be made physically and financially on the AGB-SYSTEM .

For the delivery of raw material to the factory, the warehouse official must mandatorily check the quantity reserved in the Order of Manufacture.

If there is a need for material in excess of the amount of the reserve, the amount delivered in the specific field of the reserve shall be noted. Subsequently, this difference will be justified by the person in charge of the PCP, as mentioned previously. The AGB-SYSTEM will automatically issue a warning - and generate a report to be analyzed by the PCP.

It is up to the PCP to prepare and insert in the AGB-SYSTEM the notes of manufacturing hours per Order of Manufacture

The Controllership, based on the information generated by production control planning (PCP) and Warehouse, will monthly update the accumulated values of manufacturing costs for the valuation of inventories.

The handling of the finished products is the responsibility of the Warehouse, which will enter into the inventory based on the receipt of the material from the factory. The entry is made in the system AGB-SYSTEM and will be

confronted with the Order Reserve. If there is a higher quantity than scheduled, such divergence should be analyzed and justified by the PCP. The AGB-SYSTEM will automatically issue a warning - and generate a report to be analyzed by the PCP.

V. CONCLUSION

With the implementation of the procedure as a result of research obtained through the application of the questionnaire and interviews in this company, it was noticed a great lack of management of the storage activities that entailed to the company. Afterwards, AGB-SYSTEM software was implemented, with the following main benefits: Delayed delays, better customer service, increased productivity, reduced maintenance costs, streamlined decision making, compliance with tax legislation and the final result obtained classified as excellent for the company studied, as it had greater control over the storage management and related areas, increasing its productivity by 32.25% in a period of 12 months.

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Seasonal Variability of Rainfall and its Decadal Anomaly over Nigeria: Possible Role of Solar and Geomagnetic Activities

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Abstract— This study investigates seasonal variations of rainfall and its decadal anomaly over Nigeria and the possible role of solar and geomagnetic activities. Sunspot number and geomagnetic aa index were used as solar indices. Monthly mean rainfall data from Nigeria Meteorological Agency was used in this study. Bivariate and power spectral density analyses were employed in analyzing the data. Rainfall anomaly was calculated using the mean of the base period, 1981 – 2010. Seasonally, rainfall varies from the coastal areas to the hinterland from January to December during rainy and dry seasons. On the decadal rainfall anomaly, positive anomalies increases steadily towards the coastal regions; indicating an increase in rainfall characteristic, whereas negative anomalies increases towards the northern regions; depicting decrease in rainfall characteristic. This was confirmed from the Mann-Kendall trend test. These variations are evidence of climate change. Correlation analysis revealed that the correlation of rainfall with sunspot and aa index were statistically insignificant. The spectral analysis revealed signatures of solar and geomagnetic activities on the rainfall spectrum. We therefore infer that, in addition to anthropogenic activities, solar and geomagnetic activities might play important role in the observed climate change in Nigeria; since rainfall is used as climate change indicator.

Keywords— Climate change, climate change indicator, rainfall variability, solar and geomagnetic activities, Nigeria.

I. INTRODUCTION

It is a clear fact that the Earth's climate has changed in the past, still changing at present and is expected to change in the future. These changes are observed in the day-to-day weather [1]. According to [2], the observed climate change

is based on evidence from different sources. The evidence of climate change is observed globally.

[3] reported that the evidence of climate change correspond to the patterns scientists expected to see due to rising levels of carbon dioxide and other human-induced changes. Climate change has catastrophic effects on man and its environment. The impacts of climate change have been observed both locally and globally.

The climate of any location can easily be understood in terms of annual or seasonal variations of temperature and precipitation, since they are used as climate change indicator [4], [5]. Hence, this work hopes to investigate the seasonal variability of rainfall and its decadal anomaly over Nigeria from 1950 – 2012 and the possible role of solar and geomagnetic activities on climate change in Nigeria.

Nigeria, located in West Africa lies between latitudes 4° and 14° N and longitudes 2° and 15° E of the equator. The climate of Nigeria is majorly controlled by the dry, dusty, tropical-continental air mass, and the warm, tropical-maritime air mass. The influence of both air masses is determined by the movement of the Inter-Tropical Convergence Zone (ITCZ), a zone demarcating the two air masses. The interplay of the two air masses gives rise to the rainfall characteristics and the two distinct seasons in Nigeria; the rainy and dry seasons [6], [7].

Research works on rainfall variability and flood frequency in Nigeria have been carried out by [8], as well as studies on rainfall variability and drought by [9]. Effects of El Nino and La Nina and the impact of Atlantic sea surface temperature on precipitation in Nigeria have also been studied [10].

[6] reported that rainfall in northern Nigeria from 1953 – 2002 has generally increased in the last decade. They concluded that increased in annual rainfall may lead to

improvement of water supply in some areas, while flooding, dam collapse due to excessive rainfall could lead to damage of life and properties in some other areas.

On the contrary, [11] found out from his research that the annual rainfall in Nigeria over both time and space has declined. He noted that the greatest change occurred in the onset of the rainy season which has resulted in a reduction of the growing season by nearly one month thereby increasing the risk of early planting. He concluded that there were fewer wet days and higher rainfall intensities in most part of the country thereby causing erosion. [12] reported that the mean annual rainfall in Nigeria diminished from the coast to the inland.

[5] observed that there has been statistically significant increase in precipitation and air temperature in the vast majority of the country. They also noted that the analyses of long-time trends and decadal trends in the time series further suggested a sequence of alternately decreasing and increasing trends in mean annual precipitation and air temperature in Nigeria during the studied period.

[13] predicted from the results of their work on future climatic prediction, 2000 – 2050, that the northern region will experience more decrease in rainfall even during wet season resulting in desertification, while the southern region will experience a reverse situation. They also predicted that the climatic variability currently experienced is likely to increase and intensify in future; drought, floods, and storms are likely to increase in both frequency and intensity.

Among the several researches on rainfall variability in Nigeria, most of them were based on records of the late 1980s, 1990s and early 2000s. This study is an attempt to give more information about the variations of rainfall from the 1950s to 2012. It will also investigate the link between solar and geomagnetic activities with variability of rainfall in Nigeria.

II. SOURCES OF DATA

Monthly mean smoothed sunspot numbers, spanning for 63 years (1950 – 2012) were obtained from the World Data Center (<http://www.sidc.be/sunspot-data>), while geomagnetic activity *aa* index covering a period of 61 years (1950 – 2010) was obtained from the National Oceanic and Aeronautic Agency. Monthly mean daily rainfall data for 20 stations in Nigeria were obtained from Nigeria Meteorological (NIMET) Agency Oshodi, Lagos. The data spanned for 63 years (1950 – 2012). Map of Nigeria showing the meteorological stations is shown in Figure 1.

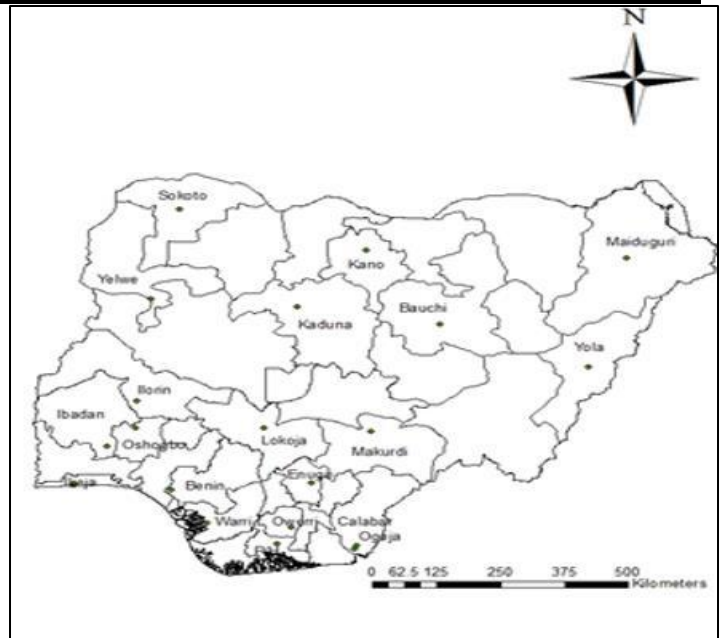


Fig.1: Map of Nigeria showing the meteorological station

III. METHODS OF DATA ANALYSIS

Descriptive analysis was employed in analysing the rainfall, sunspot number and *aa* index

- i. The daily, monthly and annual mean geomagnetic *aa* index were calculated from the three-hourly values, while the annual mean sunspot number was calculated from the monthly mean daily values.
- ii. The monthly and annual mean rainfall for each station was calculated from the daily values.
- iii. The mean of the base period (1981 - 2010) was used to compute the decadal rainfall anomaly for each station, in line with the recommendation of the World Meteorological Organization (WMO) Policy.
- iv. The results of the monthly variations and the decadal rainfall anomaly were presented using ArcGIS software.
- v. Bivariate analysis was employed to correlate annual mean rainfall with sunspot and *aa* index at 0.05 level of significant.
- vi. Mann-Kendall trend test was used to investigate the variation trends of annual rainfall from 1950 - 2012. Mann-Kendall trend test is one of the statistical tests used for trend analysis of time series data [14].
- vii. Finally, power spectral density (PSD) analysis was performed using Fast Fourier Transform (FFT) to investigate the periodicities of annual sunspot number, *aa* index and rainfall (i.e. over all the stations) using XLSTAT. The spectrum of each parameter obtained was smoothed using Hanning window function.

IV. RESULTS AND DISCUSSION

It could be observed from the monthly mean rainfall variability over Nigeria from 1950 – 2012 (Figures 2 - 4), that rainfall across the country was very low from January to March with little or no rainfall in the northern region. It increases from April (the transition period from dry to rainy seasons) steadily until July and then decreases again in August. It thereafter increases again in September in major parts of the country except in the northern region and finally decreases steadily from October (the onset of dry season in major part of the country) to December.

Generally, rainfall was very high across the country in the month of July. July is recognized as the peak of rainy season in the northern region. On the other hand, July and September are the double peaks of rainfall observed in the southwest and south eastern regions of the country, while August is the period when there is reduction in the amount of rainfall popularly called August break. This result is in line with [5], who reported that rainfall pattern below latitude 10° N is bimodal having a primary peak in June-July and secondary peak in September with little dry season in August as a result of absence of the easterly jet.

Observation of rainfall from January to December as shown in Figures 2 - 4, depicts that rainfall decreases from the coastal areas to the hinterland during both rainy and dry seasons. Similarly, increasing and decreasing trends were also observed in variation trends of annual rainfall using Mann-Kendall trend test from 1950 – 2012 (Table 1). This could be due to the influence of the two air masses from Sahara region and Atlantic Ocean [12]. According to [10], the movement of the Inter-Tropical Convergence Zone (ITCZ) across the country control the variations of rainfall in Nigeria.

Figures 5 - 6 present the decadal patterns of rainfall anomalies over Nigeria from 1951 – 2010. It could be observed in the first decade (1951 – 1960), that most parts of the country experienced normal rainfall (i.e. SPI ranging from -0.99 – 0.99). However, regions such as Calabar and Warri that were exception were extremely wet with SPI ranging from 1.399 – 2.213. It is obvious that major part of the north was moderately dry (Table 2).

In the second decade (1961 – 1970), major parts of the country experienced normal rainfall, except some stations in the northern and coastal areas. It is interesting to note that most places in the northern region were not only moderately dry, but there was a decrease in the number of stations as compared to the first decade. On the other hand, more stations in the coastal area were very wet as compared to the first decade (Table 2).

Similarly, this observation of normal rainfall patterns in major parts of the country, decrease in stations experiencing

moderate dryness in the northern region and increase in places that were very wet in the coastal area were also observed from third decade (1971 – 1980) to sixth decade (2001 – 2010) respectively (Figures 5 – 6). Generally, it is interesting to note that stations experiencing moderate dryness decreases towards the extreme northeast and north western regions as observed from first to sixth decades. This implies that even though the northern region experiences dryness, there is reduction in the number of places that experience this effect. The reverse is the case in the coastal areas as there was an increase in the number of stations having positive trends. This demonstrates that the regions were very wet as a result of increase in rainfall. This may result in the increase in flood and erosion in the coastal areas.

According to [4], rainfall is one of the climatic parameters used as climate change indicator. Based on the variability of rainfall observed in this study, it has clearly shown that climate change is obvious in Nigeria. The causes of this observed climate change may be due to natural or man-made activities. Natural factors such as solar motion, solar activity, geomagnetic activity, volcanic activity, e.t.c. have been linked to climate change. Hence, we investigate the effects of solar and geomagnetic activities on climate change in Nigeria using correlation and spectral analyses.

From Table 3, both positive and negative correlations were observed in the correlation of rainfall with sunspot number and aa index. However, the correlations were not significant at 0.05 significant levels. We can infer that solar and geomagnetic activities may have little or no influence on rainfall. Many authors have observed positive, negative and even zero correlation between solar indices and climatic parameters (e.g. [4]), but the physical mechanism for this relationship has been the major challenge. Hence, spectral analysis was further used to investigate the relationship between rainfall and solar indices (sunspot number and aa index); since the impact of solar and geomagnetic activities on climatic parameters cannot be directly measured.

From the spectral analysis, significant peak of 10.5 years was observed in sunspot number (Figure 7a). Other peaks observed include 21.0 and 7.8 years. The peaks of 10.5 and 7.8 years could be related to Schwabe cycle, while the peak of 21.0 years could be referenced to Hale cycle. It could be observed from the spectrum of aa index (Figure 7b) that the peaks of 30.5, 15.2, 10.1, 7.6, 5.5, 4.6, 3.8, 3.6 and 2.7 years were found. These peaks could be referenced to Hale cycle and Schwabe cycle, while the short term periodicities may be due to the evolution of active regions of the Sun [15].

From the spectrum of rainfall (Figure 8), peaks of 63.0, 15.7, 10.5, 6.3, 5.2, 3.9, 2.7 and 2.1 years were detected. The

significant peak of 63.0 years could be related to Gleissberg cycle. The peaks of 15.7 and 10.5 years could be referenced to Schwabe cycle, while the short term periods could be related to atmospheric phenomena such as quasi-biennial oscillation [16]. Similar periodicities were observed in the spectral of solar indices and rainfall. Other authors such as [16], [17], [18] have obtained similar periodicities between solar indices and climatic parameters.

It has been reported that solar activity varies between active and quiet phases with 11 year solar cycle known as Schwabe

cycle, 22 year polarity reversals called Hale cycle and 80 year cycle known as Gleissberg cycle [19], [20]. The Schwabe, Hale, and Gleissberg cycles can be stretched or shortened, leading to different harmonics [21].

From these observations, we can infer that Schwabe, Hale and Gleissberg cycles, as well as atmospheric phenomena, were detected in the spectral of rainfall. This suggests that signature of solar and geomagnetic activities exist on rainfall in Nigeria, which could be linked to the observed climate change in Nigeria.

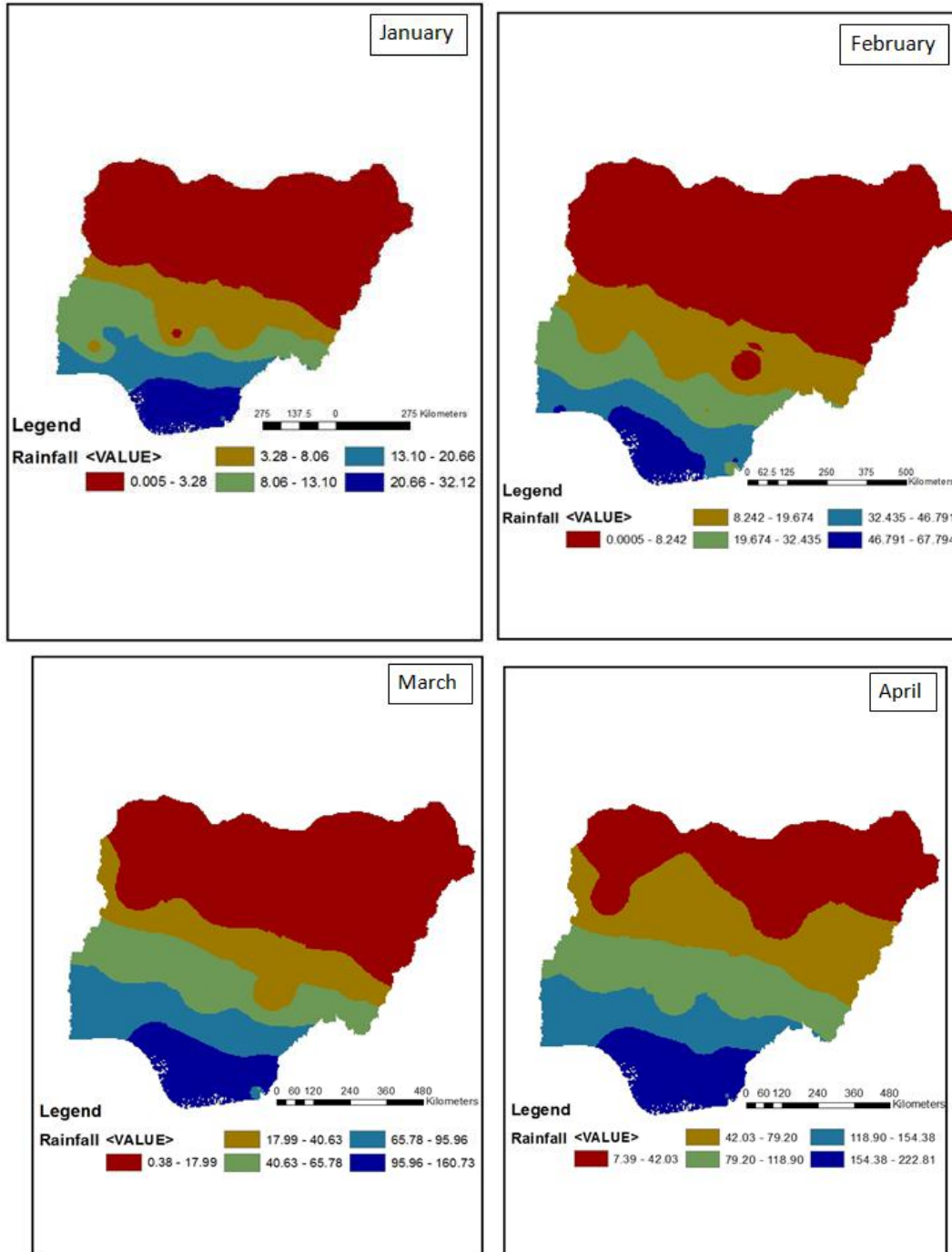


Fig.2: Monthly mean rainfall variability over Nigeria (1950 – 2012)

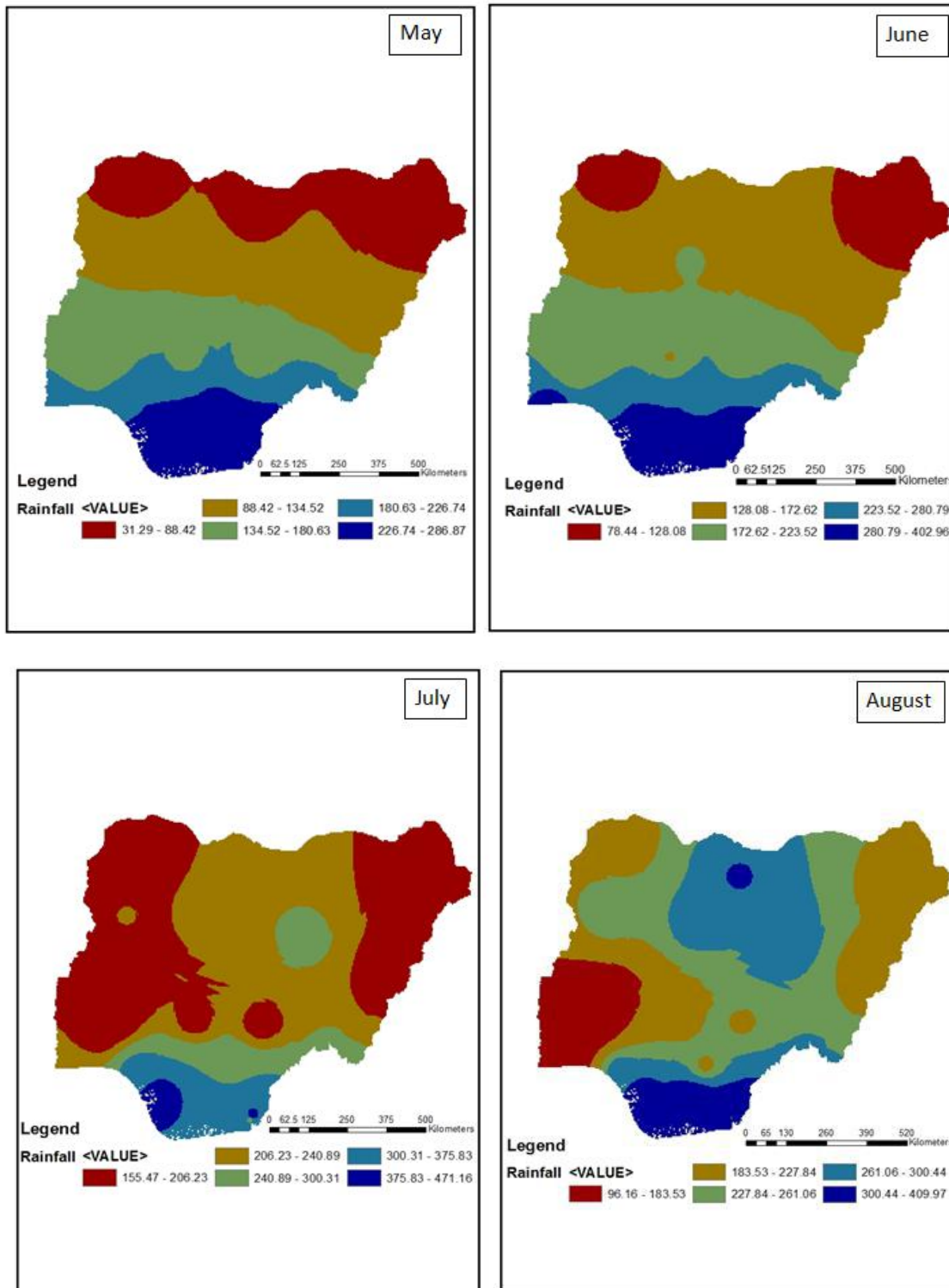


Fig.3: Monthly mean rainfall variability over Nigeria (1950 – 2012)

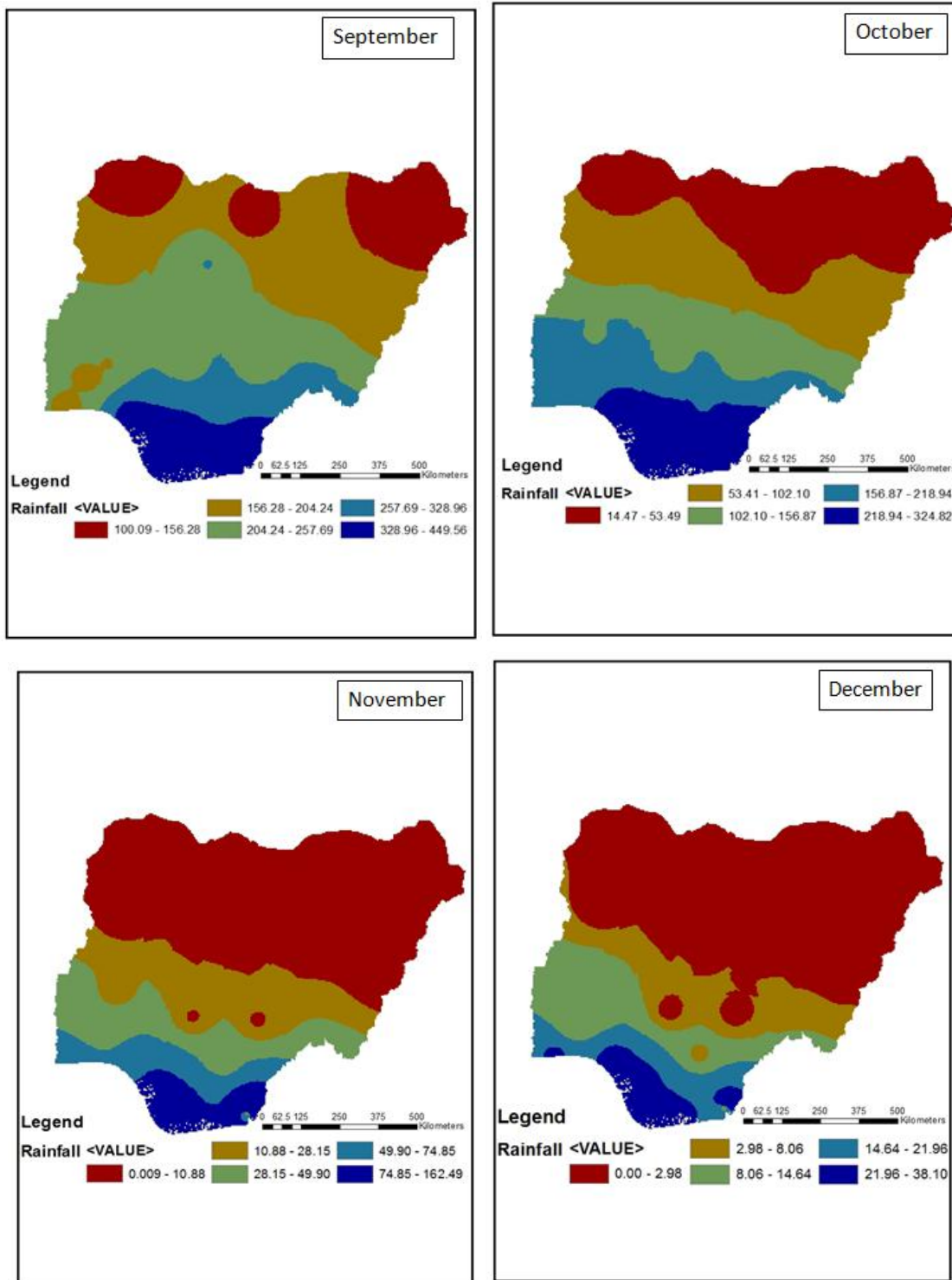


Fig.4: Monthly mean rainfall variability over Nigeria (1950 – 2012)

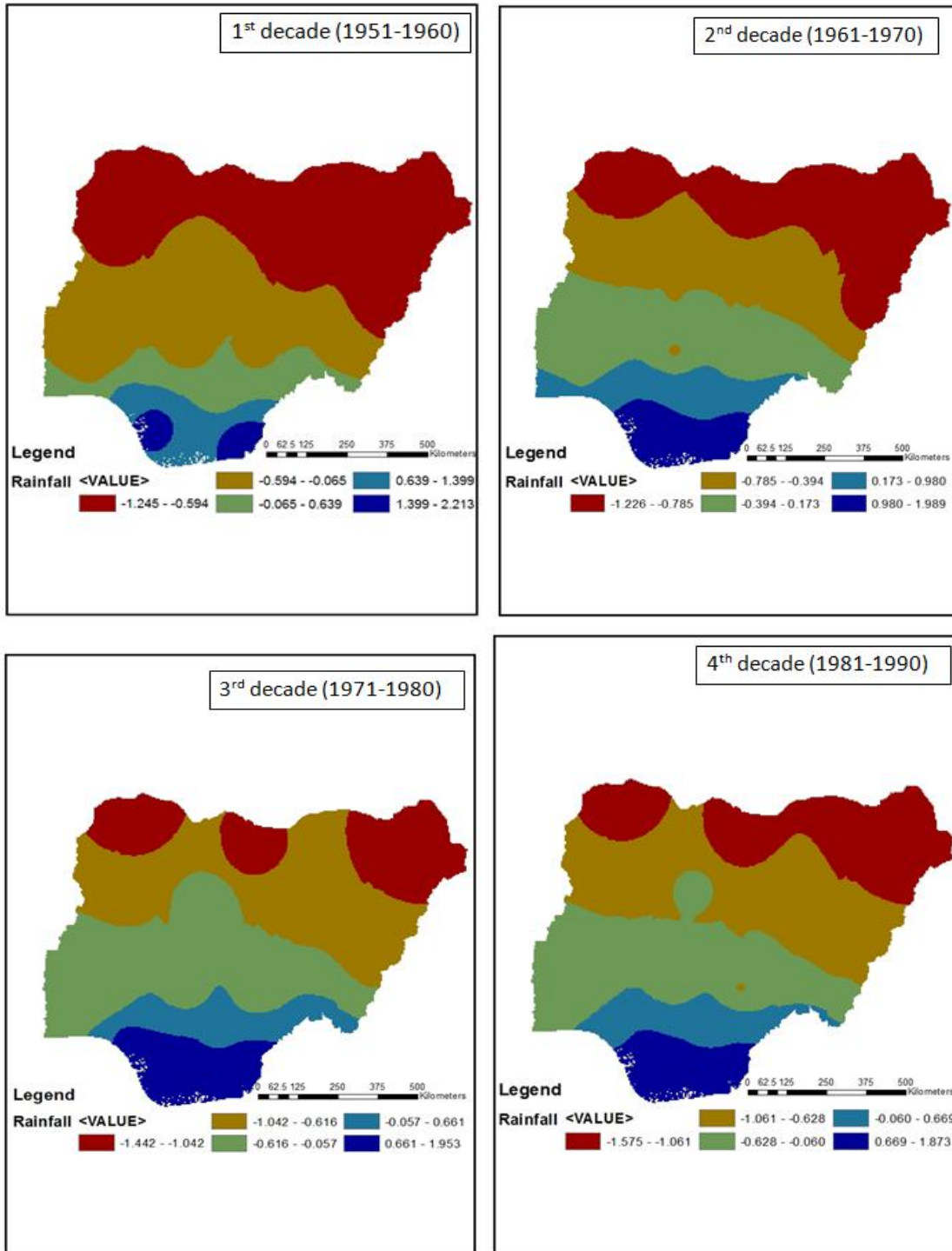


Fig.5: Decadal rainfall anomalies over Nigeria (1st – 4th decades)

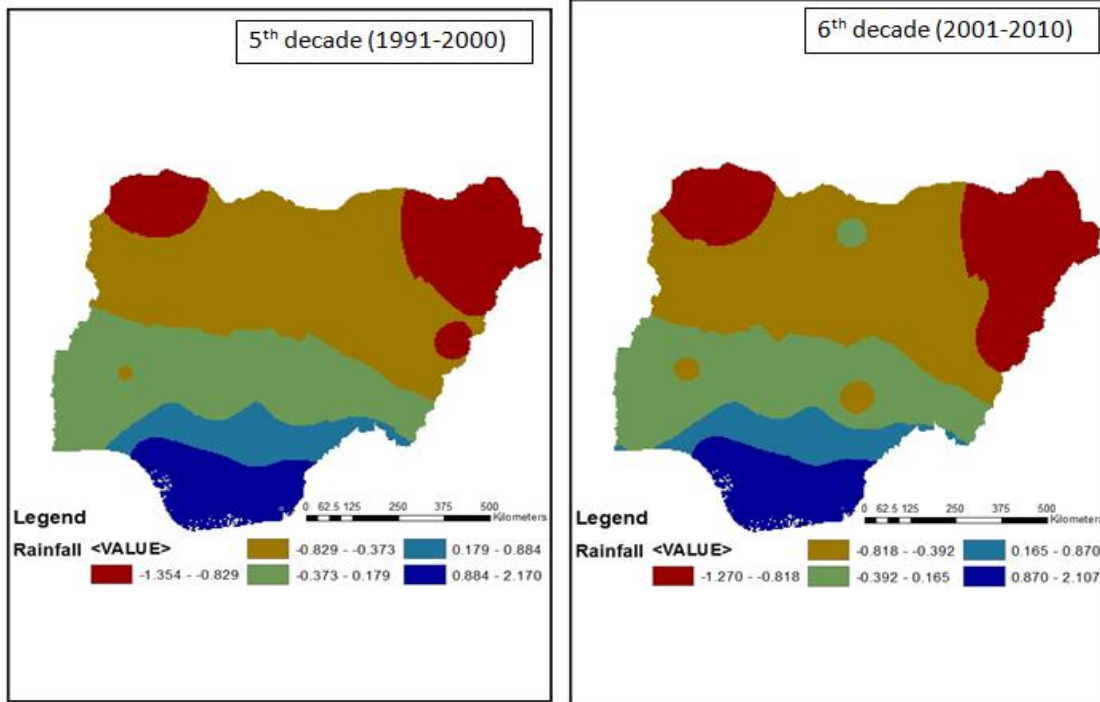


Fig.6: Decadal rainfall anomalies over Nigeria (5th and 6th decades)

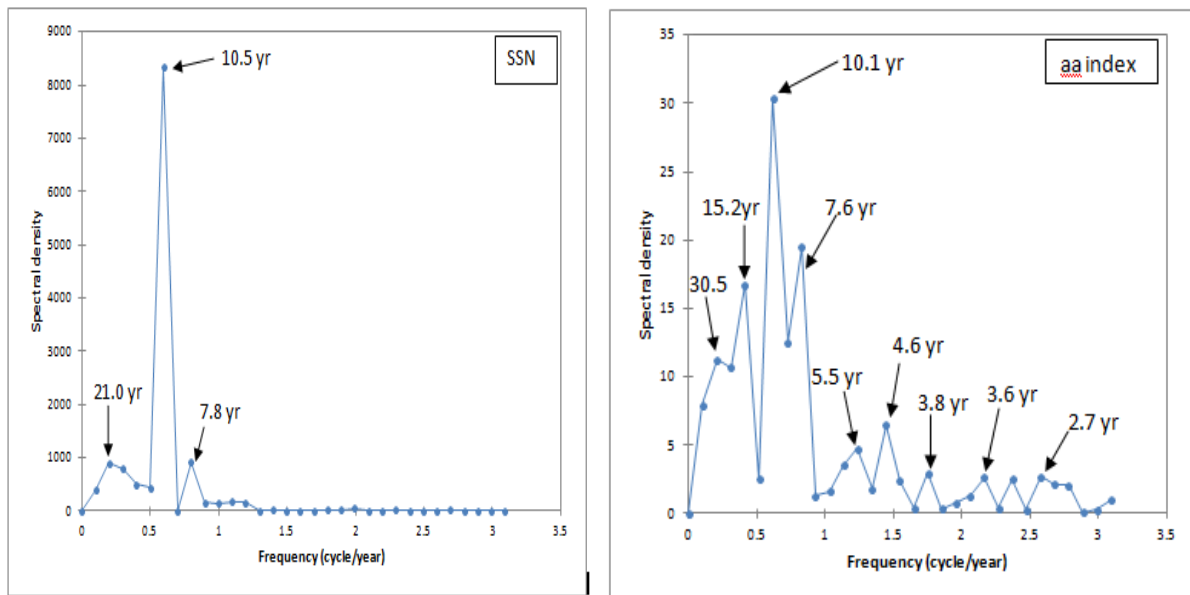


Fig.7: Power spectral density of yearly mean (a) sunspot number and (b) aa index

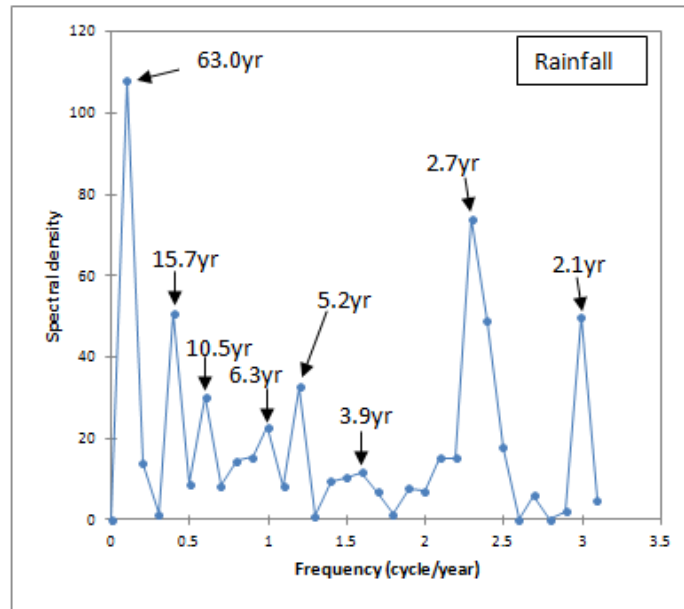


Fig.8: Power spectral density of yearly mean rainfall

Table.1: Variation trends of annual rainfall using Mann-Kendall trend test (1950 -2012)

Stations	Kendall tau	Mann-Kendall coefficient, S	Z statistic	Trend description (from Z values)	Hypothesis test (h=1: significant, h=0: not significant)	Trend significance
Yelwe	-0.0077	-15	-0.0830	Decreasing trend	0	Not significant
Sokoto	-0.0722	-141	-0.8304	Decreasing trend	0	Not significant
Kaduna	-0.1695	-331	-1.9573	Decreasing trend	0	Not significant
Kano	0.2535	495	2.9300	Increasing trend	1	Significant
Bauchi	0.0476	93	0.5459	Increasing trend	0	Not significant
Maiduguri	-0.0763	-341	-2.0166	Decreasing trend	0	Not significant
Ilorin	-0.1746	-341	-2.0166	Decreasing trend	1	Significant
Yola	-0.0497	-97	-0.5694	Decreasing trend	0	Not significant
Ikeja	-0.0067	-13	-0.0712	Decreasing trend	0	Not significant
Ibadan	0.1639	320	1.8921	Increasing trend	0	Not significant
Oshogbo	0.1121	219	1.2930	Increasing trend	0	Not significant
Benin	0.2033	397	2.3487	Increasing trend	1	Significant
Warri	-0.0148	-29	-0.1661	Decreasing trend	0	Not significant
Lokoja	0.1347	263	1.5539	Increasing trend	0	Not significant
Port Harcourt	-0.0712	-139	-0.8185	Decreasing trend	0	Not significant
Enugu	0.1869	365	2.1589	Increasing trend	1	Significant
Calabar	0.0271	53	0.3084	Increasing trend	0	Not significant
Makurdi	-0.1367	-267	-1.5777	Decreasing trend	0	Not significant

Table.2: Standardized precipitation index [22]

RANGE	MEANING
2.0 +	Extremely wet
1.5 to 1.99	Very wet
1.0 to 1.49	Moderately wet

-0.99 to 0.99	Near normal
-1.0 to -1.49	Moderately dry
-1.5 to -1.99	Severely dry
-2 and less	Extremely dry

Table.3: Correlation coefficient (r) of rainfall with sunspot number and aa index

Stations	sunspot number	aa index
Yelwe	0.0134	0.0665
Sokoto	0.0150	0.0496
Kaduna	0.1450	0.1224
Kano	-0.0607	-0.2347
Bauchi	0.0184	-0.1007
Maiduguri	-0.0038	-0.1279
Ilorin	-0.1440	-0.0267
Yola	0.0919	0.0799
Ikeja	-0.0115	-0.2069
Ibadan	-0.0655	-0.2053
Oshogbo	0.0614	0.0206
Benin	-0.0565	-0.2271
Warri	-0.0507	0.0432
Lokoja	-0.1271	-0.2893
Port Harcourt	-0.0700	-0.2315
Owerri	0.1617	0.0567
Enugu	-0.1327	-0.2665
Calabar	0.0718	-0.2537
Makurdi	-0.0167	-0.2509
Ogoja	-0.1415	-0.1910

V. CONCLUSION

Most of our findings are in agreement with well-known climatic pattern in different parts of Nigeria, little or no rain during the dry season (November to March) and heavy rain between March and October with a break in August. Furthermore, we found that positive anomalies were not only dominant in the coastal regions, but were also on the increase for the six decades under investigation. This established the fact that there was an increase in rainfall characteristic in the coastal area, hence, the increase in flood and erosion in the coastal region. On the other hand, negative anomalies were dominant in the northern region, showing that rainfall decreases towards the extreme northeast and north western regions, resulting in drought and desertification. These variations of rainfall are evidence of climate change. The correlation analysis revealed that the correlation of rainfall with sunspot number and aa index were statistically insignificant. The results of the spectral analysis have shown that signatures of solar and geomagnetic activities might exist on rainfall in Nigeria.

This suggests that solar and geomagnetic activities could be linked to the observed climate change in Nigeria.

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Science at the amazonian coast: Scientific production and training of human resources from the Coastal Studies Program – Museu Paraense Emílio Goeldi

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Abstract— *The scientific production and the training of human resources in Brazil have been investigated in many knowledge areas to subsidize their scientific, educational and technological development. To disseminate the intellectual and training of human resources contribution of the Coastal Studies Program (PEC/MPEG) at the coastal Amazon, in its timeline (1997 to 2016), it was compiled data of Curriculum Lattes of the PEC researcher and of data banks of institutional Programs of training from the Museu Paraense Emílio Goeldi (MPEG) agreed or not with others teaching and research institutions from Belém do Pará that, were typed and analyzed in the EXCELL 10.0 software. The production of 434 published articles (230 in the Biological, Health and Agricultural Sciences Area, 98 in Earth Sciences and Engineering and 76 in Human and Social Sciences) and of 427 training of human resources (128 in the Biological, Health and Agricultural Sciences Area, 128 in Earth Sciences and Engineering and 100 in Human and Social Sciences) mapping quantitatively the intellectual and training of human resources production in a multidisciplinary character, exposing the contribution of the program in its timeline, as also points out gaps and advances that can subsidize the academic and social demands fulfilling its mission.*

Keywords— *Amazon, coastal zone, knowledge production, human resources, scientific research.*

I. INTRODUCTION

1.1 The timeline in the Coastal Studies Program (PEC) from the Museu Paraense Emílio Goeldi (MPEG).

The year of 1996 followed full of events, between them highlighted one, where the coastal zone was the focus. A researchers group from Museu Paraense Emílio Goeldi (MPEG) met in Salinas, City of Salinópolis, at the Pará Coastal Zone in the Tropical Coastal Ecosystems Studies Program (ECOLAB) – *Franco-Brazilian Cooperation International Program* “an international and multidisciplinary network that develop integrate scientific studies at amazonian coastal ecosystems” (Mendes & Prost, 2001). The event has been organized and sealed by MPEG with institutional contributions, with the participation of many scientific institutions, including the United Nations Educational Scientific and Cultural Organization (UNESCO).

Other event in 1996, happened in this year: a workshop of the *Amazon Mangrove’ Program* (MADAM- Mangrove, Dynamics and Management), at Bragança, embryo of the idea of a specific Program creation inside of MPEG about Pará and its coastal zone, considering the existing critical mass and the accumulated experiences in the issues raised in the two cited events, from the various Scientific Departments – nowadays, Scientific Coordinations. Inspired in what they saw and heard during that workshop, a researchers group – integrated by Lourdes de Fátima Gonçalves Furtado, José Francisco Berrêdo Reis da Silva, Amílcar Carvalho Mendes, Cristina do Socorro Fernandes de Senna, Helena Doris Quaresma - , met in the lunch break, during the MADAM event, conjectured informally the idea of a studies program at the paraense coast developed by MPEG. That group should have its own identity seizing the individual experiences accumulated *in situ*, in a

multidisciplinary and interdisciplinary approach, preferably, to put their perceptions about the nature, characteristics and problems related to that ecosystem of the amazonian biome.

Indeed, the idea resulted: and, in 1997 the Coastal Studies Institutional Program (PEC) was created with the leadership of Maria Thereza da Costa Prost. This Program follows a chronological trajectory of investments and events checked in Borges et al., (2016). In this chronology are emphasized categories of analysis, performance evaluation and knowledge's production dynamic of the involved researchers, related to the coastal zone of the Brazilian Amazon. In the timeline between 1997 and 2016 the following facts assume relevancy in the cited indicative categories: (a) the insertion of analysis in the Social Sciences field, particularly of the Anthropology, as science that aims to know the relationship between the man and the nature, or in other words: between the social groups and the nature, or even, between nature and culture. Science that indicates and decodes *classifications* of the real (natural resources) and of the immaterial (representations about the concrete world), proposed by the social groups, and obviously, in that context they indicate the inherent logics to that human groups related to the territory that they inhabit, use and handle.

This data means that besides their purely methodological and objective practices, the Anthropology has as its priority to reach the heart of the issues through the *subjectivity* as a research technic – to approach the community (for example) from the perception of the subject, of the social actors in the presence. (b) the training of human resources to the research, from the aggregation of college students in the level of undergraduate and postgraduate, through internships with scholarships of the PIBIC or of the postgraduate programs linked to them. (c) aggregation of students from up-country with CNPq scholarship through RENAS Project (Natural Resources and Social Anthropology) and, at the same time, of people from the worked about communities to integrate research actions in real time. Of that process resulted the interaction research-community, relevant factor in the fieldwork performance of the teams.

1.2 Projects and the guiding research lines of the project.

Researches were developed by researchers from the Departments of Ecology, Botanic, Human Sciences and Museology. In this multidisciplinary context, it was elaborated the referred project, oriented by research lines in Human Sciences – Anthropology, Archeology, Communication and Museology; Biological, Health and

Agricultural Sciences – Botanic and Zoology and Earth Sciences and Engineering.

Related to the Human and Social Sciences of the RENAS Project at the fishing populations scope, previous to PEC, with studies in the coastal, estuarine and river amazonian areas, it was welcomed as one of the Anchor Projects, as was been classified at that time by Dr. Maria Thereza Prost, PEC coordinator.

The anthropological perspective glimpses the social organization, the history and the people culture that studies, in its environment (*in situ* and *in vitro*), their relationship with the natural resources and the biodiversity in their social representations that involve the social landscape, their relations and process of human occupation and mobility (migrations and internal inflows) in the long term history. Exposing in this way: cultural matrices of social groups or of the focused region, the identity and the otherness – their corollary -, the kinship, crony and neighborhood relations, the classifications of the lived world at the plan of its experiences and logics of belonging, appropriation, use of the natural resources and belonging to territories.

Later, in the PEC scope emerged the *Paraense Mangroves: Natural researchers, local uses and indicators for the sustainability* Project financed by Das Leibniz-Zentrum für Marine Tropenforschung-ZMT/German, and with financial support of the Science and Technology Fund of the Estate of Pará (FUNTEC) and more, the technic and scientific support of the Institut de Recherche et Développement (IRD-Cayenne) and of the CAPES-COFECUB Program, (developed by MPEG), Federal University of Pará (UFPA) and the Paris VII and Paris XI University (IBID).

In the FUNTEC Project the RENAS contributed to field works in different subjects, particularly in the social-anthropological characterization of the studied sites at the regions of the coastal cities from Marapanim and São Caetano de Odivelas.

Along the timeline, in the pointed out period, between other studies realized it highlights Mendes & Prost (2001), Furtado (2002), Souza-Filho et al., (2005), Furtado et al., (2012), Prost & Mendes (2013), Lins et al., (2014), Carmo et al., (2014), Furtado et al., (2015) and Borges et al. (2016).

1.3 The PEC epistemological relevance

The PEC Program is and will be a crucial institutional program for the comprehension of the social dynamics to what the various ecosystems of the amazonian biome and the involved human occupation areas are subdued, right by the multidisciplinary methodology that it uses. It is necessary to internalize a notion: the one who conceives that the scientific fields,

presents in it, does not be fragmented into monoblocs or following in a parallel way – biological sciences and social sciences, as in a previous occasion -, but in constant dialogical and interpretative relationship, if we want to have epistemological and more consistent results. This dialogical experience, how we see, gives sustentation to the teams in their respective field performance, to fortify the dialogues between research and community, the intercultural dialogues between their *partners* and other research groups from the amazonian region, from Brazil and from the Exchange.

Into this scope, the experience of the Anthropology team integrate to PEC, through the Anchor Project RENAS, has been contributed to diversify the knowledges related to the Brazilian coastal zone, particularly to the Brazilian North Coast.

The extension of these experiences at the amazonian seaboard, left this anchor project team to other latitudes, as to Portugal and Africa in Moçambique seaboards, resulting in the book *Olhares cruzados sobre os povos litorâneos de comunidades dos países de língua portuguesa: Percepção acerca do uso e gestão de territórios em comunidades haliêuticas no Brasil, Moçambique e Portugal*. Published by MCTI/Museu Paraense Emílio Goeldi and launched in 2015.

Subjects as millenarian occupation of this region fishing areas; social organization and change; social conflicts; traditional fishing technologies; fishing agreements; environmental protection areas – particularly the areas of the Marine Extractive reserves of Marapanim, Mãe Grande de Curuçá, Mocapajuba in São Caetano de Odivelas, Quatipuru-Primavera, Marauanazese do Pesqueiro, both from Soure, inscribe yourselves into their previous work schedule, participate of the interest in the anthropological and of the natural sciences perspective.

Among other Anchor Projects developed in the PEC/MPEG scope it highlights: Baía de Guajará Socioenvironmental Diagnostic, developed in the scope of the North-Northeast Environmental Monitoring of the Risk areas to Petroleum and its Derivative Spills Cooperative Network (PETRORISCO); Amazonian Coastal Ecosystems: ecological characteristics, social challenges and sustainable development; Potential Environmental Impacts of Petroleum and Derivative Transport in the Amazonian Coastal Zone (PIATAM mar I e II); Use and Appropriation of the Coastal Resources (RECOs); Preservation and diffusion of the photograph collection about amazonian coastal ecosystems; Fluvial Environmental Study in the Amazon: Hydro geochemical, climate and of vegetal philosophy implications; Economical valuation of the direct and indirect uses of the mangrove ecosystem in São Caetano de Odivelas-Pará and Botanical Research interdisciplinary Network in

Amazon, Atlantic Forest, Caatinga and Cerrado that were condemned by researchers of the Botanical and Earth Sciences Coordinations and, developed in the 1997-2016 period. These projects were executed along the north coast of Brazil, both on land and in water (estuary and sea) and, had the collaboration of researchers from many state and national institutions, always with the interdisciplinary and of training of human resources vision. The results of these important actuations are highlighted in the items result and discussion.

The PEC is a program that involves studies whose spectrum favor the comprehension of the ocean-continent line, that is, it includes objectively in course studies, other already performed and in perspective that can serve as an analytical base for regional evaluations. In a time, it appreciates an area – the coastal or maritime area -, that has links with the waters and interior territories – with the forest – a link between *Green Amazon and the Blue Amazon*. Both are inseparable in the scientific conditions. Therefore, it is necessary to appreciate this dimension. Theoretically in this case, they can be manifested (a) by the goods and services provides by the nature, especially by the flows and water pulses of the big, medium and small rivers (between the sea and the coast; between the sea and the estuaries, between the estuaries and the existent big and medium hydrographic basins). Studies in this direction, supposedly yield good fruit. In the same way they could be pointed out by the social mobility flow and pulse, those transits particularly along this line, charging its sociocultural *ethos* through the human occupation migratory processes, in the circuit of this line or of this ocean-continent axis.

In this sense it is intended to disseminate the intellectual and of training of human resources contribution of the coastal studies Program (PEC/MPEG) at the north coast of Brazil, along 19 years (1997 a 2016), exposing by a quantitative form its actuation in the timeline.

II. METHODS

The data were compiled from the search of the Curriculum Lattes (CVLattes) of 37 researchers involved in the program, of databases of the postgraduate programs in partnership with the Museu Paraense Emílio Goeldi (Biological Sciences Postgraduate Program – Tropical Botanic in agreement with the Federal Rural University of Amazon - PPGBOT/UFRA/MPEG; Environmental Sciences Postgraduate Program in agreement with the Universities: Federal Rural of Amazon, Federal of Pará and the Farming Researches Enterprise - EMBRAPA/CPATU; Human, Social Sciences and Anthropology Postgraduate Program (PPGSA) and in Zoology (PPGZOO) in agreement with the Federal

University of Pará (UFPA), and of institutional programs from the Museu Paraense Emílio Goeldi: Scientific Research Scholarship Program (PIBIC) and Institutional Training Program (PCI).

2.1 Consulted literature

A priori a search was performed about the items related to the intellectual and of Training of Human Resources production in CNPq (National Council of Scientific and Technologic Development) Curriculum Lattes from members of PEC/MPEG as also in databases of institutional and/or agreed Programs. Thus, 434 published articles about the north coast of Brazil (marine, coastal and estuary) were compiled, of Curriculum Lattes, of 37 researchers' members of (PEC/MPEG), in scientific journals, books and book's chapters and in scientific events reports, in the idioms: Portuguese, English, Spanish and French, in the period of 1997 to 2016.

The intellectual and training of human resources production of the PEC members were grouped by production type, concentration areas and activity sector in the time and in the space. The publications involve ecosystem functions and services and/or socioeconomic and cultural benefits.

However, items as: executed projects, maps, CD-ROM, research reports, events held and others, that were not analyzed here, can also, highlight the PEC actions to the north coast of Brazil development giving fundamental bases to the environmental diagnostic, public politics proposes, conservation, sustainable use and management of the Amazonian seaboard. For the discussion available publications in the subject's literature were consulted.

2.2 Selection criteria

To de intellectual and of training of human resources production obtained from the 37 Curriculum Lattes of the PEC/MPEG members, available at the CNPq Plataforma Lattes were selected: scientific articles, books, book's chapters, full articles and abstracts in scientific events reports, articles of popularization of the science, databases of the institutional training Programs (PIBIC/CNPq/MPEG - Scientific Research Scholarship Program e PCI - Institutional Training Program) and of Zoology Postgraduate Programs (PPGZool) UFPA/MPEG, Biological Sciences – Tropical Botanic (PPGBot) MPEG/UFPA, Environmental Sciences UFPA/MPEG/EMBRAPA (PPGCA) and of Social Sciences and Anthropology (PPGCSA) UFPA/MPEG that were created and implemented during the evaluated period.

2.3 Collected data

The collected data were organized by the following way: 1) Production type (scientific article, books, book's chapters, articles in events reports (full and abstracts), articles of popularization of the science and by education level (PhD, Master, Specialization and Undergraduate); 2) Knowledge areas of PEC actuation: a) Biological, Health and Agricultural Sciences (CBSA); b) Earth Exact Sciences and Engineering (CTE); c) Human and Social Sciences (CHS); d) Interdisciplinary (Environmental Education, others); 3) Sectors of Institution Activities – Coordinations: Botanic (CBO), Earth Sciences and Ecology (CCTE), Human Sciences (CCH), Zoology (CZO) and Communication and Extension (CCE); 4) Degree per level of training of human resources: PhD – D, Master – M, Specialization and Undergraduate (Scientific Research and Thesis (TCC – undergraduate conclusion issue), involving the Institutional Programs: a) the postgraduate – Zoology (PPGZool), Tropical Botanic (PPGBot), Environmental Sciences (PPGCA) and, Social Sciences and Anthropology (PPGCSA); b) others – PCI (post-doctoral and others and PIBIC (Scientific Research Scholarship Program).

2.4 Conceptual structure of the data

To adjust the performance indicators of the PEC, the production were organized using the following disposition: a) Ordination of the intellectual production informations in the knowledge areas established by the National Council of Scientific and Technologic Development (CNPq) from Brazil, followed by the ordination by research activities sectors of the institution in the period between 1997 to 2016, using as an indicator the CAPES - Qualis (A (1, 2), B (1, 2, 3, 4 e 5), C and SC (without classification). This production also was grouped in authorship and co-authorship and by collaboration type (departmental, institutional and interinstitutional); b) Organization per training of human resources level, knowledge areas and activity sector in the Institution in the period (1997 a 2015). The main reason for this information bank was to show the actuation indicators in perspectives, objectives and multiple scales of the PEC contribution for the development of the Amazonian coast.

2.5 Data analysis.

The data were compiled and analyzed in EXCELL spreadsheets version 10.0, producing dynamic tables and graphics.

III. RESULTS AND DISCUSSION

The intellectual contribution and the training of human resources of the PEC/MPEG approach ecosystem

services, social and sociocultural giving basic information's to some coastal areas as also reflects the availability of resources and people available to actuate at the Amazonian coast.

3.1 Contribution of the Coastal Studies Program (PEC) from the Museu Paraense Emílio Goeldi (MPEG) to the development of the North Coast of Brazil.

3.1.1 Intellectual contribution

3.1.2 Diffusion and Popularization of Science

3.1.3 Training of Human Resources.

3.1.1 Intellectual contribution.

The intellectual contribution of 37 researchers of the Coastal Studies Program (PEC) from the Museu Paraense Emílio Goeldi (MPEG), during 19 years of existence, was of 434 publications: 50 articles into congress reports, 84 abstracts in congresses, 165 articles in indexed scientific journals, 94 book's chapters, 23 books and 18 articles of popularization of the science, focused accord to the demands, opportunities and people availability. It is important to emphasize that more 30% of these researchers have less than five years actuating in the PEC. Besides, this contribution seems simple in quantitative terms, but it is very relevant qualitatively to subsidize important studies of environmental impact and proposes of use, management and conservation for the development of north coast of Brazil (Fig. 1).

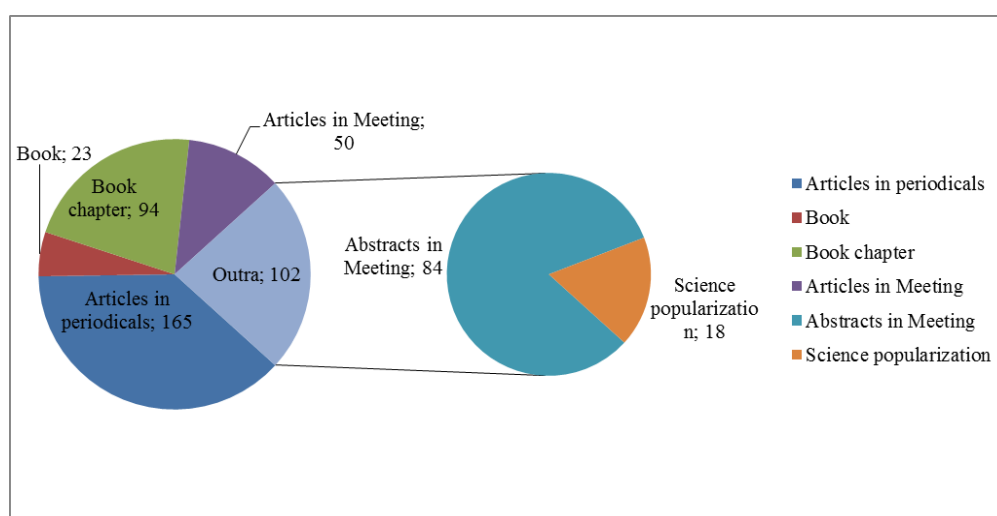


Fig. 1: Coastal Studies Program of Museu Paraense Emílio Goeldi (PEC/MPEG) contribution to the development of the North Coast of Brazil, 1997-2016

As one of the structuring programs from the Museu Goeldi (MPEG), the Coastal Studies Program (PEC), since its creation, has been engaged to develop multidisciplinary activities involving the participation of different knowledge areas, showing in small, medium and big scale the expertise of its members, to understand better the Amazonian coastal environments. On the other hand, the scarcity of human and financial resources has been provided to the program considerable fluctuations in its academic-scientific production along its existence. These factors lead to a reflection about the limitations and possibilities that affected the performance of the program.

3.1.1.1 Production per knowledge area

During 19 years, the PEC produced 434 technic-scientific articles with more emphasis in the Biological, Health and Agricultural Sciences Area (230 articles),

followed by the Earth Sciences and Engineering (98 articles) and by the Human and Social Sciences (76 articles). From this production (434 articles), 165 (38,02%) were published in scientific journal, 23 (5,3%) in books, 94 (21,66%) in book's chapters, 50 (11,53%) in congresses reports, 84 (19,35%) in abstracts in congresses and 18 (4,15%) in journals of popularization of the science. According to Café & Bräscher (2008), Silva (2013) and Freitas (2017) to measure the scientific knowledge production one should use measures that show clearly the individual production, of groups or institutions. Thus, complying with the Lotka Law, the scientific production of the program is related to the number and time of researchers' actuation in the program. When evaluated in the knowledge areas, the highest production occurred in the Biological, Health and Agricultural Sciences area (53%), followed by 22,5% in

the Natural Sciences areas and of 17,5% in the social areas. The highest scientific production in the area of the Life Sciences is related to the number of researchers (20) and their highest actuation from the year 2000 in institutional and interinstitutional Postgraduate Programs. The lowest intellectual production observed in the areas of Human and Environmental Sciences is related to the lowest researchers' number in these areas (17). Our data corroborate the data of Matos & Job (2008) related to the highest brazilian scientific production produced in the

Biological, Health and Agricultural Sciences area and, the data of Freitas (2017) who analyzed the methodological dimensions and different metrics of the Bibliometry in many fields of the brazilian scientific production.

It is observed that only 30 (6,91%) articles were classified as interdisciplinary, this did not reflect the multidisciplinary, odd activities, developed by the PEC researchers. the publications need to answer the disciplinary requirements of the majority of the current scientific journals (Fig. 2).

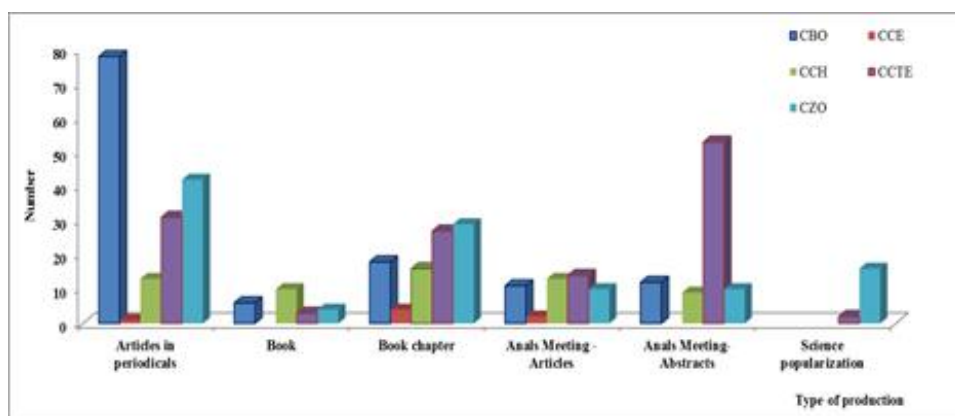


Fig. 2. Technical scientific production of the Coastal Studies Program at Museu Paraense Emílio Goeldi (PEC/MPEG) per sector of activity (CBO - Botanic Coordination, CCE - Communication and Extension Coordination, CCH - Human and Social Sciences Coordination, CCTE - Earth Sciences and Ecology Coordination, CZO - Zoology Coordination), 1997-2016.

On the other hand, we know that the availability of financial resources to the research has been decreasing, substantially, in the last twenty years and, what justifies the decrease of the activities and of the intellectual production, although, the encouragement of publications in partnership has favored the maintenance of many productions. These results corroborate the data of Borges et al., (2016).

3.1.1.2 Production per sector of activity

The highest intellectual production per sector of activity occurred at the Earth Sciences and Ecology Coordination – CCTE (130 articles) followed by the Botanic Coordination – CBO (125 articles), by the Zoology Coordination – CZO (111 articles) and by the Human Sciences Coordination – CCH (51 articles) and by the Communication and Extension Coordination – CCE (7 articles). This production is related to the time and the number of the members actuating in these sectors.

Table 1 - Intellectual production of the coastal studies program at Museu Paraense Emílio Goeldi (PEC/MPEG) per knowledge areas (CBSA - Biological, Health and Agricultural Sciences, CTE - Earth Sciences and Engineering, CHS - Social and Human Sciences, INTERD – Interdisciplinary sciences, 1997-2016.

Type of production/sector	CBO	CCE	CCH	CCTE	CZO	Total
Articles in periodicals	78	1	13	31	42	165
Book	6	0	10	3	4	23
Book chapter	18	4	16	27	29	94
Anals Meeting- Articles	11	2	13	14	10	50
Anals Meeting - Abstracts	12	0	9	53	10	84
Science popularization	0	0	0	2	16	18
Total Geral	125	7	61	130	111	434

Many factors contributed to the PEC intellectual production, for example: the availability of financial resources, the number and the actuation time of the researchers in the program. In addition, there were changes of mentality at the academy since the start of this century and, the highest requirement by the development agencies and by the institution to actuating in the training of human resources, in multidisciplinary projects and in partnerships. When we evaluate per activity sector was verified that the Zoology Coordination (CZO) concentrates the highest number of members (10), followed by the Botanic Coordination (CBO- 9) and with seven at the Human Sciences Coordinations (CCH) and Earth Sciences (CCTE). However, the Botanic Coordination commands the number of scientific publications (78) because of the greatest performance of the researchers, since 2004, in Postgraduate Programs. On the other hand, the 42 articles published by the CZO members, are due to the shorter time of performance of these researchers in the PEC.

It was observed that the shorter number of the CCTE and of the CCH members in the program, even actuating since the creation, the production is highlighted in Books and Books chapters' publications. A similar panorama has been showed, in many knowledge areas in

Brazil reflecting the changes and trends of the Brazilian science and academy (Mugnaini, et al., 2004).

3.1.1.3 Temporal production

In the implementation period (1997-2001) of the PEC, the 22 active researchers were responsible for 70 publications (18 articles in scientific journals, 2 books, 13 books chapters, 17 full articles in scientific event reports and 10 expanded abstracts corresponding to 15,13% of the PEC production during the evaluated period.

The shorter production occurred in 1997 with six issues and the highest were in 2007 with (31 articles), 2013 (38 articles), 2014 (35 articles) and 2015 (39 articles). This reflects the availability of financial resources, the inclusion of researchers in postgraduate programs and the change in the national and international politics. It is important to highlight that from 2004 the institution incorporated the academic activities in the annual evaluation of the servants (researchers) that, started to act in many Postgraduate Programs in agreement with local teaching institutions. This activity reflected significantly in the academic-scientific production of the institution and the demands of available financing for the research (Table 2).

Table 2 - Temporal distribution by type of intellectual production of the Coastal Studies Program at Museu Paraense Emílio Goeldi (PEC/MPEG), 1997-2016. APCI- Articles in indexed journals, B- Book. BC- Book's chapter. AAM- articles in Reports of Events, AEM- Expanded abstracts in Meeting, SP- Science dissemination.

Year	APCI	B	BC	AAM	AEM	SP	Total
1997	2	0	1	1	2	0	6
1998	3	0	1	0	0	0	4
1999	3	0	1	0	3	0	7
2000	2	0	0	3	9	0	14
2001	8	2	10	6	3	0	29
2002	4	4	3	3	8	0	22
2003	3	0	3	7	2	0	15
2004	3	2	3	7	2	0	17
2005	10	0	6	11	0	0	27
2006	9	0	5	4	2	0	20
2007	6	1	3	16	5	0	31
2008	5	1	9	2	2	0	19
2009	9	3	10	4	0	0	26
2010	7	2	7	4	1	0	21
2011	10	2	12	0	2	0	26
2012	8	1	2	2	3	0	16
2013	22	0	8	5	3	0	38
2014	18	4	7	5	1	0	35
2015	20	1	3	4	2	9	39
2016	13	0	0	0	0	9	22
Sum	165	23	94	84	50	18	434

The increase of the knowledge production in 2006 (31 articles), should be a reflection of the quantity of the

program members actuating in institutional or not postgraduate programs and, also, of the institutional

changes in relation to the researchers activities from 2004 (Relatório de Gestão MPEG, 2006). The results of the search in the Curriculum Lattes of the PEC researchers not only identify but map the evolution and trends of the program showing the growth of their contribution at the Brazilian north coast. Similar studies in other knowledge areas were carried out by Raghiani et al., (2006), Reveles & Takahashi (2007), Ravelli et al., (2009), Pinheiro et al., (2012) and Urbizagsastegui, & Arango (2017).

When we evaluate the intellectual production in the timeline of the PEC/MPEG (19 years) it was observed fluctuations that are shorter in the implementation period (1997 to 2000). The increase of the production in 2001 and 2011, can be justified by the actuation of the members in long term multidisciplinary projects and by the participation in postgraduate programs. On the other hand, the significant addition in the last five years, follows the world trend of the academy, even most of this production is abstracts published in scientific events. These results corroborate those found by Maia et al., (2015) that although approach different subjects, keep up with the current trend of the research in Brazil.

It is worth mentioning that the lack of financial resources for the research, has not been significantly about the knowledge generation and training of potential young people (Relatório de Gestão do MPEG, 2015). This demonstrates that the researchers have been engaged to find resources in different sources, national and international, either through notices or in person.

3.1.1.4 Performance indicator

The indicators used to measure the institutional performance of the scientific production as: a) Publication Index (PI) – corresponds to the number of published articles in scientific journals classified as A and B1 and, b) Publication General Index (GPI) – correspond to the sum of the published articles with the International Standard Serial Number (ISSN) and indexed into

Publication General Indexes (GPI) or other database that were not tested (Relatório de Gestão do MPEG 2009). On the other hand, published articles in national and international scientific journals, books, books chapters, full articles published in national and international journals or national and international congresses were evaluated using the classification QUALIS-CAPES (a,b,c and without classification (SC). Other factor measured were the partnerships (authorship and co-authorship) in the publications.

The publications were grouped in the three PEC actuation areas: Biodiversity, Environmental Sciences and Interdisciplinary accord to the classification of CAPES - Qualis, 2016, considering that the criteria of classification of this indicator are different between the different knowledge areas. It is important to mention that due to the unavailability of the Evaluations and to their respective criteria to the production of books, books chapters, articles, expanded abstracts into scientific events reports and articles of science dissemination (popularization of the science) they were computed as Without Classification (SC), and that they consist in more than 67% of all production in the evaluated knowledge areas. The results to the evaluated areas were: a) Environmental Sciences, 13 A [A1=1, A2=12]; 98 B [B1=35, B2=46, B3=7, B4=6, B5=4] and 323 SC; b) Biodiversity, 7 A [A1=5, A2=2]; 55 B [B1=11, B2=22, B3=10, B4=2, B5=10]; 75 C and 297 SC and, c) Interdisciplinary, 2A [A1=1, A2=1]; 108 B [B1=4, B2=22, B3=55, B4=20, B5=7]; 1 C and 323 SC. Was indicated a shorter production to meet the current evaluation criteria of the Postgraduate Programs in Brazil since only about 10, 20 and 3.6% of the scientific production reached the classification criteria to the mentioned areas. Besides, about 50% of the 117 publications in books and books chapters and of the 134 in scientific events reports mirror the interdisciplinary character of the PEC strengthening the condition of the structuring Institutional Research Program (Table 3).

Table 3 - Performance Indicator based on CAPES-Qualis (Coordination of Improvement of Higher Education Personnel) classification 2016 for the Biodiversity, Environmental Sciences and Interdisciplinary knowledge areas.

Qualis-Capes	Biodiversity	Environmental	Interdisciplinary
A1	5	1	1
A2	2	12	1
B1	11	35	4
B2	22	46	22
B3	10	7	55
B4	2	6	20
B5	10	4	7
C	75		1
SC	297	323	323

Accord to Pinheiro et al (2012) the use of qualitative and quantitative techniques or the combination of both is fundamental to produce indicators that show the state of art of the scientific production of the mentioned studies.

It was observed that the intellectual production of the PEC demonstrates strong interinstitutional partnerships in articles in indexed journals (93), scientific events reports (58) and dissemination of Scientific Popularization (4). Besides, of the 165 PEC publications

in interdepartmental collaboration (58 - 35,15%), intra-institutional (10-15,38%) and interinstitutional (93 - 56,37%) reflect the strong collaborative capability of the program (Table 4) that, reflects the strong capability of the program to overcome the scientific dichotomies between the natural and social sciences. Similar results using epistemological logical-historic analysis and other metrics to other knowledge areas were found by Oliveira & Gracio (2008) and Gamboa & Gamboa (2014).

Table 4 - Index of the intellectual collaborations by type of publications of the Coastal Studies Program at Museu Paraense Emílio Goeldi (PEC/MPEG, 1997-2016).

Type of production/Colaboratio	INTRADE	INTRAINST	INTERINST
Articles in periodicals	60	10	95
Book	12	1	9
Book chapter	39	14	41
Anals Meeting- Articles	22	5	23
Anals Meeting - Abstracts	36	18	30
Science popularization	15	0	3
SUM	184	48	202

Legend: Intra-departmental – INTRADEP; Intra-institutional – INTERINST; Interinstitutional – INTERINST.

Similar percentage occurred with other type of publication evaluating different metrics (Oliveira, Gracio, 2008) that show the influence of the government politics (Nobrega & Fonseca, 2010). It is observed that the highest collaborations were inside the sectors and between institutions (they occurs at the coordinations and between institutions) although, there is a simple growth of the intra-institutional partnerships that can be due to the demands of the development notices. This fact is similar to those found by Urbizagsastegui (2016) who evaluated the metrics in the brazilian literature.

Thus, is believed that the intensification of partnerships maximize the potential of the scientific production (Balancieri et al., 2005; Urbizagsastegui, 2016) and enlarge the dimensions of the programs in all aspects, fact that corroborate the propositions of Silva (2013) to the health area. Besides, the PEC/MPEG researchers showed that partnerships (between institutional, intra-departmental, intra-institutional and interinstitutional) are important factors to improve the program performance.

3.1.2 Diffusion and science popularization

The PEC/MPEG since its foundation in 1997 has been worried to divulge the results of the researches to the local society. This activity is very evident in the RENAS

Project actions (*Natural Resources and Social Anthropology* Project) – one of the lines of this program that, gives back to the community all researches accomplished since its beginning in 1967 and, that contributed with 18% of all the institutional production in the period of 2000 to 2004 (Moraes, 2010). This type of action has been practiced in the majority of the projects developed with the seal of the PEC, where the interdisciplinarity and the intra and interinstitutional interaction, have been constant, since its creation. Therefore, the structuring capability of this program comes from the actions developed by it since its idealization, in 1996. The development of multidisciplinary activities, not only strengthen the structuring characteristic of the program but also answer the communities demands, clarifying, instructing, enlarging and enabling the development of actions that come to improve their welfare and, consequently the life quality.

These activities are one of the biggest concerns of the United Nations Organization (UNU) and of the 2030 Agenda of the Paris treaty for the development of the globe. Between the multidisciplinary activities developed by PEC are highlighted: a) the publication of the book *Amazônia, costeira: termos técnicos e populares* and organized by Lins et al., (2014), unprecedented book

that approaches beliefs, myths and language of the Amazonian coastal people and, that had the participation of all the program members and, b) the execution of the project “*Valoração econômica de uso direto e indireto dos manguezais no município de São Caetano de Odivelas*” where there was commitment of members of all the PEC sectors to appreciate the mangroves of the São Miguel island, in the city of São Caetano de Odivelas. In that action, there was the recognition of the cultural and social value of the community that, also was guided to know other aspects of the mangrove and, thus to contribute with the team to appreciate this important natural environment (mangrove). Other social action involving the same project was developed as activity of the Museu Portas Abertas Project at the Museu Goeldi Research Campus, in 2016. The participants of all knowledge areas of the Project (Biology – Restinga and medicinal plants, birds and ants) and Social Anthropology (RENAS Project), introduced the results of the research in an integrate way for the visitant public.

Thus, the PEC/MPEG develops research and diffusion actions (with the highest number of publications

in journals and divulgation magazines) answering its mission to contribute for the environmental, biological, sociocultural and economic development of the Amazonian coast, utilizing recent stimuli of the research developers and of the public power to that.

3.1.3 Contribution in the training of human resources

The coastal areas were and remain one of the fundamental accesses to the continental areas of the globe. This area has a variety of peculiar ecosystems, in many cases little known and that find themselves under natural and anthropic pressure. Thus, the Coastal Studies Program from the Museu Paraense Emílio Goeldi (PEC/MPEG), since its creation, in 1997, contributes to the Training of qualified Human Resources with focus in coastal areas, aiming to enlarge the knowledge about the brazilian north coast. In this context, were qualified through the PEC/MPEG, in the period between 1997 – 2015 (18 years), 427 young people: 13 in PhD level, 104 in Master level, seven in Specialization level and 303 in Scientific Research level (PIBIC= 233 and TCC= 69) (Fig. 3).

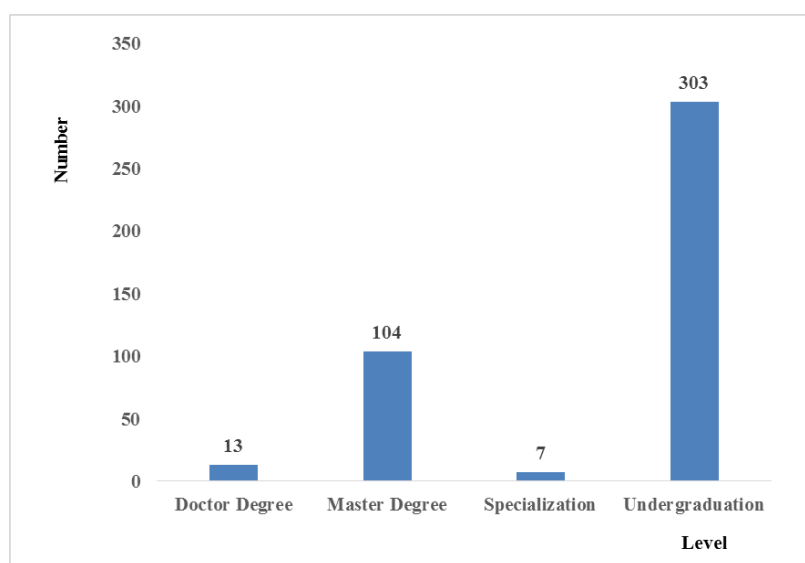


Fig. 3 - Contribution of human resources training per level of the Coastal Studies Program at Museu Paraense Emílio Goeldi (PEC/MPEG), 1997-2015.

3.1.3.1 Education by knowledge areas and sectors (coordinations) of activities.

The contribution to the training of human resources is distributed in the following knowledge areas: Biological, Health and Agricultural Sciences with 49,41% (211 degrees: 7 doctorates, 71 masters, 4 specializations, 129 scientific researches (98 PIBICs and 31 TCCs));

Earth Sciences and Engineering with 29,98% (128 degrees: 3 doctorates, 18 masters, 3 specializations and 105 scientific researches (74 PIBICs and 31 TCCs) and Human and Social Sciences with 23,19% (99 degrees: 3 doctorates, 15 masters, 1 specialization, 80 scientific researches (72 PIBICs and 8 TCCs) (Table 5).

Table 5. Number of training people per level of training and sector of activity by Coastal Studies Program at Museu Paraense Emílio Goeldi (1997-2015). CBSA- Biological sciences, Health and Agrarian, CTE- Earth Sciences and Engineering, CHS- Human and Social Sciences, INTERD - Interdisciplinary, 1997-2016.

Level of training	CBSA	CHS	CTE	Total
Doctor Degree	7	3	3	13
Master Degree	71	15	18	104
Specialization	4	1	2	7
Graduation	128	81	105	303
SUM	128	100	128	427

This action answer not only the program's mission as also the assumption that the education should be eclectic and when it is possible, attached to the scientific knowledge (Freire, 1996). The contributions of the PEC members per activity sector were: Botanic Coordination – CBO (128 training/8 researchers), Earth

Sciences Coordination – CCTE (128 training/7 researchers), Human and Social Sciences Coordination – CCH (98 training/10 researchers) and Zoology Coordination – CZO (82 training/9 researchers) (Tables 6 and 7).

Table 6 - Number of Training per level and per Sector of activity of the Coastal Studies Program at Museu Paraense Emílio Goeldi for the north coast of Brazil CBO- Botanic Coordination, CCE - Communication and Extension Coordination, CCH- Human Sciences Coordination, CCTE- Earth Sciences and Ecology Coordination, CZO- Zoology Coordination (1997-2016).

Level of training	CBO	CCE	CCH	CCPG	CCTE	CZO	Total
Doctor Degree	3		3		3	4	13
Master Degree	60	1	14		18	11	104
Specialization	2		1		2	2	7
Graduation	63		80	1	105	65	303
SUM	128	1	98	1	128	82	427

The biggest difference in the training of human resources per research sectors due to, mainly to the time of actuation of the PEC members, in their participation in postgraduate programs, in Institutional Programs: of Scientific Research and of Institutional Training, in interdisciplinary projects or not, of long, medium and short term. Therefore, the smallest participation of the CZO in this aspect due to the shortest time of actuation of the majority of the researchers in the PEC, while that, in other sectors, a big part of the researchers actuate in the PEC since its creation. Thus, the researchers have been contributed to the education and training in all the levels. Also, the scientific vision contributes in the learning process stimulating the creativity and enlarging the change of knowledge (Nascimento & Santiago, 2012), even the learning process depends of the theoretical and practical dimensions used (Abrantes & Martins, 2007).

3.1.3.2 Space-temporal training

It is observed that in the decade 1990 there was a shorter contribution than from the year 2000, in the

training of human resources, even very expressive in 1999 (26 training). However this action was intensified from 2003 with the participation of the researchers in postgraduate programs (Zoology and Botanic) and in institutional in force scientific research programs since 1996. The greater training of masters since 2007 and of doctors from 2009, is related to the institutional performance evaluation politic that stimulates a greatest actuation of the researchers in the interdisciplinary intra and interinstitutional projects and that favored the implantation of other postgraduate programs in the institution from 2004 with the creation of the Biological Sciences Programs – Tropical Botanic, Environmental Sciences and Human and Social Sciences with emphasis in Anthropology agreed with teaching and research local institutions Federal University of Amazon (UFRA), Federal University of Pará (UFPA) and Farming Researches Enterprise (Oriental EMBRAPA – CPATU) (Table 7).

Table 7- Temporal distribution of the training of human resources per sector of activity of the Coastal Studies Program at Museu Paraense Emílio Goeldi (PEC/MPEG), 1997-2015.

Year	CBO	CCE	CCH	CCPG	CCTE	CZO	Total
1997	8		5		1	2	16
1998	2		8		2	2	14
1999	7		5		7	7	26
2000	2		4		2	6	14
2001	1		2		2	3	8
2002	2		1		5	5	13
2003	4		5		10	4	23
2004	5		1		8	7	21
2005			3		5	3	11
2006	4		3		8	2	17
2007	4		6		14	2	26
2008	13		3		11	3	30
2009	14		4		10	2	30
2010	8		5		7	6	26
2011	5		7		10	6	28
2012	9		4		4	2	19
2013	12	1	11	1	8	7	40
2014	16		8		7	3	34
2015	9		6		7	9	31
SUM	125	1	91	1	128	81	427

The temporal variation with the training of human resources by the PEC/MPEG researchers due to not only the availability of resources but also the change in the institutional politic from 2000 that is directly related to the academy demands, innovation and world technologies. These results corroborate with the ones found by Nobrega & Fonseca (2010) in a case study in the Social Service area.

It is important to emphasize that the program has been worried in the institutional academic education, involving, also community members where the researches are accomplished, actions that answer the program's mission.

Other important factor in this training is the investigative capability involving education, science and technology of the titled that differentiates them of the majority of the academy trainings that also was highlighted by Nascimento & Santiago (2012), as important aspects to be approached.

IV. CONCLUSION

The analysis of the found results of the intellectual production and of the Human Resources Training in the PEC timeline (1997 to 2016), highlighted the historical construction of the PEC Program of the MPEG. The intellectual (434 articles) and personnel training (427 degrees) contribution of the Coastal Studies Program from the Museu Paraense Emílio Goeldi, in the period of 19 years (1997-2016) even it seems quantitatively simple, it gives qualitative subsidies very important to base environmental impact studies and use, management and conservation proposals to the development of the north coast of Brazil.

The PEC contributes in the training of personnel since the undergraduate until the postgraduate studies, involving members of the studied communities. The results show the multidisciplinary characteristic as one of the structuring programs from Museu Goeldi, involving all institution sectors, producing and disseminating the scientific knowledge, pointing out gaps and advances that can subsidize the academic and community demands. Besides, it concerns about turn back the produced knowledges to the communities, accomplishing, thus, its mission.

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THE WASTE MANAGEMENT PLAN AND ITS EFFICACY IN AN OFFSHORE COMPANY

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Abstract— *The study of this paper was carried out in a company that serves several platforms of Petrobrás, in Macaé-RJ, Rio de Janeiro State, Brazil, where it has maritime chamber services, including food, cleaning, cleaning and general cleaning of the areas under the responsibility of the contractor, provision of bed linings, bath, cutlery, crockery, kitchen utensils in general and leisure items. The way to evaluate the effectiveness of the company studied was to observe compliance with the Waste Management Plan. It was found that workers had no evidence of training the less the sufficient knowledge about how to segregate the waste, and were unaware of the waste management program.*

Keywords— *Garbage, waste management plan, solid waste*

I. INTRODUCTION

In the last decades, the environment has suffered the consequences of the increasing increase of an increasingly consumer population of superfluous, and can be pointed out as one of the current factors that contributes to the generation of waste (BELTRAME, 2012).

Demographic data show that in 2010 the Brazilian population was of approximately 191 million inhabitants with an urbanization percentage of 84.4% (IBGE, 2010). Also, according to the National Solid Waste Plan and the Brazilian Institute of Geography and Statistics (IBGE), in 2008 approximately 183.000 tons of waste were produced in the country (IBGE, 2010). However, in 2005, federal spending on sanitation as a proportion of total federal spending was less than 0.5% (OPAS, 2008), and it is worth noting that only in the last two decades have been effectively the projects related to recycling and selective

collections of waste produced in our country (SILVA, 2007).

The approval of Law No. 12.305 / 10, which establishes the National Solid Waste Policy (PNRS), after long years of discussions in the National Congress marked the beginning of a strong institutional articulation involving the three federated entities - Union, States and Municipalities, the productive sector and civil society in the search for solutions to the serious problems caused by waste, which has compromised the quality of life of Brazilians.

In order for the PNRS guidelines to be followed, and the goals of the National Plan for Solid Waste achieved, there is still a need for sensitization and mobilization tools and methodologies capable of influencing the various segments of society, including professionals in the area and the population as a whole .

The Waste Management Program (WMP) is closely related to the National Plans for Climate Change , Water Resources , Basic Sanitation and Sustainable Production and Consumption. It presents concepts and proposals that reflect the interface between several sectors of the economy, reconciling economic growth and environmental preservation with sustainable development (BRAZIL, 2012).

This study aims to analyze an offshore company that operates in the Campos-RJ basin regarding its waste management plan in force in the year 2017 and show how it is prepared.

II. METHODOLOGY

The study of this work was carried out in a company that provides services to several platforms of Petrobrás, in Macaé-RJ, where it has maritime chamber services, including food, cleaning, cleaning and general cleaning of areas under contractor responsibility, availability bed linens, bath, cutlery, crockery, general kitchen utensils and leisure items. It also provides laundry services, preventive and corrective maintenance of industrial kitchen equipment, leisure, lodging and pantry. And, mainly, administrative support services, collection, handling and segregation of waste from the contractor's areas of responsibility, leasing of equipment, as well as others.

The methodological procedures were the exploratory research and qualitative research, which are: a) semi-structured interviews ; b) observation ; c) field diary and d) documentary record as the main techniques available, the present study concentrates on numerous questions to the development of the solid waste management program.

In this work the way we approach the data was described by qualitative research, in the approach that there is an interrelationship between the real world and the subject, that is, an inseparable link between the objective world and the subjectivity of the subject that can not be translated into numbers, only the interpretation of phenomena and the attribution of meanings are considered in this process, the same does not require the use of statistical methods and techniques.

The natural environment is the direct source for data collection and the researcher is the key instrument. The process and its significance are the main focus in this type of approach.

For Oliveira (2002, p. 117):

Research using the qualitative approach has the ability to describe the complexity of a particular hypothesis or problem, analyze the interaction of certain variables, understand and classify dynamic processes experienced by social groups, present contributions in the process of change, creation or formation of opinions of a certain group and to allow, in a greater degree of depth, the interpretation of the particularities of the behaviors or attitudes of the individuals.

The methodological procedure used to collect and analyze the data was research-action type, this in turn can be defined as a small-scale intervention in the real world and a very close examination of the effects of this intervention (THIOLLENT, 2004). We can also say that in our studies, action research is situational, because it is

concerned with the diagnosis of the problem in a specific context to try to solve it in that context.

III. RESULTS

The document included in the WMP of the company under study the management of waste, which includes measures of reduction, segregation, identification, packaging, final disposal, registration and control, in accordance with the current legislation as required in Article 138 of the Regulation of State Law No. 7.799, dated February 7, 2001, approved by State Decree No. 7.967, dated 06/05/2001.

It is the responsibility of the company in question to ensure that the Waste Management Plan (WMP) will be updated whenever there are operational changes that result in the occurrence of new waste or the elimination of new waste, and should have evaluation parameters aimed at its continuous improvement, trainings that can define indicators to measure their effectiveness and elaborate a plan of action to act and correct their nonconformity and with that to guarantee the effectiveness of the Plan of Management of Waste - WMP.

Minimization, Reuse and Recycling:

All processes are conducted in a way that minimizes waste generated, either through the substitution or rational use of inputs. Residues that can be reused or recycled are sent for these purposes, the rest are arranged as indicated in this procedure.

Segregation, Packaging and Identification of Waste:

Guidance on the type of container or identification for the packaging of waste in the company areas follows the following criterion: waste picker painted in characteristic colors and identification indicative of the type of waste.

Waste collectors are arranged in numbers and sizes to absorb the amount generated in each area, and are constructed of material suitable for the type of waste they are intended to collect.

According to the color codes recommended by CONAMA resolution 275 of 25/04/01 and adopted by the company and its facilities, the chart 1 below is as follows:

Blue	Paper / cardboard
Red	Plastic
Green	Glass
Yellow	Metal
Brown	Organic waste
Grey	General non-recyclable waste not subject to segregation

Chart 1: For waste identification
Source : CONAMA 275 de 25/04/01

It is known that the importance of WMP lies in the fact that segregation of infected and uninfected waste potentiates

the resolution of a portion of the problem of inadequate management by helping Environmental managers to make decisions and to keep their companies sustainable before society.

It was observed that workers had no evidence of training the less the sufficient knowledge about how to segregate the garbage, and they were unaware of the waste management program. Another fact that drew much attention was that the employees of the company at the time they were segregating garbage were not using the personal protective equipment needed for such activity. It was verified that the plastic is the residue of greater volume, as shown in figures 1.



Figure 1 - Waste collected on the platform (A) wastes not secreted (B) plastic.

Source: Company X

The main raw material for commercial plastics is Nafta, one of the fractions from the cracking of oil, which in turn is a non-renewable resource. Recycling or reuse of plastics should therefore be encouraged in order to delay the depletion of this source, as well as reduce the volume of waste, increase the life of landfills, and other important factors for the environmental management of waste.

Due to their low degradability, plastics remain in nature for long periods, causing visual and possibly chemical pollution of the environment. To reduce the impact of plastics on the environment, waste management becomes imperative and, in this way, the recycling strategy can be easily introduced. However, different allocation alternatives should be considered depending on the different properties of the plastic materials. Therefore, the products made with recycled plastic, for the most part, present questionable quality. Considering the low prices of virgin resin and the low acceptance of recycled material on the market, alternatives such as sorting post-consumer resins suitable for recycling and reducing processing costs (cleaning, transport, storage, etc.) could come to add value to the product and increase market acceptance.

The practice of competitive prices for recycled products still represents a major obstacle in this productive chain.

• Final Disposal of Waste

The waste generated in the base of the company is collected and transported by outsourced and legally qualified company, being followed until its final destination.

Through the manifests the entire process of garbage traceability is done.

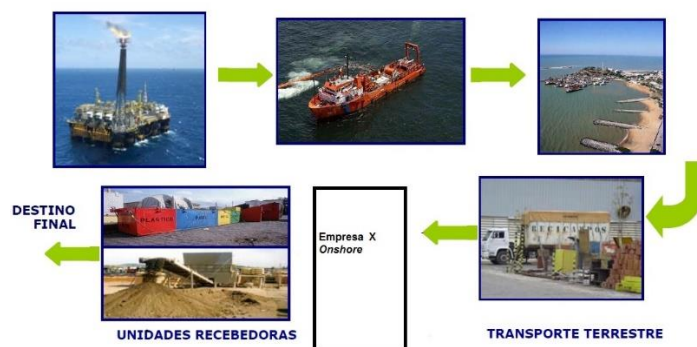


Figure 2: Flow chart referring to the movement of waste generated in marine oil production units up to the final disposal.

Source : Petrobrás

• Waste Manifest System

The manifest system is an instrument of control that allows the State Environmental Institute (INEA) to know and monitor the destination given by the generator, transporter and receiver to the waste.

The legislation establishes that all waste, other than domestic, from the garage facilities must be removed by issuing a waste manifest, duly completed and signed.

Therefore, the waste control system that, through the use of its own form, called WASTE OF MANIFEST, allows to know and control the form of destination given by the generator, transporter and receiver of waste.

Waste of Manifest - Numbered form to be used for the activities linked to the Manifest System, composed of 4 (four) ways, of the DZ (Guideline of INEA) 1310-R.7 - Waste Manifest System.

IV. CONCLUSION

In view of the objective of analyzing the Waste Management Plan of an offshore company - WMP for the adequate handling of the residues coming from onboard services, this study identified in the literature that actions such as the elaboration of a Waste Management Plan are very important. Its importance rests on the fact that the segregation of infected and uninfected waste potentiates the resolution of a portion of the problem of inadequate management, helping Environmental managers to make decisions and to keep their companies sustainable in society. It was found that workers had no evidence of training the less the sufficient knowledge about how to segregate the waste, and were unaware of the waste management program.

The WMP demonstrated a deficiency in having only qualitative evaluations, lacking goals, quantitative assessments and indexes so that the program could be more efficient.

Note the size of the importance, for the society as a whole, of the WMP through Decree 9177, which was signed on October 23, 2017 and regulates art. 33 of Law No. 12.305, which establishes the National Policy on Solid Waste, and complements art. 16 and 17 of Decree No. 7.404, of December 23, 2010 and provides other measures, such as: By the measure, even those outside the sectoral agreements will have to collect and give appropriate destination to the products after their useful life.

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Sequence Stratigraphic Analysis of the Mauddud Formation, Central Iraq

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Abstract— *The Mauddud Formation of central Iraq was deposited within different shallow and deep marine subenvironments on a distally steepened ramp setting. Local tectonism greatly affected the sequence development where the different rates of subsidence of the different tectonic provinces were the major control on the nature of 4th order cyclicity of the succession (thickness, symmetry, and facies stacking pattern). Subsidence analysis (R2 curves) revealed the effect of local tectonism, and the vertical and lateral variations in accommodation. The effect of the eustatic component was clear in the stable area to the West where there was no or very low rate of subsidence.*

Keywords— *Sequences stratigraphy, Mauddud Formation, Central Iraq.*

I. INTRODUCTION

The Mauddud Formation (Upper Albian-Lower Cenomanian) of Central Iraq was deposited on a shallow carbonate platform on the northeastern passive margin of the Arabian Plate. The studied area extends along the stable shelf and westward to the unstable shelf (Fig. 1). The Mauddud Formation was studied by many workers like Van Bellen et. al. (1959) and Jassimet. al. (1984), Al-Eisa (1997), and lately Al Yassery (2015), they among others studied the stratigraphy and paleontology of the formation but none of them dealt with the type of depositional setting and basin development in detail.

The lower boundary of the formation is conformable with the underlying Nahr Umr Formation, this boundary can be correlated with K110 MFS of Sharland et. al. (2001) Reflecting the widespread transgression of the Mauddud sea during the Late Albian. The upper boundary on the other hand is unconformable with the overlying spicular and Pelagic limestone of the Ahmadi Formation. Data from seven subsurface sections were analyzed and studied in detail where microfacies analysis of cores and cuttings provided the necessary information for facies analysis and pale environment interpretation, and this is the first step of determining the different parasequences and sequence stratigraphic subdivisions and consequently the final

interpretation of depositional setting, sequence development and, cyclicity of the succession.

The second reduction (R2 curve) of the cumulative subsidence curve was calculated by subtracting the best fit (calculated by least square method) from the backstripped curve (R1) in order to remove the accommodation space provided by tectonic subsidence, the net subsidence remaining reflect changes in accommodation generated solely by eustasy or local tectonism. R2 curve can be useful in intrabasinal correlation especially passive margin basins (Bond et. al. 1988).

II. PALEOENVIRONMENTS

On the basis of depositional texture, types of carbonate grains, and faunal content and diversity; several microfacies were recognized within the Mauddud succession in the studied sections. These microfacies can be grouped into five facies associations reflecting five major subenvironments.

Facies Association 1: Nonfossiliferous mudstones, bioclastic mudstones to wackestones. This association reflects a shallow restricted marine environment where the pure micrite represent depositon in quiet bays and ponds within the tidal flat whereas mudstones with few shell fragments and bioclastic wackestones with abundant molluscs fragments reflecte deposition in tidal flat to low energy shallow subtidal environment. The mudstones are often dolomitized.

Facies Association 2: Fossiliferous packstones to grainstones, ooidal peloidal Grainstones. Abundant and diverse fauna and numerous bioclasts as well as abundant ooids and peloid characterizes this association indicating a high energy environment where the shoal facies were deposited.

Facies Association 3: Mixed fauna wackestones to packstones, bioclastic wackestones to packstones. This association is typical of medium to high energy shallow

subtidal environment with open circulation where orbitolina, alveolina, pralveolina, nezzazata, and miliolids are abundant as well as echinoderm and shell fragments. Echinoderm fragments constitute the main component of the of the bioclastic wackestones and packstones of this association

Facies Association 4: Spicules wackestones, spicules bioclastic wackestones to Packstones. The association of fine bioclasts, disoriented sponge spicules, some echinoderm fragments, and few planktons may reflect deposition in deep outer ramp area where fine bioclasts and echinoderm fragments were driven downslope into this oligophotic (poor light) deep, non-wave agitated environment and mixed with sponge spicules and planktons.

Facies Association 5: Planktonic wackestones to packstones. The abundance of planktons as well as sponge spicules in this facies may indicate deposition in deep toe of slope to basinal environment.

III. DEPOSITIONAL SETTING

The depositional profile can be reconstructed from facies geometry, type of skeletal components and their dependence on the presence of light, as well as the amount of carbonate production. The Mauddud succession in the study area is characterized by a thick inner platform - thin marginal and outer platform facies, gradual lateral facies changes, and absence of distinct slope facies (Fig. 2) such characteristics are typical of ramp setting (Ahr, 1989, Flugel, 2010), higher carbonate production characterizes the inner ramp area where the predominantly euphotic zone was dominated with mollusks and small benthos gradually changes into deep oligophotic environments of the deep ramp and then deep basinal area eastward. The depositional profile seems to have changed from homoclinal ramp during the early stages of the Mauddud deposition into distally steepened ramp setting at later stages of sequence development.

IV. SEQUENCE DEVELOPMENT

Facies associations were related to systems tracts and attributes of key surfaces were defined in order to study the nature of cyclicity and sequence development of the Mauddud Formation of Central Iraq. The lower boundary of the succession with the underlying Nahr Umr Formation is represented by a transgressive surface (TS) where the sudden deepening reflects the major sea level rise at the Late Albian and the start of a new carbonate platform. Four 4th order cycles can be recognized (Fig.2), Cycle A is asymmetrical with a relatively thick transgressive systems tract (TST) and

thin highstand systems tract (HST) reflecting a short episode of stillstand after the initial sea level rise; It can be divided into two small subcycles in the west (Section at 7/7) in the west since the minor short term eustatic fluctuations are best represented in such a stable area with a very low rate of subsidence, this fluctuation is masked by higher rates of subsidence in the unstable towards the unstable shelf area where sections Fj-1, Eb-1, and Bd-1 lies. Cycle B is shorter, and the fluctuation between the transgressive open marine facies and highstand restricted marine facies is manifested basinward (Section at Bd-1) by basinal deep marine and open marine facies respectively (Fig. 2). This may show the beginning of higher rates of subsidence at the West where lower carbonate production due to flooding of the distal part of the ramp produced a thin basinal deep ramp facies succession. Cycles C & D are different, they reflect short episodes of sea level rises followed by long stillstands where thin transgressive deep marine facies are followed by thick progradational to aggradational shallow open marine highstand parasequences at Bd-1 in the East, and correlated in the west by shallow open and restricted marine facies respectively. Cycle D is incomplete and eroded completely in the West by the major sea withdrawal at the Early Cenomanian forming Type 1 sequence boundary (SB1) where the rate of sea level fall was greater than the rate of subsidence.

V. SUBSIDENCE ANALYSIS

After decompaction, backstripping, and removing the tectonic component of Subsidence, the remaining net subsidence reflects changes in accommodation generated by eustasy or local tectonism. The R2 curve (Fig. 3) is calculated by taking the difference between the backstripped curve and its best fit exponential. R2 curves reflects changes in accommodation through time as well as the directions of its minimum and maximum, it is useful in intrabasinal correlation showing the different degrees of eustatic effect due to local tectonism throughout different tectonic provinces. Analysis of R2 curves (Fig. 3) shows the effect of local tectonism on accommodation during deposition of cycle A in the unstable Mesopotamian Zone whereas decreasing rates of subsidence at section 7/7 allowed the reflection of the eustatic component in the West. Higher carbonate production within the inner ramp area produced a relatively thick succession in cycle B at sections Nf-1 & Fj-1, The lower rate of subsidence was concomitant with the sea level fall producing thick progradational to aggradation succession of restricted marine facies of cycle C. The trend of these curves shows an

eastward increase in accommodation, the lateral change in accommodation and the response of facies tracts to this change reflects the effect of local which differ by different locations within the stable shelf area and the Mesopotamian Zone of the unstable shelf area, also the vertical variations in R2 curves shows the effect on the nature of facies stacking pattern and cyclicity due to accommodation changes through time.

VI CONCLUSIONS

The Maaddud Formation of Central Iraq was deposited through different subenvironments within a homoclinal ramp during the first stage of platform development then changed into distally steepened ramp setting.

Four 4th order cycles were recognized, the nature of these cycles (thickness, symmetry, and facies stacking pattern) was affected by local tectonism at different tectonic provinces. Higher rates of subsidence to the East was manifested by deeper facies of cycle B and thicker successions of cycles C & D, The eustatic component was the main controlling factor on sequence development in the stable area to the West.

Calculation of R2 curves were useful in determining the vertical and lateral variations in accommodation due to eustasy or local tectonism. The trend of these curves shows an eastward increase in accommodation, This may reflect the effect of local tectonism, the vertical variations in R2 curves shows the effect on the nature of facies stacking pattern and sequence development due to accommodation changes through time.

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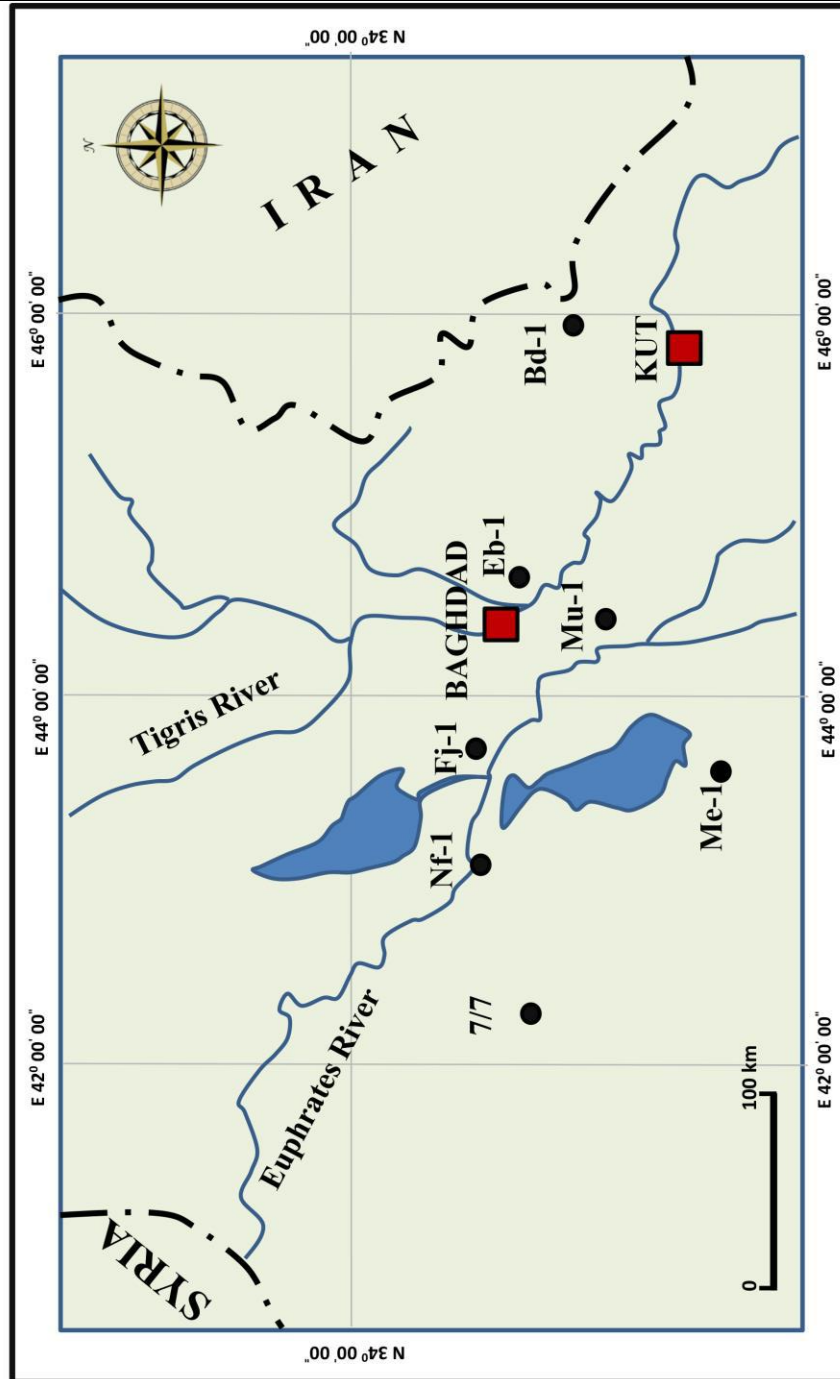


Fig.1: Location map of the study area.

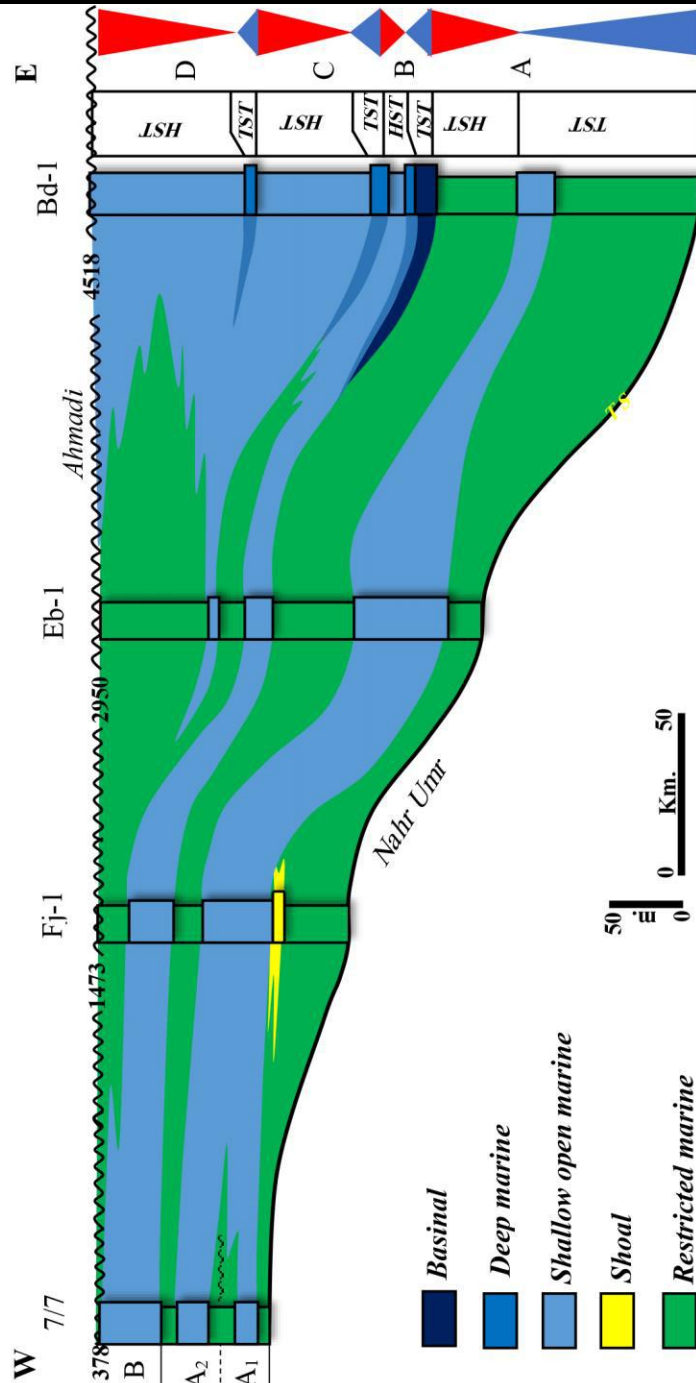


Fig.2: Stratigraphic cross section showing vertical and lateral facies changes and sequence stratigraphic subdivisions of the Maaddud Formation in the study area.

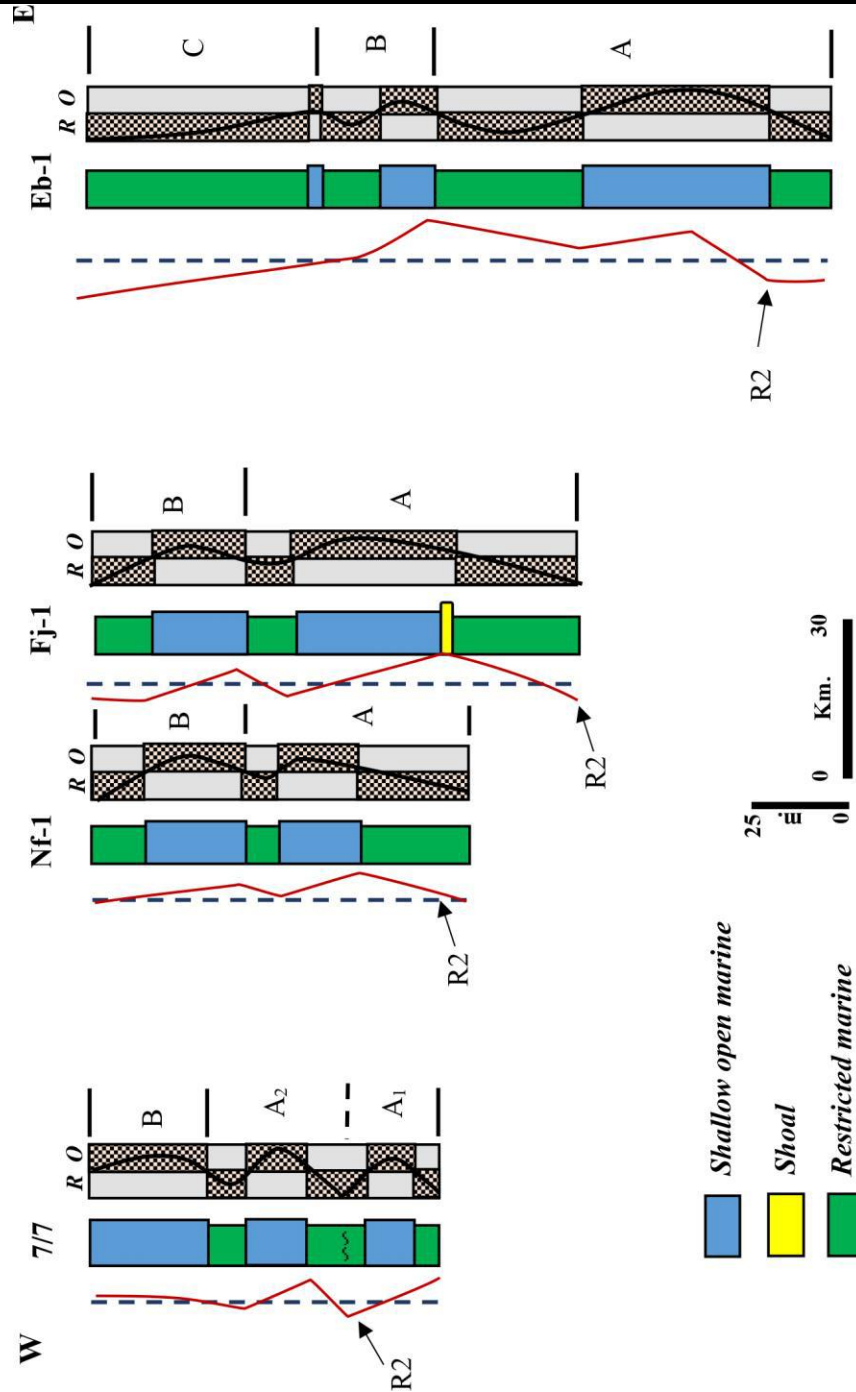


Fig.3: R2 curves of selected sections throughout different settings within the study Area.