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Modelling the Environmental Effects of Corrosion in a Tungsten Inert Gas Weld Joints Using Response Surface Methodology

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ABSTRACT

Corrosion of metal is an ubiquitous phenomenon that occurs in various forms. Atmospheric or uniform, galvanic, crevice, pitting, and microbial corrosion are most familiar forms of corrosion. The service life of engineering structures is affected by the quality and strength of the welded joints. The effects of corrosion affect the quality of the welded joints and the general structure. The offshore structures are exposed to the various environments, and it is well known that the corrosion rate and the corrosion mechanism under each environment affect the general structure. The aim of this study is to model the environmental effects of corrosion on tungsten inert gas weld joints of a mild steel pipe using response surface methodology.Mild steel pipe was cut into dimension 40mm in length, 12mm diameter and 3mm thick with a power hacksaw, grinded and cleaned before the welding process. The experimental matrix was made of twenty (20) runs, generated by the design expert 11.1.0.1 software adopting the central composite design. The response was measured, which is the rate of corrosion and then modelled using the response surface methodology.The result obtained in this study shows that the current has a very strong influence on the rate of corrosion. The minimum value of the rate of corrosion was observed to be 2.922mpy with a maximum value of 4.802mpy and standard deviation of 0.141.Based on the findings, it is summarized that the corrosion rate is minimum when a welding voltage of *V* = 18V, current = 120A and gas flow rate = 13lit/min.

Keywords**:** *Mild steel pipe; Response Surface Methodology; Rate of corrosion; Contour plot; Surface plot.*

I. INTRODUCTION

Carbon steel is the most widely used engineering material despite its relatively limited corrosion resistance. It is used in large tonnages in marine applications, nuclear power and fossil fuel power plants, transportation, chemical processing, petroleum production and refining, pipelines, mining, construction and metal-processing equipment. Carbon steel has been the popular choice of structural material as it is abundantly available, inexpensive and has adequate mechanical properties, but it has a high general corrosion rate.

Several studies have been done to investigate the effect of welding parameters on the corrosion behaviour of various metals. Rajakumaret al.[1] reported that all welding parameters have a significant effect on the corrosion rate of AA6061-T6 aluminum alloy. He mentioned that the corrosion rate was at its maximum when the tool rotational speed was at lower and higher levels, whereas the corrosion rate was found to be the minimum when the welding speed was at 80 mm/min. Prachya and Anucha[2] studied the effect of shielding gas parameter on mechanical properties and microstructures of heat-affected zone and fusion zone on gas tungsten arc welding (GTAW) in aluminium alloy AA

5083. Factorial experiment was designed for this research. The result showed that types of shielding gas and gas flow rate interaction hardness at heat affected zone and fusion zone with a P – value < .05. The factor which was the most effective to the hardness at heat affected zone and fusion zone was argon with a flow rate of 14 liters per minute at heat-affected zone with 74.27HV and fusion zone with 68.97HV. Experimental results showed that the argon condition provided smaller grain size, suitable size resulting in higher hardness both in weld metal and HAZ. They also indicated that the grain size and precipitation Mg affect the hardness of sample.Ramchandran[3] studied the various effect of the TIG welding on the Austenitic stainless steel 316L on micro structural changes through destructive and nondestructive method and various parameters such as tensile strength, hardness on varying the current, voltage and gas flow ratio respectively.Prawoto[4] evaluated the corrosion rates and pitting morphology of the selected duplex stainless steel and found that decreasing pH increases the corrosion rate. Similarly, increasing temperature increases corrosion rates this can be achieved well using different solutions with different temperature and periods of immersion. Oliver [5] investigated the relative exterior corrosion resistance of three alloys- two ferritic stainless steel (AISI Types 409 and 441) and an aluminized mild steel; concluded that the De-icingsalts have a clearly detrimental effect on corrosion resistance and stated that primary external corrosion mechanism causing failure at the cold end of the exhaust system in the presence of de-icing salts is pitting. The higher chromium type 441 alloy was far more resistant than type 409.

Corrosion is the deterioration of materials by chemical interaction with their environment. The term corrosion is sometimes also applied to the degradation of plastics, concrete and wood, but generally refers to metals. The most widely used metal is iron (usually as steel) and the following discussion is mainly related to its corrosion. Corrosion is the destructive result of electrochemical reaction between a metal or alloy and its surrounding environment. The metals are generally in high energy state because some energy is added during their manufacturing process from the ores. Low energy-state ores are more stable than the high energy-state metals. For this reason, the metals tend to release the energy and go back to their original form. Hence, the metals revert to their parent state or ore under a suitable corrosive environment. This conversion phenomenon is nothing but the corrosion. The electrochemical process involved in corrosion is by nature opposite to the extractive metallurgy involved in manufacturing of the metals. Therefore, corrosion is sometimes considered as the reverse process of extractive metallurgy.Rajakumaret al. [1] reported that all welding parameters have a significant effect on the corrosion rate of AA6061-T6 aluminium alloy. He mentioned that the corrosion rate was at its maximum when the tool rotational speed was at lower and higher levels, whereas the corrosion rate was found to be the minimum when the welding speed was at 80 mm/min.Sanga et al. [6] investigated the effects of welding energy on the mechanical, thermal and microstructural characteristics of the weld joint. The ultrasonic welding was performed on 0.36 mm thick phosphor bronze (UNS C51100) sheets. It was observed that the values of peak interface temperature and tensile-shear strength increase with the welding energy. The microstructural analysis carried out using scanning electron microscope (SEM) revealed that the joining line appears almost straight at low energy level but fades away at higher energy level. Other similar works includes that of [7-10].This study is therefore aimed at modeling the environmental effects of corrosion in a tungsten inert gas weld joints using Response Surface Methodology.

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II. MATERIALS AND METHOD

A. Materials

The material used in this study is mild steel pipe. Mild steel pipe was cut into dimension 40mm in length, 12mm diameter and 3mm thick with a power hacksaw, grinded and cleaned before the welding process. Two pieces of the mild steel pipes were welded together using the input process parameters contained in Tungsten Inert Gas welding machine. The input process parameters are current, voltage and gas flow rate.

B. Methods

Twenty (20) experimental runs comprises of eight (8) factorial points, six (6) center points and six (6) axial (star) points were carried out to dig out minimum rate of corrosion on tungsten inert gas weld joints of a mild steel pipe . Each experimental run comprises of the welding input parameters which are the welding current, voltage and gas flow rate.The rate of corrosion is the speed at which any given metal deteriorates in a specific environment. The rate or speed is dependent upon environmental conditions as well as the type and condition of the metal.In order to calculate the rate of corrosion, the following information were collected:

- Weight loss (the decrease of metal weight during the reference time period).
- Density (the density of the metal).
- Area (total initial surface area of the metal piece).
- Time (the length of the reference time period).

➢ Converting corrosion rate

- 1mpy = 0.0254 mm/y = 25.4 microm/y
  - 1mpy – 1 mils per year

➢ Calculate the corrosion rate from metal loss:

$$\frac{mm}{y} = 87.6X(\frac{W}{DAT})$$

W = weight loss in milligrams
D = metal density in g/cm3
A = area of sample in cm^2
T = time of exposure of the metal sample in hours.

➢ m/y = 0.0254mm/y

1) Experimental Design and Data Analysis

A Three-factor layout of Central Composite Design (CCD) in surface response methodology (RSM) was employed with replicates at the Centre point and star points. Input parameters such as welding current, voltage and gas flow rate are the variables used in this study with each at low (-1) and high (+1) coded levels.Table 1 show the CCD experimental conditions for the process parameters.

Table 1: The CCD Experimental Conditions for process parameters and their range

Factor	Units	Low Level (-1)	High Level (+1)
A – Current	Ampere	120	170
B – Voltage	Voltage	18	24
Gas Flow Rate	Lit/min	13	16

The above experimental analysis was carried out based on the response surface regression system to accommodate the second-order polynomial equation. The level of significance of the coefficients was less than 0.05. Statistical software package design-expert® (version 8.0.6; stat-ease, Inc., Minneapolis, USA) was used to determine the regression coefficient which help to predict the process response (rate of corrosion) as a function of the independent variables as well as their interaction that help the understanding of the system behavior.

III.RESULTS AND DISCUSSION

The rate of corrosion was determined and the results are presented in Table 2. The in-depth analysis involving the interaction of the process parameters (welding current, voltage and gas flow rate) was carried out. The Design-Expert (Stat-Ease, Inc., Minneapolis USA) software was employed for regression analysis and graphical analysis of the data obtained. The optimum values of the process parameters were gotten by solving the regression equation. This was also reached by analyzing the response surface and the contour plots. Table 2 show the design matrix for the real and the experimented values.

Table 2: Design matrix for Actual values and Experimental responses for CCD experimental combination of welding current, voltage and gas flow rate

Std	Block	Run	Space Type	Factor 1 A:Current I	Factor 2 B:Voltage V	Factor 3 C:Gas Flow Rate Lit/min	Response 1 Corrosion rate mpy
17	Block 1	1	Center	145	21	14.5	3.24829
2	Block 1	2	Center	145	21	14.5	3.24829
1	Block 1	3	Center	145	21	14.5	3.24966
14	Block 1	4	Center	145	21	14.5	3.24829
20	Block 1	5	Center	145	21	14.5	3.24966
16	Block 1	6	Center	145	21	14.5	3.24829
11	Block 1	7	Axial	145	15.95	14.5	3.07885
3	Block 1	8	Axial	145	26.05	14.5	4.5337
7	Block 1	9	Axial	102.96	21	14.5	3.06139
8	Block 1	10	Axial	187.04	21	14.5	3.57162
5	Block 1	11	Axial	145	21	11.96	3.82674
12	Block 1	12	Axial	145	21	17.02	4.33697
18	Block 1	13	Factorial	120	18	13	2.95048
9	Block 1	14	Factorial	120	24	13	4.17462
6	Block 1	15	Factorial	170	18	13	2.92224
13	Block 1	16	Factorial	170	24	13	4.7558
15	Block 1	17	Factorial	120	18	16	3.3397
19	Block 1	18	Factorial	120	24	16	3.3397
10	Block 1	19	Factorial	170	18	16	3.54843
4	Block 1	20	Factorial	170	24	16	4.80218

The model summary which shows the factors and their lowest and highest values including the standard deviation is presented in Table 3:

Table 3: Model summary showing highest and lowest values of factors

Name	Units	Type	Changes	Std. Dev.	Low	High
Current	I	Factor	Easy	0	120	170
Voltage	V	Factor	Easy	0	18	24
Gas Flow Rat	Lit/min	Factor	Easy	0	13	16
Corrosion rat	mpy	Response		0.141258	2.92224	4.80218

Result of Table 3 revealed that the model is of the quadratic type which requires the polynomial analysis order as depicted by a typical response surface design. The minimum value of the rate of corrosion was observed to be 2.92224mpy with a maximum value of 4.80218mpy and standard deviation of 0.141258. Table 4 depict the analysis of variance result table for the process parameters.

Table 4: Analysis of Variance Result for the process parameters

Response 1: Corrosion rate

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	6.70	9	0.7441	37.29	< 0.0001	significant
A-Current	0.6957	1	0.6957	34.86	0.0002	
B-Voltage	3.34	1	3.34	167.59	< 0.0001	
C-Gas Flow Rate	0.0898	1	0.0898	4.50	0.0599	
AB	0.4339	1	0.4339	21.75	0.0009	
AC	0.1563	1	0.1563	7.83	0.0188	
BC	0.4068	1	0.4068	20.39	0.0011	
A^2	0.0041	1	0.0041	0.2055	0.6600	
B^2	0.5200	1	0.5200	26.06	0.0005	
C^2	1.19	1	1.19	59.48	< 0.0001	
Residual	0.1995	10	0.0200			
Lack of Fit	0.1995	5	0.0399	79733.41	< 0.0001	significant
Pure Error	2.503E-06	5	5.005E-07			
Cor Total	6.90	19				

The F-value of 37.29 obtained in Table 4 implies the model is significant which indicate that there is only a 0.01% chance that an F-value this large could occur due to noise. The P-values that is less than 0.0500 indicate model terms are significant. In this case A, B, AB, AC, BC, B^2, C^2 are significant model terms. Values greater than 0.1000 indicate the model terms are not significant. If there are many insignificant model terms (not counting those required to support hierarchy), model reduction may improve the model. The Lack of Fit F-value of 79733.41 suggests the Lack of Fit is significant. There is only a 0.01% chance that a Lack of Fit F-value this large could occur due to noise. Table 5 depict Fit statistics for the process

Table 5: Fit statistics

Std. Dev.	0.1413		**R^2**	0.9711
Mean	3.59		**Adjusted R^2**	0.9450
C.V. %	3.94		**Predicted R^2**	0.7686
			Adeq Precision	19.0828

The Predicted R^2 of 0.7686 is in reasonable agreement with the Adjusted R^2 of 0.9450; i.e. the difference is less than 0.2. Adeq Precision measures the signal to noise ratio. A ratio greater than 4 is desirable. The ratio of 19.083 indicates an adequate signal. This model can be used to navigate the design space.The coefficient of determination R^2 for the tungsten inert gas weld joints was obtained to be 0.9711. The result point to the model been effective in describing 97. 11% of variation in the original data. The value of 0.9450 was obtained for the respective adjusted R^2. The R^2_{pre} value gotten through cross-validation advocated that the model is capable of explaining about 77% variation in predicting novel observations. Fig. 1 (a-c) shows residuals based on the empirical model developed for the input variables (current, voltage and gas flow rate). To fully understand the relationship between the variables studied, the response surface curves was plotted as it also helped us to evaluate the optimum level of the input variables for maximum response.

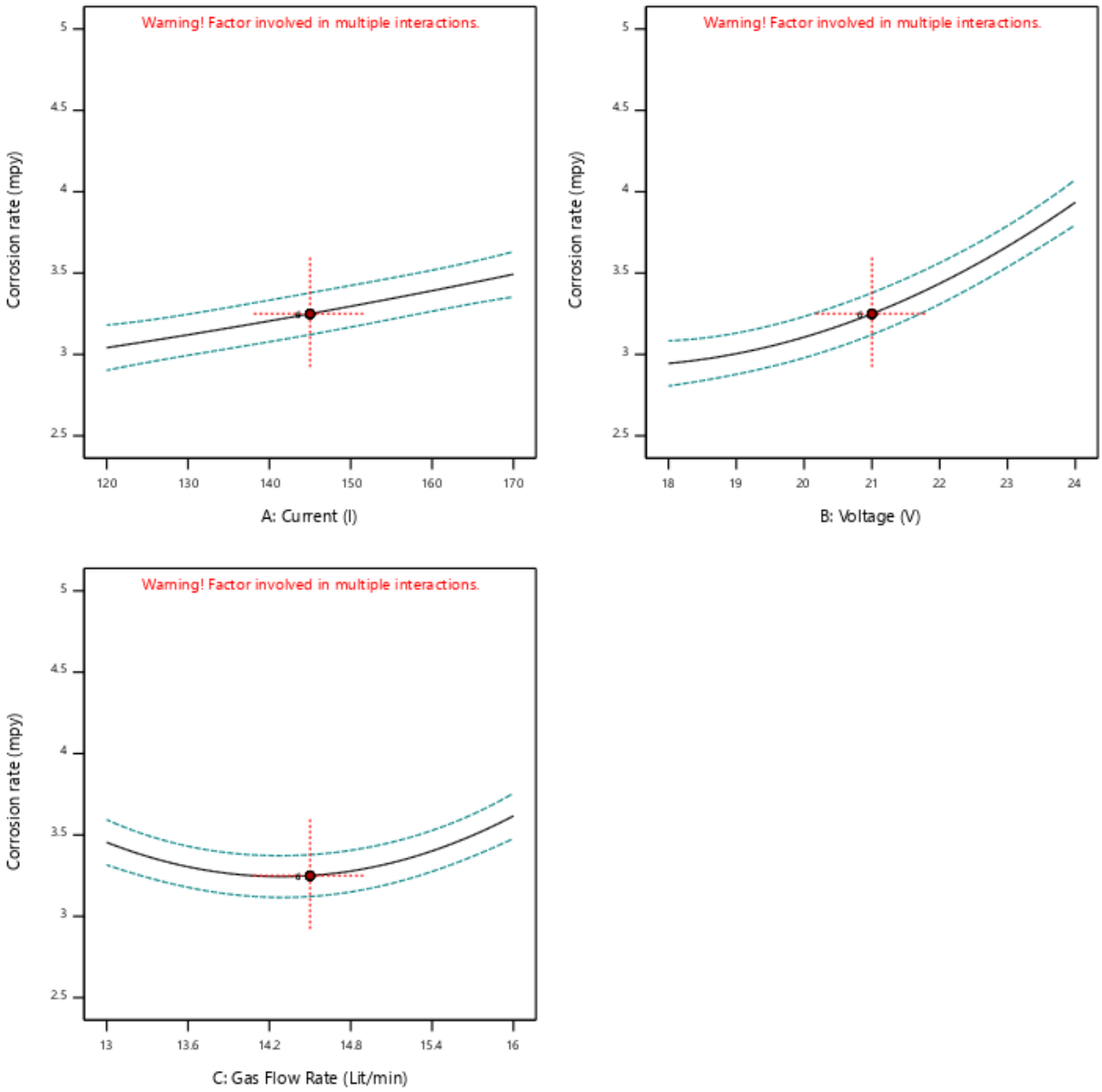

Fig. 1(a-c): ResidualPlots

Fig. 2 is a two-dimensional (2D) representation of the response plotted against combinations of numeric factors and/or mixture components. It shows the relationship between the responses, mixture components and/or numeric factors. In this case you see a plot of corrosion rate as a function of current and voltage at a mid-level slice of gas flow rate. This slice includes six center points as indicated by the dot at the middle of the contour plot. By replicating center points, you get a very good power of prediction at the middle of your experimental region.

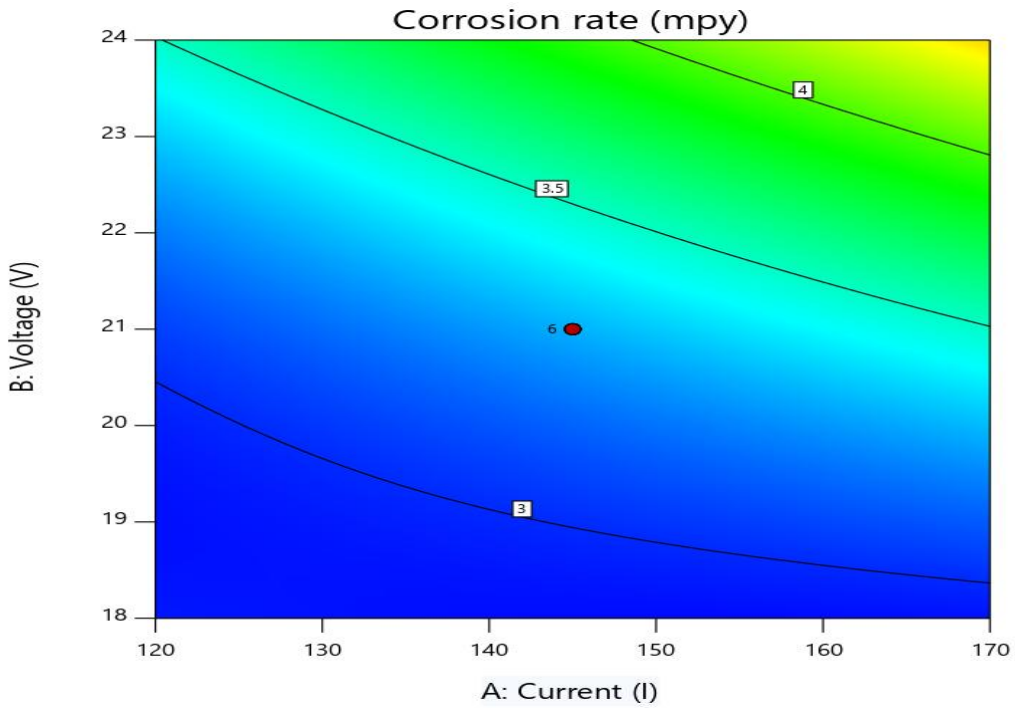

Fig. 2: Contour Plot

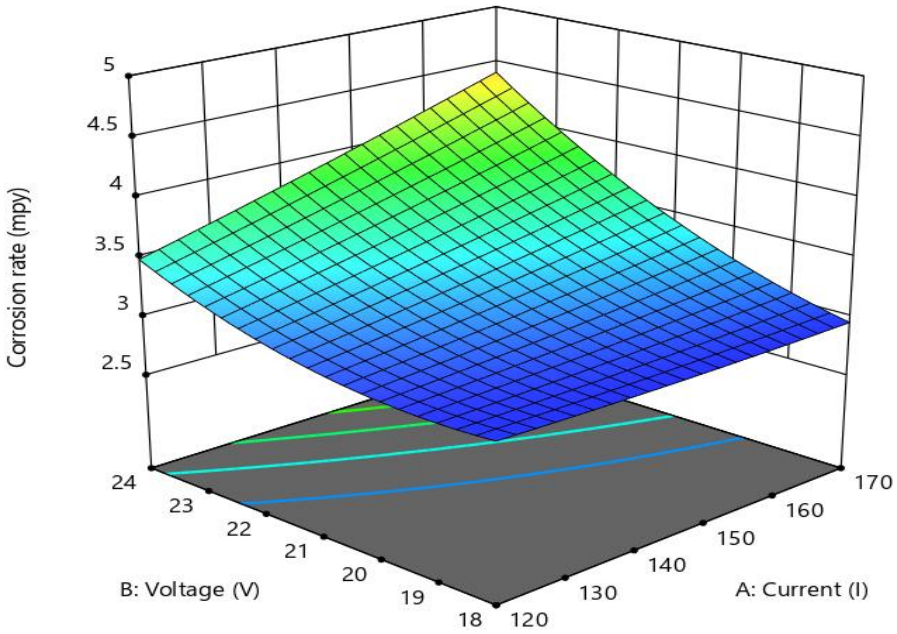

Fig. 3: Response Surface Plot

The response surface plot shown in Fig.3 is a 3D surface plot. It shows the relationship between the input variables (current, voltage and gas flow rate) and the response variables (rate of corrosion). It is a 3-dimensional surface plot which was employed to give a clearer concept of the response surface. Although not as useful as the contour plot for establishing responses values and coordinates, this view may provide a clearer view of the surface. The presence of a coloured hole at the middle of the upper surface gave a clue that more points lightly shaded for easier identification fell below the surface.

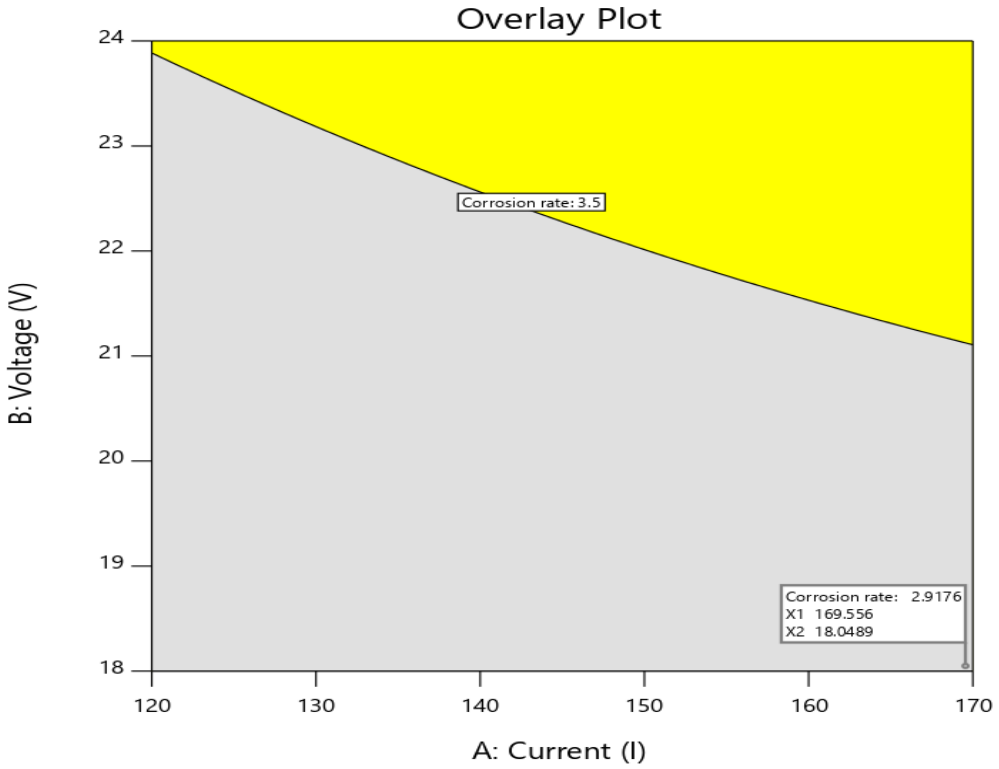

Fig. 4: Overlay Plot

Fig.4 shows an overlay plot generated from the model. The coloured area represents the region of rate of corrosion above 3.5mpy. Hence, the optimal rate of corrosion falls within the unshaded region.

IV. CONCLUSION

This study has been able to determine the effects of combined welding input parameters such as gas flow rate, voltage and current using response surface methodology. In this study, the application of response surface methodology to optimize and predict the rate of corrosion of a mild steel pipe welded joint has been successfully established. The reliability of central composite design in response surface methodology was also established in determining the process parameters such as gas flow rate, voltage and current leading to optimum rate of corrosion mild steel pipe welded joint. The butt joint specimens were performed varying the welding input parameters. The result obtained shows that current has a very strong influence on the rate of corrosion. Based on the findings, it is summarized that the corrosion rate is minimum when a welding voltage $(V) = 18V$, Current = 120A and gas flow rate =13lit/m.

REFERENCES

[1] Rajakumar, S., Muralidhara, C., Balasubramanian, V.Predicting tensile strenght, hardness and corrosion rate friction stir welded AA6061-T6 aluminium alloy Joints. Materials and Design.2011,No.32, Vol.28, pp78-90.

[2] Prachya, P., Anucha, W., Influence of Shielding Gas on Aluminium Alloy 5083 in Gas Tungsten Arc Welding", *2012 International Workshop on Information and Electronics Engineering (IWIEE),* Procedia Engineering, 2012, Vol. 29, PP.2465-2469.

[3] Ramachandran, R. Analysis And Experimental Investigations of Weld Characteristics For A TIG Welding With SS316L. International Journal of Advances in Engineering Research (IJAER),2015, VOL.NO.10,Issue no.II,e-ISSN: 2231-5152/PP.2454-1796.

[4] Prawoto, Y., Ibrahim, K. Effect of ph and chloride concentration on the corrosion of duplex stainless steel, The Arabian Journal for Science and Engineering, 2009, Volume 34. pp.115-127.

[5] Oliver, D.C., Stephan, M. External corrosion resistance of steel and FSS exhausts systems.The Journal of South African Institute of Mining and Metallurgy,2003, pp.93-100

[6] Sanga, B. Wattal, R and Nagesh, D.S. Weld joint characterization in ultrasonic welding of phosphor bronze sheets, Engineering Science and Technology, an International Journal, https://doi.org/10.1016/j.jestch.2021.07.003. In press

[7] Shin, H.S.,De Leon,M. Parametric study in similar ultrasonic spot welding of A5052–H32 alloy sheets, J. Mater. Process. Technol. 224 (2015) 222–232, https://doi.org/10.1016/j.jmatprotec.2015.05.013.

[8] Shakil, M., Tariq,N.H., Ahmad, M., Choudhary, M.A.,Akhter, J.I.,Babu, S.S. Effect ofultrasonic welding parameters on microstructure and mechanical properties of dissimilar joints, Mater. Des. 55 (2014) 263–273, https://doi.org/10.1016/j.matdes.2013.09.074.

[9] Annoni, M.,Carboni,M. Ultrasonic metal welding of AA 6022–T4 lap joints: Part I - Technological characterisation and static mechanical behaviour, Sci.Technol. Weld. Join. 16 (2) (2011) 107–115, https://doi.org/10.1179/1362171810Y.0000000014.

[10] Bakavos, D., Prangnell,P.B. Mechanisms of joint and microstructure formation in high power ultrasonic spot welding 6111 aluminium automotive sheet, Mater. Sci. Eng., A 527 (23) (2010) 6320–6334, https://doi.org/10.1016/j.msea.2010.06.038.

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Antimicrobial susceptibility of isolated strains from selected street foods in Antananarivo, Madagascar from January 2017 to December 2017

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ABSTRACT

Street food consists of ready-to-eat foods or drinks sold by a vendor, in a street or other public place. Consumers rely on the quick access and cheap service of street food for daily nutrition. However, these foods carry a large number of microorganisms. Among these microorganisms, there are pathogens, toxinogens, resistant organisms. The aim of this study was to examine bacterial profile, bacterial load, and antimicrobial susceptibility of bacterial isolates among street vended foods in Antananarivo, capital of Madagascar.

A total of 72 food samples from four different food items were analyzed and counted by standard aerobic plate count method.

Two hundred twenty one (253) samples including 102 samples of melting salads, 18 beef skewers, 15 chicken skewers, and typical Malagasy foods as : mofoanana (12 samples), mofogasy (10 samples), ramanonaka (10), makasaoka (14), mofoakondro (18) and kobandravina (22) ; were randomly collected from the street vendors in Antananarivo markets to evaluate their bacteriological quality. International Methods (ISO) was adopted for to find the load of Total Aerobic Bacteria and Enterobateriaceae, Escherichia coli and to search pathogen bacteria as Salmonella, Campylobacter jejuni, Escherichia coli O157H7 and Bacillus cereus in these foods.

Antibiotic susceptibility testing was done for pathogen isolated species, using Muller Hinton agar and data was entered and analyzed by XLSTAT.

The results revealed that the mean values ofthe Total Aerobic Bacteria count was $0.1x10^6$-4.8x106cfu/g. *Enterobacteriaceae* count range from $0.4x10^2$ to $1.9x10^2$cfu/g. *Escherichia coli* count range from $0.04x10^2$cfu/g. to 0.19 $x10^2$cfu/g. *Salmonella* was only present in melting salads, beef skewers and chicken skewers samples. *Bacillus cereus* count range from $0,1x10^2$ to $1,5x10^2$cfu/g. *Campylobacter jejuni* was only present in samples of ramanonaka and kobandravina. Two strains of presumptive *Eschercichia coli* O157 H7 (β glucuronidase -) were isolated.

Among the bacteria strains isolated, *Staphylococcus aureus, Salmonella* and *E coli* were the most resistant. The other isolated bacteria were all susceptible. A high resistance to Ampicillin and Gentamycin was noted compared to the isolated organisms. Trimethoprim, Sulfamethoxazole, Norfloxacin, Ciprofloxacin, Chloramphenicol were found to be the most effective antimicrobials against all strains.

Keywords: street foods, *Escherichia coli, food borne diseases, Antananarivo, Madagascar, antibacterial resistance.*

I. INTRODUCTION

The World Health Organization defines street food as foods and beverages prepared and sold by vendors in streets and other public places for immediate consumption (34).

The street food is a growing sector in many developing countries. They provide a source of very cheap affordable meal, while providing a source of income for the vendors.

Anyway, street vended food products may represent a risk due to a lack of basic infrastructure such as water connections and refrigeration, inadequate personnel hygiene of vendors, using raw materials of bad quality, hygienic practices utilized during transport of products to the vending area. Such contamination may render the product of inferior quality or unfit for human consumption (3).

It has been shown that Street-vended foods have been concerned in outbreaks of foodborne illnesses all around the world. In Madagascar, there was three food borne diseases due to *Salmonella typhi* reported on 2015-2016 and *Escherichia coli* was identified as responsible of so many infections and toxi-infections on 2017 (29).

Pathogenic microorganisms such as *Escherichia coli, Salmonella* and *Campylobacter jejuni* have recognized to be responsible for several out breaks of disease.

In Madagascar, there is no available data about these bacteria and street foods. Therefore, this study was led to evaluate the microbial quality of street vended foods in Antananarivo capital city of Madagascar on January 2017 to December 2017, and to assess the resistance of isolated microorganisms to antibiotics.

II. MATERIAL AND METHODS

Collection of samples

Two hundred twenty one (253) samples including 102 samples of melting salads, 18 beef skewers, 15 chicken skewers, and typical Malagasy foods as : mofoanana (12 samples), mofogasy (10 samples), ramanonaka (10), makasaoka (14), mofoakondro (18) and kobandravina (22) ; were randomly collected from the street vendors in Antananarivo markets. Samples were sent to the laboratory within two hours after collection in a cold-box containing ice-blocks.

Sample preparations and analysis

Serial dilution

Twenty-five grams (25 g) of each sample was mixed carefully with 225 ml of buffered peptone water. This mixture was homogenized and shacked to obtain a uniform mixture. One ml of the homogenized food sample was aseptically transferred into a test tube containing 9 ml sterile distilled water. Five dilutions of the homogenates were prepared in conformity with the recommendation of the norm ISO 6887 (6).

Enumeration of Total Aerobic Bacteria

Plate Count Agar (PCA) (Oxoid Ltd, United Kingdom) was used for Total Aerobic Bacteria and was done in conformity with the recommendation of the norm ISO 4833 (7).

Enumeration of *Bacillus cereus*

The recommendation of the norm ISO 7932 was used. 1 ml of the dilution of each food sample was plated onto polymyxin-pyruvate-egg yolk mannitol-bromothymol blue agar plates (Oxoid), which were air dried and incubated at 37°C for 24 to 48 h. Blue colonies with blue zones were subjected to appropriate biochemical tests (9,18).

Detection of *Salmonella* spp.

Salmonella spp was detected with the recommendation of the norm ISO 6579. Twenty-five grams (25 g) of each sample was mixed with 225 ml of buffered peptone water and incubated at 37^{o}C for 16 h. One ml of this culture was pipetted into 10 ml of Rappaport-Vasilliadis Soya broth (RVS). These were incubated at 41^{o}C for 24 h. The culture was streaked into Hektoen Agar. The agar plate were incubated at 37^{o}C for 24 h. The plate were examined for typical green blue colonies of *Salmonella* (8, 16, 19).

Detection of *Escherichia coli β* glucuronidase +

1 ml of the dilution of each food sample was plated onto Eosin Methylen Blue Agar Medium and incubated at 44°C for 24h to 48 h. Black green metallic colonies were subjected to appropriate biochemical tests according to the norm ISO 16649 (11,14).

Detection of *Escherichia coli* O157:H7

This strain was determined using sorbitol MacConkey agar (Oxoid) plates. *Escherichia coli O 157 H7* doesn't use sorbitol and gives characteristics colonies on this medium. Then, strains suspects belonging to *E. coli* O157 H7 must be identified by PCR, using Kit BAX (Qualicon, Inc. - USA) for screening *Escherichia coli* O157H7 with a detection rate around 96,5 % (12, 14, 16).

Detection of *Campylobacter jejuni*

25 g of the food sample was mixed with 100 ml Preston broth (Oxoid) and homogenized for 2 min. The enrichment broth was incubated at 42°C for 24 to 48 h. The broth culture was streaked onto Skirrow's agar plates (Oxoid), which were then incubated at 42°C. Colonies were Gram stained and tested for oxidase reaction. Suspect colonies were subjected to appropriate biochemical tests, done in conformity with the recommendation of the norm ISO 10272: 2006 (10).

Antibiotic sensitivity testing or **antibiotic susceptibility testing**

Bacteria on the selective media were isolated, purified and identified. The antibiotic resistance of the identified pure strains was carried out.

The growth method was performed. At least three well isolated colonies of the same morphological type was selected from an agar plate culture. The top of each was touched with a loop, and the growth was transferred into a tube containing 4 to 5ml of a suitable broth medium. The broth culture was incubated until it achieved or exceeded the turbidity of the 0.5MacFarland standards which took up to six hours.

Inoculation of test plates.

Optimally, within 15 min after adjusting the turbidity of the inoculum's suspension, a sterile cotton swab was dipped into the suspension. The swab was then rotated several times and pressed firmly on the inside wall of the tube above fluid level.

Excess inoculums were removed from the swab. The dried surface of a mueller-hinton agar was inoculated by streaking the swab over the entire sterile agar surface. this procedure was repeated by streaking two or more times, by rotating the plate to ensure an even distribution of inoculums.

The rim of the agar was swabbed. The lid was left ajar for some minutes to allow for any excess surface moisture to be absorbed before applying the drug-impregnated discs.

Placement of discs

The predetermined battery of antimicrobial discs (Chloramphenicol, Gentamycin, Ciprofloxacin, Trimethoprim, Sulfamethoxazole, Ampicilline, Norfloxacin) was dispensed onto the surface of the inoculated agar plate. Each disc was pressed down to ensure complete contact with the agar surface.

The plates were then inverted and placed in an incubator within 15 minutes after the discs are applied.

Reading plates and interpreting results

After 16 to 18 hours of incubation at 37°C, each plate was examined, the diameters of the zones of inhibition are measured, including the diameter of the disc.

The sizes of the zone of inhibition are interpreted by referring to the (SFM, WHO) table on zone diameter interpretive standards.

III. RESULTS

As shown in Table 2, melting salads, beef skewers, chicken skewers and kobandravina were found to be contaminated. A high level of Total Aerobic Bacteria TAB (>10^6 ufc/g), Enterobacteriaceae (>10^2/g) and *Escherichia coli* β glucuronidase + is noted.

The values of the Total Aerobic Bacteria count was 0.1x10^6- 4.8x10^6 cfu/g. Enterobacteriaceae count range from 0.4x10^2 to 1.9x10^2 cfu/g and *Escherichia coli* count range from 0.04x10^2 cfu/g. to 0.19 x10^2 cfu/g.

Pathogen bacteria as *Salmonella* was only present in melting salads, beef skewers, chicken skewers samples. *Bacillus cereus* count range from 0,1x10^2 to 1,5x10^2 cfu/g. *Campylobacter jejuni* was only present in samples of beef and chicken skewers. Two strains of *Eschercichia coli* O157 H7 (βglucuronidase -) were isolated and identified by PCR reaction from beef skewers.

Two hundred twenty one (253) samples including 102 samples of melting salads, 18 beef skewers, 15 chicken skewers, and typical Malagasy foods as : mofoanana (12 samples), mofogasy (10 samples), ramanonaka (10), makasaoka (14), mofoakondro (18) and kobandravina (22).

Table 1: Microbiological assessment of street foods samples collected in Antananarivo market on 2017-2018.

Number	Samples	TAB.10^6/g	Ent. 10^2/g	E.C.BG+ 10^2/g	E.C.BG-/g	SLM/g	CAMP/g	BC10^2/g
102	Melting salads	5,77	2,61	1,34	A	9,52	A	2,01
18	Beef skewers	4,52	1,98	1,01	2	14,40	0,19	A
12	Mofoanana	0,61	0,97	0,10	A	A	A	0,47
14	Makasoka	0,14	0,36	0,07	A	A	A	0,19
10	Mofogasy	0,70	0,88	0,23	A	A	A	0,18
10	Ramanonaka	0,68	0,54	0,31	A	A	A	0,16

18	Mofoakondro	0,31	0,555	0,067	A	A	A	0,374
54	Chicken skewers	3,998	1,961	1,338	A	2,06	0,942	A
15	Kobandravina	1,585	1,199	1,011	A	A	A	1,553

TAB : Total Aerobic Bacteria, Ent : Enterobacteriaceae, E.C.BG + : *Eschercichia coli βglucuronidase +,* E.C.BG - : *Eschercichia coli βglucuronidase -,* SLM : *Salmonella spp,* CAMP : *Campylobacter jejuni,* BC : *Bacillus cereus,* A: Absent

In this study, usually used antibiotics are selected for the antibiotic susceptibility testing. The antibiotic selection also depends on the bacterial species because different bacterial species need different classes of antibiotics for optimal antibacterial activity. Some of the antibiotics were not tested in this study because some bacterial species are naturally resistant to certain classes of antibiotics; hence the antibiotics were excluded from the analysis.The bacterial isolates and their percentage of resistant are shown in Table 2.

Table 2 : Percentage of resistant of bacterial isolates

Antibiotic susceptibility patterns of isolates		Salm	%	B c	%	*E coli*	%	*Ec* O157	%	*Ca. j*	%	*S.aur*	%	Sty%
chloramphenicol	S	24	96,00	12	100,00	37	84,09	2	100,00	1	100,00	51	82,26	93 ,72
	R	1	4,00	0	0,00	7	15,91	0	0,00	0	0,00	11	17,74	
Gentamycin	S	4	16,00	11	91,67	42	95,45	-	-	1	100,00	43	69,35	74,49
	R	21	84,00	1	8,33	2	4,55	-	-	0	0,00	19	30,65	
ciprofloxacin	S	23	92,00	12	100,00	39	88,64	2	100,00	1	100,00	52	83,87	94,08
	R	2	8,00	0	0,00	5	11,36	0	0,00	0	0,00	10	16,13	
trimethoprim	S	25	100,00	-	-	40	90,91	2	100,00	-	-	-	-	97,72
	R	0	0,00	-	-	4	9,09	0	0,00	-	-	-	-	
Sulfamethoxazole	S	22	88,00	12	100,00	38	86,36	2	100,00	1	100,00	57	91,94	94,38
	R	3	12,00	0	0,00	6	13,64	0	0,00	0	0,00	5	8,06	
Ampicilline	S	12	48,00	11	91,67	31	70,45	-	-	1	100,00	10	16,13	60,89
	R	13	52,00	1	8,33	13	29,55	-	-	0	0,00	52	83,87	
Norfloxacin	S	25	100,00	12	100,00	34	77,27	2	100,00	1	100,00	54	87,10	94,06
	R	0	0,00	0	0,00	10	22,73	0	0,00	0	0,00	8	12,90	
Rce%			22,85		2,38		15,00		0,00		0,00		24,19	

Salm : *Salmonella*, B.c. : *Bacillus cereus*, E coli : *Escherichia coli*, Ec O157 *Escherichia coli* O157H7, Ca.j : *Campylobacter jejuni*, S. aur : *Staphylococcus aureus*,S : Sensitive, R : resistant, Sty : susceptibility, Rce : resistance

The most resistant are: *Staphylococcus aureus*, especially against Beta-lactam antibiotics (Ampicillin). The percentage resistant is around 83.87%. Then there is *Salmonella*, resistant to Ampicillin (52.00%) and Gentamycin, in the order of 84.00%. In third place, there is *Eschercichia coli* with a resistance of 29.55% against Ampicillin and 22.73% against Norfloxacin.

Staphylococcus aureus is naturally susceptible to virtually every antibiotic that has ever been developed. Resistance is often acquired by horizontal transfer to genes from outside sources, although chromosomal mutation and antibiotic selection are also important.

Salmonella is a main pathogen in humans as well as in animals and comprises 12000 serotypes. They are generally dispersed in nature and are common inhabitants of the intestinal tract of domesticated and wild mammals, reptiles, birds, and even insects.
Increasing antimicrobial resistance in *Salmonella* species has been a serious problem for public health worldwide. The high percentage of resistance is hampering the use of conventional antibiotics, and growing resistance to newer antimicrobial agents is aggravating the situation. The circumstances of occurrence and spread of antimicrobial resistance are complex; however, a main cause is the widespread use of antimicrobial agents in food animals, particularly in animal feed. Genetic analysis has shown that the source of resistance is frequently a transferable plasmid. Current studies have revealed that some serotype-specific virulence plasmids form hybrid plasmids through recombination with resistance plasmids or acquire gene cassettes consisting of multiple resistance genes. Such evolutionary events provide a virulent strain the advantage of survival in an unfavorable drug

environment. In view of the serious implications associated with drug-resistant *Salmonella* species, a more careful use of antibiotics in both human medicine and animal industry is warranted. Continued surveillance of antimicrobial resistance and use of antimicrobial agents in food animals is also indispensable.

Patients with invasive salmonellosis require antimicrobial treatment. Increasing antimicrobial resistance may add to the difficulty or delay in administration of microbiologically effective therapy, leading to increased morbidity and mortality. On the other hand, antimicrobial use causes a transient decrease in an individual's resistance to colonization with noncommensal bacteria and increases the probability of infection on exposure to a foodborne pathogen, such as *Salmonella* species.

The statistical analysis compared to the antibiotics tested shows that the bacterial isolates have highest percentages of susceptible were towards Trimethoprim (97.72%), Sulfamethoxazole(94.38%), Ciprofloxacin, followed by Chloramphenicol 93.72% and Gentamycin which is around 74.49%.

The bacterial isolates showing high percentages of resistant were towards Ampicillin, (60.89%), which may affect the treatment of diseases caused by these germs. We can see a therapeutic failure.

Still according to these results, pathogenic germs therefore circulate in community settings, in extra-hospital settings. Foodstuffs are the carriers of these germs.

The presence of these bacteria could be due to the use of phytosanitary products, antibiotics or feed that contain a high amount of antibiotics,...

In this study, the antibiotic resistant patterns for all isolates were also determined to monitor the spread of antibiotic resistance. There is species isolates with 0% resistance towards all antibiotics tested in all sampling: *Escherichia coli* O157H7 and *Campylobacter jejuni*.

IV. Discussions

Isolation of antibiotic resistant bacteria from street foods indicates the health risk associated with these type of food.

There had been reports on detection of antibiotic resistance genes in bacteria isolated that can be transferred to human microbiota.

In antibiotic resistance analysis, the history of antibiotic application in particular area is reflected by the percentage of bacterial resistance to antibiotics. The frequency of antibiotics usage is related to the level of resistance among bacteria. In this present study, high percentage of susceptibility was observed towards Trimethoprim (97.72%), Sulfamethoxazole (94.38%), Ciprofloxacin, followed by Chloramphenicol 93.72% and Gentamycin which is around 74.49%.

Gentamicin was approved for use in 1963 (*2*). Although gentamicin resistance was rare in human *E. coli* isolates, we found resistance rates <40% among animal *E. coli* in 2002. Since 1980, resistance to gentamicin has increased among animal *E. coli* isolates.

Similarly, Tsirinirindravo et al. in their studies observed a high percentage of sensitivity of Gram negative bacteria (*Escherichia coli, Salmonella typhi)* to this family of antibiotics, especially Trimethoprim family and Ciprofloxacin *(second-generationquinolones) (31)*.

High percentage of Ampicillin resistance was observed in this study. Similarly, high ampicillin and streptomycin resistance were also observed by Zhang et al. in their study on antibiotic resistance detection in *E. coli* strains isolated from communautary area in South China (26).

Antibiotic resistance pattern may vary depending on the geographical locations and selective pressure and these patterns change rapidly from time to time. The different patterns exhibited by different strains or species suggest how complex is the understanding of the antibiotics resistance in the study area.

It is expected that environments where antibiotic use is high will select for a high level of antibiotic resistance in isolated bacteria. Therefore, the higher number of multidrug resistant bacteria from the rehabilitation centres was not surprising.

Awareness on antibiotic resistance threat should be instilled in the community regardless of age as precaution and prevention step against dissemination of antibiotic resistant bacteria.

The community must be educated on antibiotics and their effects on public health. Many surveillance programs had also been introduced to monitor the emergence and spread of antibiotic resistant bacteria. Plasmid screening should be considered as an additional procedure in the monitoring programs to trace antibiotic resistance dissemination.

Conclusion

The study aims to determine the microbial quality and the sensitivity of bacteria isolated frompre-cut ready-to-eat vegetable salads sold by food vendors in the Antananarivo markets on 2017.The most contaminated food are melting salads, beef skewers, chicken skewers and kobandravina. The typical Malagasy food as Mofogasy, Ramanonaka, Menakely are the healthiest, referring to their sanitary hygienic quality.Melting salad, chicken skewers, beef skewers and kobandravina constitute a health risk to consumers, in terms of microbial quality.

Staphylococcus aureus, Salmonella and *E coli* were the most resistantcompared to the antibiotics tested. A high resistance to Ampicillin and Gentamycin was noted compared to the isolated organisms.
Trimethoprim, Sulfamethoxazole, Norfloxacin, Ciprofloxacin, Chloramphenicol were found to be the most effective antimicrobials against all strains.
The contamination could come from unhygienic food preparation, process, environmental conditions, raw materials and improper food handling. The circumstances of occurrence and spread of antimicrobial resistance are complex; however, a main cause is the widespread use of antimicrobial agents in food animals, particularly in animal feed.

REFERENCES

[1.] ACHYUT A., KAREN K. Effect of storage time and temperature on the viability of *E. coli O157:H7, Salmonella spp., Listeria innocua, Staphylococcus aureus, and Clostridium*sporogenes vegetative cells and spores in vacuum-packed canned pasteurized milk cheese. Journal of Microbiology. July 2018, Volume 56, Issue 7, pp 450–459

[2.] BIBEK R., Fundamental Food Microbiology 2nd ed. The CRC Press Ltd Washington, DC 2001, 56-90).

[3.] CHUKWUEMEKA, and CHRISTIAN U.I., Bacteriological quality of foods and water sold by vendors and in restaurants in Nsuka, Enugu State, Nigeria: A comparative study of three Microbiological methods, Journal of Heath Population and Nutrition, 29(6), 2011, 560-566.

[4.] EVANS MC, WEGENER HC. Antimicrobialgrowthpromoters and *Salmonella* spp.,*Campylobacter*spp. in poultry and swine, Denmark. Emerg Infect Dis **2003**; 9:489–92.

[5.] G. J. TORTORA, B. R. FUNKE, and C. L. CASE, *Microbiology: An Introduction*, Pearson Benjamin Cummings by PearsonEducation, Inc, San Francisco, Calif, USA, 9th edition, 2007

[6.] INTERNATIONAL STANDARD ORGANISATION. Microbiologie des aliments. Préparation des échantillons, de la suspension mère et des dilutions décimales en vue de l'examen microbiologique. ISO 6887-1:1999.

[7.] INTERNATIONAL STANDARD ORGANISATION. Microbiologie des aliments. Méthode horizontale pour le dénombrement des micro-organismes. Technique de comptage des colonies à 30 degrés. ISO 4833:2003.

[8.] INTERNATIONAL STANDARD ORGANISATION. Microbiologie des aliments. Méthode horizontale pour la recherche des *Salmonella spp*. ISO 6579:2002.

[9.] INTERNATIONAL STANDARD ORGANISATION. Microbiologie des aliments. Méthode horizontale pour le dénombrement de *Bacillus cereus* présomptifs. Technique par comptage des colonies à 30 degrés C. ISO 7932:2004.

[10.] INTERNATIONAL STANDARD ORGANISATION. Microbiologie des aliments. Méthode horizontale pour la recherche et le dénombrement de *Campylobacterspp*. ISO 10272:2006

[11.] INTERNATIONAL STANDARD ORGANISATION. Microbiologie des aliments. Méthode horizontale pour le dénombrement des *Escherichia coli* bêta-glucuronidase positive. ISO 16649 :2001.

[12.] INTERNATIONAL STANDARD ORGANISATION. Microbiologie des aliments. Méthode horizontale pour la recherche des *Escherichia coli* O157. ISO 16654:2001.

[13.] FOOD AND AGRICULTURAL ORGANIZATION. 1997 .Agriculture food and Nutrition for Africa. A resource book for teachers of Agriculture, Rome. 12 (3):25-29.

[14.] FOOD AND AGRICULTURE ORGANIZATION FAO.1992. *Escherichia coli* and other coliforms. Manual of food quality control. Rev.1- Microbiological Analysis, Food and Agriculture Organization of the United Nation, Rome, Italy, Chap. 3PP, 13-26.

[15.] FOOD AND DRUG ADMINISTRATION "FDA" 2001. *Staphylococcus aureus*. Bacteriological analytical manual .8th Ed. Chapter12. Gaithersburg, p.562.

[16.] FRANZ E., BRUGGEN A. H. 2008. Ecology of *E. coli* 0157:H7 and *Salmonella enterica* in the Primary Vegetable Production Chain." Crit. Rev. Microbiol. 34 (3-4): 143-161.

[17.] GILBERT R., DE LOUVOIS J., DONOVAN T., LITTLE C., NYE K., RIBEIRO C. D., RICHARDS J., ROBERTS D., BOLTON F. B. 2000. Guidelines for the microbiological quality of ready-to-eat foods sampled at point of sale. Commun. Dis. Public Health 3:163–167.

[18.] GRANUM P. E., ANDERSSON A., GAYTHER V., GIFFEL TE M., LARSEN H., LUND T. O., O'SULLIVAN K. 1996. Evidence for a further enterotoxin complex produced by *Bacillus cereus*. FEMS Microbiol. Lett. 141:145–149

[19.] JONGHYUN B., EUNNA C., EUN-JIN L. A rule governing the FtsH-mediated proteolysis of the MgtC virulence protein from *Salmonella entericaserovarTyphimurium*. Journal of Microbiology, August 2018, Volume 56, Issue 8, pp 565–570

[20.] LARPENT J-P., LARPENT-GOURGAUD M. Mémento technique de microbiologie, 3éd. Londres, New York, Paris. Lavoisier, 1997 : 1039 p.

[21.] MANANJARA P., TSIRINIRINDRAVO H.L., RAHERIMANDIMBY M., RANDRIANIERENANA A. Etude des levures endogènes d'*Evodiabilahe*, rutacée endémique de Madagascar. Int. J. Biol. Chem. Sci. 10 (4): 1694- 1701. August 2016.

[22.] McDONALD LC, CHEN MT, LAUDERDALE TL, Ho M. The use of antibioticscritical to humanmedicine in food-producinganimals in Taiwan. J MicrobiolImmunol Infect **2001**; 34:97–102.

[23.] PRESCOTT L.M., KLEIN D.A. (2008). Pathogenic Organisms. Microbiology, 7th ed McGrew hill, New York. pp 340, ISN 978-0-07-110231-5.

[24.] RANGEL J. M., SPARLING P. H., CROWE C., GRIFFIN P. M., SWERDLOW, D. L. 2005. Epidemiology of *Escherichia coli* O157: H7 Outbreaks in the United States from 1982 to 2002. Emerg. Infect. Dis.11 (4): 603-609.

[25.] RASOLONIAINA L., RANDRIAMAMPIONONA S., ANDRIAMANANTENA H., RAZAFIARIMANANA V., RASOAMAMPIONONA R., RAKOTOARISOA N., TSIRINIRINDRAVO H.L., ANDRIANJAKA A., DUPONNOIS R., ANDRIANARISOA B. « Effets des produits volcaniques sur les cultures du riz et maïs et dynamique de la microflore telurique sur la culture de maïs » : GDRI-BDDM et les questions de biodiversité 3 au 5 nov 2010, Lyon-France.

[26.] R.-Q. ZHANG, G.-G. YING, H.-C. Su, L.-J. ZHOU, and Y.-S. LIU, "Antibioticresistance and geneticdiversity of *Escherichia coli*isolatesfromtraditional and integrated aquaculture in South China,"

Journal of Environmental Science and Health, PartPesticides, Food Contaminants, and Agricultural Wastes, vol. 48,no. 11, pp. 999–1013, 2013.

[27.] TINKER I. (1997). Street Foods, Urban Food and Employment in developing Countries. Oxford. University Press, New York, 1997. pp 124-126

[28.] TOMOYASU, T., YAMANAKA, K., MURATA, K., SUZAKI, T., BOULOc, P., KATO, A., NIKI, H., HIRAGA, S., OGURA, T. 1993. Topology and subcellular localization of FtsH protein in *Escherichia coli*. J. Bacteriol. 175, 1352–1357.

[29.] TSIRINIRINDRAVO H. L., RANDRIANIERENANA L. A., ANDRIANARISOA B., RAHERIMANDIMBY M., RANDRIANANTOANDRO H. H., RAZAFINJATOVO D. N., DE PERCIN G., PIERLUIGI B. *Aspects épidémio-cliniques des toxi-infections alimentaires collectives (TIAC) dans la région Analamanga, cas de janvier à juin 2015. Communication lors des Journées QualiReg 2016. 5eme rencontre de l'Agroalimentaire en Océan Indien « La qualité et l'innovation au service du développement des filières agroalimentaire de l'Océan Indien. Saint Pierre, La Réunion.*

[30.] TSIRINIRINDRAVO H.L., ANDRIANARISOA B. Société Française de Microbiologie VIIIe Congrès National Marseille 2010, carrefour des microbiologies du Nord et du Sud Palais des Congrès, parc Chanot, Marseille SFM MARSEILLE 2010 - ABSTRACT n°039 Programme : ACTIVITES ANTIBACTERIENNES DE L'EXTRAIT ISSU DE MESANTHEMUM RUTENBERGIANUM (ERIOCAULACEES). 2, 3 et 4 juin 2010.

[31.] TSIRINIRINDRAVO H. L., RANDRIANIERENANA L. A., ANDRIANARISOA B., RAHERIMANDIMBY M., RANDRIANANTOANDRO H. H., RAZAFINJATOVO D. N., DE PERCIN G., PIERLUIGI B.Espèces de *Salmonella*multiresistantes véhiculées par les aliments de rue à Antananarivo. *Communication lors des Journées QualiReg 2016. 5eme rencontre de l'Agroalimentaire en Océan Indien « La qualité et l'innovation au service du développement des filières agroalimentaire de l'Océan Indien. Saint Pierre, La Réunion.*

[32.] TSIRINIRINDRAVO H.L., ANDRIANARISOA B. Activités antibactériennes de l'extrait des feuilles de *Dalechampiaclematidifolia* (Euphorbiaceae). Int. J. Biol. Chem. Sci. 3(5): 1198-1202, October 2009.

[33.] WATARU H., NORIYUKI N. High prevalence of blaCTX-M-14 among genetically diverse *Escherichia coli* recovered from retail raw chicken meat portions in Japan. Journal of Microbiology. August 2018, Volume 56, Issue 8, pp 530–535

[34.] WORLD HEALTH ORGANIZATION, Food borne diseases; a focus for health education, 53rd world health assembly, Geneva, 2000. Expert Committee on Food Safety, Geneva: WHO: 1-79.

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Analysis of Electrical Power Usage in Houses Using Smart Electrical Distribution Switch

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ABSTRACT

Various power meters are introduced by electricity company to measure the consumption of power of consumers. Household with many occupants who use these electrical power meters need an automated smart switching system for the household electrical devices to monitor and control the power consumption in order to save power. This paper aims at proposing Smart Distribution Switch which is connected to household electrical devices and it is programed to monitor and control the electric power consumption of devices in households such that any device whose usage is not needed at a time is isolated from the grid in order to save power.A field survey was conducted to collect data randomly from a sample of households in the Sunyani municipality and the issues concern were why individuals in a household wish to have their separate power meters, how individuals use their electrical appliances and how much electric power consumed at the end of the month. The average consumption of each device used was determined, and the results confirmed that more devices used at a greater amount of time corresponded with higher consumption, and hence higher bills. Linear regression was used to analyze the results because it uses the methods of optimization and gradient decent to learn models that have parameters and it is practically used to make prediction of linear functions.

Keywords— *Power meter, consumption, Smart Distribution Switch, microcontroller, EPROM, Electrical, Optimization*

I. Introduction

Electrical Power is very important in our daily life and most of our activities are associated with electricity [1]. If it is not properly used, a great amount of it is wasted annually [2]. It should therefore be managed very well to enhance it judicious use. There has been a great increase in the consumption of electrical power in our homes and residential areas [3]. Most individuals who live in a large family and use the same meter who contribute equal amount of money to buy electric power but consumes different amount of power. The individuals are not able to monitor the consumption of others and their consumption hence there is the need to use smart electrical power meter [4] in order to avoid the inability in monitoring and controlling of the usage of electric power by the consumers. The unmetered electric power and some other factors such as power theft, defective power meters

which generate wrong figures or do not read at all, the disconnection from the grid and reconnection to the grid which may lead to voltage leakages, when consumers use electrical power over a period and they fail to pay for itcan cause power losses**,** and these losses represent about several hundreds of Kilo Volts Amperes, however, these losses, the voltage, real and apparent power can be checked using smart electrical meter which sends the power consumption data and some other operational information to the distribution operating center [5]. There are several power meters which have been proposed and designed because the power meter is very important in measuring the amount of electric power consumed by a consumer, however, [6] the function of some of these power meters is limited and hence their application is restricted. Some of these power meters are designed so that data is been sent through Bluetooth or wireless communication to a personal computer and such meters will be difficult to be used at remote areas where telecommunication networks are weak or not available or personal computers are not available.

There are several switches, and in electrical engineering, a switch is an electrical component which can be used to connect or disconnect or divert the flow of electric current in an electrical circuit. A switch can therefore control the amount of electrical power that flow in electrical systems and can also be used to block the flow of electrical power. In this case a switch can be used to control and monitor the flow of electrical power in electrical distribution system. There are smart electrical switches which don't use wireless communication and which can be programmed to control and monitor systems, and for smart distribution, it is very important to get smart switch which will optimize the distribution performance and as distribution grid is becoming very complex, smart switches are needed for controlling and monitoring of electrical power distribution in the household where distribution will not be interrupted and the user can be provided with very vital information about power consumption, and the smart switch can be programmed according to the requirement of the user [7]. There is also a switchgear which is a type of a smart switch and which is made up of components like switches, fuses, and circuit breakers which are combined and can be used to control, protect and isolate an electrical equipment to facilitate continuous and reliable supply of electricity. According to [8], it is very important to have smart distribution systems that can perform efficiently without any interruption and can also provide to users the necessary information about the consumption of power and its quality. That smart distribution system can help power sources to be managed intelligently which can make efficient and reliable distribution of power. However, smart distribution switch will control and monitor devices and individuals' consumption and disconnect the devices which are not to continue consuming power and user from the household grid as soon as their share of contribution is finished. Also in [9], it is clear that for the optimization of the performance of smart distribution, it is very necessary to use smart switch. This will enhance general performance in distribution of power, hence Smart Distribution Switch is proposed to monitor and control individual's consumption of electric power, and it will help the consumer to plan on which electric power appliances to use and how long to use them in order to avoid power wastage. Smart distribution will need smart meters and according to the U.S. Department of Energy's report on smart grid system, it is estimated that about sixty-five million smart meters have been installed by 2015 [10] and also by 2020, it is expected that about 830 million of smart meters would be deployed worldwide [11]. The smart meters are able to accumulate greater amount of data that is able to give enough information to monitor operational systems in almost real time [12].

The proposed smart distribution switch is used to control andmonitor the electric power consumption of electrical devices of individuals in households in both remote and urban areas and can also help to save and manage power in order to avoid power wastage. It also helps consumers to plan well on the appliances to use and how long to use them and help in the prediction of consumption.

This paper is organized as follows: Section 2 talks about the related literature, Section 3 describes the methods and the materials, Section 4 presents the results and discussion and finally the conclusion is in Section 5.

II. RELATED LITERATURE REVIEW

These scholars [13] aimed at how single phase energy meter is designed and implemented which can also be monitored remotely by the use of Short-Message Service(SMS)**.** Some discrete components or devices and a metering chip (ADE7755) were used to design the energy meter. The Short-Message Service (SMS) with the meter was set up with the help of Neoway M590 Global System/Standard Mobile Communication (GSM) module. The GSM receives commands from mobile phone for communication. Nonetheless, this meter has to be connected to a switch before connecting to the home appliances.[14] designed a digital energy meter where he used Advanced Virtual RISC (AVR) microcontroller to transmit the data measured by wireless means to a computer. The circuit designed was implemented or put into effect on PCB, that is Printed Circuit Board. Microsoft visual studio C# was used to write a program to monitor the received. An 8-bit Advance Virtual RISC (AVR) low power microcontroller was used, however, smart distribution switch will control and monitor devices and individuals' consumption and disconnect the devices which are not to continue consuming power and therefore manage and save power. Again, [15] focused at developing a management system which was prototype to manage prepaidelectrical power meter based on RFID. The work was done by using wireless gateway, digital meter, microcontroller, and Radio Frequency Identification (RFID) reader to design the proposed prepaid electrical meter and the designed circuit is connected to a computer, where Radio Frequency Identification (RFID) reader is used to read the information on the credit card. The RFID reader reads the information on the ID card and this information is sent to the server to check if it is authentic and later the client receives the information. It is obvious that in the areas where there is no telecommunication network or the telecommunication system is not working well, it will be difficult to implement such system. Furthermore, [16] developed a system of energy meter which used wireless communication with a circuit in which the power can be on or off. The system is used to measure electrical energy bills and the information about energy consumption is sent to the consumer. The dead line information about the payment of the bill is also sent to the consumer and if the consumer refuses to pay the bill, the power supply is disconnected. Though it is a very good technology, however, it implementation will be difficult at an area where the wireless and telecommunication technology is not available. In addition, [17] presented a work on the prepaid electricity meter which alerts the consumer on the usage of energy consumption, however, this proposed energy meter use a Radio Frequency Identification (RFID), personal computer and a wireless gateway in it operation. In an area where wireless and RFID technology is not available, or not reliable, it will be difficult to implement this system. More so, [18] gave a presentation on the effectiveness of feedback on energy consumption using wireless communication, [19] designed an Electricity Power Detection Theft using wireless prepaid Meter which was used to detect the stealing of electrical power, and [20] designed the Building of a prototype wireless prepaid Electricity Metering that was used to determine the amount to be consumed at a time. All these power meters use wireless technology and they help consumers to plan and use energy wisely. Besides, wireless communications are used in many smart grid applications which can be used to collect meter data [21], however, certain environments remain a challenge when it comes to wireless solutions [22]. It is a fact that areas where telecommunication infrastructure are not available will surely have wireless communication issues and therefore it will be difficult implementing wireless metering system and even where it is available it is subject to interference.

III. MATERIALS AND METHOD

A field survey was conducted on several credit or post-paid meters and prepaid meters used by different consumers for a period of twelve months in the Sunyani Municipality to collect data on the electrical consumption of consumers. The meters were read monthly by the meter reader and the researcher where the previous and present readings were noted, and again the researcher selected two tenants and recorded hourly and daily consumption of the appliances; radio,11W bulb, Television, Fridge, Iron and Heater. This was to compare the hourly, daily and the monthly consumptions. The electrical power meters recorded consumption in Kilowatt hour (KWh) and are connected across a 240V with 60Hz transmission line, and a current of 15A to 60A can flow through it without breaking it.

The issues concern were why individuals in a household wish to have their separate power meters, how individuals use their electrical appliances and how much power consumed at the end of the month. Linear regression was used to analyzed the results which confirmed that higher bills corresponded to higher consumption.

The control of the circuit is done with the used of the PIC16F877A microcontroller chip made by Microchip Technology with a data memory of 16-bit which can be programed easily using C/C++ compilers [23], LCD display Max232 is the screen which displays the power used and 20MHz crystal clock which shows the smallest interval of time to accomplish any instruction by the microcontroller. The proposed Smart Electrical Distribution Switch (SEDS) is connected to the power meter and which has multiple phases of connection to the occupants of a house and to the various appliances for the control of power consumption. The amount of power consumed based on the consumption rate will be recoded and stored on EPROM of the microcontroller which is programed and run in MikroC compiler. The microcontroller is used in an embedded system and need no operational or external digital parts to function as a complete computer and it is used to accumulate or gather the real power information. Smart distribution switches are devices acting as an interface between the utility-controlled smart meters and the home area network. These devices control and take care of the data exchange between smart meters, utility or service providers and power consumption in-house objects. They also manage the information for several homes, a multi utility controller, also known as gateway of energy, manage and control the exchange of data for a particular home. The smart distribution switch is operating as a Data concentrated unit (DCU) that manages the data input from the occupant in the house and also allows saving and better management of power. Each network connected to an apartment will be managed and monitored by the DCU through a console based application written on the microcontroller. It coordinates the activities between the users and the meter [24]

Both hardware and software are implemented at desired stages. The microcontroller is programed to monitor the usage of power and also provide a set of control commands for isolation of devices that should not consume power. The programming language employed to run the microcontroller is MikroC compiler. The MikroC compiler generates code for the PIC microprocessor. The proposed model block diagram is shown in figure 1 and the circuit diagram is also shown in figure 2.

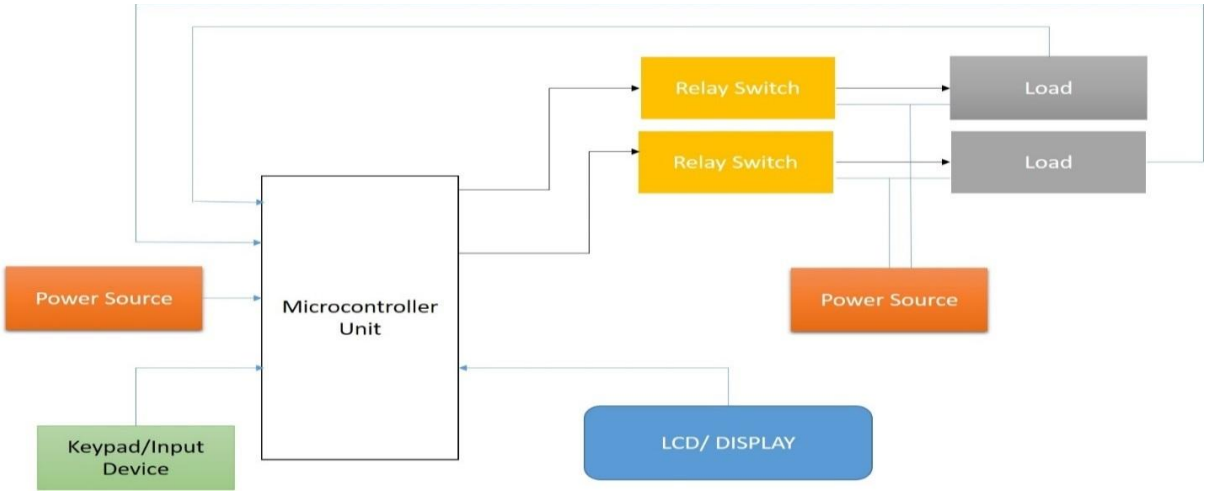

Figure 1 Proposed model block diagram.

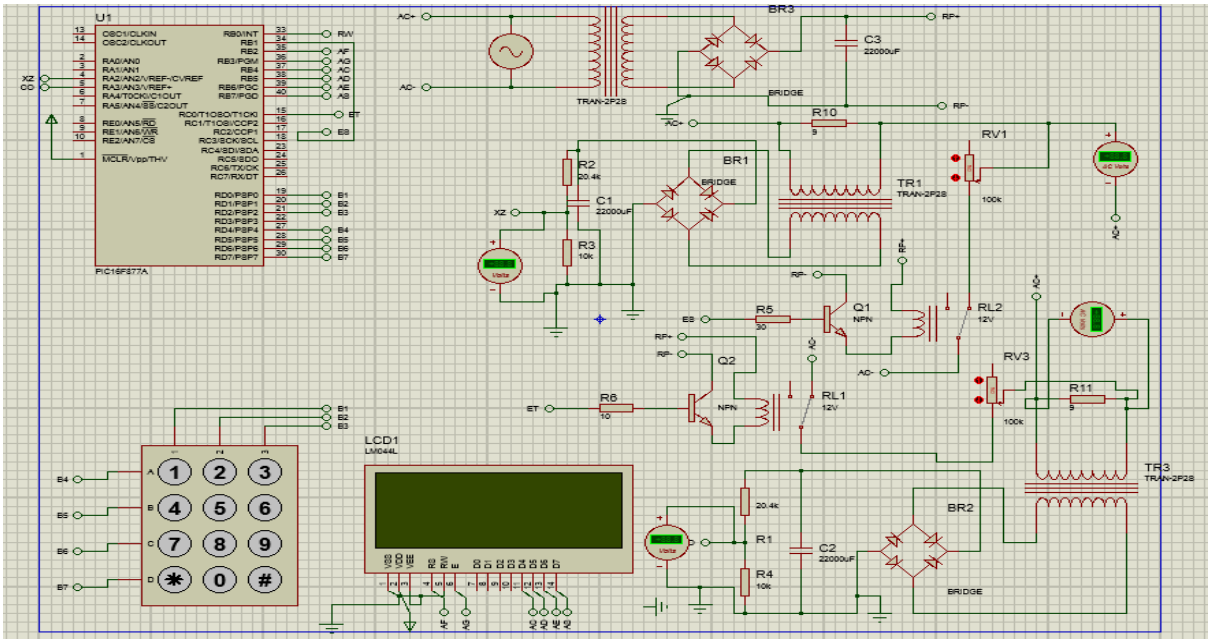

Figure 2 circuit diagram of proposed model

The main work is demonstrated in the embedded control system. The system is mounted between the main switch and the loads of the individual consumers. Here the system monitors all individual loads connected through the main switch, and upon reading the power consumption at all instances, the consumption can be quantified to take further decisions. The average power as well as the power factor are calculated and hence the active or the average power can be calculated as:

$P = V_{rms} I_{rms} \cos\theta$, where P is the active or average power, V_{rms} , is the root-mean-square-voltage, I_{rms}, is the root-mean-square-current, and $\cos\theta$ is the power factor, where θ is the phase angle which is the measure of how much the applied voltage leads or lags the current in the alternating current (AC) circuit. Hence the energy delivered to the load in a given period of time is given as:

Energy = power x time, which is measured in Kwh.

The main embedded control system is partitioned into five sections: These are

Sensor: The sensor consists of a series resistor in the consumer live cable and a step down transformer across it which constantly measures the voltage of the output based on the current drawn by the consumer. With the help of other electronic circuits like rectifiers and operational amplifiers, the value is cut down to a manageable value that can easily be processed by the control unit.

ADC: The signal to be process at all point is in the form of analogue signal which needs to be converted to a digital signal before it can be processed by the control unit. The ADC is an analogue to digital converter which converts the output from the sensor to digital value to be delivered to the control unit.

Control Unit: The control unit serves as the brain of the whole unit. It consists of a microcontroller and its associated components which deal with the real computations of values and purposely for decision making. With any value exceeding threshold value key on it through the key pad and values stored in the EPROM, it issues commands for the buffer circuit to be activated for further actions to be taken. This can be done to either connect or disconnect individual consumer circuits.

Buffer: The buffer circuit links the control unit and the relay driver circuit. It consists of a group of transistor circuits which are activated to cause current to flow for the groups of relays to make the connections and disconnections of the hot cable wires.

Relay Driver: The relay driver is a group of relays connecting different consumer circuits. They are energized and de-energized based on the decision taken by the control unit through the buffer circuit. They are the only section which interacts directly with the consumer hot wire.

The final product is to be achieved through software implementation (simulation) using MATLAB programming environment.

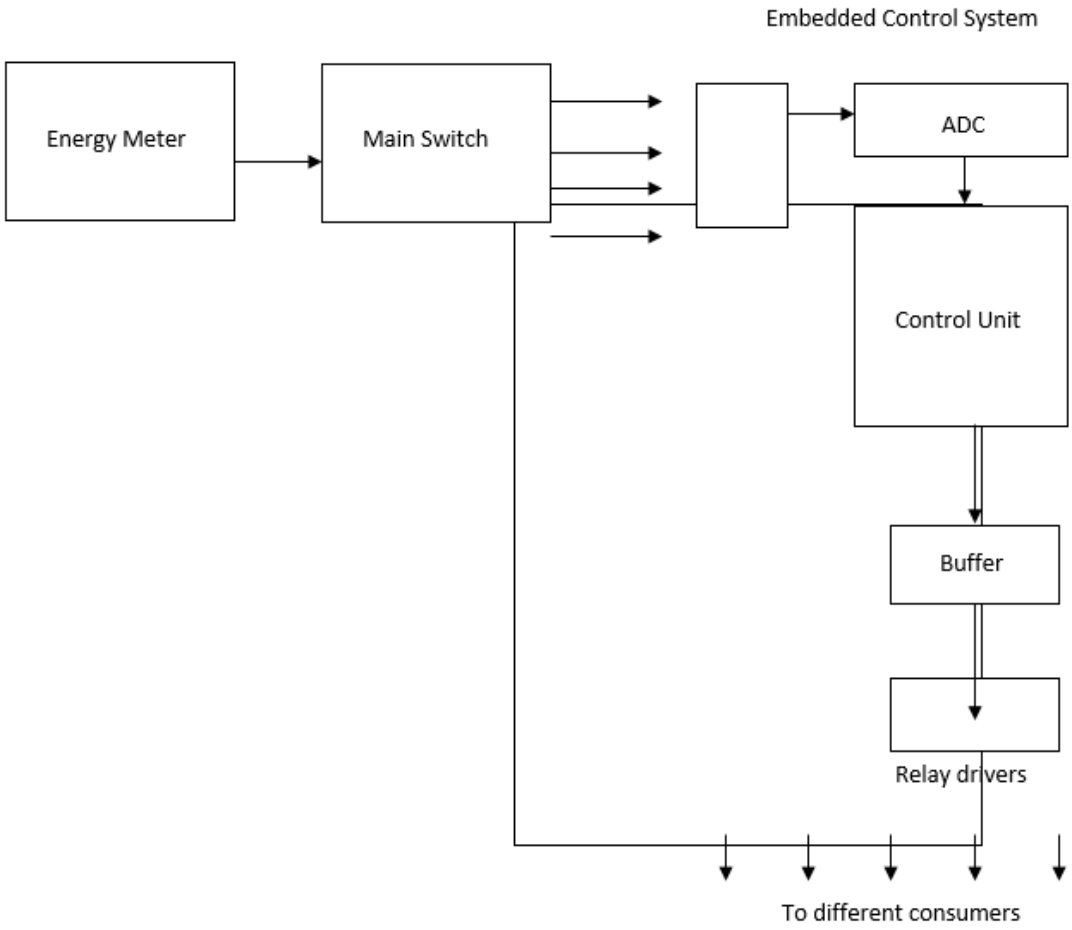

Figure 3. Embedded control system

IV. RESULTS AND DISCUSSION

The table 2.0 is a data used to test the simulation of the Smart Electrical Distribution Switchandthe figure 5 shows a cross-section of multiple power meters installed on a wall of a household in a section of the Sunyani Metropolitan Assembly.

In testing the proposed system, two lines L1 Units and L2 Units showing on the Lead Crystal Display (LCD) of the proposed system, representing two consumers were initialized to 00.0kwh each before connecting load to it. Figure 4(a) shows the initialized figures. Each line was then connected to the same load leading to the same consumption of 2.2kwh and that is shown in figure 4(b). More loads were added to each line, but much more load was added to L2 and it recorded higher consumption than L1. This is shown in figure 4(c).

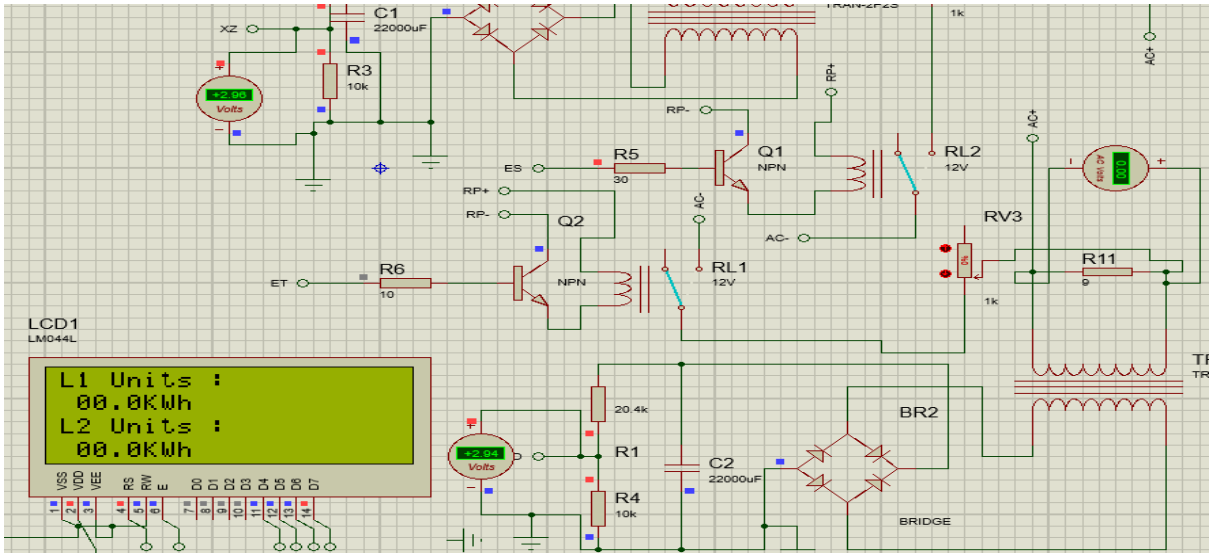

Figure 4(a) showing 00.0khw for L1 and L2

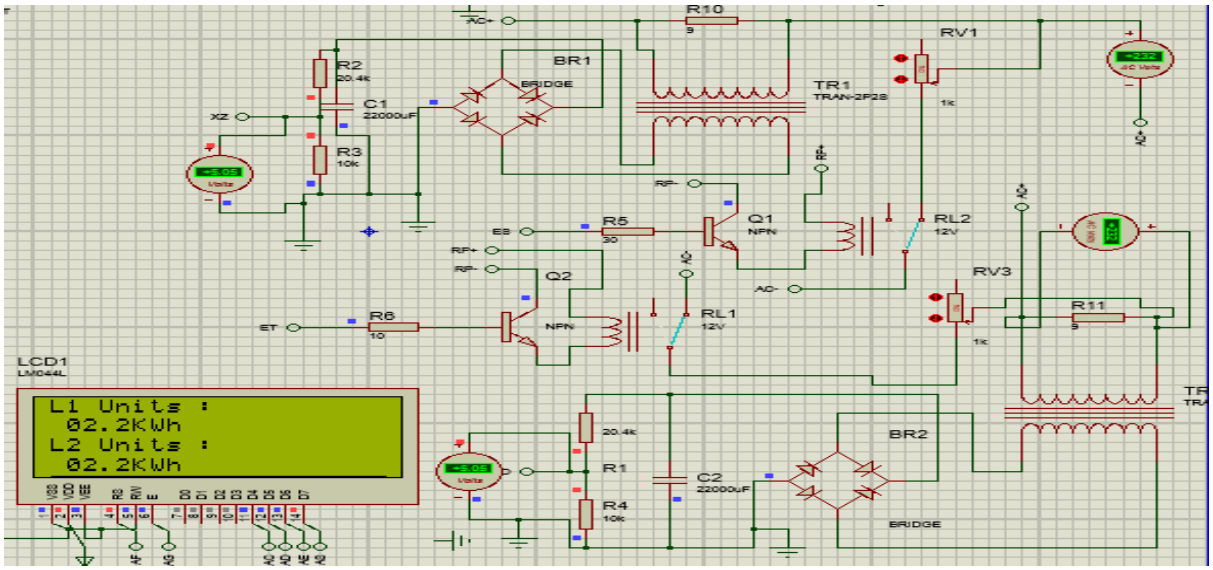

Figure 4b, showing 2.2kwh for L1 and L2

Figure 4(c) showing 09Kwh for L1 and 16Kwh for L2

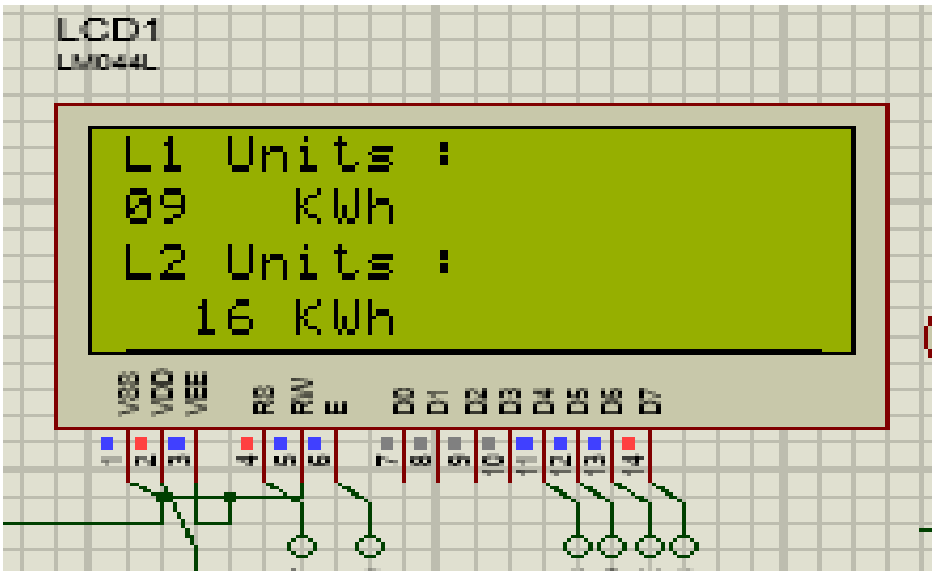

Figure 5a. A postpaid power meter.

Figure 5b shows multiple prepaid power meters on a wall.

The Smart Electrical Distribution Switch proposed also calls for one meter and the amount of power consumed or paid by each contributor is recorded and stored in EPROM of a microcontroller that will reduce each user's power consumption base on the user's consumption rate. It is programed to calculate the electrical power consumed by any device or contributor and it will monitor each contributor's consumption and isolates the user or any appliance from the grid when they are not supposed to consume power and in that case there is saving and better management of power.
The simulated system was loaded up and connected to a device of 2.2kw. As the load absorbed the power supplied, the power reduced until it finally finished. The complete time of consumption of the power was recorded as the simulation time. When the simulated system was loaded up with more power, and maintaining the 2.2kw load, it took more time for the power to finish, hence more time to isolate the user from the system. However, it was observed that a little change or fault can cause the setup to record error and therefore there is the need for optimization in the designing and programming.
The table 1.0 represents a sample of the amount of consumption in Kwh and equivalent unit price in cedi (GHS) and table 2.0 illustrates monthly power consumptions, load (Kw) and the simulation time in minutes.

Table 1.0

User/Energy	Energy/GHS	Energy/Kwh
A	5.0	12.2
B	6.0	14.8
C	9.0	22.0
D	7.0	17.1

(Sample of users' consumptions in money, GHS and their equivalent energy in Kwh)

The figures 6a and 6b hypothetically explains the consumptions in the table 1.0. In figure 6a, the end of each continues vertical line from the E/GHS axis shows that a device or a contributor should not continue consuming power, but they continue to consume and waste power because there is no an automated smart switch to isolate the devices from the grid. However, in figure 6b, the automated Smart Electrical Distribution Switch monitor and control the devices power consumption and isolate the devices from the grid and hence saving power.

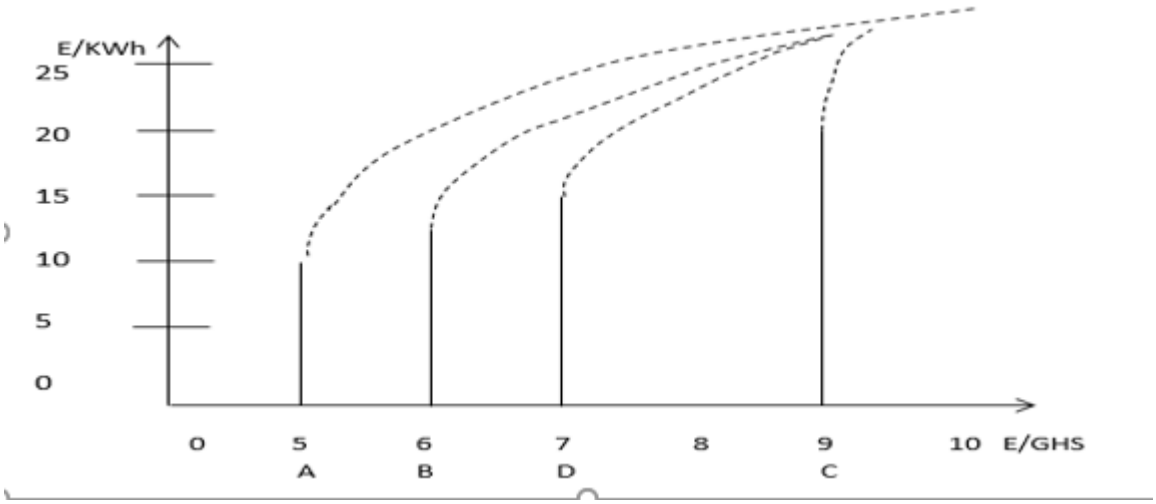

Figure 6a, a graph energy(kwh) against energy(GHS)

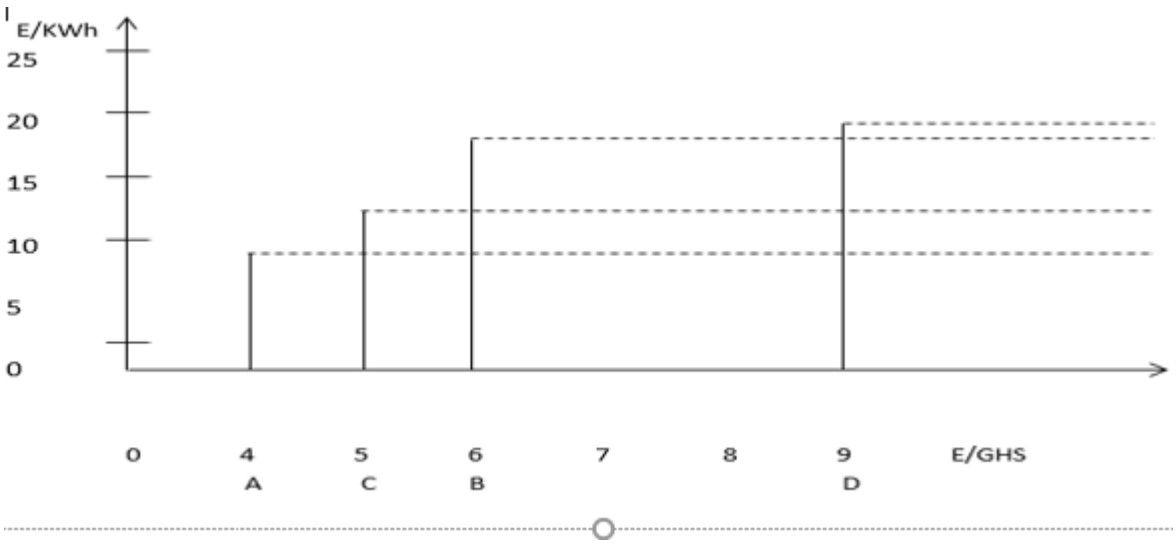

Figure 6b, a graph of energy(kwh) against energy(GHS)

Table 2

MONTH	ENERGY (KWH)	LOAD (KW)	SIMULATION TIME/MINUTE
1	9.70	2.2	1.94
2	14.5	2.2	2.90
3	17.0	2.2	3.40
4	19.4	2.2	3.88
5	9.00	2.2	1.80
6	10.0	2.2	2.21
7	15.0	2.2	2.26
8	16.0	2.2	2.39
9	14.5	2.2	3.90
10	19.3	2.2	3.86
11	19.0	2.2	3.38

(Users energy, load used and simulating time)

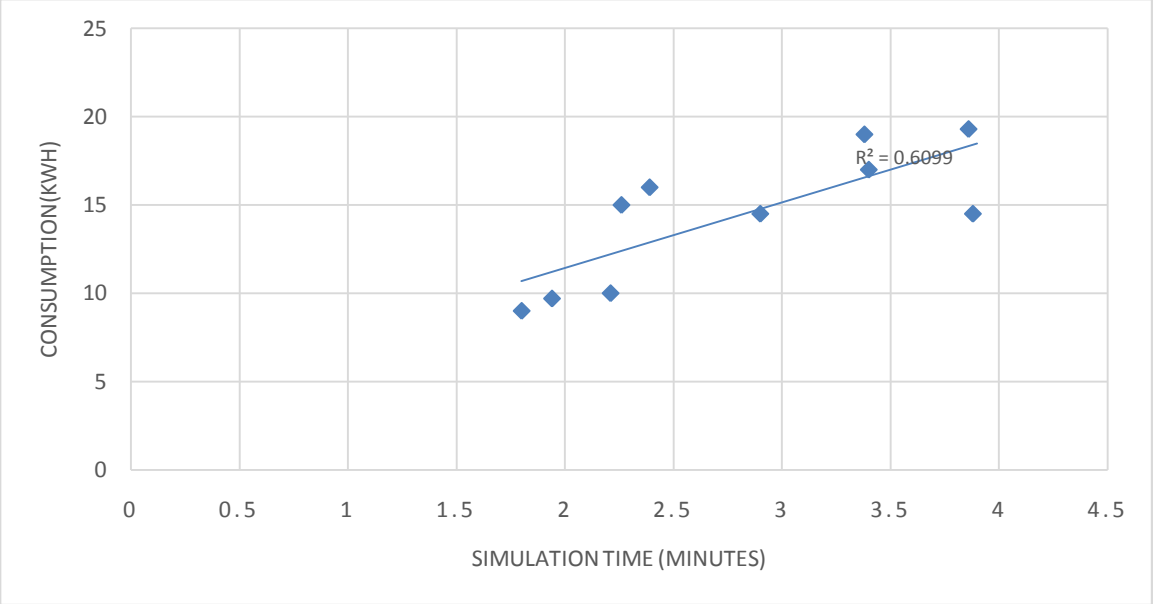

Figure 7. A graph of power consumption (KWh) against Simulation time (minutes)

From the graph illustrated in figure 7, the model is linear and the time is dependent on how long the appliances are used, therefore when the appliances are used for a longer period, the consumption of power is high. The correlation coefficient (R) was 0.78 and that shows that as the time of usage of appliances and load increase the consumption also increases. The SED is programed to appropriately monitor and control the time of usage of the appliances such that an appliance cannot exceed the period of time allocated to it. The system isolates any appliance from the grid whose time expires, hence controlling the amount of power consumption. The proposed system can be used for both credit and prepaid energy meters.

Table 3

	PREPAID HOURLY	POSTPAID HOURLY	PREPAID DAILY	POSTPAID DAILY	PREPAID MONTHL	POSTPAID MONTHL
APPLIANCE	----------	----------	----------	----------	----------	----------
RADIO	0.01	0.01	0.12	0.01	3.60	3.60
BULB(11W)	0.01	0.01	0.12	0.12	3.60	3.60
TV	0.02	0.02	0.19	0.19	6.00	6.00
FRIDGE	0.06	0.07	0.54	0.56	18.00	18.00
IRON	0.09	0.09	1.08	0.99	32.40	32.40
HEATER	0.10	0.11	1.20	1.20	36.00	36.00
FAN	0.05	0.05	0.55	0.55	15.00	15.00

Table 3 shows the hourly, daily, and monthly consumption of the various appliances.

The total monthly consumption can be predicted using the expression:

$T_c = (H*D*C)_1 + (H*D*C)_2 + (H*D*C)_3 + \ldots\ldots + (H*D*C)_n$

$T_c = \sum_1^n (H * D * C)$

Where T_c is the total consumption, H is the average number of hours in a day, Dis the number of days in the month, C is the hourly consumption of a device and n is the number of devices used. If the consumption rates per Kwh at varied consumption are known, the total amount of money per month can be estimated.

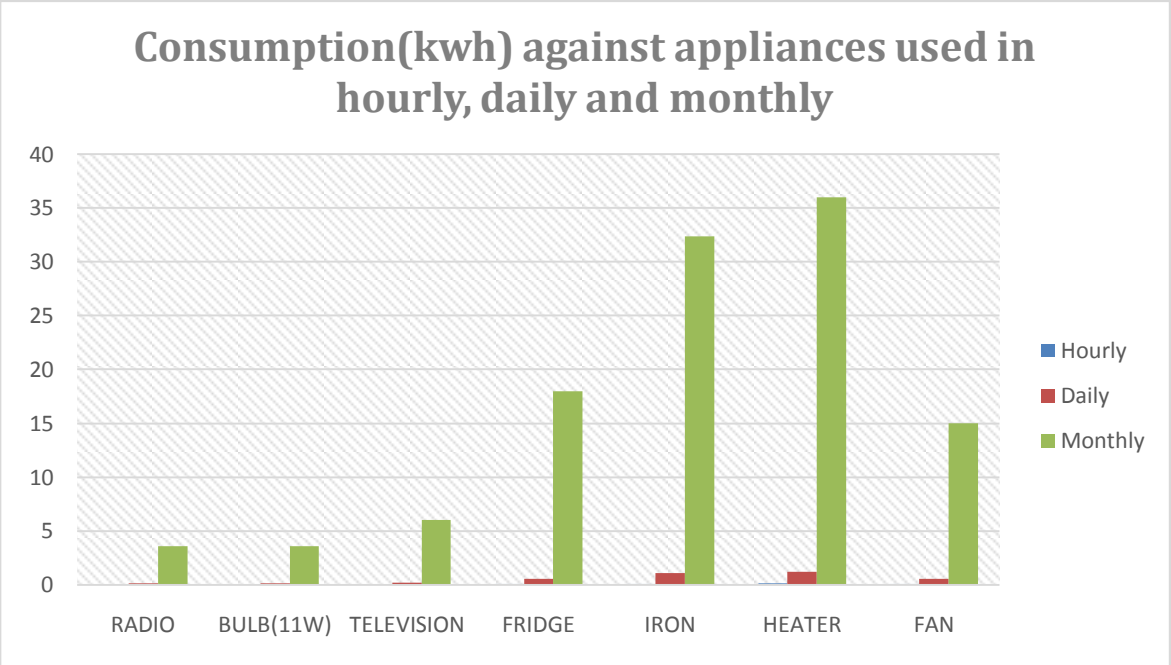

Figure 8, consumption(kwh) of appliances in hourly, daily and monthly.

Figure 8 shows the average consumption in Kilowatt-hour against the various appliances that were used. The water heater consumed higher, followed by the iron, fridge, fan, Television and the radio and bulb. For the water heater and the iron, the consumption for each was so high because these devices have heating coils that consume greater current [25], however, in the case of the Fridge, Television, fan, radio and the bulb their consumptions were moderate. It also shows that it will be difficult to use a short term like hourly or daily to make an accurate prediction of load consumption, however, the hourly and daily consumption of various appliances can be used to predict the monthly consumption.

V. Conclusion

The study is about electrical power usage in households and aims at proposing Smart Distribution Switch for monitoring and controlling the electric power consumption of devices in households and the usage of it helps to preserve power and avoid power wastage by isolating a device that is not in used at any giving time and can also be used in both rural and urban areas. The findings will help to eliminate the difficulties and the limitations that exist in the manual monitoring of power and will also help consumers to plan well on which appliances to use and how long to use them and it helps in the prediction of household power consumption. The right amount of power a consumer decides to use is what is consumed and therefore there is better management of power usage that avoid power wastage. It was observed that a little change or fault can cause the setup to record error and therefore there is the need for optimization in the setup and programming.

REFERENCE

[1] S. S. Ali, "Switching Gears for Smart Distribution," Electrical and Power Review Magazine, 7 June 2018.

[2] C.-C. L. a. Y. X. Yazhou Jiang, "Smart Distribution Systems," 19 April 2016. [Online]. Available: http://www.mdpi.com/journal/energies. [Accessed 30 March 2021].

[3] C.-C. L. a. Y. X. Yazhou Jiang, "MDPI," 19 April 2016. [Online]. Available: htpp:/www.mdpi.com/journal/energies. [Accessed 30 March 2021].

[4] M. E. T. a. T. B. Martinez-Pabon, "Smart meter data analytics for optimal customer selection in demand response program," Energy Procedia, pp. 49-59, 2017.

[5] S. W. L. D. V. Depuru, "Depuru, S.S.R., Wang, L., DevabhSmart meters for power grid: challenges, issues, advantages and status.," Energy Rev., no. 15, pp. 2736-2742, 2011.

[6] R. Shahrara, "semanticscholar.org," January 2011. [Online]. Available: https://www.semanticscholar.org. . [Accessed September 2015].

[7] S. Kabunda, "The Smart Switch and its supporting role in Smart grids," Engerati, 2015.

[8] S. S. Ali, "Switching Gears for Smart Distribution," Electrical and Power Review Magazine, 7 June 2018.

[9] S. Saxena, "Switching Gears in Smart Distribution," Electrical and Power Review Magazine, 7 June 2018.

[10] h. s. g. s. r. 2014., "http://energy.gov/sites/prod/files/2014/08/f18/ smart grid system report 2014.," 18 August 2014. [Online]. Available: http://energy.gov/sites/prod/files/2014/08/f18/ smart grid system report 2014.. [Accessed 18 August 2014].

[11] Telefonica, "m2m.telefornica.com," 2014. [Online]. Available: https://m2m.telefonica.com/multimedia-resources/the-smart-meter-revolution-towards-a-smarter-future. [Accessed 31 January 2014].

[12] C.-C. L. a. Y. X. Yazhou Jiang, "Smart Distribution Systems," MDPI, no. 9, 2016.

[13] D. A. Shomuyiwa and J. O. Ilebare, "Design and implementation of Remotely-monitered Single-phase smart energy meter via short message service (sms)," International Journal of Computer, 2013.

[14] R. Shahrara, "semanticscholar.org," January 2011. [Online]. Available: https://www.semanticscholar.org. [Accessed September 2015].

[15] Fawzial-naima and Bahaajalil, "Building a prototype prepaid Electricity Metering," International Journal of Electrical and Electronics Engineering, vol. 1, no. 1, 2013.

[16] Rajesh Parvathala, T. Venkateswarareddy, N. V. G. Prasad, "Arm Based Wireless Energy Meter Reading System along with power on/off circuit," International Journal of Engineering and Advance Technology, 2012.

[17] A. Singh, "Abstract on prepaid Electricity meter," Academia, 2013.
[18] S. Darby, "Effectiveness of feedback on energy consumption," Academia, 2006.

[19] E. A. F, "Electricity Power detection theft using wireless prepaid meter," Academia, 2011.

[20] F. Al-Naima, "Building a prototype prepaid Electricity Metering," International Journal of Electrical and Electronics Engineering, 2013.

[21] A. Z. a. M. X. H. A Gabber, "Smart energy grid engineering," Academic Press, pp. 433-452, 2017.

[22] G. wireless, "In-Tunnel wireless solutions report," Gap Wireless, Ontario, 2021.

[23] L. Eric, "www.microchip.com," 21 July 2013. [Online]. Available: https://www.microchip.com. [Accessed 21 December 2017].

[24] G. S. A. V. J. S. S. Syed Sajjadh Ali, "Switching gears for smart distribution," Electrical &Power Review Magazine Editorial, India, 2018.

[25] R. A. S. a. J. S. Faughn, Holt Physics, Houston, TX, U. S. A: Holt McDougal, 2006.

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Technological innovation due to Lightning effects on the reliability of Power Distribution Systems in Colombia

HoracioTorres-Sanchez[1]

Featured Application: The technological innovation presented in this paper can be implemented in any power distribution system that is located in an area of high lightning activity.

ABSTRACT

The failure of distribution transformers, mainly in rural areas of very high lightning activity, has been a constant problem for the reliability of Power Distribution Systems in Colombia in recent decades. Research centers and consulting firms have carried out particular diagnostic work and specific solutions. However, to date, the problem persists, with costs that exceed million dollars per year. An important portion of transformers present failures rates 45 times higher than normal and very large overhead lines, representing a high portion of the total system, present very high failure rates over 70 times higher than in normal weather conditions. Initially, a theoretical and laboratory study was carried out with models of distribution transformers and later a systematic study was carried out in the field. The main contribution of this paper is to present a technological innovation in the design, manufacture and installation of prototype transformers that operate satisfactorily in areas of high lightning activity, thus improving the reliability of electrical power systems.

Keywords: *Lightning, tropical region, reliability, technological innovation, distribution transformer*

I. Introduction

It is estimated that at any one time there are about 2000 electrical storms on the earth, generating about 100 lightning strikes per second. The highest incidence occurs in the three areas with the highest deep tropical convection [1, 2]: Tropical South America, Central Africa and the maritime continent.

Colombia, located in the intertropical confluence zone (Tropical South America), has one of the highest atmospheric activities in the world, with a number of lightning strikes per year in excess of ten million. Although the lightning protection methods developed by researchers worldwide apply in Colombia, the parameters estimated in other latitudes are not necessarily applicable in tropical region [3, 4, 5].

The economic and social costs that Colombia currently assumes due to this risk factor represent incalculable losses in human lives, livestock, trees, facilities and equipment; and for the power energy companies, it is the biggest cause of outages and low reliability.

In particular, regarding the failures in distribution transformers in rural areas, and the consequent losses, in the Research Program on the Acquisition and Analysis of Signals (PAAS-UN) of the National University of Colombia, a direct observational correlation was be inferred between the areas of high risk due to lightning and the mortality of distribution transformers. In this way, in this program a specific alternative solution was proposed for this case.

Several investigations have shown that one of the most lightning active areas in the world is located in Colombia [6, 7]. The lightning phenomenon has its maximum occurrence in tropical regions and its physical parameters present variations compared with those typically observed in other regions of the world [4-24]. The most lightning-active zones worldwide is the region that connects the Magdalena River Valley in Colombia with the Catatumbo region in Venezuela [6].
Besides the geographical location, the big mountains in this region represent very lightning dense locations, which are within the highest Ground Flash Densities - GFD reported [5]. This last paper investigates the effect of the lightning activity in Colombia on the reliability of power distribution systems and tries to state whether lightning is responsible to the major portions of the value of reliability indexes such as system interruption duration index (SAIDI) [25].
In order to achieve that a solution to an engineering problem is efficient, adaptable, economical and thus improve the reliability of an electrical power system, it is necessary to guarantee three phases that must be integrally related:

- Comprehensive diagnosis of the problem,
- Technological alternatives and implementation of the solution,
- Control and monitoring of variables

A Comprehensive Diagnosis implies:

• Evaluation of the studies and previous solutions that have been carried out
• Analysis of the Causes of the problem and its Effects
• Characterization of the environment
• Technical and economic indices for evaluation After the Comprehensive Diagnosis of the problem, we proceed to propose technological alternatives for solving the problem.

Once these alternatives have been analyzed, one or more is chosen and the proposed solution is designed and implemented in a comprehensive manner. To do this, you must take into account:

• Mathematical modeling of each and every one of the system components
• On-site and laboratory measurements
• Appropriate designs, technically and economically feasible
• Adaptation and Improvement of variables: Networks, Equipment, Protections, Improvement of grounding.
• Proper handling and installation

Finally, a control, monitoring and maintenance of the implemented system (protections, grounding, equipment, network) is necessary, in such a way that solutions can be adjusted or improved, the implementation is maintained in optimal conditions and reliable conclusions can be inferred about the solution.
These three phases of the methodology can take several years and their costs are relatively high. But, in the face of a chronic problem, such as the failure of distribution transformers and the reliability of electrical power systems, this methodology is much more economical in the medium and long term than the short-term, conjunctural and punctual solution such as Generally, these types of engineering problems are attacked in Colombia.
The following describes how the proposed methodology was developed, implemented and applied in order to improve reliability and the solution to the problem of failure of distribution transformers for the Colombian Power Distribution Companies. This methodology can be implemented in any power distribution system that is located in an area of high lightning activity.

II. Materials and Methods

2.1 Applied Methodology

Based on the high mortality of distribution transformers, a continuous, systematic, methodological research project was proposed to a Colombian Electric Power Company, with the aim of contributing to find technical-economic solutions, on firm and objective scientific and technological bases to the high mortality of distribution transformers to improve their reliability.

In the first phase of this research project, an evaluation of the previous studies and the existing information was carried out, both on mortality of transformers and the environment (atmospheric electric discharges, easement, grounding, handling and installation) in order to carry out a comprehensive diagnosis and propose preliminary hypotheses to seek an objective solution to the problem.

In the second phase, the contingencies to which a rural distribution electrical system may be subjected were raised and the theoretical design, construction and laboratory tests of an appropriate transformer for areas of high lightning activity were developed. Subsequently, an Experimental Pilot Circuit EPC located in an area of high mortality of transformers and Severe Risk from lightning was selected, with the aim of implementing technological innovations found. During three continuous years the behavior of the EPC was monitored.

Complementary, the main variables that directly affect the failure of transformers were controlled, such as: growth of trees around the easement area, handling and installation of the transformer, electrical components of the network, protection elements, starting resistance ground and atmospheric electrical activity in the area. The latter was monitored through the Colombian Lightning Location Network. A control, monitoring and maintenance of the implemented system (protections, grounding, equipment, network), allow minor adjustments and keep the solution in optimal conditions.

The process of monitoring the variables that was carried out shows that, despite the more than 130 lightning strikes that have struck less than 100 m from the EPC in three years, the technological innovations implemented have responded satisfactorily.

2.2 Analysis cause – effect

The failure of a distribution transformer occurs due to the interaction of various factors, which deteriorate it to a greater or lesser degree, leading to its final failure [4]. One of the most useful analysis tools for processes of this type is the Cause - Effect diagram, also known as the Ishikawa diagram (see Figure 1), which allows observing the interactions between the different factors in-volved and giving guidance on technological alternatives from solution.

To develop the Cause - Effect diagram, the following steps were followed:

• All relevant factors were identified by consulting the existing bibliography and subsequent discussion with expert engineers on the subject.
• The component subsystems of the system involved in transformer failure (transformer, load, network and environment) were determined.
• A diagram was prepared, Figure 1, which characterizes each subsystem of the system.
• The elements of each subsystem were chosen, taking into account which ones are susceptible to technological innovation and which can only be monitored.

The electrical distribution system for analysis is broken down into:

The Transformer, which in turn breaks down into a subsystem that involves:

• Design (Coils, Core, Accessories, Tank, Insulation Level - BIL)
• Transformer construction process
• Operation and maintenance of the transformer

The Network, like the transformer, breaks down into design:

• Civil (Configuration, Route, Structures)
• Electrical: Protections (Surge Arresters, Circuit Breakers, etc.) Parameters (Power, Voltage, Regulation, etc.) Isolation Level (BIL) Grounding
• Construction process of previously designed elements (civil and electrical)
• Operation and maintenance of the network as a whole (Protections, structures and grounding)

The load, which is considered a subsystem composed of:

• Planning by the Energy Company, in which electrical parameters are taken into account (power, voltage, regulation)
• Operation by the user, being regulated by the energy supplier company.

The system environment, which is considered to be composed of:

• Natural phenomena that intervene in the fault (atmospheric electric discharges, wind, vegetation, etc.)
• Unnatural phenomena (pollution, human errors, vandalism).

An analysis of the Cause - Effect diagram and the 26 previous studies [4] related to distribution transformer failure, carried out in Colombia by consulting firms, energy companies and universities were analyzedand show that transformer failure has tried to be solved by modifying only the elements that make up the network, such as structures, protections, grounding, insulation, but not the transformer itself.
The 26 studies were classified into five groups as follows: Selection of protections; Analysis of Atmospheric Electric Discharges; Manufacture, selection and handling of transformers; Failure analysis, insulation coordination and Models.
A common aspect of the 26 studies is that none of them took into account the distribution transformer and its electromagnetic environment; raised the solution's supervision indexes and neither was a short- and medium-term follow-up, by monitoring and control of the proposed solution, nor cost / benefit ratio of the solution.
The failure of a distribution transformer occurs due to the interaction of various factors, which deteriorate it to a greater or lesser degree, leading to its final failure. One of the most useful analysis tools for processes of this type is the Cause - Effect diagram, also known as the Ishikawa diagram[26] (see Figure 1), which allows observing the interactions between the different factors involved and giving guidance on technological alternatives from solution.

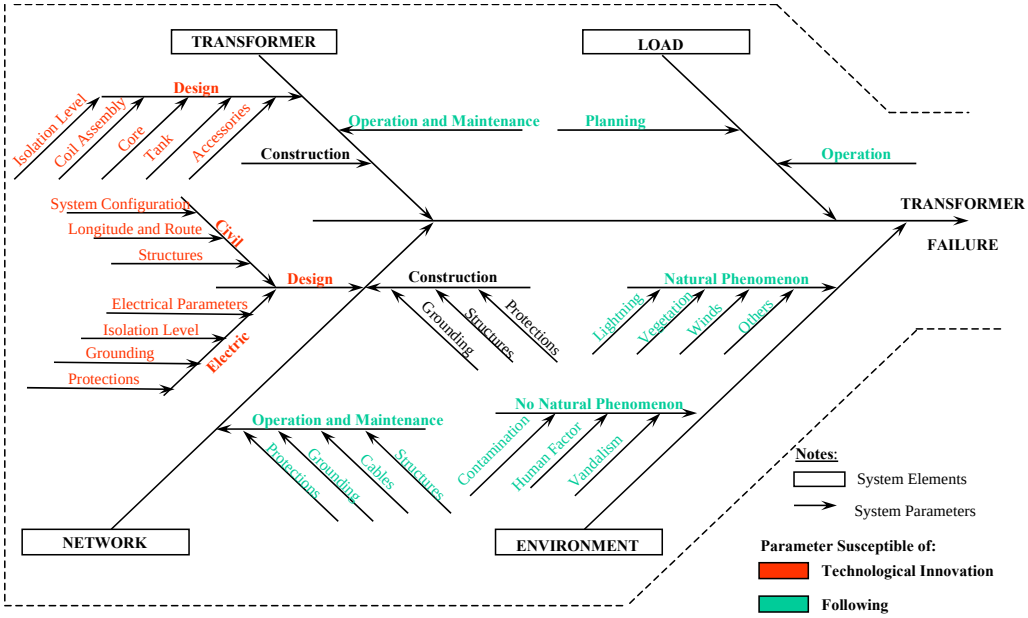

Figure 1. Diagram Cause-Effect for transformer failure analysis

To develop the Cause - Effect diagram, the following steps were followed:

- All relevant factors were identified by consulting the existing bibliography and subsequent discussion with expert engineers on the subject.
- The component subsystems of the system that intervene in transformer failure (transformer, load, network and environment) were determined.
- A diagram was prepared, Figure 1, which characterizes each subsystem of the system.
- The elements of each subsystem were chosen, taking into account which ones are susceptible to technological innovation and which can only be monitored.

2.3 Characterization of the environment

In studies on atmospheric electric discharges, carried out by the PAAS-UN Research Program, for more than 40 years, it has been found that Colombia, due to its geographical location in a tropical zone, presents variations in the magnitudes of the lightning parameters with respect to other latitudes [5], [6], [7].

Based on the multiannual data obtained from the Colombian Lightning Location Network for the Average Peak Current and the Ground Flash Density GFD, a Lightning Risk Factor matrix was elaborated [3] which indicates that there are areas in Colombia Severe, High, Moderate and Low Risk Level. See Figure 2.

The Lightning Risk Factor matrix was developed within the Colombian Technical Standard [3] based on the principle that the magnitude of the lightning current and the GFD, are the primary sources of damage. The 4 sources of damage and the 4 causes of damage were statistically analyzed, according to the methodology of the IEC 62305 Standard [26] and the multi-year data obtained with the Colombian Lightning Location Network [5].

LIGHTNING RISK FACTOR				
Ground Flash Density GFD [Flashes/km²- Year]	R_{iabs} R_{GFD}	**Average absolute peak current [kA]**		
		$40 \leq I_{abs}$	$20 \leq I_{abs} < 40$	$I_{abs} < 20$
$30 \leq GFD$	1	1.000	0.895	0.790
$15 \leq GFD < 30$	0.75	0.825	0.720	0.615
$5 \leq GFD < 15$	0.50	0.650	0.545	0.440
$GFD < 5$	0.25	0.475	0.370	0.265

SEVERE HIGH

MODERATE LOW

Figure 2. Lightning Risk Factor

Figure 3 presents the Lightning Risk Factor Map of the Power Companyobtained based on Lightning Risk Factor. Its distribution, as can be seen, is not homogeneous, presenting areas of Severe Risk for Lightning in the Northwest, where an Experimental Pilot Circuit EPC waschosen to apply the proposed methodology.

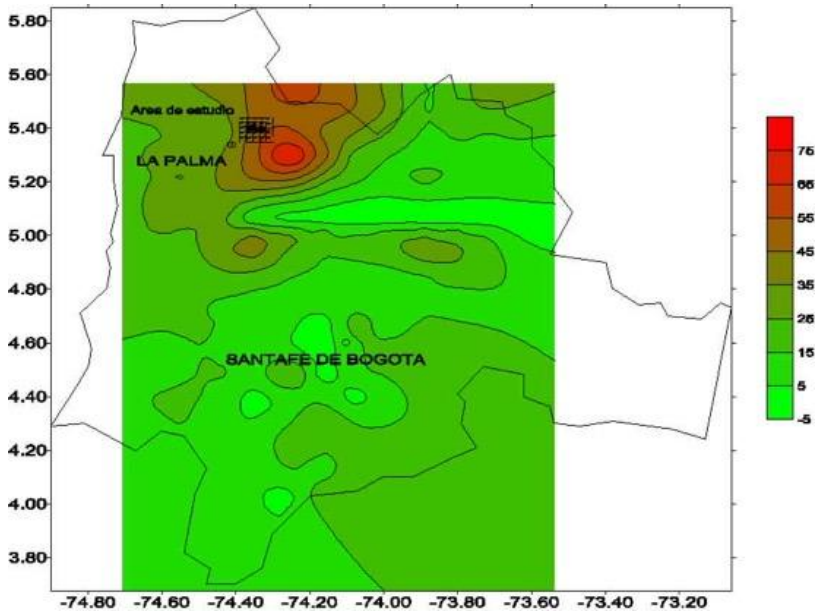

Figure 3. Lightning Risk Factor Map

An evaluation of the information available at the Electric Power Company on transformer failures shows highly correlated results between the areas of high mortality of transformers and Severe Risk from Lightning, as presented in the map of Figure 4 of Mortality of Transformers.

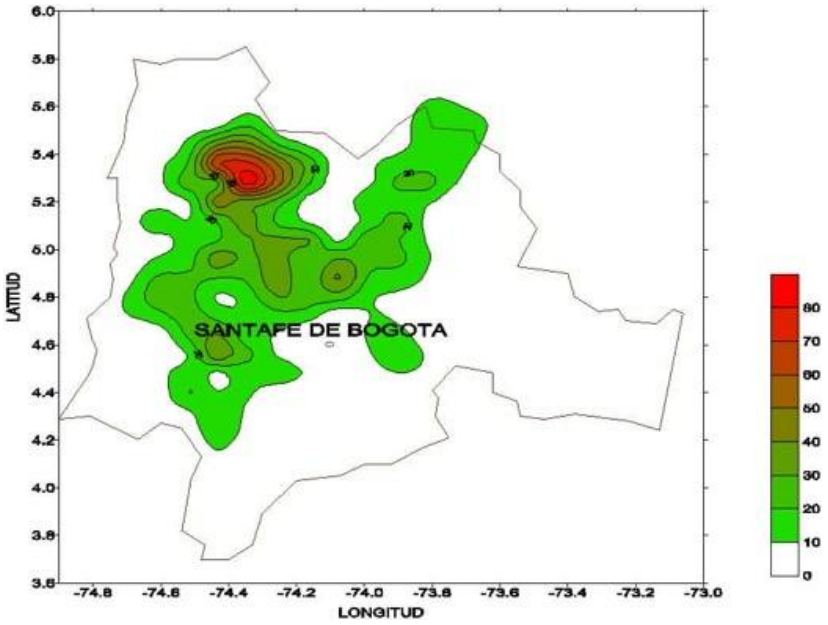

Figure 4. Distribution Transformer failure Map.

This observation raised the need to study in more depth the designs, modeling, maintenance, operation, handling and relationship of the transformer with the electromagnetic environment.
As an element of the diagnosis and follow-up, failure rates were studied for the transformers of the Power Distribution Electric Company, presented in Figure 5. The Useful Life Index was prepared with a sample of 2500 transformers. According to the Lightning Hazard Index, it was divided into three zones: Severe (81-100%), Moderate (41-80%) and Low Risk (0-40%).

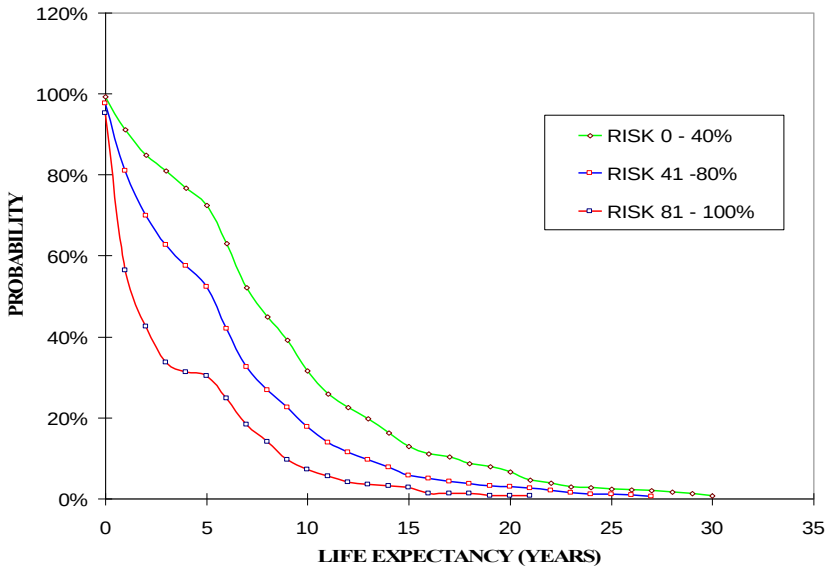

Figure 5. Probability of life expectancy [4],[5]

These curves show years of useful life of distribution transformers well below that guaranteed by the manufacturing companies, with values of 50% probable of 2 years for areas of Severerisk due to lightning, 6 years for Moderate risk and 8 years for areas of Low risk.

2.4 Electromagnetic Compatibility Zones (Lightning Risk Factor)

Reviewing the bibliography on the historical development of the measurements and estimates of the lightning parameters [4-24], a methodology was used that compared averages and characterized

regions. When researchers in lightning physics proceeded to classify the different regions of the earth, according to the different measured lightning parameters, they only took into account data from local measurements from northern latitudes and generalized them to the entire planet [8]. Thus, even today in the specialized literature (CIGRE) and in international technical standards (IEEE, IEC, NFPA) [27], [28], [29] there are probability distribution curves, for example, for the Lightning Return Current, measured in temperate latitudes. such as Europe, which are recommended to be used in lightning protection design, insulation design in electrical machines, shielding design in transmission lines, for any part of the world.

According to the IEC 801-3 [30] standard on Electromagnetic compatibility for industrial-process measurement and control equipment, the Electromagnetic Compatibility (EMC) is defined as the ability of electrical or electronic equipment or system to operate satisfactorily in its electromagnetic environment. Operating satisfactorily means not introducing intolerable disturbances in that environment or other equipment and withstanding those produced by the electromagnetic environment or other equipment or systems.

The design parameters of most electrical and electronic equipment have been estimated at non-tropical latitudes. However, on a local scale, in a tropical environment, their particular operating conditions do not always coincide with the conditions for which they were designed; that is, the electromagnetic environment in which they will operate is not taken into account. A better knowledge (characterization) of the requirements of the electromagnetic environment existing in the Colombian tropical environment can quantify the levels of disturbance and the interaction between sources and receivers (the environment and the equipment or systems).

Said characterization leads to the proposal of zoning the phenomenon of the disturbance of atmospheric electric discharges, determining Electromagnetic Compatibility Zones; being able to arrive at the proposal of changes in the design of equipment and in the construction standards of the Company, which can later be taken to national technical standards.

After the Comprehensive Diagnosis of the transformer failure problem, we proceed to propose technological alternatives to solve the problem. Once these alternatives have been analyzed, one or more is chosen and the proposed solution is designed and implemented in a comprehensive manner.

2.5 Modeling of capacities and inductances of distribution transformer

Normally the coils of standard distribution transformers of small rating powers (5-112.5 kVA) are manufactured in elliptical shape.

The ellipse is still a complicated geometry, therefore, to find the capacity between these two elements, the mathematical method of Conformal Transformation is used, or "Conformal Mapping", which allows the solution of problems with value at the border, within the theory of the potential calculation. With this, the transformation of a "complicated" region into a simpler one in the new plane is achieved, making use of the axiom: "The capacity is invariant under a conformal transformation".

The deduced expression starts from two elliptical elements of infinitesimal thickness, confocal and with greater radii R_1 and R_2. By doing two successive transformations to the region between these two ellipses, we arrive at the expression of the equation:

$$C = \frac{2.\pi.\varepsilon.l}{arcosh(R_2/c) - arcosh(R_1/c)} \qquad [F]$$

Where:

$\in$ = $\in_0 \in_r$

$\in_0$ = Empty permittivity = 8.85*10-12 [F/m]

$\in_r$ = Relative permittivity of dielectric.

l = Winding height [m]

R_1 = Major semiaxis of curve 1 [m]

R_2 = Major semiaxis of curve 2 [m]

c = Coordinate of focus [m]

The inductance calculation expressions reported in the literature are applied to windings of circular section. When the winding geometry does not present a cylindrical symmetry, they do not allow to reliably evaluate the inductance value, being necessary to propose new expressions for its calculation. The starting point for the calculation is the Neumann equation [31], which expresses the mutual inductance between two circular elements in free space, separated by a distance (d) in space. Posing this equation in mathematical terms, using the equivalent radii r_1, r_2 of the parametrized ellipses as a function of an angle ψ, an expression is obtained that represents the mutual inductance between two elliptical elements.
Generalizing the equation found for two windings of lengths l_1 and l_2 with N_1 and N_2 turns respectively, with a separation distance between the two layers equal to zero (for coaxial coils), we find the equation:

$$M = \mu_0 N_1 N_2 \int_{-l_2}^{l_2} \int_{-l_1}^{l_1} \int_{0}^{\pi} \frac{r_1 r_2 \cos\psi' \, d\psi' \, dz_1 \, dz_2}{\sqrt{(z_1 - z_2)^2 + r_1^2 + r_2^2 - 2 r_1 r_2 \cos\psi'}}$$

Where:

N_1, N_2 = Number of turns per unit length of each winding in the axial direction.
ψ '= Angle of azimuth.

The parameters of each and every one of the designed and built transformers were measured in the laboratory and compared with the mathematical models developed for the EMTP / ATP digital program. The results of more than 50 transformers tested in the laboratory and modeled in the EMTP / ATP show a very good correlation between the values obtained with the mathematical model of the distribution transformer and those obtained in the measurement, with errors that did not exceed 10%.
A sample of these results of calculated and measured,at a frequency of 60 Hz, ofInductances and Capacities values is presented in Table 1.

Table 1. Arithmetic average value of capacitances and inductances measured at a frequency of 60 Hz.

Coil	C_g HV (pF)	C_g LV (pF)	C_{HV-LV} (pF)	L_{HV} (mH)	L_{LV} (mH)
Calculated value	471.2	621.8	897.1	662.9	305.8
Measured value	424.0	649.0	817.0	468.5	268.8

2.6Modeling in EMTP / ATP digital Program and evaluation of the Transferred Pulse
The digital program for the analysis of electromagnetic transients (EMTP / ATP) allows, with the help of an adequate modeling, the prediction of the behavior of electrical systems in steady state conditions or in transitory state conditions.
In this research, the EMTP / ATP was used to evaluate the behavior of the system in terms of overvoltage present in the network, transformers, surge arresters and load, when lightning impacts occur on the distribution network, depending on the different types of installed transformers.
Three models were developed for each transformer, each one of which allows representing its behavior for different frequency ranges, taking its constructive simplicity as a premise. The methodology used to derive these models has as its starting point the classical circuit network used to represent the behavior of transformers at 60 Hz, gradually adding the capacities and observing their behavior when different excitation waves are applied, simultaneously comparing with the experimental results.
The first of them corresponds to the low frequency model, which adequately represents the single-phase transformer up to a frequency of the order of 2 kHz, with any type of signal. The medium frequency model, for frequencies between 2 and 250 kHz and finally the high frequency model with which the behavior of transformers can be adequately represented before transient phenomena such

as the impact of lightning. Every model must comply with a general rule in which both its constructive simplicity and the degree of accuracy to be obtained are related.
The modeling was done using the TRANSFORMER subroutine, which allows modeling, in addition to the resistances and stray reactance of each of the windings, the magnetization branch through a resistance representative of the losses in the core, in parallel with a Non-linear element that corresponds to the magnetization characteristic of the material. The EMTP / ATP program has different sources to simulate different types of signals, sine waves, pulse, square etc.
With the help of the transformer model for high frequencies developed for the EMTP / ATP, the measurements carried out on the different types and powers of transformers and theoretical calculations, the mathematical models of each and every one of the types and transformer powers, in order to evaluate the phenomenon of voltages transferred between the high voltage winding and the low voltage winding and, in this way, analyze which is the best configuration for it.The main change in the design of the prototype PROT transformer was the placement of the High Voltage winding - core, that is, in contact and isolated from the core. With this change, the capacity between high and low voltage changes with respect to a standard design and the transferred pulse decreases. By placing the high voltage coil-core, the insulation must be increased and the BIL of the transformer increases.In section 3 of this paper the other characteristics of the prototype transformer PROT are presented.
The objective of the simulations presented below was to compare the behavior of the transformer that we have called New Design Prototype PROT with that of standard design transformers.

For this purpose, the following types of transformers were chosen:

- Standard design transformer, BIL 95 kV. Low vs. Core Construction. (to be called from now on TYPE 1: 95 BN).
- Standard design transformer, BIL 95 kV. High construction against core. (to be called from now on TYPE 2: 95 AN).
- Standard design transformer. BIL 150/45 kV. Low vs. Core Construction. (to be called from now on TYPE 3: 150 BN).
- Prototype transformer new design PROT. BIL 125/30 kV. High Voltage winding - core, that is, in contact and isolated from the core. (Called TYPE 4: PROT).

The simulations were performed by comparing the transformers separately, based on the pulse transferred from unit step and pulse waves, to a setup like the one shown in Figure 6.

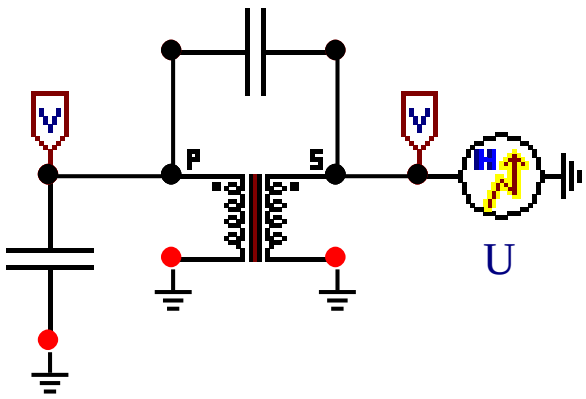

Figure 6. Transformer model in the EMTP / ATP for transferred pulse analysis

Figure 7 were obtained, for each of the four types of transformers. As can be easily observed, the New Design Prototype PROT transformer presents pulse voltage values transferred from Primary to Secondary 4 times lower than the standard manufacturing type with increased BIL and 6 times lower for standard type transformers.

After simulating each of the transformers individually, we proceeded to simulate each of the system components (surge arresters, grounding, lines) and completely the experimental circuit.
The characteristics of the Experimental Pilot Circuit EPC that were taken into account for the simulation were the following:

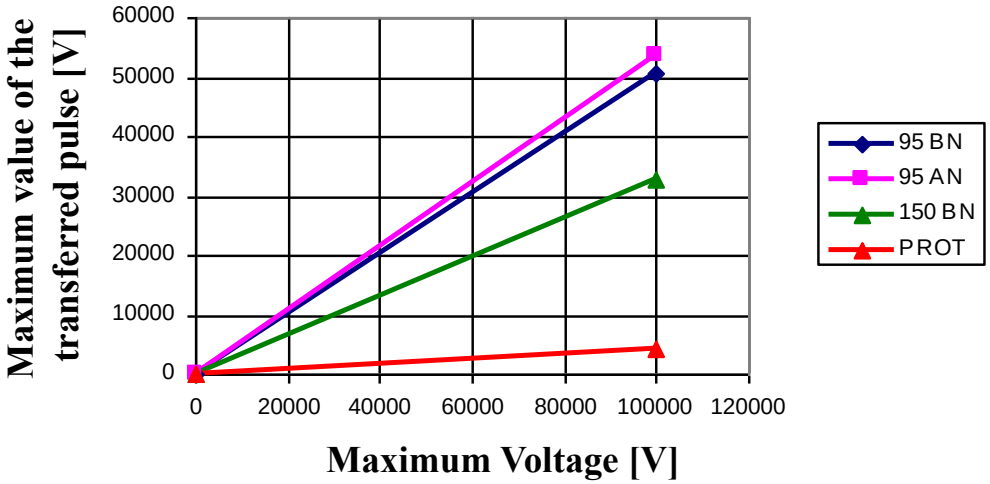

Figure 7. Pulse transferred for four types of transformers (lightning wave)

- Two simulations of the complete circuit were made calculating the parameters of the lines for high and low frequency using the JMarti model of variable parameters with frequency.
- The structures used are 12m high and have a 6m separation between high voltage conductors. In low voltage, single-phase lines of 100m in length and a separation of 40cm between the conductors were simulated.
- Soil resistivity was assumed to be constant 500 Ohm-m at all sites in the network.
- It was assumed that the loads connected to each of the phases were approximately balanced.
- The load connected to each of the transformers is the same as that placed in the simulations of the transferred pulse.

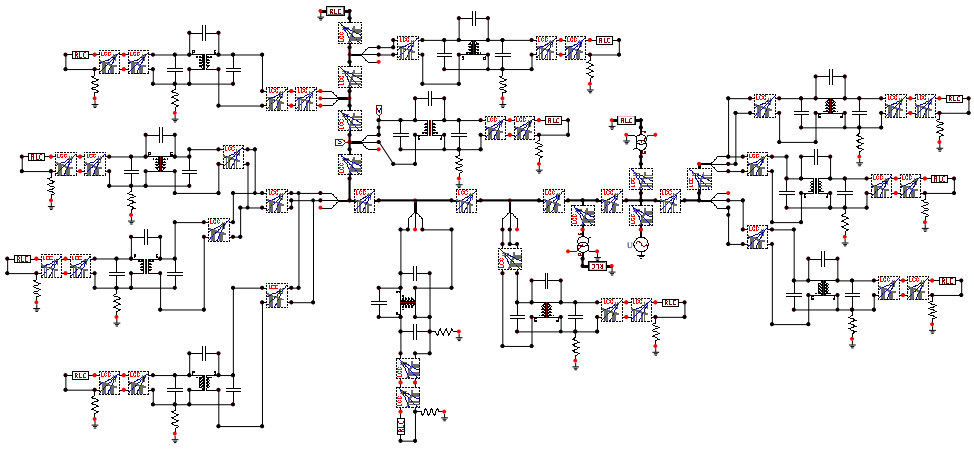

Figure 8. Experimental Pilot Circuit EPC mounted on the EMTP / ATPDraw digital program.

The simulations that were carried out are of typical events that occur in distribution networks in areas of high lightning activity.In the EMTP / ATP model of figure 8 lightning wave impacts were randomly modeled at different points in the network.

2. 7 Field implementations of the proposed solution

The EPC selected with the information on lightning activity for the last 5 years and an average useful life of the transformers of less than 2 years, is a rural three-phase medium voltage network, 13200 kV, with wooden poles and guard cable. 14 standard transformers of different nominal capacities (from 5 to 112.5 kVA) with their corresponding surge arresters.

The EPC circuit model where the Prototype New Design PROT transformers were installed corresponds to the one located in a rural municipality with high lightning activity (GFD greater than 10 lightning strikes / km2-year, see figure 3), whose single-line diagram is shown in Figure 9.The EPC has an approximate length of 7.5km and is comprised within a 6km x 3km area.

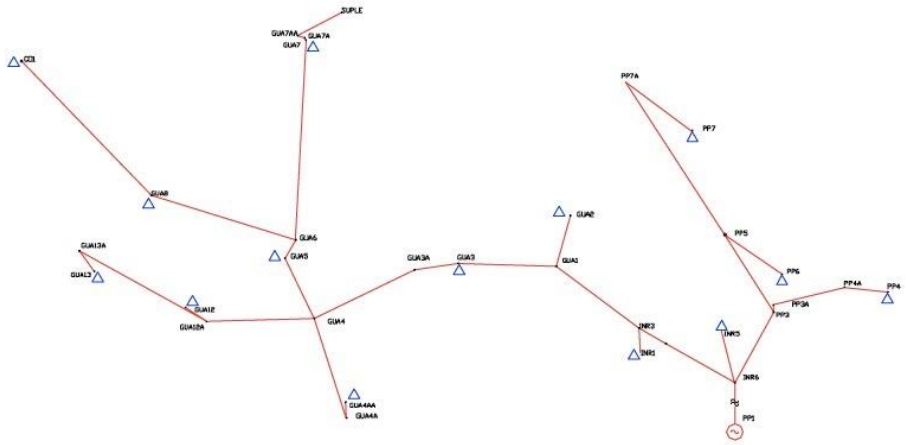

Figure 9. Experimental Pilot Circuit EPC

The 14 standard transformers were replaced by 14 PROT transformers. Continuous monitoring with the Colombian Lightning Location Network was carried out during the 3 years of the project in order to be able to evaluate the incidence of lightning and, in case of failure, if the origin was one of them. When conducting a 3-year temporal analysis of lightning activity with the Colombian Lightning Location Network.

A filtering was carried out to identify those discharges that impacted in a range of less than 100m, around the corridor of the line. The maximum current was –47.83kA and 46.02kA. Making a projection of the data taken for a whole year, the density of lightning strikes per square kilometer GFD would be approximately 19, which is consistent with the historical density maps of the area

Figure 10 shows as an example the lightning activity during the first year (58 lightning strikes) less than 100 meters from the electric power distribution network without presenting any failure of the 14 PROT transformers.It was found that storms occur probabilistically in the afternoon and part of the night.

In the three years of follow-up to the EPC, the result is similar to that modeled. It has been possible to reduce the failure rate of transformers in this circuit from 50% prior to the installation of the New Design Prototype transformers PROT to 0% in the first year, to 7% in the second year and 0% in the third year, with more than 130 discharges presented within 100 meters of the circuit, according to the Colombian Network of Lightning Detection.

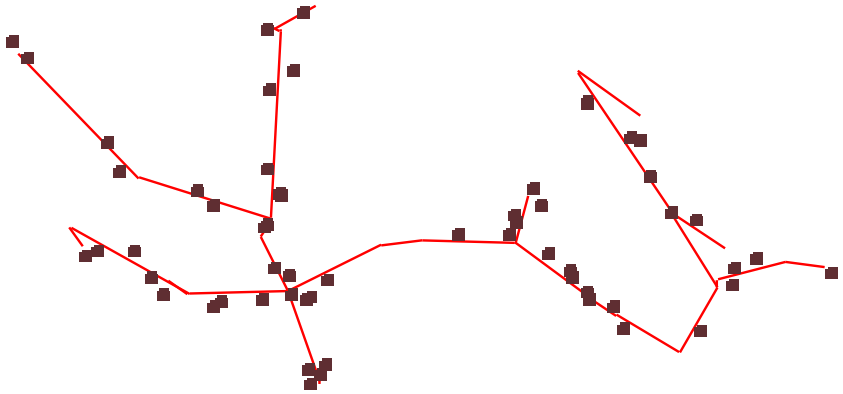

Figure 10. Atmospheric Electrical Activity (58 discharges) in a year, 100m around the EPC Experimental Pilot Circuit.

III. Results and Discussion

The most significant results of a systematic and successful theoretical-experimental investigation of more than 12 years have been presented in this paper, the purpose of which has been to contribute to the solution of the costly problem of the failure of distribution transformers installed in areas of highlightning activity, which affects the reliability of electric power companies in Colombiaand countries with high lightning activity.

Following the applied methodology and in conjunction with transformer manufacturing companies and an Electric Power Company, the design, construction and implementation of a technological innovation: New Design Prototype Transformer PROT, which iselectromagnetic compatible in zones of high lightning activity.

Prototype PROT transformers were designed and built with the high voltage winding-core, that is, in contact and isolated from the core, since according to the calculations and simulations carried out, the pulse transferred from high to low is lower due to having a higher high-low capacity than a conventional transformer. The individual cost of the PROT transformer may be higher, but if its probability of life expectancy is longer, its value to the customer will decrease.

As a result of the experiences with the Experimental Pilot Circuit EPC and the Lightning Measurement Experimental Station (Ilyapa) of the National University of Colombia, the following are, in summary, the eight Basic criteria to take into account for the optimal operation of the New Design Prototype Distribution Transformer PROT:

- Greater robustness: Increased transformer BIL 125/30 kV.
- Reduction of Transferred Pulse: Coil-Core Design. High voltage winding- core
- Easy handling: Modification of the mechanical supports for transport in hard-to-reach areas
- Improvement of Protections: HV and LV arresters, Self-protection (CSP), additional network protections if necessary
- Proper handling and installation: at least 24 hours of rest before energizing.
- Improvement of Grounds: Grounds of low ohmic value.
- Permanent monitoring and maintenance of the system - environment (Network, protections, transformer, grounding, vegetation)
- Evaluation of the cost / benefit ratio

A self-protected CSP transformer includes, from its design stage, protection elements against overvoltage, overloads and elements to isolate it from the network in case of internal or external failures.

Regarding the last criterion, we have evaluated the cost / benefit ratio for the transformers installed in the EPC. We have considered the worst case, that is, a New Design Prototype transformer PROT cost 1.5 times the cost of a standard transformer. Nowadays the cost of the New Design Prototype transformer depends on several aspects such as the manufacturer and the number of units to purchase, but it can have a cost equal to that of a standard. Additionally, having considered a cost of 1.5 times, it was

done on the basis of the construction of a single transformer; however, due to economies of scale, the cost will decrease as hundreds or thousands of them are built. The results obtained for the worst case are as follows:

A time horizon of 10 years was considered with a number of 100 transformers installed in year zero, an annual growth in demand of 2%. A unit value of 1000 in per unit (p.u) was estimated for a standard design transformer and 1500 in the case of the New Design Prototype transformer PROT, for an average power of 15kVA.

The costs of the New Design Prototype PROT (1500 p.u) include: manufacturing costs (CSP, low voltage protection, improved BIL in High and Low Voltage, tank adaptation, land improvement and easement cleaning). The cost of labor for changing the transformer is not taken into account. This cost would be in favor of the costs of the New Design Prototype PROT, since it would have a longer useful life, therefore fewer changes.

The EPC located in one of the two areas with the highest lightning activity in the world, show promising results for the solution to the problem of failure of distribution transformers in Colombia and improvement of the reliability in power systems. For example, after installing the New Design Prototype PROT transformers, the failure rate went from 50% for a period of 7 years, to 0% in year one, 7% in year 2 and 0% in year 3.

The effect of lowering the ground value for high (impulse) frequencies does not have a great impact on the surges received by the transformer, although a value less than 20 ohms is desirable, to guarantee a reliable operation of the surge arrester.

The transformer, once installed on the pole, must be allowed to stand for at least 24 hours, due to the shaking it experiences in transport to the installation site.The Colombian rural area is very mountainous with bridle paths. Handling a distribution transformer along these rough roads causes the insulating oil to easily form air bubbles that diminish its insulation and requires at least 24 hours of standing before energization

The research on the reliability in electric power systems is part of the theoretical and practical results of a research hypothesis and its applications, about the spatial and temporal variation in the magnitude of the lightning parameters that has been developed, published and tested in the last decades in lightning research in Colombia.

Through a process of interdisciplinary, rigorous, systematic and scientifically based research, it was possible to contribute to the knowledge of a natural phenomenon that due to its physical and meteorological characteristics is very different in the tropical latitude than in temperate latitudes, where this type of phenomenon generally develops research [4], [5], [7].

The hypothesis has been implicit in all the works that the author has carried out and directed in the PAAS-UN Research Program and has been demonstrated in papers of international academic arbitration.

The hypothesis is based on the scientific principles proposed by the English physicist Wilson in 1920 [1, 2], on the Global Electric Circuit and the dominant contribution, by a superposition of effects, of the three largest areas of Deep Tropical Convection on the planet: South America Tropical, Central Africa and South East Asia and Australia.

Although the areas of Deep Tropical Convection were identified at the beginning of the 20th century as having high atmospheric electrical activity, until a decade ago most of the information available on the characteristics and magnitudes of the lightnings was based on studies carried out in semi-tropical areas or temperate, but very few in tropical areas.

After studying a vast area in Central Colombia, it is found high lightning active areas agree with the location of important portions of the power overhead distribution lines and a high number of power distribution transformers. 26.4% of the total power transformers are located in high or very high lightning active areas and their failure rates increases to an average of 13 (high) and 45 (very high) times higher than to the considered normal weather condition. Extremely large power overhead lines reach failures rates 175 time higher than normal [5].

Torres [4], [5], [32] studied the failure of power distribution transformers in Colombia and found the cumulative distribution of lifetime given in Figure 5. In low-risk areas (risk given as a function of Ground

Flash Density GFD) the mean lifetime was higher than 8 years, in medium risk zones it was 5 years and in severe risk the life time was close to 1.5 years. Data from Torres [4] show that approx. 65% of the transformer fails occur in the lightning active seasons.
Failure rates of rural power systems are statistically studied based on lightning parameters and a two-state weather model (normal and adverse). Lightning information is matched with coordinates of 251.024 power transformers in a vast area in Central Colombia [25]. An important portion of transformers present failures rates 45 times higher than normal and very large overhead lines, representing a high portion of the total system, present very high failure rates over 70 times higher than in normal weather conditions [5].
These results show that a technological product such as an electric power distribution transformer has a different behavior in tropical zones with high lightning activity than in a temperate zone. Therefore, it is essential that these technological products have electromagnetically compatible designs with the environment and thus improve the reliability of electrical power systems.
It is advisable to continue with the monitoring and control phase for at least another five years and expand the comprehensive solution to other areas of high lightning activity.

IV. Conclusions

These technological innovations, after a comprehensive diagnosis such as the one presented here, can be applied to circuits located in high-risk lightning areas.These leads to the proposal of zoning the lightning phenomenon, determining Electromagnetic Compatibility Zones; being able to arrive at the proposal of changes in the design of equipment and in the construction standards of an electrical power company, which can later be taken to national technical standards.
Through the zoning found with the parameter "Lightning Risk Factor", three types of adaptation are proposed for the distribution systems (Low, Moderate and Severe), so that they are more in line with the surrounding conditions.
For severe-risk areas, the technological innovation New Design Prototype transformers PROT, new grounding designs and more robust protections would be installed; in low-risk regions, use standard design and for moderate risk regions implement a combination of new design and standard design.

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References

[1.] Wilson C. T. R. On some determinations of the sign and magnitude of electric discharges in lightning flashes. Proc. Roy. Soc., (A92):555–574, 1916.

[2.] Wilson C. T. R. Investigations on lightning discharges and on the electric field of thunderstorm. Philos. Trans. A., (221):73–117, 1920.

[3.] Icontec, NTC 4552-2004, 2008, Norma Técnica Colombiana sobre Protección contra descargas eléctricas atmosféricas (rayos). (*Colombian Technical Standard on lightning protection*).

[4.] Torres, H. El Rayo, Mito, Ciencia y Tecnología (The Lightning, Myth, Science and Technology) ISBN: 958-70-1213-5, Unibiblos, Bogotá, 2002.

[5.] Torres, H. El rayo en el trópico (*Lightning in thetropics*). ISBN 978-958-775-454-4 Colección apuntes maestros, Ed. UN, Bogotá, Colombia, 2015.

[6.] Albrecht, R., Goodman, S., Buechle, D., Blakeslee, R., Christian, H. "Where are the lightning hotspots on Earth?" DOI: 10.1175/BAMS-D-14-00193.1. Bulletin of the American Meteorological Society, 2016.

[7.] Torres, H., Pérez, E., Younes, C., Aranguren, D., Montaña, J., Herrera, J. "Contribution to Lightning Parameters Study Based on Some American Tropical Regions Observations", IEEE Journal of selected topics in applied earth observations and remote sensing, Vol. 8, No. 8, August 2015, pp. 4086-4093.

[8.] Golde R.H. "Lightning". Vol. 1. Academic Press. 1977.

[9.] Baharuddin, M., Z. Abidin, Hashim, A., Hussein, H., Chin, Y., and Mohamad, A, "Application of Lightning Performance Analysis for a Tropical Climate Country". First International Power and Energy Conference PECon 2006 November 28-29, 2006, Putrajaya, Malaysia.

[10.] Cooray, V., Rubinstein, M., Rachidi, F. "Latitude and Topographical Dependence of Lightning Return Stroke Peak Current in Natural and Tower-Initiated Negative Ground Flashes", Atmosphere 2020, 11, 560; DOI:10.3390/atmos11060560.

[11.] Cooray, V. Jayaratne, K.P.S.C., "Characteristics of lightning flashes observed in Sri Lanka in the tropics", J. Geo. Res., vol 99, pp 21051-21056, 1994.

[12.] Mackerras, D., Darveniza, M. "Latitudinal variation of lightning occurrence characteristics" JFR, Vol.99, 1994.

[13.] Orville, R. "Peak-current variations of lightning return strokes as a function of latitude", Nature, Vol. 343, Jan. 1990.

[14.] Pinto, O Jr., I. Regina, C.A. Pinto, J.H. Diniz, A.C. Filho, L.C.L. Cherchiglia and A.M. Carvalho, A seven-year study about the negative cloud-to-ground flash characteristics in southern Brazil, J. Atmos. Sol. -Terr. Phys. 65, 2003, pp. 739–748.

[15.] Suárez, O., Martínez, J., Torres, H., Campos A., Álvarez, L. "Spatial and temporal distribution of thunderstorm days in the Cuba Isle" (in Spanish) Proceedings ALTAE. Panamá, Jun. 2005.

[16.] Thomson, E.M., "The Dependence of Lightning Return Stroke Characteristics on Latitude" JGR, Vol. 85, No. C2, Pages 1050-1056, Feb. 1980.

[17.] Torres H., Barreto L. "The lightning parameters and its spatial and temporal dependence". Working Group C4.01, Activity report of TF C4.01.02-B. Work Document CIGRE, 1996.

[18.] Cooray, V. "Latitude dependence of peak lightning return stroke current- A theoretical explanation", Proceedings, 34th ICLP, Rzeszow, Poland 2018.

[19.] Mackerras, D., Darveniza, M. "Latitudinal variation of lightning occurrence characteristics" JFR, Vol.99, 1994.

[20.] Orville, R. "Peak-current variations of lightning return strokes as a function of latitude", Nature, Vol. 343, Jan. 1990.

[21.] Pierce, E.T. "Latitudinal variation of lightning parameters "J. Appl. Meteor., 9, 194-195, 1970.

[22.] Torres H., Bernal G., Lopez R., Joya A. "Estudio Caraterización deat en Colombia (*Study of Characterization of Thunderstorm days in Colombia*)" Convenio Universidad Nacional – Himat. 1990.

[23.] Torres H., Barreto L. "The lightning parameters and its spatial and temporal dependence". Working Group C4.01, Activity report of TF C4.01.02-B. Work Document CIGRE, 1996.

[24.] Torres H. "Variation of Lightning Parameter Magnitudes within Space and Time". Proceedings 24th. ICLP, England, 1998.

[25.] Aranguren, D., Tovar C., Inampués, J., López J., Soto E., andTorres, H."Lightning effects on the reliability of Power Distribution Systems in Colombia", Rev. Ingenieria e Investigación, Bogota, Vol. 35 N_0 1, 2015. DOI: https://doi.org/10.15446/ing.investig.v35n1Sup.54069.

[26.] Ishikawa, Kaoru (1976). Guide to Quality Control. Asian Productivity Organization. ISBN 92-833-1036-5.

[27.] IEC 62305-2:2006, Protection against lightning - Part 2: Risk management.

[28.] NFPA-780:2020 Standard for the Installation of Lightning Protection Systems

[29.] IEEE Std 1410™_2010 IEEE Guide for Improving theLightning Performance of ElectricPower Overhead Distribution Lines.

[30.] IEC 801-3: 1987 Electromagnetic compatibility for industrial-process measurement and control equipment – Part 3: Radiated electromagnetic field requirements

[31.] Sonntag C., Lomonova, E. Duarte, J. C. L. W. "Implementation of the Neumann formula for calculating the mutual inductance between planar PCB inductors," 2008 18th International Conference on Electrical Machines, Vilamoura, Portugal, 2008, pp. 1-6, DOI: 10.1109/ICELMACH.2008.4799978.

[32.] Torres, H., Herrera F., Amórtegui F. "Application of a methodology in order to reduce Distribution transformer failures due to high lightning Activity". Proc. V International Symposium on Lightning Protection, IEEE, Sao Paulo, Brazil, 1999.

Effects of drinking water acidifier's use on broilers *Gallus gallus domesticus (F. : Phasianidae)*

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ABSTRACT

The current study is a trial of incorporation of the pathocidal (acidifying) liquid in the drinking water of broilers in poultry farm in Antsirabe, Madagascar. The pathocidal liquid, has been incorporated into the drinking water of 100 broilers and the other batch of 100 chickens drink only water without the pathocidal liquid. Drinking water containing acidifier can promote better zootechnical performance in chickens. The aim of this study is to find out the benefit of using the acidifier in the drinking water of broilers. In this work, we determined the zootechnical parameters. Microbiological analysis of water samples with and without acidifier was done. Chicks who drink water with pathocidal liquid showed an average daily gain of 58g / day, significantly above that of chicks who drink water without pathocidal liquid which is 37g / day. The Consumption Index of chickens which take pathocidal liquid to the finish is 2.02 which is below the Consumption Index of chickens which take water without the acidifier which is 2.28. The zootechnical results show the prolificacy of the incorporation of the pathocidal liquid in the drinking water of broilers with the performances relatively close to the standard. These results made it possible to conclude a technical feasibility and a profitability of the exploitation with the pathocidal liquid.

Key words: *acidifier, broiler, pathocidal liquid, zootechnical parameters.*

I. INTRODUCTION

Poultry farming has become one of the sectors that have developed rapidly since the past decade. Over the past decade, it has increased by 23% in developed countries and 76% in developing countries (ALDERS R, 2005)

In the Malagasy context, the intensive type poultry sector showed its development around the 1990s. In fact, most intensive farming is carried out in the peripheral areas. Products sold on the market fail to meet consumer expectations both qualitatively and quantitatively (ANONYMOUS, 2004).

Unfortunately, the rise of this poultry farming is faced with obstacles due to the lack of systematic control by breeders. These problems are due to feed in general, more specifically the relationship between the quality of the water supplied to poultry and its production performance.

In addition, the consumption of good quality water is essential to optimize poultry production. The quality of drinking water for livestock is a matter of the utmost importance, as it can directly and indirectly affect the health and productivity of animals (UMAR S et al., 2014). This is why it was suggested to breeders an acidifying liquid to improve the purity of the water and increase the production.

II. MATERIALS AND METHODS

Materials

This study was performed on two hundred (200) chicks of the Arbor Acres strain. It is an excellent option due to their rapid growth rate and low feed cost. This is why the farm chose to breed this strain. The chicks are raised in a room of 20m x 10m so an area of 200m². It is composed of a window of 0.8m x 0.44m and a door of 1.62m x 0.75m, the walls are made from bricks covered with concrete.
The acidifier used is a liquid. It is a synergistic blend of organic and mineral acids: Formic acid - sodium formate acid salt (12%) - propionic acid - lactic acid - ortho-phosphoric acid - antibiofilm agent.
The laboratory equipment used is subdivided into glassware, small and large equipment. Selective and elective culture media allowed microbial cultures to be performed.

Methods

These 200 heads are weighed one by one to have the weight of these animals per day, in order to find their zootechnical performance evolutions. This operation is carried out every 7 days.
The crawl space is made two weeks before the reception of the chicks. During the crawl space, when the previous animals are gone, the manures are removed, wiped down and washed. The house where the animals lived, was left to dry completely for two days, then disinfected for the next fifteen days. Finally, two days before the reception of the chicken, the building is disinfected again. The disinfectants used are Fenosteryl, used fifteen (15) days before the chicken is taken 10ml per liter of water, and Macroclore 1000, used two (2) days before the chicken is taken, dosed at 10ml per liter of water.
Drinking water distributed to broilers must be clean and uncontaminated 24 hours a day. However, depending on the source of supply, the water may contain various minerals in excessive amounts or be contaminated with bacteria. So it is necessary to clean the drinking water of animals so that there are not various problems of animal health and products.
The two well water samples (sample I and sample II "treated water") were taken using the 5 L plastic drums. The cans are then stored in a cooler at a temperature of 8°C during their transport to the laboratory. On arrival at the laboratories, the water samples were subjected to microbiological and physicochemical analyzes.
For bacteriological analysis, any contamination of the water by ambient air and other contaminated objects is avoided. The cans are not completely filled to allow any aerobic microbes that would be in the water to survive until the time of analysis.
The analysis began on the day of the sample.
As for the physicochemical analysis, this involves determining the pH of two water samples in order to measure the acidifying power of the pathocidal liquid. Table 1 gives the different analyzes carried out on the two samples.
As zootechnical parameters studied, the average live weight is the ratio of the sum of the weights of individuals from the same lot by their number.
Individual food consumption makes it possible to assess the amounts of food consumed per animal over a specified period of time. It is calculated from the quantity of food distributed and that refused. The feed is dispensed at 3.30 in the evening and this lasts for 24 hours and the refused quantity of feed weighed before each new distribution.
The weekly measurements of the weights listed, made it possible to calculate the average daily gain by making the ratio of the weight gain during a period over the corresponding duration.

The Consumption Index (CI) is the ratio between the average amount of food consumed over a given period and the average weight gain corresponding to that period.

Table 1. Analysis carried out on drinking water samples from chickens

MICROBIOLOGICAL ANALYSES		
MICROORGANISMS	**CULTURE MEDIUM**	**STANDARD**
Revivable germs in 22 °C	Plate Count Agar (PCA)	ISO 4833
Revivable germs in 37 °C	Plate Count Agar (PCA)	ISO 4833
Escherichia coli	Eosine Methylen Blue (EMB)	NF V 08 053
Pseudomonas aeruginosa		ISO 13720:2010
Streptococcus D	SLANETZ et BARTLEY Agar	SLANETZ et BARTLEY
FSC spores	TSC Medium	ISO 6461-1
Salmonella sp.	Hektoen Enteric Agar (HEA) and Rappaport Vassiliadis Soja	NF V 08 052
PHYSICO-CHEMICAL ANALYSIS		
pH	**Potentiometric method**	

Source: Laboratories of IOI University Madagascar, 2020

The mortality rate is the ratio of the total number of dead chickens to the initial number of chicks, expressed as a percentage. In general, broiler farming is profitable if the mortality rate is ≤ 6%.

III. RESULTS AND INTERPRETATIONS

Results show that untreated well water has pH = 8 which means the water is slightly basic. From a hygienic point of view, given the exceeding of certain benchmarks, this untreated water with acidifier is not drinkable for chickens. Its microbiological quality is therefore not compliant.

The pathocidal liquid decreases the pH of the water to equal 3, this means that the treated water is very acidic. From a microbiological point of view, no germ exceeds the reference criteria. This suggests that microbiological quality of the acidified water meets the drinkability standard.

The results of the weight growth measurement are recorded and shown in Tables 2 and 3.

On the first day, the average live weight of the animals is 46g. In one week of age (precisely on the 7th day of age), the difference in mean weight on the chickens are opposite so for chickens that drink water with the pathocidal liquid is 152.875 g and 143.058 g in mean weight for chickens that drink clean water.

Table 2: Evolution of the growth of a hen which drinks water with pathocidal liquid

Age (day)	**Growth Evolution (g)**		
	Minimum	**Maximum**	**Average/hen**
0	40	50.5	46.61
7	128,58	180.79	152.875
14	350	495	424
21	525	760	632.3
28	844	1238	1053.2

35	1175	1705	1458.5
42	1505	2265	1892.5
45	2000	2600	2250

Source: Authors, 2020

Table 3: Evolution of the growth of the chicken which drinks water without pathocidal liquid

Age (day)	Growth Evolution (g)		
	Minimum	**Maximum**	**Average/hen**
0	40	50	46.57
7	115.89	159.47	143.058
14	230	430	362.5
21	525	700	624
28	803	1260	1015.5
35	1085	1840	1426
42	1570	2100	1814
45	1780	2400	2089.5

Source: Authors, 2020

The variation in weight is therefore between the 1st day of age and the 45 days of age. It was found that the growth of chickens that drink clean water is slower than that of chickens that drink water with the pathocidal liquid.

Tables 4 and 5 summarize the variation of the ADG obtained every seven (7) days of age on the farm.

Table 4: Evolution of the ADG of the chicken which drinks water with pathocidal liquid

Breeding phase	Age (week)	Live weights (g)	ADG (g/hen)
STARTING	0	46.61	
	7	152.875	15
	14	424	39
	21	632.3	30
FINISHING	28	1053.2	60
	35	1458.5	58
	42	1892.5	62
	45	2250	119

Source: Authors, 2020

According to this table, the minimum ADG is 15g and the maximum is 119g which gives an average ADG of 58g / day. The ADG decreases on the 21st and 35th days; this decrease is due to sudden climate change. However, on the 45th day, the chicken will gain its weight.

Table 5 : Evolution of the ADG of the chicken which drinks water without pathocidal liquid

Breeding phase	Age (week)	Live weights (g)	ADG (g/hen)
STARTING	0	46.57	
	7	143.058	14
	14	362.5	31
	21	624	37
FINISHING	28	1015.5	56
	35	1426	59
	42	1814	55
	45	2089.5	92

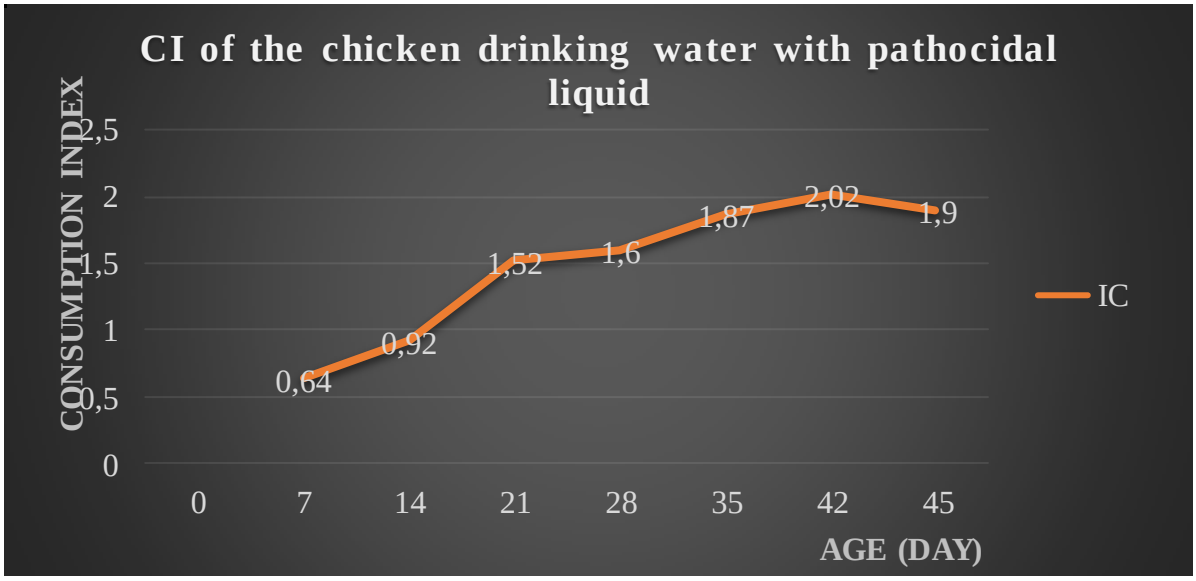
Source: Authors, 2020

From this table, the minimum ADG is 14g, the maximum is 92g. And which gives an average ADG of 37g / day. The ADG decreases on the 42nd day which is due to the problem not clearly specified. In any case, the chicken gains its weight faster on the 45th day which is 92g. The ADG obtained expresses that in the 45th day of age of the chicken, the weight gain of the chicken which drinks water with pathocidal liquid is 119g which is greater than 92g which is the weight gain of the chicken which drinks the pathocidal liquid.
The refusal feed is between 6 and 70g during the start-up phase until the finishing phase. From the start until slaughter, the intake of the chicken is constantly increasing. The total amount of feed consumed per chicken is 4294 g.

According to this table, the refused feed is between 8 and 100g during the start-up phase until finishing. Chicken ingestion increases slowly compared to chicken which drinks water with pathocidal liquid. The total amount of feed consumed per chicken is 4617g. The difference between the chicken that drinks water with pathocidal liquid and the chicken that drinks water without pathocide is diligence in eating.

The consumption index (CI) is a criteria used in zootechnics to measure the efficiency of the conversion of a food into a given production (generally the increase in weight) by an animal. The average consumption index per chicken, depending on age, is shown in Figure 1.

Figure 1. Variation in feed efficiency of chicken drinking water with pathocidal liquid



Source: Authors, 2020

From this figure, the minimum CI is 0.64 and the maximum is 2.02. Normally the CI should be in increasing mode during the cycle, but on day 45 there is a decrease. The chick stage had the best CI 0.64kg and 0.92kg of feed can give 1kg of live weight.
The maximum CI is 2.28 and the minimum representing the best CI is also 0.66. In addition, the CI decreases to 2.2 in the 45th day of breeding. This is because the CI of the chicken drinking water without pathocidal liquid which is 2.28 is higher than the CI of the chicken drinking water with pathocidal liquid which is 2.02. Generally, the more the live weight and age of a chicken increases, the more the food processing capacity decreases.
As for the mortality rate (MR), it is the percentage of dead chicken during the production cycle. Remembering the initial band size is 20 heads but during the rearing cycle there were no dead chickens. This gives us a zero mortality rate (MR = 0%).

IV. DISCUSSION

With regard to laboratory analyzes, this work is limited to the assessment of the overall quality of the treated water. It is therefore a question of studying its potability for chickens. The microbiological analyzes revealed the importance of adding the acidifier to the water. However, since the pathocidal liquid is a chemical acidifier, we should have studied the effect of the use of this disinfectant on the health of the chicken. This fluid may be hepatotoxic. This should therefore be the subject of another, more in-depth study. Moreover, the volume of the manuscript imposed by the school and given that it is a mini-thesis, we are forced to limit the scope of our study.

According to the results of analyzes of untreated well water, the presence of germs is confirmed especially *Escherichia coli* (present in the respiratory and digestive tract). This enterobacteria causes avian colibacillosis disease (Hassane Malal Ba, 2012). For its part, *Salmonella* sp, which is practically present in the digestive tract, is responsible for avian salmonellosis. It is for all these reasons that Sample I does not meet the bacteriological criteria for potability. On the other hand, sample II, which is acidified water, does not present any bacteriological risk for chickens. This could be explained by the addition of the pathocidal liquid which is either bactericidal or bacteriostatic. Another reason would be the acidifying power of the pathocidal liquid. Indeed, its addition strongly acidifies the water. However, most bacteria do not survive in an acidic environment. It is therefore important to study the antibacterial activity of this fluid using the antibiogram technique.

In the study of zootechnical parameters, in the case of the sample size, the results affirm that the mortality rate is 0% neither for chickens which drink water with pathocidal liquid, nor for chickens who drinks water without pathocidal liquid. According to the result obtained in the farm, the broilers which drink water without pathocidal liquid weighed 2.09 kg at slaughter (45 days) and the other chickens which drink water with liquid. pathocide weighed 2.25 kg at slaughter so the comparison shows that the difference in live weight between these two is 0.16 kg live weight. These results are close to the performance objective (Aviagen Brand, 2012) especially the weight of chickens which drink water with pathocidal liquid. This weight shift is due to diligence in eating and clean water that impact broiler performance and weight growth.

Regarding the ADG, it is a parameter that varies according to the age and the quality of the food and drinking water (Ayssiwede et al., 2012). The ADG of broilers drinking water with pathocidal liquid is 58g / d, and other chickens have an ADG of 37g / d. These results mean that the shift between the ADGs of these two samples is 27g. For the all-rounder of Gnabro Ouakoubo G. (2017) of Arbor Acres strain which is 35g / d is lower than that of chickens which drink water with pathocidal liquid, nor of others; but the ADG of the chicken which drinks the pathocidal liquid is close to that of the Hubbard Classic (2005) which is 59 g / day; higher than the standard chicken which is 50g / day. The ADG of chickens which drink water without pathocidal liquid is close to that of standard chickens.

For CI, the two criteria that say that a breeding is good profitability are the weight of the slaughter and the consumption index. Technically, the best consumption index should not exceed 2, which implies that two kilos of food produces one kilogram of live weight. After processing the data and calculating certain criteria, the CI of broilers drinking water with pathocidal liquid was 0.64 as the minimum which is the best CI during the rearing cycle and 2.02 the maximum; and for the other chickens which no longer drink water with pathocidal liquid is 0.66 the minimum which is also a better CI but the maximum is raised to 2.28. These results indicate that broilers which drink water with pathocidal liquid have a better CI than chickens which drink water without pathocidal liquid, so this represents that the pathocidal liquid is one of the reasons, which decreases the CI of broilers.

During the study period (8 weeks), broilers that drink water without pathocidal fluid grew slowly compared to broilers that drink water with pathocidal fluid. The use of the acidifier in the drinking water of chickens that drink it has had a positive effect on their growth.

V. CONCLUSION

This study allowed us to analyze the well water used in this farm in the laboratory to know the quality of the water, to analyze the zootechnical parameters to confirm the effect of use of the acidifier on the

water of drink of broilers. The results suggest that the addition of the acidifier to the drinking water of chickens improves the hygienic quality of the drinking water, this was confirmed by the satisfactory results of the microbiological analyses carried out on the drinking water treated with pathocidal liquid. In addition, zootechnical results revealed a difference between the use of water treated with acidifier and that of untreated water. The use of the pathocidal liquid gives the best results. However, it remains to be seen whether these differences are significant or not. In addition, a toxicological study and another on the antibacterial activity of this acidifying product will have to be the subject of another scientific experiment.

REFERENCES

[1.] Alders R : « L'Aviculture : source de profit et de plaisir-Organisation des Nations Unies pour l'alimentation et agriculture-Rome », 2005, 21 pp

[2.] Al Hassane Malal B.A : «La colibacillose du poulet de chair, Etude Anatomo-clinique et circonstances d'apparition dans la zone péri-urbaine de DAKAR », 27 septembre 2012, 23 pp

[3.] Aviagen B. : « Objectifs de performance des poulets de chair », 2012, 10 pp

[4.] Ayssiwede S, Missoko Mabeki R, Mankor A, Dieng A : « Effet de l'incorporation de la farine de feuilles de Cassia Tora (Linn) dans la ration alimentaire de jeunes poulets traditionnels de Sénégal, Revue Méd. Véto., Dakar, 2012 : 375-386

[5.] Christèle P et Fabrice M : « l'Agriculture biologique en pays de la Loire », 2012, 4 pp

[6.] FAO : « Prévention et contrôle de la grippe aviaire dans les petits élevages de volailles », 2006, 21 pp

[7.] Fabrice M. « Alimentation des volailles en Agriculture Biologique », 1985, 8pp

[8.] Gnabro Ouakoubo G. « Essai expérimental et évaluation des performances zootechniques des poussins de souche Arbor Acres dans un élevage traditionnel de Diégonéfla (Côte d'Ivoire) », 2017, 124 pp

[9.] Hubbard Z. « Guide d'élevage poulet de chair », 2005, 62 pp

[10.] Jean François D, Brigitte A : « Guide d'élevage des volailles au Sénégal », septembre 1997, 133 pp

[11.] Kenneth M, Larry Ritter et al. : « Elevage pratique de la volaille », 1981, 289 pp

[12.] Manh Charles M B : « Gestion technique d'une ferme Avicole, cas de l'élevage de poulet de chair », 2015, 36 pp

[13.] Sehad H, Goucem L : « Analyse de l'efficacité alimentaire chez le poulet de chair élevé à l'ORAC », 2017, 48 pp

[14.] Shaver Starbro : « Guide d'élevage de poulet de chair », 1996, 20 pp

[15.] Umar S, Munir M T et al.: « Effect of water quality on productivity and performance of livestock», A mini review veterinaria, 2014 : 11-15

[16.] Villate D : « Maladies des volailles », Edition France Agricole, 2001 : 12-21

[17.] Vitalac : « Vitacid : la sécurité digestive », 2016, 3 pp.

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Valorization of *Moringaoleifera* leaves by incorporation in tamarin (*Tamarindusindica*) and banana (*Musa sativa*) pastes

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ABSTRACT

This study concerns the valuation of *Moringaoleifera* leaves which come from 2 regions of Madagascar: Antananarivo and Tulear. A survey carried out showed that only 42.5% of the people questioned declared to have already consumed *Moringaoleifera* leaves and that they were consumed occasionally, that is to say 81% of the respondents. Those who have already consumed it do not adopt the good culinary methods since 40% and 25% consume it in decoction and soup and only 25% in salad. Thus, the incorporation of *Moringaoleifera* leaves in tamarind *(Tamarindusindica)* and banana *(Musa sativa)* pastes was undertaken. Nutritional analysis showed that the energy value of Tulear leaves is higher than that of Antananarivo, respectively 375.53Kcal and 323.86Kcal per 100g of leaf powder. In addition, the protein and lipid contents are higher in Moringa leaves from Tulear than those from Antananarivo, that is 19.6%, 3.01% against 18.2% and 2.18%. In contrast, the mineral content was higher in Moringa leaves from Antananarivo (11.76%) than those from Tulear (8.00%). Moringa Banana and tamarind pasta was the subject of a sensory analysis which showed that Moringatamarin pasta (hedonic average of 6.470 and 5.930) was more popular than Moringa banana paste (hedonic average of 5.230 and 5.930).

Keywords: *Moringaoleifera*, tamarind paste, banana paste, nutritional analysis, sensory analysis.

I. INTRODUCTION

Madagascar is privileged by the diversity of food plants due to its geographical and climatic situation. Tropical and semi-tropical fruits such as bananas, mangoes, apples, oranges, melons...; vegetables, mainly carrots, beans, green beans, cucumbers; also leafy vegetables such as chard, leeks, cabbage and many others are the most sold and bought in the markets. Despite this diversity of its resources, There is chronic malnutrition in Madagascar, which affects 47% of children under the age of 5 [8], which has consequences for the cognitive and physical development of the child as it affects learning capacity, productivity in adulthood and therefore the country's economy [8].

The daily energy intake of 2133 kcal/per capita/day is not reached [3]. In fact, households have poor food consumption in terms of quantity and quality, respectively 60% and 58% of households [2], [7]. The causes of malnutrition are diverse, including inappropriate eating habits, economic crises, lower incomes and limited access to raw materials. To avoid this food insecurity, other edible and available natural resources have been highlighted, *Moringaoleifera* called “the tree of many uses» [4].

Thus, in this study, tamarin and banana pastes are used as snacks at any time of the day, enriched at 30% with powdered *Moringaoleifera* leaves [5] from Tulear and Antananarivo. The objective is to valorize available and edible food resources that are not usually consumed and to contribute to the fight against chronic malnutrition.

II. MATERIALS AND METHODS

II.1. Material

The study materials are *Moringaoleifera* leaves collected in Tulear and Antananarivo. They were transported without being removed from their stems. During the study, the leaves from the two localities were processed separately. Then, the fruits, bananas (*Musa sativa*) and tamarind (*Tamarindusindica*) bought at the market of Anosy be.

Tamarind and banana pastes are enriched with 30% of Moringa leaf powders from Antananarivo and Tulear according to the method described by HARIMALALA ANDRIAMBELO, 2014.

The results are processed in Excel.

II.2.2. Determination of the nutritional composition of *Moringaoleifera* leaves from Tulear and Antananarivo [1].

The pH of the samples is measured with a pH meter (type TACUSSEL) on a 20% sample solution in distilled water

The water content is determined according to the Guilbot methodby drying the samples in a ventilated oven until a constant weight is obtained with a precision of ±0.001.

The lipid content is obtained by the Soxhlet method: fats are extracted with petroleum ether by reflux system for seven hours.

The amount of ash is determined by calcining the sample in a muffle furnace for 16 hours at 600°C. The amount of mineral elements (sodium, potassium and magnesium) is measured from the ash with an atomic absorption spectrophotometer.

The crude protein was determined using micro Kjeldahl method as described in AOAC procedures (AOAC, 2000).

The carbohydrate content of a food can be determined by calculating the percent remaining after all the other components have been measured: % Carbohydrates = 100 - %Moisture - %Protein - %Lipid - %Mineral.

The energy content of each plant samples were determined by multiplying the values obtained for protein, fat and available carbohydrate by 4.00, 9.00 and 4.00, respectively and adding up the values, according to Atwater index (AOAC, 2000).

II.2.3. Determination of consumers' appreciation of products[6]

The hedonic test is used to determine consumers preference for products and to deduce their acceptability. The evaluation is done in order to know which of the fruit pastes, banana and tamarind, enriched with *Moringaoleifera* leaves from Tulear or Antananarivo is the most appreciated. To do this, the samples are presented anonymously, the subject must give his appreciation on a rating scale of 1 to 9 by filling out an individual form.

The statistical processing is carried out with the XLSTAT 2014 software with a significance level of 0.05.

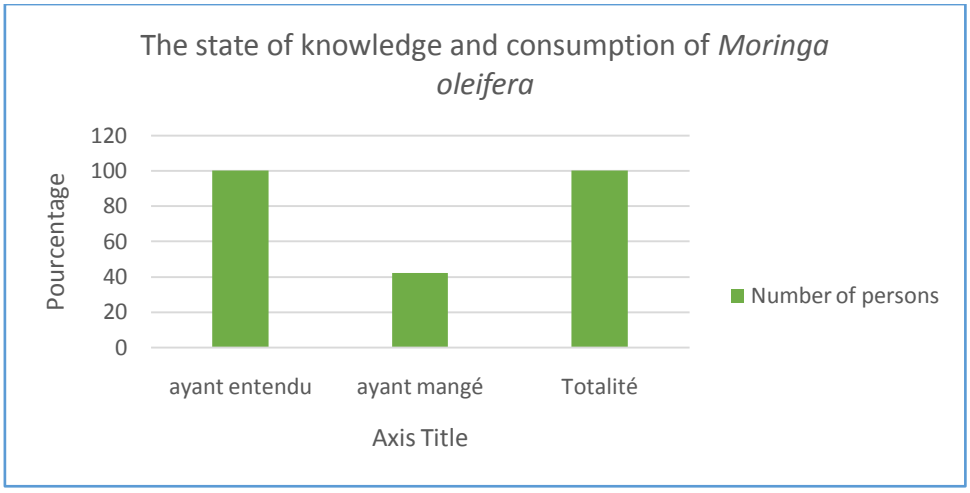

Figure 1 :State of knowledge and consumption of Moringaoleifera

Thus, respondents claim to have heard of the nutritional and therapeutic properties of *Moringaoleifera*, but only 42.5% have ever consumed it at least once.

Figure 2 shows that among those who had ever consumed *Moringaoleifera* leaves, the majority consumed it occasionally, i.e. 81%. Figure 3 shows that 69% of respondents buy Moringa leaves at the market, 14% do not buy but have a plant at home, and 17% choose or ask someone they know.

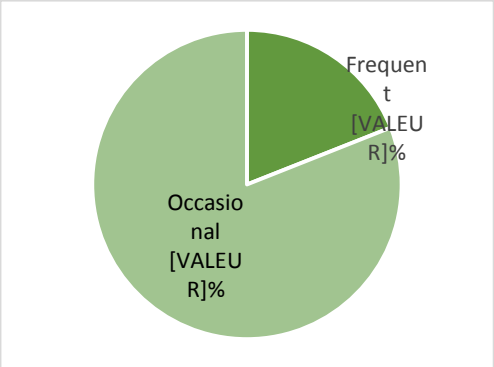

Figure 2 : Frequency of consumption of Moringa

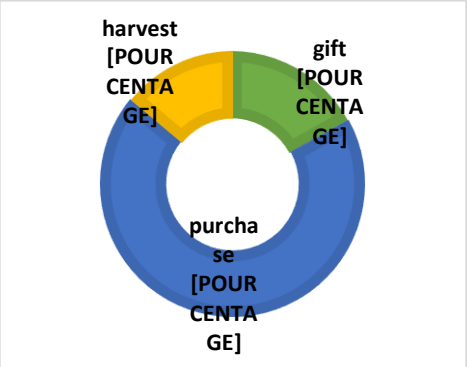

Figure 3: Means of obtaining Moringa

Dried leaf powder of *Moringaoleifera* is one of the most effective ways of preservation (DE SAINT SAUVEUR and Coll., 2010). According to surveys, 62% of respondents say they like the taste of the leaves, while 30% are reluctant because of its rather strong aroma (ANDRIAMITAHA, 2016). This method of preservation is not known by the Malagasy who consume it fresh. Thus, Figure 4 illustrates the modes of consumption of the leaves.

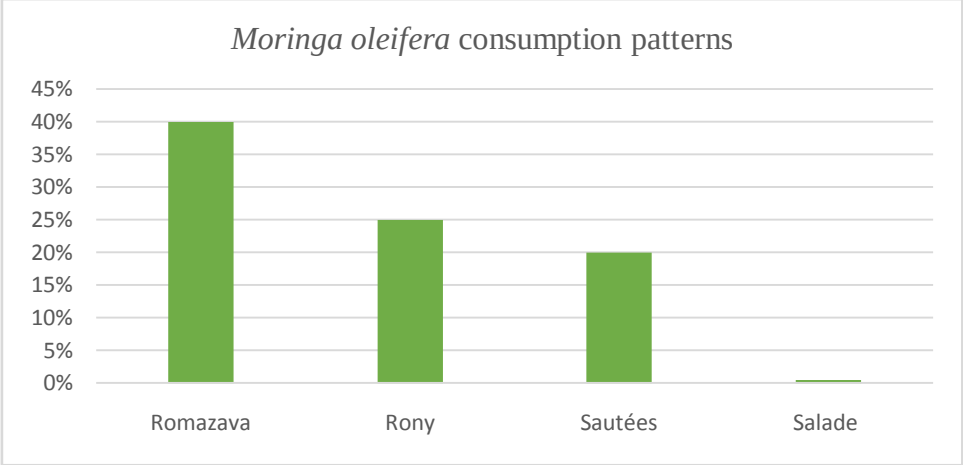

Figure 4: Methods of preparation of Moringa leaves

Moringa leaves are most consumed as a "romazava" (décoction), i.e., more than 40% of respondents, or in soup with meat, i.e., about 25% of respondents. Very few know about its consumption in salads.

III.2 Results of nutritional analyses of Moringa leaves from Tulear and Antananarivo.

Table 1 shows the nutritional values of Moringa leaves from Antananarivo and Tulear.

Table1 : Nutritional composition of Moringaoleifera leaf powders (in g per 100g sample) from Antananarivo and Tulear

	Antananarivo	**Tuléar**
Matière sèche	90	98,12
Eau	10	1,88
Protéines	18,2	19,6
Lipides	2,18	3,01
Glucides	57,86	67,51
Cendres brutes	11,76	8,0
Fibres	1,6	1,9
Valeur énergétique (Kcal)	323,86	375,53

The results obtained show that Moringa leaves from Antananarivo have a higher water content (10%) than those from Tulear (less than 2%). This low water content of the Tulear leaf powders gives it a high dry matter content of 98%.

The protein contents are respectively 18.2% and 19.6% for the leaf powders from Antananarivo and Tulear. However, the Antananarivo leaf powder is lower in protein than that from Tulear.

The crude ash content of the Moringa leaf powders was high, at 11% and 8% for Antananarivo and Tulear respectively, indicating a high mineral content. However, the leaves from Tuléar are less rich in mineral elements than those from Antananarivo.

In terms of energy, the *Moringaoleifera* leaf powders have a high energy density, with the Tulear leaf powder providing more energy than the Antananarivo leaf powder.

Table 2 gives the frontal references and the amino acid composition of the samples.

Table2: Amino acid composition of Moringaoleifera

Acides aminés	Références frontales	Moringa Antananarivo	Moringa Tuléar
Histidine	0,20	-	His
Méthionine	0,62	Met	Met
Acide aspartique	0,17	-	Asn
Isoleucine	0,74	Ile	Ile
Tyrosine	0,47	Tyr	-
Glutamine	0,31	Glu	Glu
Alanine	0,38	Ala	-
AA1	0,11	-	AA1
AA2	0,08	-	AA2
AA3	0,03	-	AA3

The results in Table 2 show the qualitative presence of 5 identifiable amino acids including the essential amino acids: methionine, isoleucine and essential in children which is histidine. Referring to the chromatogram, Moringa from Tulear is composed of 3 amino acids more than that of Antananarivo.

III.3. Sensory analysis results

The hedonic test is carried out on banana and tamarind pastes enriched with Moringa leaf powder enriched with 30% *Moringaoleifera* from Antananarivo and Tulear. The test is carried out on 113 naive consumers, over the age of 15. Table 3 gives the means of the hedonic values of the products.

Table3: Average hedonic values of banana and tamarind pastes enriched with Moringa

Produits	PB Tana	PB Tulear	PT Tana	PT Tulear
Moyennes	5,23	5,93	6,2	6,47

The results show hedonic values for all four products that are higher than 5, indicating that all four types of enriched pastes are appreciated by consumers. However, tamarind pastes enriched with Moringa leaves from Tulear are more appreciated since the hedonic values are higher than those of tamarind pastes enriched with Moringa from Antananarivo. This assessment is confirmed by the sum of the rankings of consumer preference of the products in Table 4.

Table4: Sum of preference rankings for banana and tamarind pastes with Moringa leaf powder

Produits	PB Tana	PB Tuléar	PT Tana	PT Tuléar
Somme des rangs	339	284	267	240

The results show that the smaller the sum of the ranks, the more the product is appreciated. Thus, in ascending order, consumer preference for the different fruit pastes is as follows: Tamarind pastes from Tulear> Tamarind pastes from Antananarivo > Banana pastes from Tulear> Banana pastes from Antananarivo.

A multiple comparison test and a product clustering test are performed to identify significant differences between products. The results are reported in Tables 5 and 6.

Tableau 5: Multiple comparaison test of Moringaoleifera fruit pastes from Antananarivo and Tulear

Modailtés	différence	différence réduite	valeur critique	Pr.>Diff	Significatif
PB Tana~PT Tuléar	-1,24	-1	12,706	0,5	Non
PB Tana~PT Tana	-0,97	-0,782	12,706	0,577	Non
PB Tana~PB Tuléar	-0,7	-0,565	12,706	0,673	Non

PB Tuléar ~PT Tuléar	-0,54	-0,435	12,706	0,739	Non
PB Tuléar ~PT Tana	-0,27	-0,218	12,706	0,864	Non
PT Tana~PT Tuléar	-0,27	-0,218	12,706	0,864	Non

Tableau 6 Product classification and grouping test

Modalités	Moyenne valeur hédonique	Regroupements
PB Tana	5,23	A
PB Tuléar	5,93	A
PT Tana	6,2	A
PT Tuléar	6,47	A

Thus, the statistical results of the test show that there is no significant difference in consumer appreciation and acceptability between tamarind and banana pastes made with Moringa leaf powder from Antananarivo and Tulear.

IV. DISCUSSION

Tamarind and banana pastes enriched with *Moringaoleifera* from Antananarivo and Tulear are products that allow, on the one hand, to valorize foods that are placed in the background of the diet such as *Moringaoleifera* and *Tamarindusindica*. On the other hand, these products are rich in protein and mineral elements provided by the leaves of *Moringaoleifera* and whose analysis of products has been done in previous works [5]. They contribute to the achievement of the recommended nutritional intake [3] of the population. These products allow diversification of food intake, especially snacks made from natural raw materials, and contribute to protein and mineral intake. They are also a means to alleviate household food insecurity and to contribute to the fight against malnutrition.

V. CONCLUSION

In order to fight against chronic malnutrition, which is the most serious form of malnutrition, it is interesting to enhance the value of existing food products in the various localities and to proceed with enrichment in order to provide the daily needs necessary for the organism and to allow for food diversification.

REFERENCES

[1] AFNOR, Contrôle de la qualité des produits alimentaires, les méthodes d'analyses officielles. Paris : AFNOR, 1ère édition, 1989. 373p.

[2] AGSANV, 2013. Analyse Globale de la Sécurité Alimentaire et Nutritionnelle, et de la Vulnérabilité (AGSANV), Résumé. 11p.

[3] FAOSTAT, 2014. Données de l'alimentation et de l'agriculture.

[4] HALDAR R., KOSANKAR S. 2017. *Moringaoleifera* :l'arbre miracle. International Journal of Advance Research Ideas and Innovation in Technology. ISSN : 2454- 132x. Vol 3, Issue 6. 2017.

[5] HARIMALALA ANDRIAMBELO N., 2014. Nutritional quality of fruit pastes enriched with *Moringaoleifera* leaves. In International Journal of Applied Science and Technology. SSN 2221-0997 (Print), 2221-1004 (Online). Vol 4, N°5, 2014.

[6] LEFEBVRE A., BASSEREAU J. 2003. L'analyse sensorielle, une méthode de mesure au service des acteurs de la conception : ses avantages, ses limites, ses voies d'amélioration. pp3-11.

[7] PAM 2014. Analyse Globale de la Sécurité Alimentaire et Nutritionnelle, et de la Vulnérabilité, Madagascar. Programme Alimentaire Mondial, Service de l'Analyse de la Sécurité Alimentaire (VAM)

[8] PNAN III, 2017- 2021. Plan National d'Action pour la Nutrition. La nutrition garant d'un capital humain pour un développement social et économique durable. 46 p.

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An Empirical Model Integrating Ai into Government

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ABSTRACT

This study explores the evolution of global AI dynamics by discussing its role in government with a focus on aspects of development and governance of social and technological systems (STS). This document reports three research questions, including the extent of the analysis: (1) theories regarding the concept of AI in the public sector; (2) expectations regarding the development of AI in the public sector; and, (3) the challenges and opportunities of AI in the public sector. This experimental study provides an experimental framework for a comprehensive approach to measuring the magnitude of AI policy that allows for the methods of evaluating different governance practices and policy priorities in different countries. The study sheds light onto areas of policy that have the potential to implement AI programs and strategies; administrative functions open to the acceptance of AI applications and strategies; and the challenges / risks that community managers may face in defining AI policies and projects in the public sector including how to deal with cyber-troops.

Keywords: AI, socio-technological systems, tech policy, cyber-troops, mis-information, HCI

I. Introduction

Big data systems powered by AI technology are transforming governments and communities, challenging what were once considered values.

Probably, the most common use of AI in government occurs in security, using face recognition. Gershgorn (2019) [1] reported facial recognition by California police; Margetts and Dorbantu (2019) have reported the issue of the London Metropolitan Police in 2017. World governments have defined AI strategies and policies that address the uncertain future [3]Therefore, the purpose of this paper, as well as other domains of online government-based technology [1,2,3]is to understand the understanding, expectations, challenges / opportunities. of key public sector stakeholders.

There is a growing concern that the widespread use of facial recognition will lead to the dramatic decline of privacy and civil liberties. Ubiquitous CCTV cameras and giant databases of facial images, ranging from public social network profiles to national ID card registers, make it alarmingly easy to identify individuals, as well as track their location and social interactions. Moreover, unlike many other biometric systems, facial recognition can be used without subjects' consent or knowledge.

Pervasive surveillance is not the only risk brought about by facial recognition. Apart from identifying individuals, the algorithms can identify individuals' personal attributes, as some of them are linked with facial appearance. Like humans, facial recognition algorithms can accurately infer gender, age, ethnicity, or emotional state[4,5,6]. Unfortunately, the list of personal attributes that can be inferred from the face extends well beyond those few obvious examples.

National / state governments are actors in a variety of contexts in introducing new regulations on key issues, including data protection and security, citizen privacy, the future of public employment, the implementation of robots, automated decision-making, ethical principles, among others [13, 23, 26]. Not to mention, not all countries will be controlling and designing AI in government with the same principles, democratic values, and objectives. Therefore, the purpose of this study is to understand the understanding, expectations, and challenges / opportunities regarding AI in the public sector. This article presents three research questions, including three dimensions of analysis:

(1) What is the view of those who handle AI in this sense? Ideas related to the concept of AI in the public sector;

(2) What are the expectations of those stakeholders managing AI in terms of its progress in public administration?

(3) What are the major challenges and opportunities for public administration to manage AI? Challenges and opportunities for AI in the public sector.

The framework of the proposed method in this study will provide a descriptive method for evaluating these research questions.

The paper is structured as follows:

Starting with a review of emerging AI management models in the public sector, the paper develops analytical strategy and research methods, including research questions. Section four presents the research framework in terms of three dimensions of analysis.

Section five discusses the usefulness of the framework by looking at emerging AI documents in government.

The final section concludes with a conclusion, developing ideas for the future development of this area of developing research and training content lead to user learning and understanding of how machines learn.

Related Work

The use of artificial intelligence (AI) in government is nothing new. Since the 1980s, public AI adoption has evolved from an emperor-based system equipped with human expert knowledge to evolving systems and learned big data in digital environments through a decision-making body that continues to be independent and powerful [33].

Early in the history of computer science, one of the pioneers in computer science, James H. Moor, explained in his famous article "What is computer ethics?" policies open when policies conflict with technological advances that force us to "discover and make clear what our favorite values are" [17].

The history scholar Thomas P. Hughes described the general development stages of major technological development and expansion programs from the establishment, development, innovation, transfer and growth, competition and integration [22, 27]. Hughes refers to a "systemic war" in which the old and new systems exist simultaneously in a "linguistic tension" relationship. The stage of competition and integration is therefore also a time of conflict and resolution not only between engineers but also politically and legally. In these times of conflict, critical issues are identified, various interests are discussed and finally solutions are put together to guide the emergence of programs. The new system, or modification of the old system, then shifts to the very problems identified in this section.

Unlike Moror (1982) [19], Hughes [32] does not consider these periods to be described as being influenced solely by the changing character of technology programs. He looks at their conversations in complex social contexts. In fact, he held that technology itself was linked to social, economic, and cultural problems.

This paper does not intend to enter into discussions on epistemological weights on the scale of social constructivism and relativism or technical determinism and environmental truth in science and technology (e.g., as should be the case in some studies [26, 14, 19, 32]). Instead, it has to do with how we know the things and the skills and resources we use to create technology from an STS perspective. Harry M. Collins defines skills as goals and objectives and collections of technological principles. They are unexplained or "hidden" technological advances [29, 30].

Background: Government and AI

Aside from the growing importance of AI in the public sector, there are a few studies that address this emerging topic. Valle-Cruz, et al. [4] expanded the literature review on AI in government, recognizing that practice and practice are much faster than scientific and theoretical manifestations. In general, AI-based publications in the public sector are based on experience, cases, opinions, and results from the private sector [5]. From a public point of view, some argue that the massive use of social media, robots, big data, and more recently, AI in the public sector can be regarded as the fourth wave of information and communication technology (ICTs) from the public sector or the introduction of the fourth industrial revolution [39]. This new wave of technological dissemination in the public sector encompasses all aspects of operations (i.e., strategic management, human resource management, performance appraisal, institutional communication) and policy areas (i.e., health, education, boundary control, customer service, emergencies, taxes, social benefits)and based on open and large

data volumes and the ability to process new organizations [33]. Therefore, this fact opens the door for public sector organizations to establish themselves in a different dimension.

Only in the last few millennia have we begun to commit our conversations to writing, and only in the last few decades have we begun to outsource them to the computer.

As Bauman (2005) mentioned in his theory of "liquid modernity"—the "melting" of the steel structures that once upheld the "solid modernity" of the industrial revolution into a state of limitless liquidity that we witness in the communication through technologies which also affects the sphere of the traditional discourse.

Semantic textual similarity (STS) refers to the task of measuring the similarity in meaning of sentences, and there have been widely adopted evaluation benchmarks including the Semantic Textual Similarity Benchmark (STS-B) (2017; 2016; 2015; 2014; 2013; 2012) and the Microsoft Research Paraphrase Corpus (MRPC) (Dolan and Brockett, 2005). The STS-B benchmark assigns discrete similarity scores of 0 to 5 to pairs of sentences, with sentence pairs scored zero being completely dissimilar and pairs scored five being equivalent in meaning. The MRPC benchmark assigns binary labels that indicate whether sentence pairs are paraphrases or not. Semantic textual similarity is a problem still actively researched with a dynamic state of the art performance.

Shaar et al. (2020) discussed retrieval and ranking of fact-checked claims for an input claim to detect previously debunked misinformation. They introduced the task, as well as a dataset covering US politics in English, and two BM25 based architectures with SBERT and a BERT-based re-ranker on top. Vo and Lee (2020) tackled a similar problem by finding relevant fact-check reports for multimodal social media posts. However these projects only focus on English data that mainly cover U.S. politics and at least one of the matching pairs is a claim from a fact-check report. Additionally, the data collection process used in Shaar et al. (2020) might not necessarily capture all possible matches for a claim, since the dataset is constructed by including only the claims mentioned in one fact-check report and not all previous occurrences. This may skew results and increase the risk of the model having a high false negative ratio.

Iten et al. published in January 2020 an article, on neural networks about physical concepts, where the authors were exploring whether the laws of quantum physics, and other physical theories can explain data from experiments if one assumes no prior knowledge of physics. They claim to achieve this goal by implementing a neural network, called SciNet, that mimics a physicist asking questions about the future behavior of a system. In other words, SciNet aims at mimicking a physicist who deduces from observations the corresponding equation, e.g. in a simple case of constant motion at speed. The functioning of SciNet is schematized in Fig. 1, reproduced from Iten et al. (2018).

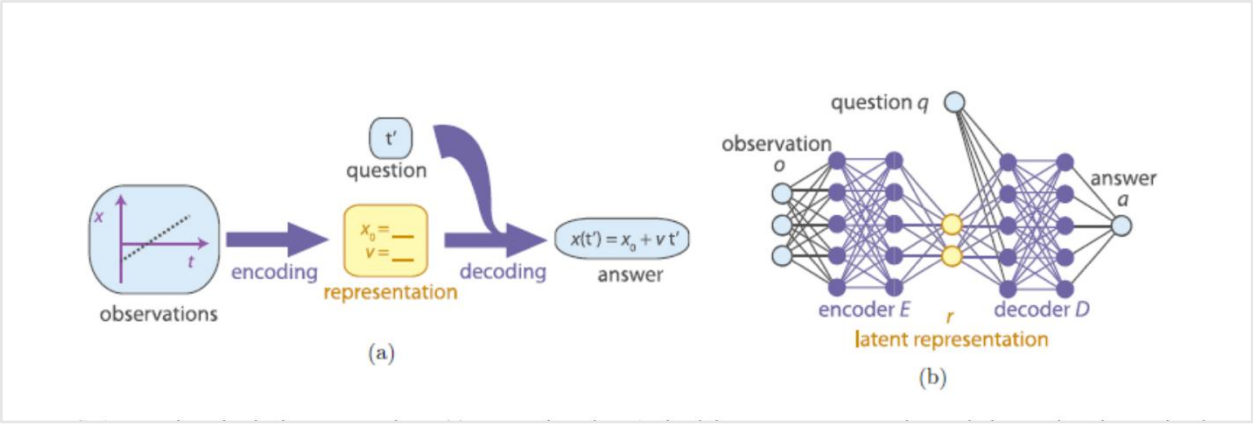

Fig. 1. Learning physical representations

As seen in Figure 1, part (a) provides an overview of human learning in which a physicist compresses experimental observations into a simple representation (encoding). When later asked any question about the physical setting, the physicist should be able to produce a correct answer using only the representation and not the original data. This process of producing the answer from the representation is referred to as "decoding." For example, the observations may be the first few seconds of the trajectory of a particle moving with constant speed; the representation could be the parameters "speed v" and "initial position" and the question could be "where will the particle be at a later time?"

However, there are still several problems that have yet to be addressed by AI-enabled learning interventions such as designing and assessing adaptive courses, high instructor workload, lack of a specific framework for

implementing intelligent agents in the systems and high levels of attention among learners in the execution of the proposed tasks. Most of the models, as noted by Dargue and Biddle (2014, p. 1), 'are quite complex to enable just about any learner to get the optimum tailored experience possible'. Several studies have applied AI-enabled learning interventions to address different concerns such as poor feedback or quality of the learning process. One good example is a personalized adaptive online learning analysis model that analyses the structure of a learning process using big data analysis (Liang & Hainan, 2019). This proposed novel adaptive e-learning model can improve the quality of the learning process by providing the most suitable learning content for each learner. This model was designed to address inaccurate and incorrect learning material selection processes in adaptive learning systems.
Another major criticism is that AI is based upon an obsolete and limited conception of cognition (Rescorla, 2020; Strube, 2001). The argument is that the old view of cognition underlying AI ignores the situated and social nature of cognition. The new view is that 'cognitive systems are [to be] conceived [of] as autonomous social agents, situated in a complex dynamic environment' (Strube, 2001). Most of the AI programming tools are capable of controlling robotic artefacts and communicating with other agents.

The reviewed articles leave no doubt that some of the most advanced research efforts in AI precisely aim at constructing ANNs that can learn, discover, and master (use) concepts, laws, and ultimately theories – in the cases studied physical concepts, laws, theories. This is clear in Iten et al. (2018, 2020): here the networks are trained to discover concepts and law statements, and use these to answer questions about the future evolution of specific systems.

Some scholars claim that AI will provide the benefits of efficiency in public organizations drawn from the creation of large data sources and analytics to improve all internal processes and functions [23, 27, 29]. Some think that AI will open up a different phase of public institution management including AI-related technological disruptions in policy making and decision-making processes [38]. Most public administration experts think that the power and conclusions of private companies could be transferred more quickly to the public sector. This AI and public sector learning approach takes the need to define a particular focus on staff, jobs, citizens, and ultimately participates in public administration and policy.

This study focuses on AI analysis from ambiguous ICT goals in government and public administration. AI in government involves the design, construction, implementation and testing of computer algorithms and techniques to improve the management of public organizations [20, 26]. At this stage, governments around the world are beginning to adopt independent strategies for algorithmic management to transform decision-making and policy processes, service delivery, and citizen engagement [23, 27, 29]. However, there are no consensus on the impact of AI on the public sector.

Existing Work of AI Research on Government

Existing work on AI and algorithms are limited directly related to public administration. In particular, automated technology is expected to have a direct impact on the state of the public sector. This could mean a shift from the passion for automation, computer policies, and digital management (based on Web-based technology), to intelligent governance that requires continuous communication and learning with people (based on inter-algorithm technology) [13, 17]; Also, this new wave of technology in the public sector will be reflected in the emergence of dynamic forms of organization (e.g., Holacracy), or open cultures of cooperation between individuals and government employees [23].

Feed AI data is generated, collected, stored, and processed using information systems and technology algorithms that are perceived as neutral, or at least impartial by humans [30, 33, 27]. These instruments of logical technology are the basis of descriptive, predictive, descriptive, and automated positivist analytics [11, 33]. Therefore, AI thinking has been incorporated into the concept of big data analysis, as well as non-testing algorithms [11, 19, 28]. This type of thinking make sit difficult for government organizations and public sector managers analyzing the risks of policy-making processes and public decisions based on biased sets of data or unethical algorithms [3, 5, 18].
Under the guise of "political marketing", various political parties, trade unions and other civil society organizations and actors may be involved in deliberately spreading harmful information by following dissenters against anti-founders or homosexual lines and xenophobia. The growth or domination of a particular political ideology (left or right) can also contribute to the practice and toxic public discourse. In general, there are three types of main characters that can be involved in manipulating social media. They are the state, the media and the private sector:

- Firstly, the government can be a key source of false domestic information and false information through state news outlets, troll forces and the police to spread false information online. The government controls a number of news outlets [13] such as state-run newspapers or television companies

- Second, many untrue stories and untrue stories come from government-controlled media. By 2020, "all state institutions have shown evidence of propaganda and deception," said an independent media monitoring report [23].

- Third, most troll groups can be linked to the state. These trolls can create "dirt and lies" on social media [13, 17, 18] by linking their activities online.

Strategies, Tools, and Strategies

Social media, which now counts as part of AI, is often blamed for a lack of independence and often mixed with real and false news, is linked to political activists or people who spread false stories that pretend to come from trusted sources like CNN or the BBC's personal Facebook accounts, anonymous Facebook groups and WhatsApp. Sometimes the mainstream media can take those stories or politicians to discuss false information made by social groups or people who share it with their supporters.

Trolls are very active on Facebook. The main sources of deceptive content on social media are human-based accounts. They include social networking sites, websites, and messaging apps. Unidentified information on social media can also come from the accounts of government-run stores and groups harassing political opponents with small words, and misleading the public into believing this is anonymous. Typical foreign-language narratives include presenting EU or US institutions as "weak" and promising the imminent collapse of the West [13, 19, 28].

There are also other troll farm signs running on social media. However, they do not seem to serve as a major source of false information on social media. The platforms most affected by the ignorance are Facebook, Twitter and YouTube, in general.

Facebook is the forerunner of all social media for any cyber troop activity. Research since the 2014 elections has shown that 70% of voters use Facebook to access news and information [11, 14, 17]. As of May 2020, active use of Facebook was almost 68%, compared to 18% for Pinterest and 10% for YouTube (Global Statistics, 2020). Twitter and Instagram are lagging behind by less than 2% (Global Stats, 2020). Although the general public uses Facebook rather than Twitter, politicians and political activists also have Twitter accounts.

Political activists rely on Twitter to move their issues consistently forward, so that politicians do not see them as meaningless arguments but as real social problems. In addition to the low use of Twitter, repetition pays to influence politicians' view of social status.

Given the fact that WhatsApp is a private messaging system, rather than a social media platform, WhatsApp's fake news situation is a threat that can only be started with more digital learning.

Table 1 summarizes the strategies, tools and techniques seen to exploit social media in general.

Account Types	Messaging and Valence	Content and Communication Strategies	Platforms
Human	Polarization strategies including attacks on government reforms, immigration, diversity and inclusion, and religious values/human rights/social issues, Trolling and Harassment, Defamation attempts/accusations of corruption	Facebook pages, disinfo/misinfo websites, including news websites linked to political parties, memes, misleading photos or images from elsewhere	Facebook, WhatsApp, Twitter

Table 1. Observed Strategies, Tools and Techniques of Social Media Manipulation

Propaganda efforts may be centered and distributed:

- Central co-ordination is possible through government agencies that control all key statistics in the police and state affairs.

- Some troll groups operate in a very reduced way. However, their origins and interactions are uncertain. There is little information available about the source used to fund fraud attempts. Government-controlled media will certainly need essential resources to share deceptive political content.

If there is any attempt to use bots for political propaganda, they can also be done in a negative way. For example, many accounts can share the same text, so these are easily recognizable. However, any such efforts can be combined. Theoretically, bots can have a huge impact, but when it comes to spreading false information in small countries, misinformation can go further and faster than tools like WhatsApp without the use of bots.

Similarly, high-level "deep fakes", in which a person in a photo or video is inserted by another to use the content, are possible. For political purposes. In some cases, political activists may use images that have come from elsewhere, making them easier to identify as false.

Finally, the systematic use of media prosecutors (paid or unpaid) by political parties or other political actors to amplify their messages, could also be one of the government's options.

Government and private responses

Government actors are very concerned about information from a foreign country. The most important method used by the government to respond to this false information sponsored by the government is the media network. To date, the government may use the "Information Security Concept" based on the purposes of "information ownership." The concept can prioritize state-of-the-art information management. This concept is likely to involve a greater response to misinformation and the propaganda of foreign powers. Therefore, it should be aimed at ensuring the security of the information of the authorities "rather than the people".

Various public and private sector projects can be implemented to curb the spread of online information. This includes public sector initiatives such as protecting the integrity of the electoral process, as well as projects investigating the truth by the government, or other media. Each is briefly described below.

Social sector programs

Some non-profits may choose to fight against disinformation campaigns through education and communication (rather than following a punitive approach). Such a strategy is based on three main pillars:

a) advanced digital literacy;
b) improved communication; and
c) immediate response to anonymous information campaigns.

Other workshops can be conducted with the target audience, including local politicians, municipal leaders and youth political leaders. Some may be open to the public. Similarly, social media companies can offer conferences to public officials, political parties, and the media on how to identify false information and propaganda.

The second pillar is based on the development of interactive communication and dialogue and videos to dispel common myths about elections, and to explain electoral processes to journalists, especially municipal elections. The purpose is to prevent untrue stories from getting into the bloodstream. Building relationships with an open channel of communication with the media is important to ensure that when suspicious items are found, they are skeptical, ask critical questions, and call on the relevant organization to confirm before contributing to the leading false news.

A third pillar of public response to inappropriate information campaigns involves the immediate implementation of responses by including in its agreement an open channel with social media such as Facebook that contains censorship content that may threaten the integrity of the electoral process. To achieve this, election judges will be compelled in the first phase to issue a decision to provide evidence to support their decision. Once approved, the related non-profit organization will be allowed to call the number on Facebook to request that the content be reduced. The provision will only be used in extreme cases, for example when public order or the basic right to vote is threatened by false news or organized media fraud.

In addition to these processes, a fact-finding alliance between all major issues can also be established at the national level with the help of telecommunications companies. The idea is that each media company can assign two of its journalists to the fact-finding team during the election process and will publish the unit's findings in all participating news outlets. This unit will maintain the ownership of the editing process and the social media platform may be able to inform its users of false information.

II. Proposed Model

The study provides a framework for conducting online research for government / national officials leading governmental policies.

The research process for data collection contains research (see the Appendix to review the analysis strategy and research questions). The questionnaire consists of 19 questions targeting public officials who control ICT in various international departments.

Research has been developed and constructed based on a review of various books focusing on art and theoretical studies [20, 25, 24, 17, 19]. This research identifies various typologies and concepts that are very helpful in formulating final questions.

To assess the magnitude of this study, research results can be analyzed using descriptive statistics. These simple but effective methods are useful to achieve the purpose of exploratory research.

III. Results and Discussion

This section provides a framework for three key elements as it will be explored by public officials: ideas, expectations, and AI opportunities / challenges in government. The study provides key information from senior public officials leading technical policies in national / state governments.

Ideas on the concept of AI in the public sector

In the first case, this study examines the perceptions of government officials about AI in the public sector, as emerging technologies can be unanimously understood, accepted and applied. In particular, the views of senior management will help to realize the magnitude and power of AI in the public sector as this community management team "plans" IT policies. Therefore, this part of the study sheds light on the concepts, and strategies commonly associated with, AI by national / national stakeholders such as CIOs (Chief Information Officers) or IT managers.

The survey question asks, "how much do you agree with the following ideas about artificial intelligence". The answers to the study question are Likert's seven-point scale, ranging from "I totally agree" (7) to "strongly disagree" (1). Table 2 shows the overall sample view for general deviations.

	Average	Standard deviation
I am open-minded in terms of adoption of AI.		
AI in the public sector is similar AI in the private sector.		
It is likely that robots and humans will share jobs.		
Given complex interactions between robots and human-beings replacement process will have huge impacts.		
Other		

"intelligences" might be necessary for public sector.		
Emerging professions in the public sector relating to AI need to be evaluated in detail.		
Average		

Table 2: General AI-related ideas in the public sector

Ultimately, size will include a section set to identify the skills and behaviors of senior executives who link them to changes based on the use of AI in the public sector. The research question on power / morality says, "in terms of this level of power and morality of the people, how much do you agree with their transformation by artificial intelligence in the public sector?" Table 3 shows a summary of the officials' responses as they report common experiences on AI-based power and behavior change in the public sector.

	Average	Standard deviation
Monitor		
Monitor		
Analyze		
Act		
Interact		
Remember		
Anticipate		
Feel		
Moralize		
Create		
Decide		
Average		

Table 3: Human capacity and behavior based on AI

Expectations for AI in the public sector

Social and political expectations about AI are high in terms of achievement and benefits, but also in terms of potential problems. This part of the study examines the expected impact of AI on various management functions in the public sector. To understand this magnitude, the survey question was, "in your view, what about the following activities that will be most affected by artificial intelligence in the short term?". Figure 1 shows the sample answers in the study in the multiple-choice question (minimum of three response options in the full list).

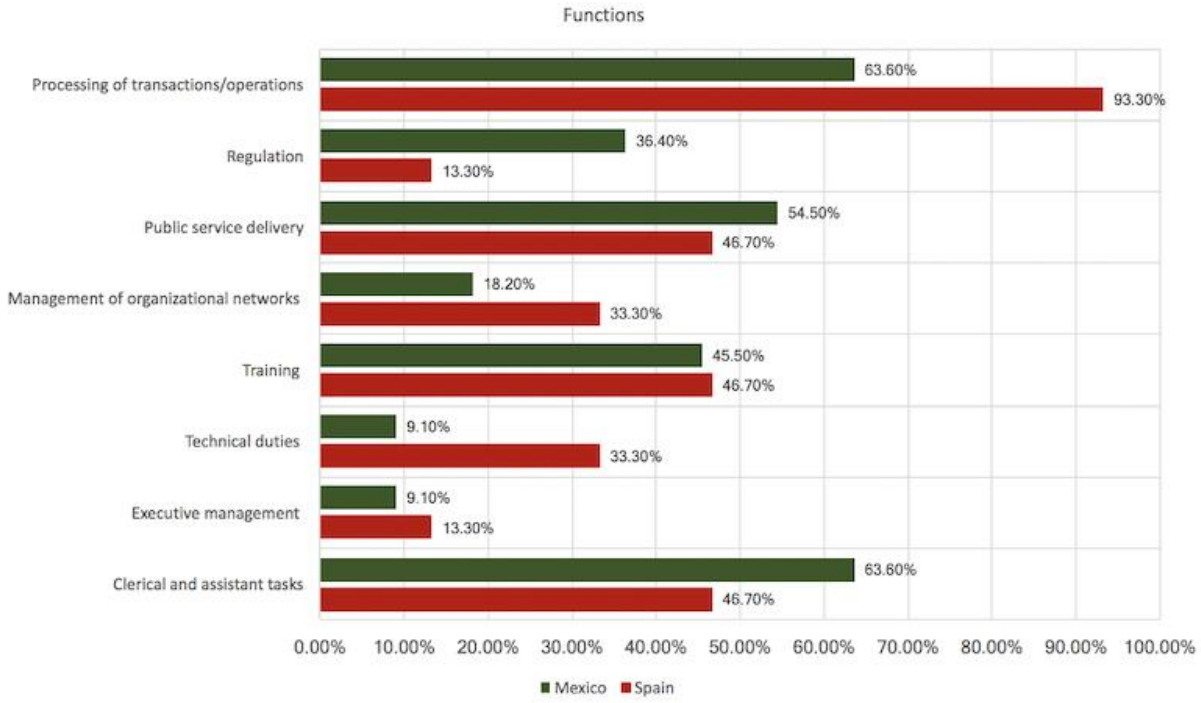

Figure 1: Sample expected tasks that are most affected by AI performance

The final section of this rating examines the expected impact of AI on various areas of high-level public policy. To understand this magnitude, the survey question I am asking is, "In your opinion, when will public policy domains be adopted artificial intelligence from the outset?" Figure 2 shows the sample answers in the study in the multiple-choice question (minimum of three answer options in the full list).

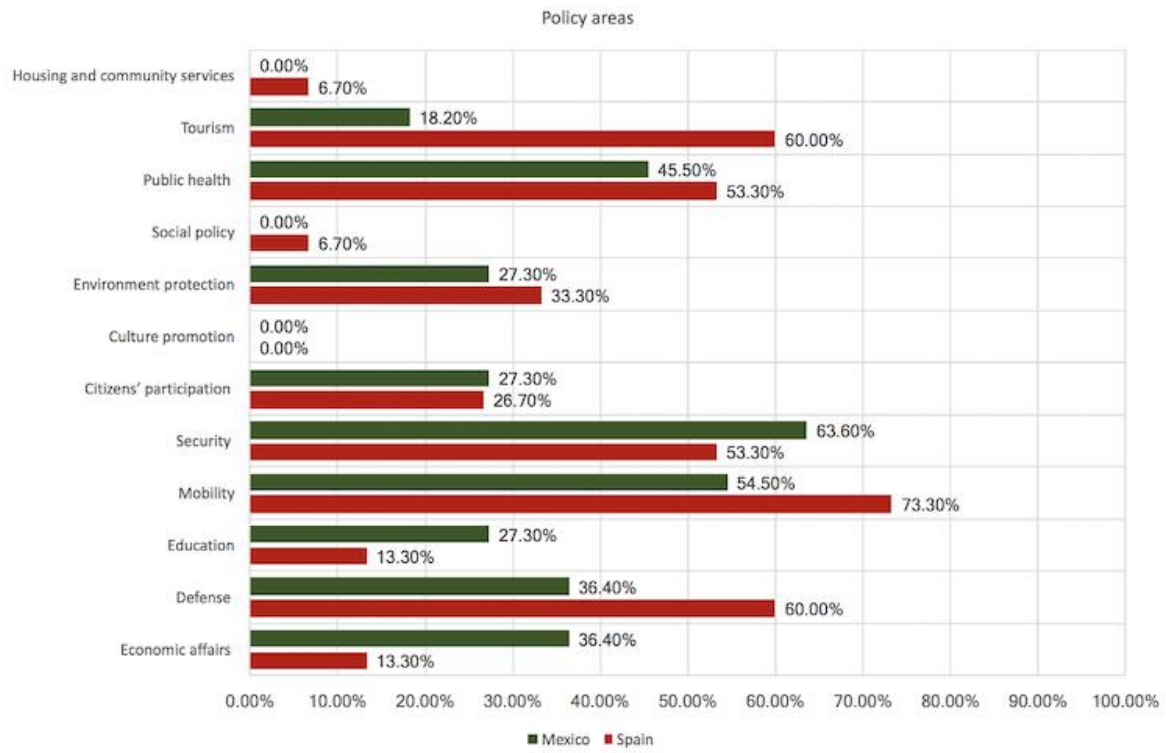

Figure 2: A sample of the expected policy areas using artificial intelligence is still young

Challenges and opportunities for AI in the public sector

This final aspect of the study described the challenges and opportunities based on the realities in the use of AI in the public sector. Here, attention is paid to IT leaders in departments that promote or organize, at least in part, applications, cases, and strategies, based on algorithms, big data analytics, and AI technology, programs, or applications, dealing with inhibitors different and providers.

First, analyzing inhibitors explained how CIOs understand the real challenges in AI implementation in their organizations. To understand this magnitude, the survey question states, "what are the major barriers to the use of artificial intelligence in the public sector?" Answers to the survey are multiple choice questions (minimum of three response options in full list). Figure 3 outlines three key constraints, including digital budget diversification, technical and legal infrastructure. (This section reports real differences in the experience of implementation based on each country. At the same time, the barriers address different issues in the public sector, developing, in a way, the same ideas in different AI governance systems.

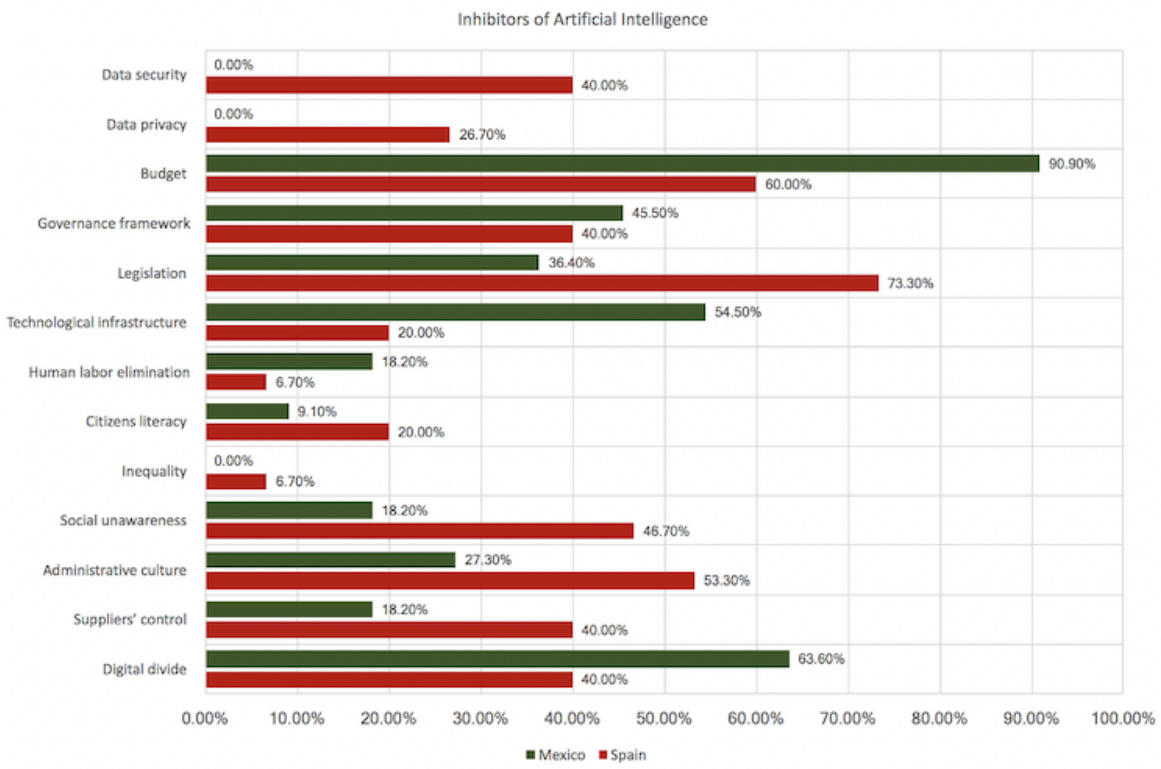

Figure 3: Inhibition of implants in public organizations

Learning developers provided insight into how CIOs understand the real possibilities in the use of AI in their organizations. As for the promoters, the question for the survey is, "What are the most important factors in the application of artificial intelligence in the public sector?" Figure 4 shows the sample answers in the study in question multiple answers (minimum of three response options in the full list).

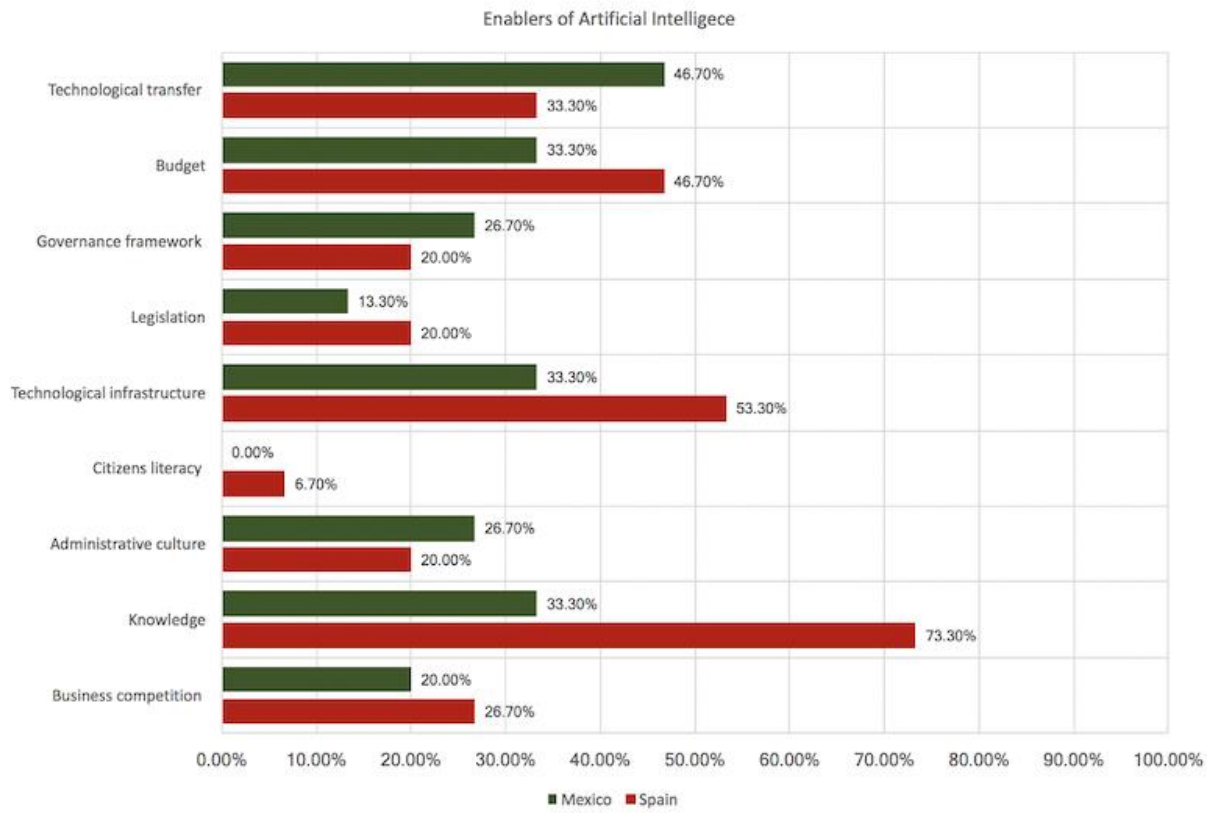

Figure 4: AI power makers in community organizations

IV. Conclusions

Politics is in large part a conversation about how we define those ground rules in a way that enjoys the widest possible legitimacy, and the challenge that social media now faces is, for better or worse, inherently political.
The framework provided in this study is an attempt to understand the first steps of government artificial intelligence (AI). In the light of public opinion, it will be clear how much the country advertises AI, at least in some way, not only to the government itself, but also to the government to the public (promoting business or citizen ideas, providing little or no prominence in data protection, privacy, and security. certain and other areas of policy), and designed different forms of governance.

Should a private company be intervening to shape the ideas that flow across its systems, above and beyond the prevention of serious harms like incitement to violence and harassment? If so, who should make that decision?

Essentially, this research sheds light onto areas of policy that have the potential to implement AI programs and strategies; administrative functions open to the acceptance of AI applications and strategies; and the challenges / risks that community managers may face in defining AI policies and projects in the public sector including how to deal with cyber-troops.

The future of AI in government and public administration is not predetermined. Various voices seek appropriate AI policies and strategies, anti-discrimination, and equality. The results would also assist senior officials to evaluate their nationally submitted AI policies in practice during the construction and implementation of various national / state, regional / state, and local / municipal environments.

Last, but not least, agreeing on what constitutes the collective good is very hard indeed. A better understanding of the relationship between the user and the algorithm is in everyone's interest. People need to have confidence in the systems that are so integral to modern life. The internet needs new rules for the road that can command broad public consent. And tech companies need to know the parameters within which society is comfortable for them to operate, so that they have permission to continue to innovate. That starts with openness and transparency, and with giving you more control.

References

[1] Agre, P. E. (1994). Surveillance and capture: Two models of privacy. The Information Society, 10(2), 101–127.

[2] Allen, J. (2016). Topologies of power. Beyond territory and networks. Routledge.

[3] Bratton, B. (2015). The Stack: On software and sovereignty. MIT Press.

[4] Bucher, T. (2018). If...then: Algorithmic power and politics. Oxford University Press.

[5] Castañeda, L., & Selwyn, N. (2018). More than tools? Making sense of the ongoing digitizations of higher education. International Journal of Educational Technology in Higher Education, 15(1).

[6] Decuypere, M. (2019a). Open Education platforms: Theoretical ideas, digital operations and the figure of the open learner. European Educational Research Journal, 18(4), 439–460.

[7] Dieter, M., Gerlitz, C., Helmond, A., Tkacz, N., Vlist, F., Der, V., &Weltevrede, E. (2018). Store, interface, package, connection : Methods and propositions for multi-situated app studies. CRC Media of Cooperation Working Paper Series No 4.

[8] Drucker, J. (2020). Visualization and Interpretation: Humanistic Approaches to Display. MIT Press. Journal of New Approaches in Educational Research, 10(1)

[9] Mathias, Decuypere The Topologies of Data Practices: A Methodological Introduction Fedorova, K. (2020). Tactics of Interfacing. Encoding Affect in Art and Technology. MIT Press. Goriunova, O. (2019). The Digital Subject: People as Data as Persons. Theory, Culture & Society, 36(6), 125–145.

[10] Gulson, K. N., Lewis, S., Lingard, B., Lubienski, C., Takayama, K., & Webb, P. T. (2017). Policy mobilities and methodology: a proposition for inventive methods in education policy studies. Critical Studies in Education, 58(2), 224–241.

[11] Gulson, K. N., &Sellar, S. (2019). Emerging data infrastructures and the new topologies of education policy. Environment and Planning D: Society and Space, 37, 350–366.

[12] Hartong, S. (2020). The power of relation-making: insights into the production and operation of digital school performance platforms in the US. Critical Studies in Education, 00(00), 1–16.

[13] Hartong, S., &Förschler, A. (2019). Opening the black box of data-based school monitoring: Data infrastructures, flows and practices in state education agencies. Big Data & Society, 6(1),

[14] Lash, S. (2012). Deforming the Figure: Topology and the Social Imaginary. Theory, Culture & Society, 29(4-5), 261–287.

[15] Latour, B. (1986). Visualization and cognition: Thinking with eyes and hands. Knowledge & Society, 6, 1–40. Retrieved from http://hci.ucsd.edu/10/readings/Latour(1986).pdf

[6] Law, J. (2004). After Method: Mess in Social Science Research. Psychology Press.

[17] Lewis, S. (2020). Providing a platform for "what works": Platform-based governance and the reshaping of teacher learning through the OECD's PISA4U. Comparative Education, 56(4).

[18] Lewis, S., & Hardy, I. (2017). Tracking the Topological: The Effects of Standardised Data Upon Teachers' Practice. British Journal of Educational Studies, 65(2), 219–238.

[19] Light, B., Burgess, J., & Duguay, S. (2018). The walkthrough method: An approach to the study of apps. New Media and Society, 20(3), 881–900.

[20] Lindh, M., & Nolin, J. (2016). Information We Collect: Surveillance and Privacy in the Implementation of Google Apps for Education. European Educational Research Journal, 15(6),

[21] Lury, C., & Day, S. (2019). Algorithmic Personalization as a Mode of Individuation. Theory, Culture & Society, 36(2), 17–37.

[22] Mathias, Decuypere The Topologies of Data Practices: A Methodological Introduction Lury, C., Fensham, R., Heller-Nicholas, A., &Lammes, S. (2018). Routledge Handbook of Interdisciplinary Research Methods. Routledge.

[23] Lury, C., Parisi, L., & Terranova, T. (2012). Introduction: The Becoming Topological of Culture. Theory, Culture & Society, 29(4-5), 3–35.

[24] Lury, C., Tironi, M., &Bernasconi, R. (2020). The Social Life of Methods as Epistemic Objects: Interview with Celia Lury. Diseña, 16, 32–55.

[25] Lury, C., & Wakeford, N. (2012). Introduction: A perpetual inventory. Inventive Methods (pp. 15–38). Routledge.

[26] Martin, L., &Secor, A. J. (2014). Towards a post-mathematical topology. Progress in Human Geography, 38(3), 420–438.

[27] Piattoeva, N., &Saari, A. (2020). Rubbing against data infrastructure(s): methodological explorations on working with(in) the impossibility of exteriority. Journal of Education Policy, 00(00), 1–21.

[28] Plantin, J. C., Lagoze, C., Edwards, P. N., &Sandvig, C. (2018). Infrastructure studies meet platform studies in the age of Google and Facebook. New Media and Society, 20(1), 293–310.

[29] Prince, R. (2017). Local or global policy? Thinking about policy mobility with assemblage and topology. Area, 49(3), 335–341.

[30] Ratner, H. (2019). Topologies of Organization: Space in Continuous Deformation. Organization Studies, 1–18.

[31] Ratner, H., & Gad, C. (2019). Data warehousing organization: Infrastructural experimentation with educational governance. Organization, 26(4), 537–552.

[32] Ratner, H., & Ruppert, E. (2019). Producing and projecting data: Aesthetic practices of government data portals. Big Data & Society, 6(2), 1–16.

[33] Ruppert, E., Law, J., & Savage, M. (2013). Reassembling Social Science Methods: The Challenge of Digital Devices. Theory, Culture & Society, 30(4), 22–46.

[34] Suchman, L. (2012). Configuration. In C. Lury& N. Wakeford (Eds.), Inventive Methods: The Happening of the Social (pp. 48–60). Taylor and Francis.

[35] Thompson, G., & Cook, I. (2015). Becoming-topologies of education: deformations, networks and the database effect. Discourse: Studies in the Cultural Politics of Education, 36(5), 732–748.

[36] Thompson, G., &Sellar, S. (2018). Datafication, testing events and the outside of thought. Learning, Media and Technology, 43(2), 139–151.

[37] van de Oudeweetering, K., &Decuypere, M. (2019). Understanding openness through (in)visible platform boundaries: a topological study on MOOCs as multiplexes of spaces and times. International Journal of Educational Technology in Higher Education, 16(1).

[38] van de Oudeweetering, K., &Decuypere, M. (2020). In between hyperboles: forms and formations in Open Education. Learning, Media and Technology, Advance online publication, 1–18.

[39] Williamson, B. (2017). Learning in the "platform society": Disassembling an educational data assemblage. Research in Education, 98(1), 59–82.