Global Scientific JOURNALS

GSJ: Volume 9, Issue 7, July 2021, Online: ISSN 2320-9186
www.globalscientificjournal.com

THE IMPACT OF PREVENTIVE MAINTENANCE ON THE FREQUENCY OF ELECTRICITY SUPPLY INTERRUPTIONS IN CAMEROON

Felix Nkellefack Tapang, PhD Fellow

Student, The ICT University USA, Cameroon Campus

ABSTRACT

This study analyses the impact of preventive maintenance on the frequency of electricity supply interruptions in Cameroon. The specific objectives were to access the impact of wooden pole replacements with concrete poles, Transformers upgrade and distribution cables upgrade on the frequency of electricity supply interruptions in Cameroon. The study was composed of a quantitative and a qualitative analysis. The quantitative study was composed of independent variables (preventive maintenances) and dependent variable (Electricity Supply Interruptions).The instruments used for primary data collection were survey questionnaires administered with the help of a well-designed Google form through social media platforms and an interview guide to Cameroonian electricity users. A Pre-test through Cronbach alpha was conducted to ensure the reliability and internal consistency of items. The Cronbach Alpha reliability coefficients were all found to be acceptable, specifically, 0,171 for Electricity Supply Interruption items, 0,802 for Wooden Pole Replacement items, 0,862 for Transformer Upgrade items, and 0,909 for Distribution Cable upgrade items. The population for the study was 101, from whom collected data were organized, analyzed and interpreted. For the quantitative analysis, Ordinary least square linear multiple regression was used to analyze and test the hypothesis formulated for the study. The results revealed an R-square (coefficient of multiple determinants) of 0.319, implying that 31.9 % changes in electricity supply Interruptions in Cameroon is caused by changes in Wooden Pole Replacements, Transformers upgrade and Distribution Cables upgrade carried out by the electricity utility company in Cameroon. This

implies that the other 68.1 % changes in the level of electricity supply interruptions could be caused by other variables not found in model that guided this study but represented by the error term. The Adjusted R-square value was found to be 0.298, which means that the model specified to guide the study was 29.8% goodness fit. The F-statistics was found to be 14.853 which is significant at 0.05 level implying that there is a significant relationship between preventive maintenances and the rate of electricity supply interruptions in Cameroon. The estimated coefficients for Wooden Pole Replacements, Transformers Upgrade and Distribution Cables Upgrade were all positive, also implying that there exists a direct relationship between these preventive maintenances and the frequency of electricity supply interruptions. From the qualitative analysis, preventive maintenance on the electricity network, recruitment of more qualified technicians, engagement of local communities in various quarters to monitor the electricity network, quality of technicians, long term planning of the electrical network and the poor state of the electricity distribution network in Cameroon emerged as recurrent themes.

Keywords: Preventive, maintenance, electricity, interruptions, quantitative, qualitative

1. INTRODUCTION

Electricity is one of the most essential requirements to function in modern life. In the days of old, the early man depended on fire to obtain light, heat and for cooking. In these modern times, by just turning on a switch or pushing a button, we can instantly have power to supply these needs. Electricity has become a very fundamental requirement in our everyday lives. It is a requirement for the smooth functioning of homes, schools, shopping centers, work places, industries. Various devices we use today like mobile phones, tablets, computers, and many other types of equipment require electricity to function. The use of electricity today is not limited only for local purposes, but also for the various aspects of the modern life in the world around us. Many production and communication industries need electricity to operate. Domains like the radio, television, the internet cannot exist in the absence of electricity.

As recorded by the Institute for Energy Research, IER (n.d.), one of the first major breakthroughs in electricity occurred in 1831, when British scientist Michael Faraday discovered the basic principles of electricity generation, by inducing electric current through moving

magnets inside coils of copper wire. Today, there are various modern technologies used in producing electricity. In most developed countries today, electricity is generated through steam turbines using fossil fuels, nuclear, biomass, geothermal, as well as solar photovoltaic and wind turbines gradually becoming popular. In many developing countries, hydro turbines and gas turbines are the most principal sources. In Cameroon, mainly hydro and thermal stations are used to generate the electricity transmitted and distributed to supply electricity consumers.

In order for various electricity dependent activities to function optimally, there is need for a reliable and uninterrupted supply of electricity. The interruption of electricity supply has become a big problem for electricity consumers for many countries in the world today. Electricity interruption can be momentary, sporadic or chronic. According to Sinan (2015), momentary interruptions last for a very short time typically some seconds. Sporadic interruptions are caused by harsh weather conditions such as thunder storms or floods. This type of interruptions pose a great threat to the power system since they cause long lasting blackouts which mean significantly high economic losses for the consumers of electricity. On the other hand, Chronic interruptions might be caused by poor power system planning and operation, insufficient power generation, overloading of the system, as well as faults in the electricity network due to aging or lack of maintenance.

Particular indicators are universally used in measuring the reliability of electricity distribution. Typically, the System Average Interruption Duration Index (SAIDI), the System Average Interruption Frequency Index (SAIFI) and the Undistributed Energy (END) are used. For the purpose of this research the SAIFI will be of interest. Following the World Bank statistics (http://www.enterprisesurveys.org/), Pakistan stands as having the worst levels of average electricity interruption frequency in the world today, while Cameroon stands at the twenty fifth position. However, for average interruption durations of electricity outage per year in Africa, according to the recent publication of Sönnichsen (2021), Nigeria recorded the worst with 4600 hours, followed by Niger 1400 hours, DR Congo 830 hours, Cameroon & Ghana 790 hours each, Angola 760 hours, Tanzania 670 hours, Ethiopia 570 hours, Kenya 420 hours, Zimbabwe 280 hours, Ivory Coast 20 hours, Zambia 180 hours, Senegal 130 hours, Mozambique 80 hours, South Africa 50 hours. The ranking reflects Cameroon at the fourth position in Africa with poor average duration of electricity outage per year. Cameroon, being at this position is a big concern that directly reflects the state of its electricity distribution network of today. This research seeks to identify the underlining factors contributing to the frequent electricity interruptions in Cameroon that need to be addressed with the ultimate goal of developing strategies to help the

electricity utility company of Cameroon (ENEO) compete with the better performers in the African continent and eventually satisfy its consumers with reliable supply of electricity.

2. RESEARCH OBJECTIVES

The main purpose of this research is to assess the impact of preventive maintenance on electricity supply interruptions.

More specifically this work seeks to:

- ✓ Access the impact of wooden pole replacements with concrete poles on electricity supply interruptions in Cameroon.
- ✓ Access the impact of distribution Transformers upgrade on electricity supply interruptions in Cameroon.
- ✓ Access the impact of distribution cables upgrade on electricity supply interruptions in Cameroon.

3. RESEARCH QUESTIONS

The main question of this research is; what is the impact of preventive maintenance on electricity supply interruptions?

This study aims at assessing the impact of preventive maintenance on electricity supply interruptions by addressing the following specific questions;

- ✓ What is the impact of wooden pole replacements with concrete poles on electricity supply interruptions in Cameroon?
- ✓ What is impact of distribution Transformers upgrade on electricity supply interruptions in Cameroon?
- ✓ What is the impact of distribution cables upgrade on electricity supply interruptions in Cameroon?

4. RESEARCH HYPOTHESIS

This work has as main research hypothesis: there is a significant impact of preventive maintenance on electricity supply interruptions.

More specifically, the following hypotheses will be tested:

- ✓ There is a significant impact of wooden pole replacements with concrete poles on electricity supply interruptions in Cameroon
- ✓ There is a significant impact of distribution Transformers upgrade on electricity supply interruptions in Cameroon.
- ✓ There is a significant impact of distribution cables upgrade on electricity supply interruptions in Cameroon.

5. RELATED WORKS ON THE SUBJECT MATTER

This section is focused on previous studies by different researchers on the impact of electricity supply interruptions worldwide. It covers several arguments posted by various researchers across the world.

The problems of lack of electricity supply popularly referred to as power outages gives electricity users serious economic losses. According to Mao et al. (2018), the economic impact of power outages can be divided into the direct economic impacts and the indirect economic impacts. The study of Sinan (2015) titled Economic Impacts of Electric Power Outages and Evaluation of Customer Interruption Costs with objective to provide Customer Interruption Cost (CIC) estimations which will be customer specific and easy to duplicate in any part of the world underscored that the direct impacts of electricity interruptions covers losses in manufacturing and production, interruption of services such as transportation, telecommunication, as well as loss of sales, damages on the equipment, spoiled goods, damages on the electronic data, accidents and injuries. According to Sinan (2015), the indirect impacts of electricity interruptions include public disorder, looting, and other crimes seen upon blackouts, property losses and so on.

The study conducted by Otuekong, Etim & Ekong (2021) on Automated Real-Time Electricity Supply Monitoring System in Nigeria underscored that the distribution network consists of all the components necessary to link consumers to the grid and is usually where most failures (also

referred to as outages) occur. According to these Authors, there is gross insufficient energy to be distributed to the approximately 180 million population of Nigeria. As such, Distribution Network Operators DNOs resort to constant load scheduling, overloading, under-voltage, and in extreme cases cutting off some communities (Blackouts) so as to balance the load in their network. These acute electricity problems hinder development regardless of the availability of vast natural resources in any country

The work of Mathewman & Hugh (2014) on the sociology of electrical power failure which focused on providing an understanding to the patterns of Electrical network failure, i.e. the accidental loss of electrical power referred to as blackouts revealed that the continuing sophistication and prevalence of electrical appliances only serves to increase our dependence. According to these authors, in the digital world, interruptions and disturbances less than one cycle (1/60th second) can have catastrophic effects like crashing of Servers and computers , life support machines becoming dysfunctional which compromises intensive care operations. Also, Power outage is associated with economic cost, food safety and increased crime rates (Mathewman & Hugh, 2014).

Following the study of Ali, Ghazalian & Ghazzawi (2020) to examine the effects of power outages on the performance of manufacturing firms in the Middle East and North Africa (MENA) using a firm-level dataset derived from the World Bank's Enterprise Surveys (WBES) database, with the argument that Power supply in developing countries is often characterized by unreliability and inefficiency, resulting in disruption costs for operating firms with extents of power outages in the Middle East and North Africa (MENA) more significant compared to other geo-economic regions, findings revealed adverse consequences of power outages for the performance of manufacturing firms in the MENA region in terms of sales and productivity rates. According to Ali, Ghazalian & Ghazzawi (2020), different patterns of power outages have varying implications for firm performance and that the effects of power outages exhibit variations with firm size.

Klinger, Landeg & Murray (2014) argued that extreme events (e.g. flooding) threaten critical infrastructure including power supplies and that many interlinked systems in the modern world depend on a reliable power supply to function effectively with the health sector being no

exception but that the impact of power outages on health is poorly understood. In their attempt to identify the impact of power interruption and how many power outages were identified and in how many countries within the first three months of 2013, from 20 relevant articles found, Power outages were found to impact health at many levels within diverse settings with recurrent themes that included the difficulties of accessing healthcare, maintaining frontline services and the challenges of community healthcare. According to Klinger, Landeg & Murray (2014) a total of 52 power outages were identified in 19 countries that were the direct consequence of extreme events during the first three months of 2013.

Dipoma & Tamo (2013) came up with theories and arguments that the cost of electricity outages are high for industries in Cameroon and that the cost for running Generators by industries during outages are high, but that when outages are notified, industries can save money. With objectives to estimate the average outage cost for industries in Cameroon, to estimate the percentage reduction of average outage cost if suspension notice is given by the electricity utility company and to estimate the cost of running generators during outages, Dipoma & Tamo (2013) found and concluded that power interruptions have a significant negative effect on industries in Cameroon. According to these authors, the average outage cost varies from €3.62/kWh to €5.42/kWh for a one hour interruption and from 1.96/kWh to €2.46/kWh for a four hours outage. The study found that advance suspension notices could help in reducing outage costs by 19.83-33% and that the total capital costs and total running costs of generators are approximately €180,040,180.08 and €4,305,510.6, respectively (Dipoma & Tamo, 2013).

Lassana & Abdoulaye (2013) observed that the Senegalese economy has undergone a major crisis in the electricity sector citing failed privatizations, the increased cost of fuel, and lack of public investments as the main factors that led to a poor electricity supply that shows in the daily occurrences of power outages. These authors aimed at finding out the effect of power outages on cost and technical efficiencies on Small and Medium size Enterprises SMEs, as well as larger ones. In their findings according to Lassana & Abdoulaye (2013), power outage duration has a positive significant effect on cost and technical efficiencies, and SMEs were more successful in doing so than larger ones. Finding a solution to the power outage issue while affecting negatively cost efficiency, seems to promote technical and scale efficiencies.

Anselm (2016) argued that Africa currently faces major electricity shortages with a number of power outages which has the tendency of rendering many firms less efficient in their production. Seeking to find the impact of power outages on production efficiency of firms in Africa, Anselm (2016) concluded that the number of power outages experienced in a typical month has a negative impact on the production efficiency of firms in Africa.

6. METHODOLOGY

The research adopted the ex-post facto study design. A sample size of 101 Cameroons across the national territory who are users of electricity and observers of the electricity network were randomly selected. The primary data collection instruments were a questionnaire administered with the help of a well-designed Google form sent to respondents through social media platforms and an interview guide. The research instruments were validated and the reliability and internal consistency of items ensured using Cronbach Alpha reliability coefficient which were all within the acceptable range between zero and one, specifically as follows: 0,171 for Electricity Supply Interruption items, 0,802 for wooden pole replacement items, 0,862 for Transformer Upgrade items, and 0,909 for Distribution Cable upgrade items.

This research was guided and directed by a specified model. The model was stated thus:

ESI= f (WPR, TU, DCU)

Mathematically:

$ESI = a0 + a_1WPR + a_2TU + a_3DCU + \xi$

Where

ESI = Electricity Supply Interruptions

WPR = Wooden Pole Replacement with concrete Poles

TU = Transformers Upgrade

DCU= Distribution Cables Upgrade

a_0, a_1, a_2, a_3 = Constants

ξ = error term

7. DESCRIPTION OF VARIABLES

The various variables for this study are preventive maintenances considered as the independent variable (influencing variable) and Electricity Supply Interruptions considered as the dependent variable (variable being influenced). The specific independent variables for the study are Wooden Pole Replacement with Concrete Poles, Transformers Upgrade and Distribution Cables Upgrade

Electricity Supply Interruptions is a function of the various preventive maintenances. This implies that without carrying out proper preventive maintenances, specifically Wooden Pole Replacement with concrete Poles, Transformers Upgrade and Distribution Cables Upgrade, the Cameroon Electricity Utility Company ENEO is likely not to improve the situation of frequent Electricity Interruption which is necessary for customer satisfaction. This is because electricity is a fundamental prerequisite for the development of every community, and also essential for every domain of human activity. On the other hand, if the Cameroon Electricity Utility Company ENEO carries out proper preventive maintenances, the situation of frequent Electricity Interruption is likely going to be improved and the long term goals on the communities and every domain of human activity that rely on electricity would likely be realized.

8. FINDINGS

8.1 FINDINGS FROM QUANTITATIVE ANALYSIS

In order to analyze and test the hypotheses formulated for this study, ordinary least square linear multiple regression was used. The results are presented in Tables 1, 2 and 3.

Demographic information

A total of 101 respondents provided answers to the questionnaire for the study, with 74 men (73, 3%) and 27 women (26, 7%). 16 of them were above 60 years old (15,8%), 14 were between 18 and 29 years old (13,9%), 51 were 30 and 49 years old (50,5%), 20 were between 50 and 60 years old (19,8%).

Table 1: Regression Result on the Impact of Preventive Maintenance on the frequency of Electricity Interruptions in Cameroon

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	1.974	.199		9.913	.000	1.578	2.369
	WPR	.157	.072	.293	2.166	.033	.013	.301
	TU	.104	.064	.213	1.639	.105	-.022	.231
	DCU	.067	.068	.121	.977	.331	-.069	.203

a. Dependent Variable: ESI

WPR=Wooden Pole Replacements with concrete poles

TU= Transformers Upgrade

DCU=Distribution Cables Upgrade

From table 1, the estimated coefficient for wooden pole replacement WPR with concrete poles is positive. This implies that there exist a direct relationship between wooden pole replacements with concrete poles and electricity interruptions. By implication an increase in replacing wooden poles with concrete poles will lead to improvements on the frequency of electricity interruptions. This result is in order with economic a priori criteria and is significant at both 5 and 10 per cent level of significance. The estimated coefficient for Transformers upgrade TU is positive. This implies that there exists a direct relationship between the upgrade of Transformers to higher capacities on the frequency of electricity interruptions. In other words an increase in the upgrade of Transformers will lead to improvements on the frequency of electricity interruptions. This result is in order with economic a priori criteria and is significant at both 5 and 10 per cent level of significance. The estimated coefficient for distribution cables upgrade DCU is positive. This implies that there exist a direct relationship between distribution cables upgrade and the frequency of electricity interruptions. In other words increase in distribution cables upgrade will lead to improvements on the frequency of electricity interruptions. This result is in order with economic a priori criteria and is significant at both 5 and 10 per cent level of significance.

Table 2: Model Summary Result on the Impact of Preventive Maintenance on the frequency of Electricity Interruptions in Cameroon

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.565[a]	.319	.298	.28729

a. Predictors: (Constant), DCU, TU, WPR

b. Dependent Variable: ESI

Table 2 revealed an R-square (the coefficient of multiple determinants) of 0.319. This implies that about 31.9 % changes in electricity Interruptions in Cameroon is caused by changes in wooden pole replacements, Transformer upgrades and Distribution Cable upgrades carried out by the electricity utility company in Cameroon. This implies that the other 68.1 % changes in the level of electricity interruptions could be caused by other variables not found in model but represented by the error term. The Adjusted R-square value of 0.298 means that the model is 29.8% goodness fit.

Table 3: ANOVA results on the Impact of Preventive Maintenance on the frequency of Electricity Interruptions in Cameroon

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.678	3	1.226	14.853	.000[b]
	Residual	7.841	95	.083		
	Total	11.518	98			

a. Dependent Variable: ESI

b. Predictors: (Constant), DCU, TU, WPR

From table 3, the F-statistics is 14.853 which is significant at 0.05 level and implies that there is a significant relationship between preventive maintenances and the rate of electricity interruptions in Cameroon.

Test of Hypothesis

One sample T-Test was used in SPSS to test the hypothesis developed for the study. The test value was the mean of 3.89 at 95% confidence level. The result is represented in table 4.

Table 4: One Sample Test results on the Impact of Preventive Maintenance on the frequency of Electricity Interruptions in Cameroon

One-Sample Test

	Test Value = 3.89					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
WPR	-2.705	99	.008	-.17400	-.3017	-.0463
TU	1.403	100	.164	.09762	-.0405	.2357
DCU	1.603	99	.112	.10000	-.0238	.2238

WPR=Wooden Pole Replacements with concrete poles

TU= Transformers Upgrade

DCU=Distribution Cables Upgrade

Decision rule:

Reject Hi if P-value > 0.5

Accept Hi if P-value < 0.5

Hypothesis I:

Hi: There is a significant impact of wooden pole replacements with concrete poles on electricity supply interruptions in Cameroon

Ho: There is no significant impact of wooden pole replacements with concrete poles on electricity supply interruptions in Cameroon

Decision rule

Since the calculated P-value of 0.08 is less than 0.5 the hull hypothesis is rejected. It therefore means that there is significant statistical evidence that wooden pole replacements with concrete poles has an impact electricity supply interruptions in Cameroon

Hypothesis II:

Hi: There is a significant impact of distribution Transformers upgrade on electricity supply interruptions in Cameroon

Ho: There is no significant impact of distribution Transformers upgrade on electricity supply interruptions in Cameroon

Decision rule

Since the calculated P-value of 0.164 is less than 0.5 the hull hypothesis is rejected. It therefore means that there is significant statistical evidence that distribution Transformers upgrade have an impact electricity supply interruptions in Cameroon

Hypothesis III:

Hi: There is a significant impact of distribution cables upgrade on electricity supply interruptions in Cameroon

Ho: There is no significant impact of distribution cables upgrade on electricity supply interruptions in Cameroon

Decision rule

Since the calculated P-value of 0.112 is less than 0.5 the hull hypothesis is rejected. It therefore means that there is significant statistical evidence that distribution cables upgrade have an impact electricity supply interruptions in Cameroon

8.2 FINDINGS FROM QUALITAIVE ANALYSIS

A qualitative analysis was also carried out where responses from participants to three pertinent questions were required to complement the quantitative part of the study.

The first question was designed to obtain the views of the respondents on what the electricity utility company of Cameroon should do to improve its electricity network. Three themes emerged from the participants, namely, preventive maintenance on the electricity network,

recruitment of more qualified technicians and engagement of local communities in various quarters to monitor the electricity network. As far as the first category on preventive maintenance on the electricity network is concerned, major concerns of participants were on replacing wooden poles with concrete or metallic poles, replacing cables from smaller to larger cross sections and installing more Transformers. The second category on the recruitment of qualified technicians was focused with having more field technicians capable of repairing faults on the electricity network without delay each time there is an interruption from a fault. The third category on the engagement of local communities in various quarters according to the participants was to serve as support for the technical teams of the electricity utility company by monitoring the network in their quarter and informing them promptly each time a fault occurs.

The second question was designed to find out the views of the participants on what the Cameroon electricity utility company should do satisfy their customers. Again three recurrent themes or categories were on electrical network maintenance, quality of technicians and long term planning of the electrical network. For the first category emphasis were made on increasing the number of Transformers on the network, and regular checks for maintenance on the network. For the second category on quality of technicians, it emerged in responses that the utility company should have an improved human resource department capable of matching technicians with relevant skills to works on the electricity network, as well as increasing the number of technicians for network operations. Finally the for the third category on long term planning of the electrical network, the issue of extending the medium and low voltage networks was of great importance to respondents.

The third question was designed to have the views of the participants on how they would compare the efficiency of electrical distribution services of ENEO to those of other African countries. The majority of the respondents expressed that the efficiency of electricity distribution of Cameroon is worse than what obtains in many other African countries. According to one respondent, "*Services of ENEO are very very bad. On a scale of 5, ENEO is rated on one (1)*". However, a number of respondents cited Nigeria as having worse electricity distribution efficiency than Cameroon.

9. DISCUSSIONS ON FINDINGS

9.1 DISCUSSIONS ON QUANTITATIVE FINDINGS

These results are all significant at the 0.05 level of significance and in line with electricity distribution efficiency theories. These findings are in line with the thoughts of Mao et al. (2018), which considered electricity interruptions with impacts that can be divided into the direct economic impact and indirect economic impact of power outages. In the case of electricity interruptions in Cameroon, public disorder is beginning to become a phenomenon to deal with. The thoughts of Sinan (2015) with respect to the indirect impacts of electricity interruptions include public disorder, looting, and other crimes perpetuated during blackouts. Therefore it becomes paramount that the electricity utility company in Cameroon invests more in preventive maintenance projects in order to reduce the occurrence of electricity interruptions.

The R-square (the coefficient of multiple determinants) of the study was 0.319. This implies that about 31.9 % changes in electricity Interruptions in Cameroon is caused by changes in wooden pole replacements, Transformer upgrades and Distribution Cable upgrades carried out by the electricity utility company in Cameroon. By implication 68.1 % changes in the level of electricity interruptions could be caused by other variables that were not in model but represented by the error term. This means that more research is required to determine other factors responsible for electricity interruptions in the electricity utility company in Cameroon.

The significant impacts on the preventive maintenance variables considered in this study quite relevant. Along this path, Klinger, Landeg & Murray (2014) argued that extreme events threaten critical infrastructure including power supplies and that many interlinked systems in the modern world depend on a reliable power supply to function effectively. Extreme weather conditions with strong winds for example, have the capacity of pulling down wooden poles on the electricity network, thereby causing sporadic interruptions. It is therefore a call for concern for the wooden poles on the network to be replaced with concrete or metallic ones. In this way electricity interruptions due to fallen wooden poles will be improved.

Finally, the economic significance of electricity interruptions should be a center of consideration and efforts made to reduce their frequency to the basic minimum. This is in line with the study of Dipoma & Tamo (2013) which provided significant costs of electricity interruptions that vary

from €3.62/kWh to €5.42/kWh for a one hour interruption and from 1.96/kWh to €2.46/kWh for a four hours outage.

9.2 DISCUSSIONS ON QUALIITATIVE FINDINGS

The findings from the qualitative analysis substantiate those of the quantitative analysis as they provide more insight in the same direction. Preventive maintenance projects are of paramount interest to improve on the efficiency of the electricity distribution network in Cameroon such that indicators like that of frequent electricity interruptions can be improved. From the findings, the key relevant projects are the replacement of wooden poles on the network with concrete ones, the installation of more Transformers to reduce load on existing ones and also the upgrade of cables on the network which will reduce the phenomenon of burnt cables due to saturations. According to World Bank statistics heighted in the introduction, Cameroon is the fourth country in Africa with high electricity interruption. This fact was validated in the qualitative analysis which means the frequent electricity problems in Cameroon are real and need attention. As found in the analysis, there is need for a number of things to be done by the electricity utility company in Cameroon. Essentially, focused investments are needed to hire sufficient qualified technicians for field operations, as well as focused investments in upgrading electricity network components and extending the electricity networks.

10. CONCLUSION

This research had as main objective to assess the impact of preventive maintenance on electricity supply interruptions in Cameroon. The primary data from the field revealed that there is a significant impact of the independent variables (preventive maintenances) on the dependent variable (Electricity interruptions) in Cameroon. It revealed that wooden pole replacements to concrete poles, Transformers upgrade and Distribution cables upgrade which are relevant keys to electricity interruptions played significant roles to electricity interruptions in Cameroon. Findings from the qualitative data substantiated and gave more meaning to those of the quantitative analysis. The problems of frequent electricity interruptions could be improved if investments could be made to hire more qualified technicians for field operations, and investments in upgrading electricity networks.

11. RECOMMENDATIONS

Due to the numerous challenges faced by the electricity utility company in Cameroon and electricity users, the following recommendations could help bring improvements.

11.1 RECOMMENDATIONS TO THE CAMEROON ELECTRICITY UTILITY COMPANY

With the goal of reducing the frequent electricity interruptions, the following recommendations are made;

- ✓ To continue ensuring that the materials used in the construction of electrical networks are original, from known fabrication companies, and with well-known technical specifications.
- ✓ To provide sufficient budgets for long systematic replacement of wooden poles with concrete or metallic poles
- ✓ To provide sufficient budgets for long systematic upgrade of distribution Transformers
- ✓ To provide sufficient budgets for long systematic upgrade of distribution cables, both on the medium voltage and low voltage sides.
- ✓ To recruit more qualified technicians and engineers to better plan and operate the electricity distribution networks

11.2 RECOMMENDATIONS TO GOVERNMENT REGULATORS IN CAMEROON

The following recommendations do apply to government regulators;

- ✓ To forbid the usage of wooden poles on electricity network construction.
- ✓ To institute penalties on the electricity utility company for interruptions exceeding a defined limit

REFERENCES

IER. (n.d.). *History of electricity*. Retrieved from https://www.instituteforenergyresearch.org/history-electricity/.

Sinan, K. (2015).*Economic Impacts of Electric Power Outages and Evaluation of Customer Interruption Costs*. (Aalto University publication series 131/2015) [Doctoral Dissertation, Aalto University].Retrieved from https://core.ac.uk/download/pdf/301131449.pdf

Sönnichsen,N. (2021). Average duration of electricity outages per year in Africa as of 2018, by select country*(in hours). Retrived from* https://www.statista.com/statistics/617570/average-monthly-electricity-outage-africa-by-select-country/

Otuekong, E., Etim,A. & Ekong, A. (2021). *Automated Real-Time Electricity Supply Monitoring System*. Proceedings of the 27th iSTEAMS Multidisciplinary Innovations & Technology Transfer (MINTT) Conference. Academic City University College, Accra, Ghana. June, 2021. Pp 10-16 www.isteams.net/ghana2021. DOI - https://doi.org/10.22624/AIMS/iSTEAMS-2021/V27P2

Mao, S. et al.(2018).Review on Economic Loss Assessment of Power Outages. Amsterdam, Niederland: Elsevier

Mathewman, S. & Hugh, B. (2014).Blackouts: a sociology of electrical power failure. (n.p.).Retrieved from https://www.researchgate.net/publication/264985468_Blackouts_a_sociology_of_electrical_power_failure

Ali, F.,Ghazalian,P. & Ghazzawi, N.(2020).The Effects of Power Outages on the Performance of Manufacturing Firms in the MENA Region.Berlin, Germany : De Gruyter. https://doi.org/10.1515/rmeef-2020-0011

Klinger, C., Landeg, O. & Murray, V. (2014). Power Outages, Extreme Events and Health: a Systematic Review of the Literature from 2011-2012. PLOS Currents Disasters. DOI: 10.1371/currents.dis.04eb1dc5e73dd1377e05a10e9edde673.

Dipoma, B. & Tamo, T.(2013).Power interruption costs to industries in Cameroon. Amsterdam, Niederland: Elsevier. DOI:10.1016/j.enpol.2013.07.014

Lassana, C. & Abdoulaye, S. (2013). Electric Power Outages and the Productivity of Small and Medium Enterprises in Senegal. Retrieved from https://www.issuelab.org/resources/34954/34954.pdf

Anselm, K. (2016). Power Outages and Production Efficiency of Firms in Africa: EconJournals. Retreived from https://www.econjournals.com/index.php/ijeep/article/viewFile/1488/1073