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Full Length Research

Acute epileptic electricity supply in Isoko North Local Government Area of Delta State: Its causes and remediation

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ABSTRACT: Epileptic electric power supply had become a common factor in Isoko North Local Government Area of Delta State, Nigeria. This study looks at the immediate causes of the prolong power failure in the area, in order to proffer solutions to them. Field work and questionnaires were used to obtain data for this study. During the field work, the main 33 KVA Isoko-Kwale transmission line was thoroughly inspected to ascertain its current state. In addition, the primary (11 KVA) and secondary (415 V) distribution lines, the transformer and feeder pillars were also inspected. Furthermore, questionnaires were distributed to three categories of people (electricians, civil servants and traders), to ascertain the remote causes of epileptic power supply in the region. Results obtained from the field work revealed that some of the electrical materials used in the 33 kVA transmission line were in bad shape. There were instances of missing cross arms from the utility poles, and the insulators were fixed directly to the poles. It was also observed that some cross arms were freely handing at the side of the utility poles. Considering the primary and secondary distribution lines, most of them were in bad shape. Slanting utility poles and cables overgrown with tree branches were regular occurrences. In terms of the feeder pillars, some of them were not functioning. The operational feeder pillars showed signs of overloading and burnt cables. The analysis of the questionnaires feedback with chi-square and graphical methods, revealed that: the poor state of electrical materials, and the negligence of the people of the region in adhering to the electrical rules were highly responsible for the poor electrical supply in the area. Results obtained from the study had revealed that the best remedies to the persistent power failure in the area is the total overhauling of the distribution lines patterns and the transformers. In addition, the people should adhere to the Nigeria electrical safety practices by switching off unnecessary appliances. This will help to conserve electrical energy, and minimized overloading of the 33 KVA transmission line.

Keywords: Distribution, electricity, Isoko, power failure, transmission.

INTRODUCTION

Nigeria has largest economy in Africa but epileptic power supply is hindering its growth. Electricity was introduced into Nigeria in 1896 by the colonial masters (Makoju, 2007; Sule, 2010). Currently, its electric production stands at about 4,000 megawatts (MW), which highly inadequate compared to its population of about 200 million people. Nigeria has the capacity of producing about 12,522 MW (thermal ~ 10,142 MW and hydro ~ 2,380 MW) from the commissioned power plants across the country but most of the power plants are performing below their average capacities (Onohaebi and Omorogiuwa, 2014; USAID, 2020). Nigeria has the lowest (150 kWh) per capita electrical energy consumption in Africa, compared with other Africa countries (Ekpenyong et al., 2013). Electric power production stations in Nigeria varied from gas powered, coal powered, oil powered, and hydro powered (Sambo et al., 2010). Nigerians have been experiencing epileptic electrical power for donkey years despite the numerous intervention programmes various governments have put in place, to improve electricity production, transmission and distribution across the country (Okolo and Etekpe, 2011; Aremu, 2019).

Currently, eleven distribution companies are registered by the Nigeria government to undertake the transmission, distribution and sales of electricity within their area of control (Folorunso and Olowu, 2014). High voltage transmission lines are used for efficient transmission of electrical energy over long distances. Today, the insulation of overhead transmission lines with composite insulators is common practiceworld-wide. The electric insulators are used in transmission lines to support the cables and isolating them of the ground (Kakani, 2010). Insulation of transmission and distribution lines with insulators is recommended by the International Standards Organizations. Appropriate insulators are necessary in electricity transmission, because live metallic conductors are connected on top of them to prevent electrical shocks. Insulators support the electrical cables and isolating them of the ground. Some common types of insulators used in transmission lines are string, suspension, and pin insulators (Kakani, 2010; Electrical Concepts, 2016).

Electricity production and distribution in Nigeria is faced with the following hurdles: Insufficient generation, insufficient and delayed rectification of electrical faults, inadequate funding of power sector, out dated electrical machines and equipment, lack of operational vehicles, inadequate exploration teams to tap all energy from other available resources, and use of ad-hoc staff (Obuka et al., 2014). According to Abanihi et al. (2018), electricity distribution in Nigeria is currently facing high voltage drop, which varied according to the distribution pattern. Sagging is one of the problems that are witness in electricity transmission and distribution lines. Sagging of electrical cables in most cases is gradual process. Electrical cables can sag due to age and high temperature; thereby, limiting the amount of electrical power it can transmit, and increasing their tendency of them touching trees and shorting out (Oluwajobi et al., 2012). Extreme sagging of transmission cables can increase the dead load of the power line, which can cause the weak utility poles and towers to fall. Additionally, excessive sagged cables have higher electrical resistance (due to increase in the cable length between two points); hence, lowering the current the transmission line can normally transmit (Liquidators, 2020). According to Slegers (2011), the distance that a transmission cable will cover before it sags is dependent on the length of the cable between two fixed points, the cable weight, the initial cable tension, and the cable mechanical properties. Transmission poles are designed and installed in a manner to maintain a suitable vertical clearance between the cables and the earth surface; a clearance that must guaranteed maximum static load.

Load shedding is a common phenomenon in most Nigeria towns and villages. This is to either reduce electricity consumption by the customers due to poor power generation, or avoid overloading of the transmission and distribution lines. Load shedding can still be caused by bad weather conditions or dilapidating electrical equipment (Harrison, 2019). Several researchers (Ologundudu, 2014; Aremu, 2019) have investigated the causes and implications of epileptic power supply in some parts of Nigeria. But there is no such research work on the causes of epileptic power supply in Isoko region of Nigeria. Therefore, this research was carried out to investigate the remote causes of the acute epileptic power supply in Isoko North Local Government Area (LGA) of Delta state, and proffer possible solution to them.

MATERIAL AND METHODS

Study area

Isoko North is one of the 774 Local Government Areas (LGA) of Nigeria, with the headquarters located at Ozoro community. The local government consists of 10 major communities, with population of about 143,500 and land mass of about 479 km², according to information obtained from the Delta State government (DSG) portal (DSG, 2013). The local government is powered by the 33 KVA Isoko – Kwale transmission line that comes directly from the Ughelli Power Station. This 33 KVA transmission line, supplied electricity to three LGAs, which are: Isoko North, Isoko South and Kwale. The total length of the Isoko-Kwale 33 KVA transmission line is about 80 km, which span from Ughelli Power Station, and terminated at Kwale. Several Isolators are installed along the line, permit load shedding and hitch free maintenance, if there is a fault in a particular area. The Ughelli power station is being managed by Benin Electricity Distribution Company (BEDC). Benin Electricity Distribution serves customers based in Delta, Edo, Ondo and Ekiti States.

Isoko North LGA had two substations, which are 2.5 KVA and 7.5 substations, which stepped down the 33 KVA that comes from Ughelli power station. These two substations only serve a part of Ozoro community, the remaining part and the other communities that made up the LGA, are connected directly to the 33 KVA transmission line. The customers within the study area experience electric power shedding, at a formula of three hours per day. Isoko North LGA, just like most LGAs in Delta state is suffering from consistent electric power failure, which the power distribution company (BEDC) usually attributed to either overloading or electrical fault. Estimated billing is common in the area, as only few customers had electric meters. Electrical energy consumed is calculated using Equation 1.

$$E = P \times t \text{ (kWh)} \quad (1)$$

Where: E = Energy consumed, P = Power rating of the appliances and t = Time

Data collection

Primary data used for this study were collected through two major methods: field survey and the questionnaire. A field survey was taken to ascertain the state of the electric power transmission equipment across the study area. During the field survey, the 33 KVA transmission line was closely inspected from Ughelli to Ozoro; while the 11 KVA primary distribution lines and 415 V secondary distribution lines in selected communities were thoroughly inspected. In addition, the physical states of the transformers and feeder pillars were inspected.

Questionnaire with well-tailored questions were administered to special group of people to ascertain the remote causes of epileptic power supply in the region. The categories of people selected were: electricians, civil servants and traders. All the questionnaires distributed were recovered due to close monitoring. In addition, information was obtained from some BEDC staff through oral interview.

Data analysis

The results of this study were presented using tables and charts. The chi-square statistical method was used to analyze the data obtained from the questionnaires. The chi-square equation is presented in Equation 2.

$$X^2 = \frac{\sum(O-E)^2}{E} \quad (2)$$

Where: X^2 = Chi square, O = Observed frequency and E = Expected frequency

The expected frequency is calculated using equation 3.

$$E = \frac{ith\ row\ total \times jth\ column\ total}{grand\ total} \quad (3)$$

If the X^2 calculated is greater than X^2 critical; then the null hypothesis is rejected.

RESULTS AND DISCUSSION

Profile of the respondents

The profile of the categories of people sampled in this study is presented in Table 1. The results showed that most of the respondents (61.0%) were graduates from high institutions, while 33.3% of the respondents attained the secondary education level. Only few respondents (1.7%) had non-formal education. The high percentage of the graduates observed in this study could be attributed to the categories of people (electricians and civil servants) samples, and they can provide reliable answers that can be used to access the state of electrical supply in Isoko North region.

Table 1. The profile of the respondents

Education level	Number	Percentage (%)
Tertiary	183	61.0
Secondary	100	33.3
Primary	12	4.0
Non-Formal	5	1.7
Total	300	100

Source: Authors field work, 2020

Causes of ecliptic power supply in Isoko North LGA

The major cause of the acute epileptic power supply is electrical faults and not overloading of the 33 KVA transmission line. Although, vandalization of the electrical materials (transformer, amour cables, feeder filler, uprising cables, transmission cables, etc.) still played a minor role. Overloading causes only about 28% of the power failure experienced in Isoko North LGA, the remaining 78% is caused by electrical faults. Electrical faults can be caused by fallen utility poles, bridging of the transmission/ distribution cables, leakage in the earthing, etc. According to the BEDC ad-hoc staff, power outage caused by overloading can be rectified easily. This is done by reducing the total load consumed in the area, simply by isolating some communities from the 33 KVA transmission line, through the isolation switches. In contrast, in the case of electrical fault, electricity can only be restored to the area after the fault must have been traced and cleared. Considering the Isoko terrain, and the large area the transmission and primary distribution lines covered and lack of workforce, it can take days before the fault can be cleared. According to BEDC, the rough terrain of the area makes tracing and fixing of electric faults difficult problems.

Undue overloading

Results obtained from questionnaires and field survey revealed that most of the residents of the area abuse the electric power supplied to them. A greater proportion of them do not switch off their security (outside) lights during the day time (Figure 1). As seen in (Figure 1), 56% of the electricians, 62% of the civil servants and 75% of the traders did not switch off their security lights during the daytime. In addition, the respondents admitted (Figure 1) that they do not switch off their electrical appliances (e.g. freezers, inner electricity bulbs, ceiling fans, etc.) when leaving the house, despite the warnings of Nigeria Fire Service that this act can leads to overloading and electrical fire. It was only 69% of the electricians, 23% of the civil servants and 14% of the traders that switch off their electrical appliances when leaving the house; while the remaining respondents intentionally left their appliances on when leaving their houses. The respondents attributed their actions to the “high” estimated electricity bills given to them by BEDC. This unnecessary energy wastage could lead to overloading and tripping of the electric power at the power station. BEDC had stated many times that its 33 and 11 kV feeders are being overloaded; thereby leading to

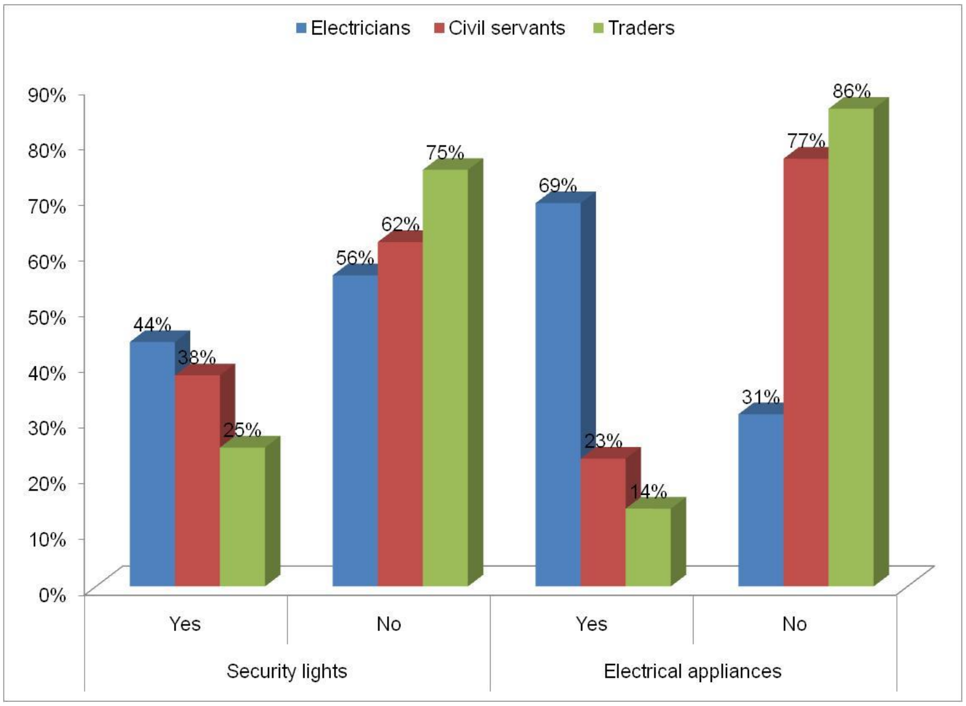

Figure 1. Undue power consumption in Isoko North.

Figure 2. Insulator attached directly to the utility pole at Oleh Community.

power outages (Uhunmwagho and Okedu, 2014). For instance, a 100 watts bulb will consume 1.2 KWh of electric power for 12 hours during the day time; while a 200 watts bulb will consume 2.4 KWh of electric power for 12 hours during the day time. Therefore, leaving the unnecessary bulbs on, does not justified the claim of estimated billing, as it has now negative impact on the electricity health of the Isoko region.

State of the 33 KVA Isoko-Kwale transmission line

The field survey revealed that the 33 KVA transmission line transmitting electricity from Ughelli Power Station to Isoko North LGA, contained a lot of faulty points. These faults ranged from sagging transmission cables to missing insulators. Case of the pin insulators attached directly to the utility poles due to lack of cross arms (Figure 2) were common occurrence along the transmission line. It was observed during the field survey that some of the utility poles tips had broken; thence the cross arms were hanging at the edges of the pole (Figure 3). Attaching the insulators directly to the utility pole is very dangerous, as it can lead to voltage leakage or electrocution during downpour, still the earth had been distorted. Also, the tendency of the cables been bridged by reptiles, falling trees, etc. is higher, as the distance between the cables is smaller than the required NIS standard. It was observed at many points, inside most of the communities that the right of way of 11 m approved by the NIS as not adhered to. According to NIS, transmission line construction in Nigeria power sector

Figure 3. Hanging cross arm at Emede Community.

Figure 4. Sagging transmission cables Between Oleh and Ozoro community.

must meet the IEC 60826 provisions. Therefore, it must be capable of withstanding expected electrical and climatic loads while maintaining design consistency between strengths of line components (NERC, 2014).

Figure 5. Secondary distribution line overgrown with trees.

Additionally, extremely sagging of the transmission line was notice at various points (Figure 4). The sagging was very obvious in the forest regions, where the transmission line passes through. These conditions are against the standard practice of electrical installation and safety standards. Although, the tension in the cable should not be too high, as the cable can snap under high voltage; but excessive sagging of the cable can lead to electrical problems. According to Oluwajobi et al. (2012), excessive sagging of transmission cable is liable for causing power failure. High voltage sagging transmission cables can touch trees during windy condition, hence, creating electrical sparks which usually leads to power failure. Additionally, Liquidators (2020) stated that extreme sagging of transmission cable is hazardous; if it falls below the recommended height, the cable will come with contact with trees, buildings and other structures beneath it; therefore, causing electrical fire and electrocution.

Primary and secondary distribution lines

During the field work, it was notice that some of the primary and secondary distribution lines were not hitch free. Slanting utility poles and cables overgrown with trees were observed in the field (Figures 5 and 6). As seen in (Figure 5), the secondary distribution lines were covered with tree branches. This is unsafe for both the residents of the area and the power transmission system. The tendency of the cables been bridged during light breeze or rain is higher, since wet materials (wood) are good conductor of

Figure 6. A slanting utility pole at Owhe community.

Figure 7. A transformer feeder pillar.

electricity. These poor states of the distribution lines can result in high energy losses, damping oscillations and instability in the 33 KVA transmission line (Onohaebi and Omorogiuwa, 2014). According to Onohaebi and Omorogiuwa (2014), high demand for electricity above the production capacity, couple with poor transmission and distribution facilities are the major causes of consistent power failure in Nigeria (Omorogiuwa and Ike, 2014).

Power transformers

The field survey revealed that most of the power transformers were in bad conditions and unable to operate at the rated capacity. Incidence of built amour cables and feeder pillars were high in most of the transformers visited (Figure 7). Standard NIS rating fuses were missing in almost all the feeder pillar visited, as the feeder pillars were fused with copper wires of unknown rating. The implication of this unethical act is that, any fault in the secondary (415 V) distribution line can bypass the feeder pillar (if a higher rating fuse wire is used) and affect either the transformer or the primary (11 KVA) distribution line. This can cause major power outage that can takes weeks or months to rectify. Information obtained from the BEDC staff revealed that in case they fused the feeder pillar with very low rating wire to safeguard the transformer and transmission line for overloading or other electrical faults, this act can lead to consistent electric power tripping off, which will affect the consumers of the 415 V transmission lines. According to NERC and NIS recommendations, transformers fuses must be installed in accordance with manufacturer's specifications (NERC, 2014).

Testing the of hypotheses

The hypotheses were tested and the results were discussed below:

Hypothesis 1

H_{01}: *State of electricity transmission and distribution materials is not responsible for electric power failure in Isoko North LGA of Delta State.* Since X^2 calculated is greater than X^2 critical, the null hypothesis is rejected; hence, the state of electrical installation materials is responsible for epileptic power supply in the Isoko North Area of Delta State (Table 2). This result affirmed that the poor state of power transmission and distribution materials are highly responsible for the poor electrical supply in the region. As seen in the field work, most of the electricity transmission and distribution materials were in dilapidating state. Therefore, there is urgent need to carry out replacement maintenance in the area, in order to improve the power supply.

Table 2. Chi-square summary.

O	E	O-E	$(O-E)^2$	$(O-E)^2/E$
95	73.33	21.67	469.59	6.4
5	26.67	-21.67	469.59	17.61
72	73.33	-1.33	1.77	0.02
28	26.67	1.33	1.77	0.07
53	73.33	-20.33	413.31	5.64
47	26.67	20.33	413.31	15.5
Total				45.24

X^2 calculated = 45.24; Degree of freedom (df) = 2; X^2 critical at (df) of 2 = 5.99; Testing at 95% confidence level.

Table 3. Chi-square summary.

O	E	O-E	$(O-E)^2$	$(O-E)^2/E$
92	71.33	20.67	427.25	5.99
8	28.67	-20.67	427.25	14.9
55	71.33	-16.33	266.67	3.74
45	28.67	16.33	266.67	9.3
67	71.33	-4.33	18.75	0.26
33	28.67	4.33	18.75	0.65
Total				34.84

X^2 calculated = 34.84; Degree of freedom (df) = 2; X^2 critical at (df) of 2 = 5.99; Testing at 95% confidence level.

Hypothesis 2

H_{02}: *Type of distribution method is not responsible for electric power failure in Isoko North LGA of Delta State.* Since X^2 calculated is greater than X^2 critical, the null hypothesis is rejected. Hence, the type of electricity distribution method adopted within the locate government area significantly affect the power supply in the area (Table 3). Due to the non-availability of substations within the study area, most of the primary distribution lines are connected directly to the 33 KVA transmission line. They are commonly called ‘direct lines’. According to BEDC staff, any fault (electrical or otherwise) that occurred within these primary distribution lines, which are connected directly to the 33 KVA transmission line, will trip (shut off) the power off at the main power station at Ughelli. Electricity can only be restored to the area, after the fault must have be traced and corrected. Considering the terrain, the large area the transmission line covers and lack of workforce, it can take days before the fault can be corrected.

Conclusion

Results obtained from the field work revealed that the 33 KVA transmission line, primary and secondary distribution lines, and the transformers were in shady conditions. Most of the feeder pillars lack the fuses recommended by NIS and NERC, while right of way was not adhered to. Feedbacks from questionnaires revealed abuse of electricity in the region. A large number of the population does not switch off their security lights during the day time, or off their electrical appliance when leaving home for work. This will cause overloading of the 33 KVA transmission line and tripping off of the power at the power station at Ughelli. Analyzing the questionnaires feedbacks with chi-square revealed that the poor state of electrical materials and the negligence of the people of the region in adhering to the electrical rules were highly responsible for the poor electrical supply in the area. Overhauling of transmission and distribution lines, coupled with the adherence of the people to the Nigeria electrical safety practices by switching off unnecessary appliances will help to improve the persistent electric power outage in the area.

Remediation

It the light of the above, the following recommendations were made:

1. Overhauling of the entire 33 KVA and distribution lines. Some sections distribution lines are obsolete when compared to the NIS recommendations. The overhauling should be done in accordance to the

NERC and NIS recommendations. This will help to minimize the rate at which electromechanical faults occurred along the lines. Hence, power outages will be minimized, since a lot of the power failures experienced in the area are due to electromechanical faults.

2. There is need for the people of the region to conserve electrical energy by switching off their electrical appliances at the odd times. This will help to protect the 33 KVA and 11 KVA transmission lines from overloading; hence, tripping off of the power supply from the Ughelli Power Station.
3. More high power capacity transformers should be supplied to the communities. Due to the insufficient high capacity transformers in many communities across the study area, load is being shred within the communities.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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