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Maintainability Assessment Of 11kv Feeders In Benin City, Edo State, Nigeria

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Abstract

Nigeria's power supply has been experiencing incessant interruptions due to failures in the distribution system. The maintainability of the power system is important in meeting customers demand. The maintainability of three 11kv feeder in Benin Electricity Distribution Company (BEDC), Edo State Nigeria is evaluated in this study. the failure data which includes; time of failure, time outage was restored, causes of failure, and the outage duration(also known as 'repair time') from the Injection substations of the three feeders for the year, 2020 and 2021 was collated and used . Monthly and Yearly Mean time to repair (MTTR) and repair rate were calculated for the analysis. The analysis results revealed that the year 2021 had the accumulated higher MTTR than 2020 for the feeders as a result of decline in response to faults except in the Ihama Feeder that had a decrease in MTTR for the year 2021 which implies that there was improvement in response to faults

1. Introduction

Over the last half-century, power systems have been growing exponentially around the globe, creating a pathway for industrial development [1]. There has been modification of Electric Power System since the year 1896 till date. Over the years, there has been restructuring and reorganization of power sector in Nigeria aimed at improving the energy demands, however the energy demands of the country is yet to be met [2,3]. A stable and reliable electric power supply system is a pre-requisite for the technological and economic growth of any nation [4]. Nigeria's power supply has been experiencing incessant power interruptions caused by failures in the generation, transmission, and distribution *system.* Electric power is a vital element in any modern economy. The maintainability of reliable power supply at a reasonable cost is crucial for the economic growth and development of a country [4]. The satisfaction and importance of maintainability of electricity supply to consumers at the time of usage cannot be over-emphasized. A reliable power supply boost productivity and reduces waste in any system [5, 6, 7]. The electric power supply in the feeder under study has become alarming and a source of concern to all stakeholders.

Distribution systems are large-scale systems that comprises many components and assets which need periodic maintenance to work properly and provide reliable energy and power to customers [8]. Although relevance of distribution system fault/failure are much greater than other parts of power

systems like generation and transmission. Studies shows that around 90% of all customer reliability problems are due to the problem in the distribution system [4] hence, improving 'response to faults' in a distribution system is the key to improving customer reliability. Many power systems studies have carried out different optimization studies via heuristic, network configuration, integration of renewable energy resources, and coordination of distributed generation aimed at improving the system network. Therefore, improving distribution reliability through 'maintainability assessment' is the key to improving customer reliability [4, 9, 10].

The aim of this research is to carry out the maintainability evaluation of the feeders under study. Despite the realization of the importance of the distribution sector, the performances of Nigerian distribution utilities of these feeders have not been measured empirically. The performance evaluation of the distribution sector is important in order to assess the impact of reform measures. The maintainability of electric power supply is crucial for economic development because of electricity's role as a powerful engine of social and economic change. 78% of firms in Africa experienced power outages yearly. Also, 41% of firms identified electricity as a major constraint to their business operations [11, 12, 13, 14]. The predominant factor that differentiate modern man from his ancestor is the ability to manage energy/power [14]. Performance evaluation has been carried out with the use of reliability, availability and maintainability (RAM) assessment for electric power generation, transmission and distribution. Haven gone through the various articles and researches that have been published on RAM assessment within and outside the country, only few worked on the feeders of distribution systems

2. Materials and Methods

2.1. Area of Study

This study will analyse the maintainability of Three Feeders (G.R.A Etete, Ihama, and Oko) under the Government Reserve Area (G.R.A) Business Unit in the location illustrated in the figure 1 below.

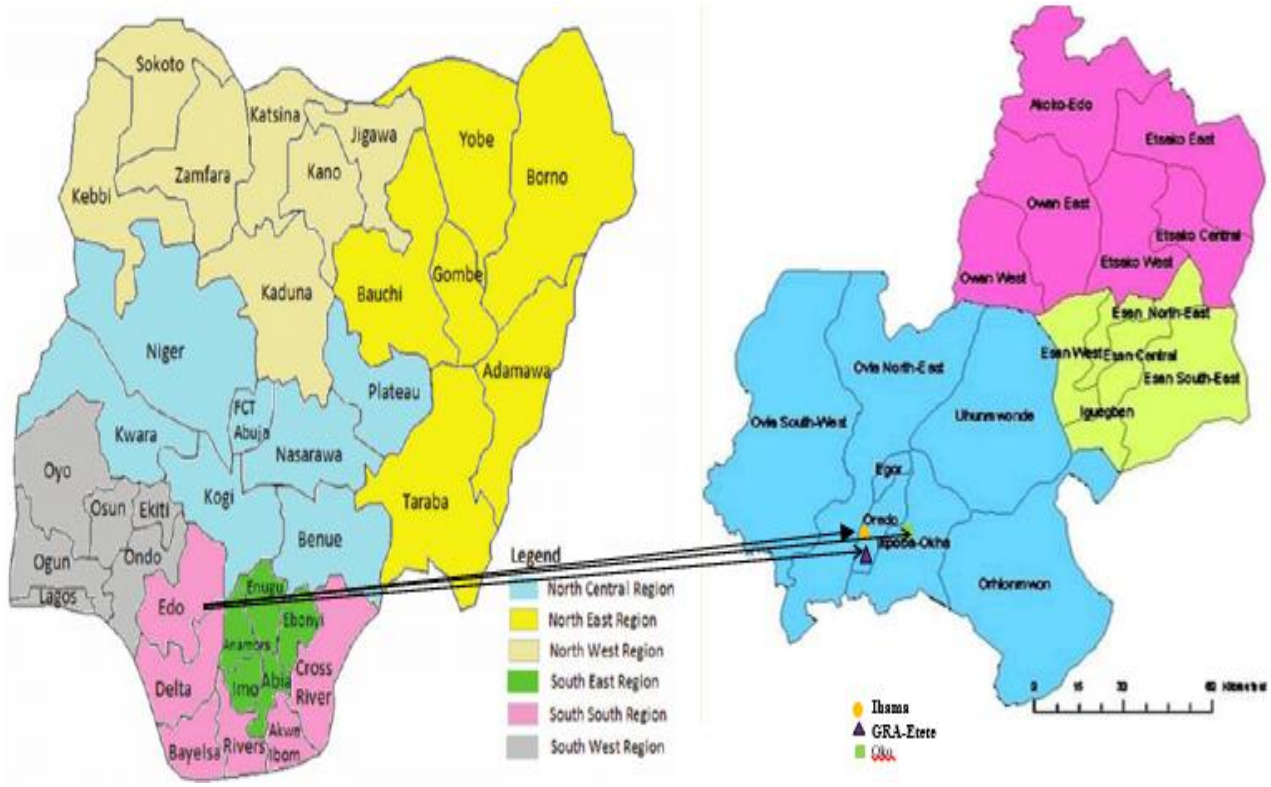

Figure 1: Maps indicating the location of the three feeders in Benin City, Edo State, Nigeria.

2.2. Data Collection and Analysis

The interruption data (comprising of the time power went off and the time it was restored) were gotten from the substation of the feeders Feeder [15]. The analysis started with computing the repair

time which implies subtracting the time power was restored from the time power went off. Then, Mean time to repair (MTTR) and repair rate (μ) were computed and analysed graphically using Spreadsheet (Microsoft Excel). The flow chart of the research is represented in figure 2 below

$$\text{Mean time to repair (MTTR)} = \sum_{i=1}^{n} \frac{Time\ to\ repair}{n} \quad (1)$$

Where 'n' stands for the number of occurrence of failures

$$\text{Repair rate } (\mu) = \frac{1}{MTTR} \quad (2)$$

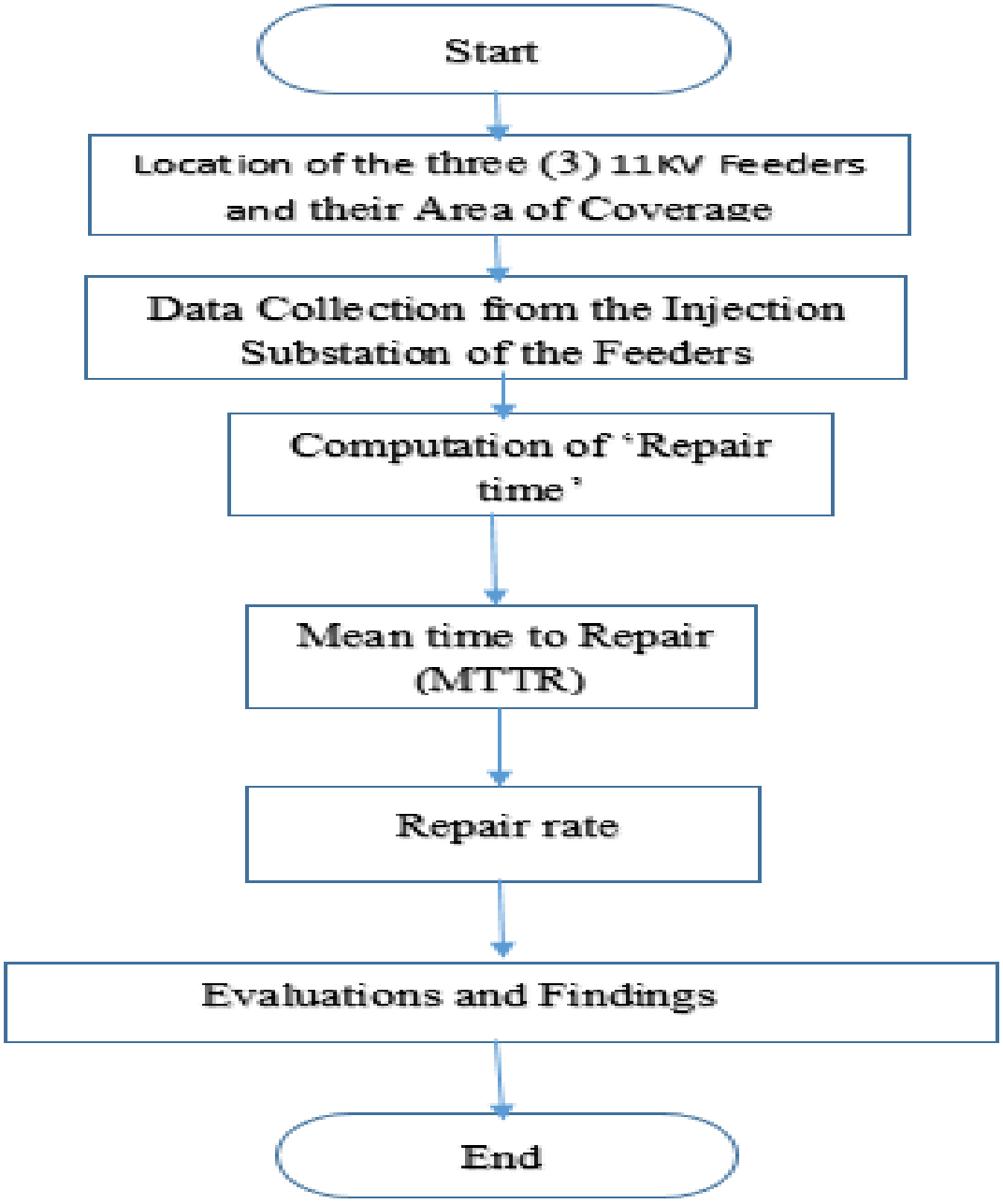

Figure 2: Research flow diagram [16, 17, 18, 19, 20]

3. Results and Discussion

3.1. Monthly Trend Analysis

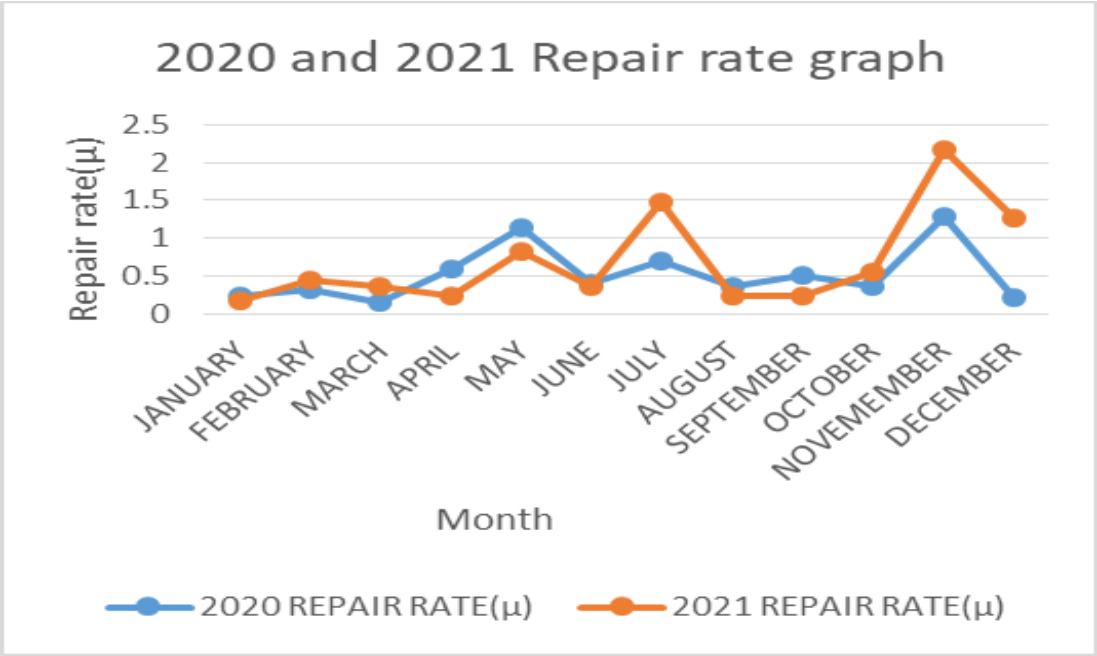

Figure 3: G.R.A Etete 11kv Feeder repair rate graph

Figure 3 above describes the repair rates for G.R.A Etete feeder for the year 2020 and 2021, there was a drastic decline in repair rate from May to June, and November to December for the year 2020. The decline in repair rate implies less response to the resolution of faults.

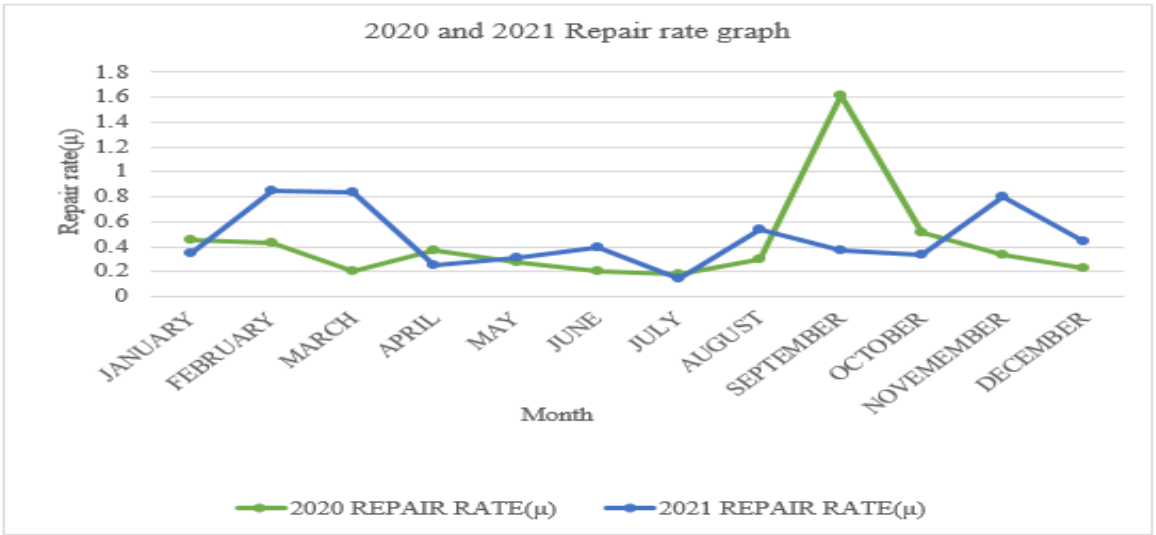

Figure 4: Ihama 11kv Feeder Repair rate graph

Figure 4 above describes the repair rates for Ihama feeder for the year 2020 and 2021. There was an increase in repair from February to March and drastic decline in the Month of September in the year 2021. The increase in repair rates implies improved response to the resolution of faults.

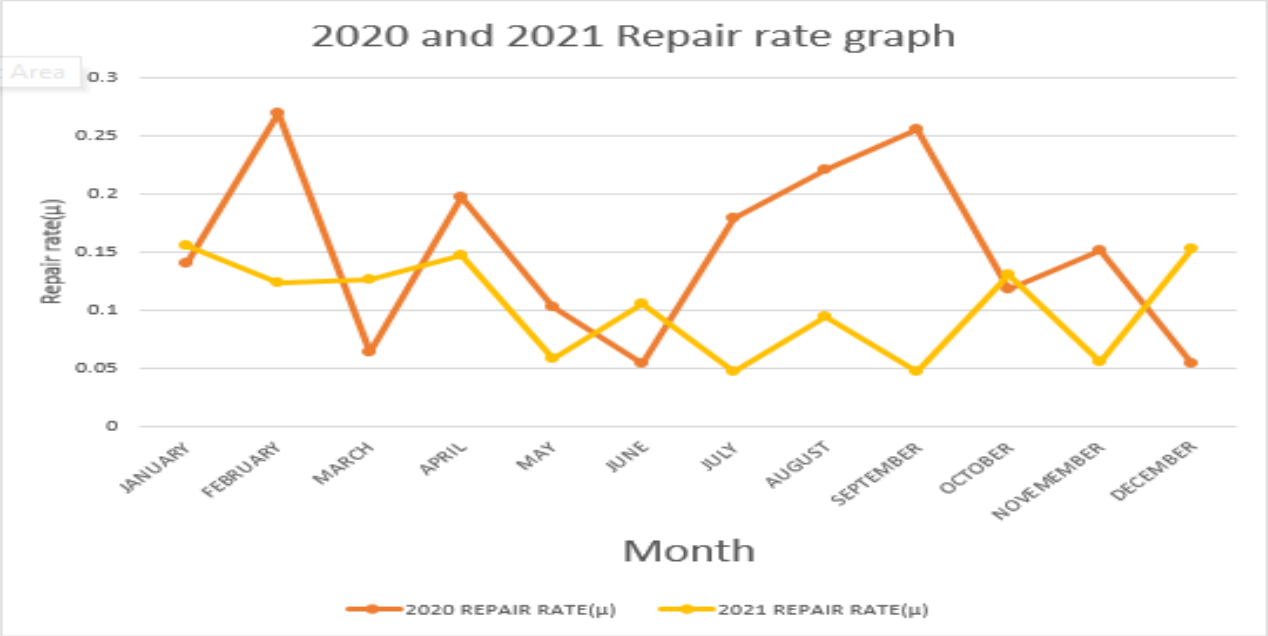

Figure 5: Oko 11kv Feeder Repair rate graph

Figure 5 above describes the repair rates for Oko feeder for the year 2020 and 2021. There was a sharp decline in repair rate for the following months (like February, April, July, August, September, and November) in the year 2021. This implies sharp decline in response to the resolution of faults

Table 1: Maintainability Indices for the three feeders

YEAR	2020		2021	
FEEDERS	MTTR	REPAIR RATE(μ)	MTTR	REPAIR RATE(μ)
G.R.A Etete	2.8	0.3569	2.84	0.3521
Ihama	3.21	0.3114	2.79	0.3578
Oko	7.4861	0.1336	10.57	0.0946

Table 1 above shows maintainability indices of the three feeders for the year 2020 and 2021. The repair rate is mostly applied in manpower assessment. There were decrease in repair rate in the year 2021 except for Ihama feeder (where the repair rates are 0.3114 and 0.3578 for the year 2020 and 2021 respectively). The decrease in repair rate for the year 2021 illustrates a better performance of the man powers/personnel in charge of the maintenance of the feeders.

4. Conclusion

The analysis was conducted on Three (3) 11 KV feeders (G.R.A Etete, Ihama, and Oko) in Benin Electric Distribution Company (BEDC) which covers four states in Nigeria (Edo, Ekiti, Ondo, and Delta). Two (2) years failure data for the feeder (which consist of the following; time of outage, time outage was restored, causes of outages, load interrupted) were collated and collected from their Injection sub-station. 'Time to repair' were computed from the data collected after which mean time to repair (MTTR) and repair rate (μ) were calculated and plotted for the year 2020, and 2021. The analysis from this study revealed that the year 2021 had the accumulated higher MTTR (which means there was decline in response to outages) for the feeders except Ihama that had MTTR of 3.21 and 2.79 for the year 2020 and 2021 respectively. Therefore, it can be concluded that there was decrease in man power competency in the resolution of faults for the feeders under study except for Ihama.

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