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Tripping Profile 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 failure time were collated and collected from the Injection substations of the three feeders for the year 2020 and 2021. Monthly and Yearly Mean time between failures (MTBF) and failure rate were calculated for the analysis. The analysis results revealed that the year 2021 had an increased failure rates than the year 2020 for the three feeders which implies a better performance.

Keywords:- *Failure Time, Repair Time, Maintainability, Mean Time to Repair (MTTR), and Repair Rate.*

I. 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 a failures in the generation, transmission, and distribution *system. Electric power is a vital element in any modern economy. The maint*ainability 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].

Tripping profiles have been carried out for other feeders within and across the country but none have been carried out in G.R.A Etete, Ihama and Oko feeders for the year 2020 and 2021.

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II. METHODOLOGY

➢ *Area of Study*

This study will analyse a 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.

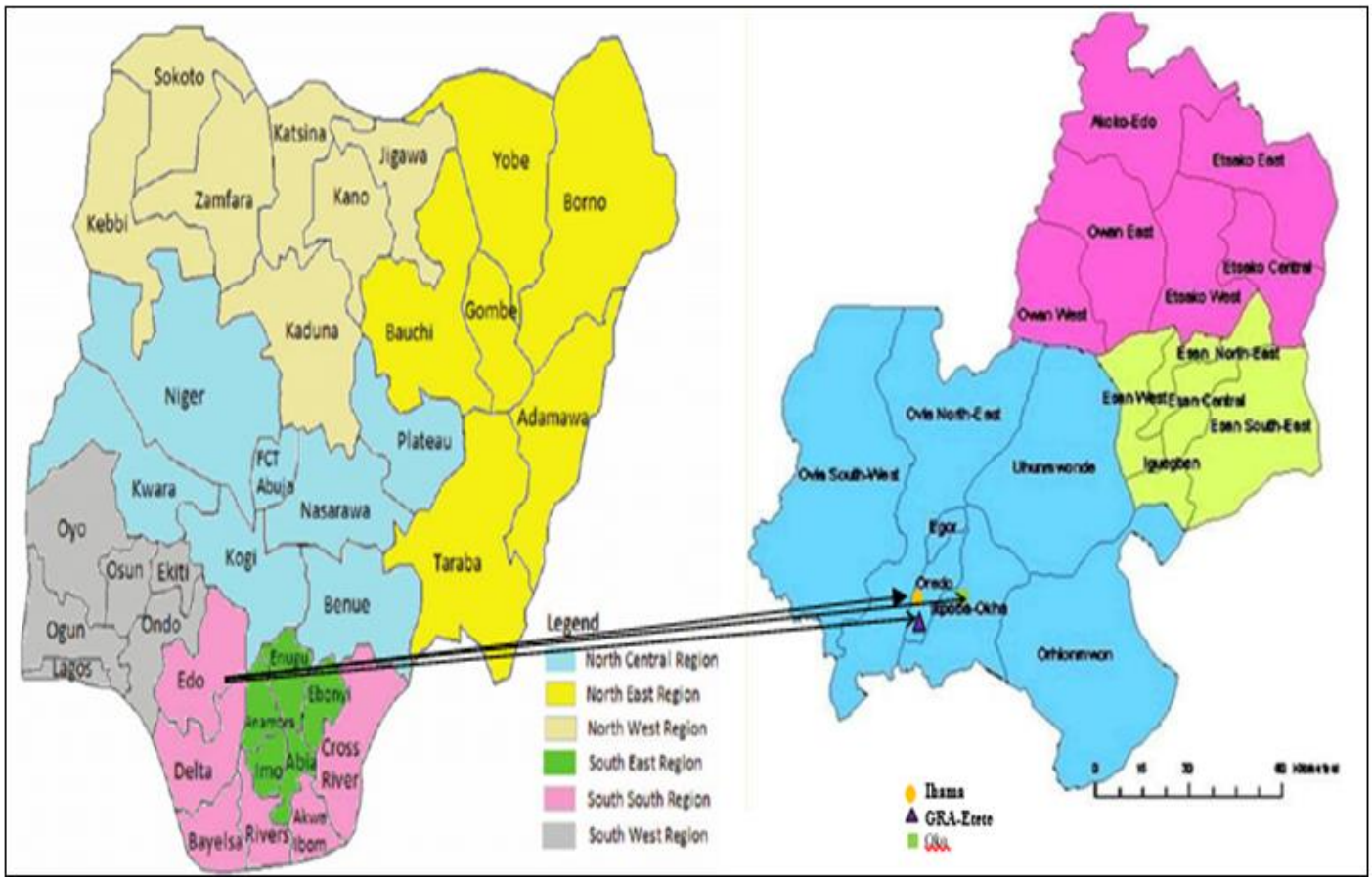

Fig 1 Maps Indicating the Location of the Three Feeders in Benin City, Edo State, Nigeria

➢ *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 analyzed graphically using Spreadsheet (Microsoft Excel). The flow chart of the research is represented in figure 2 below

$$\text{Mean time between failures (MTBF)} = \sum_{i=1}^{n} \frac{Time\ between\ failures}{n} \quad (1)$$

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

$$\text{Failure rate } (\lambda) = \frac{1}{MTBF} \quad (2)$$

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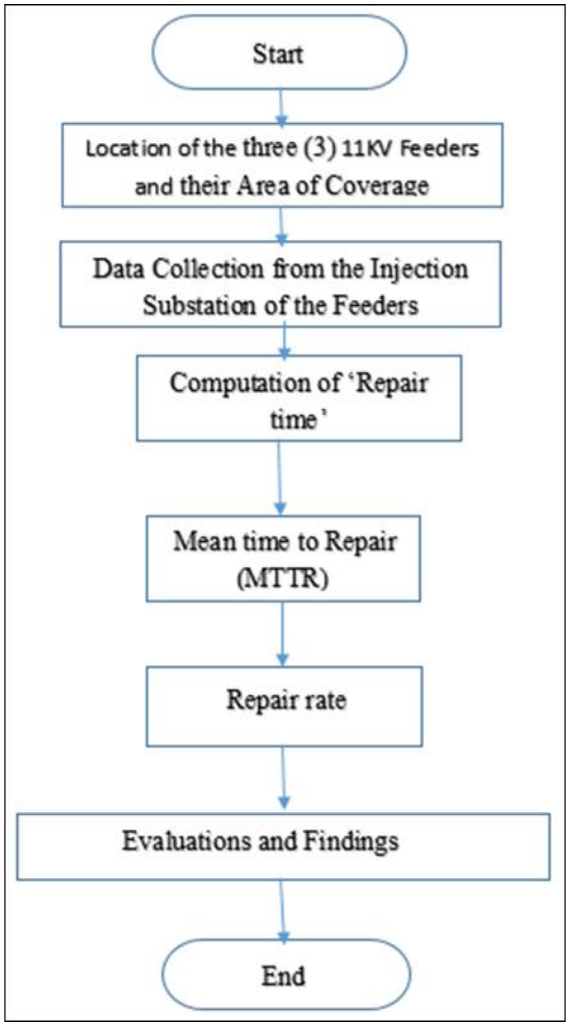

Fig 2 Research Flow Diagram [16, 17, 18, 19, 20]

III. RESULTS AND DISCUSSION

➢ *Monthly Trend Analysis*

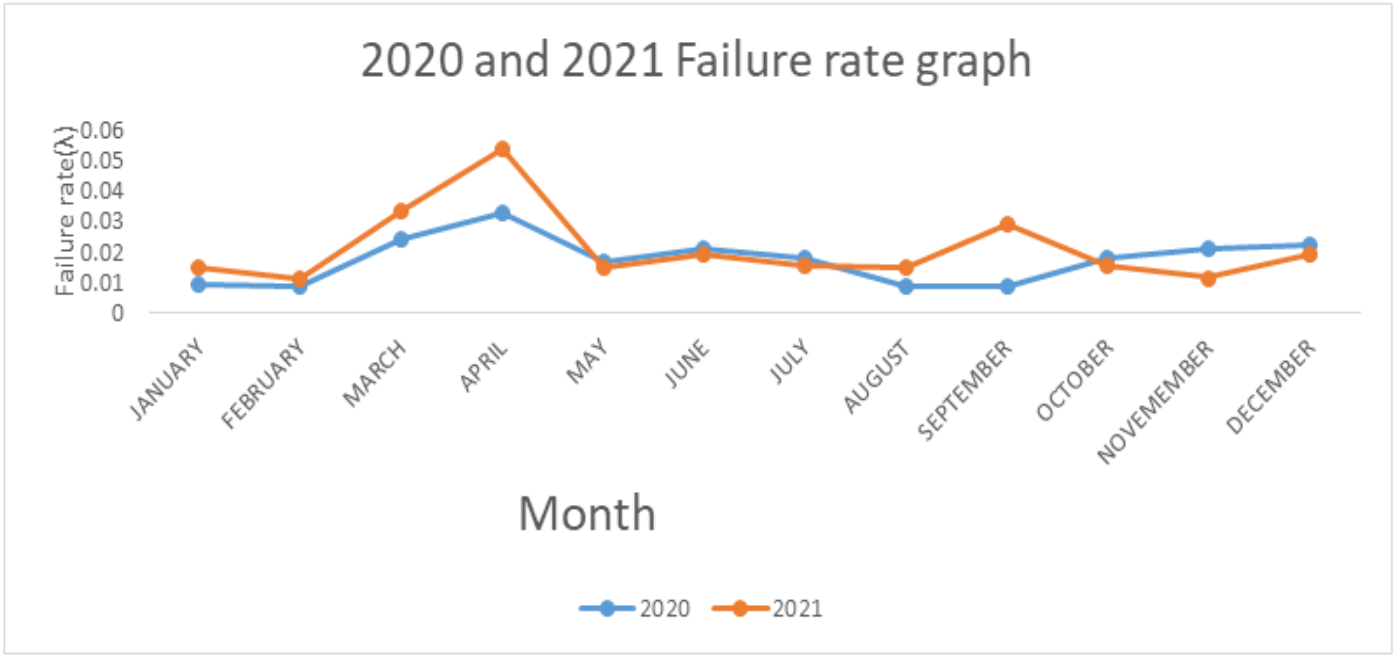

Fig 3 G.R.A Etete 11kv Feeder Failure rate Graph

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Figure 3 describes the drastic decline in failure rate from April to May (both in 2020 and 2021). The same is also applicable in July to August, 2020 and September to October, 2021. The decline in failure rates implies less outages which will always trigger the customers to pay their bills thereby increasing the revenue of the distribution company and vice versa.

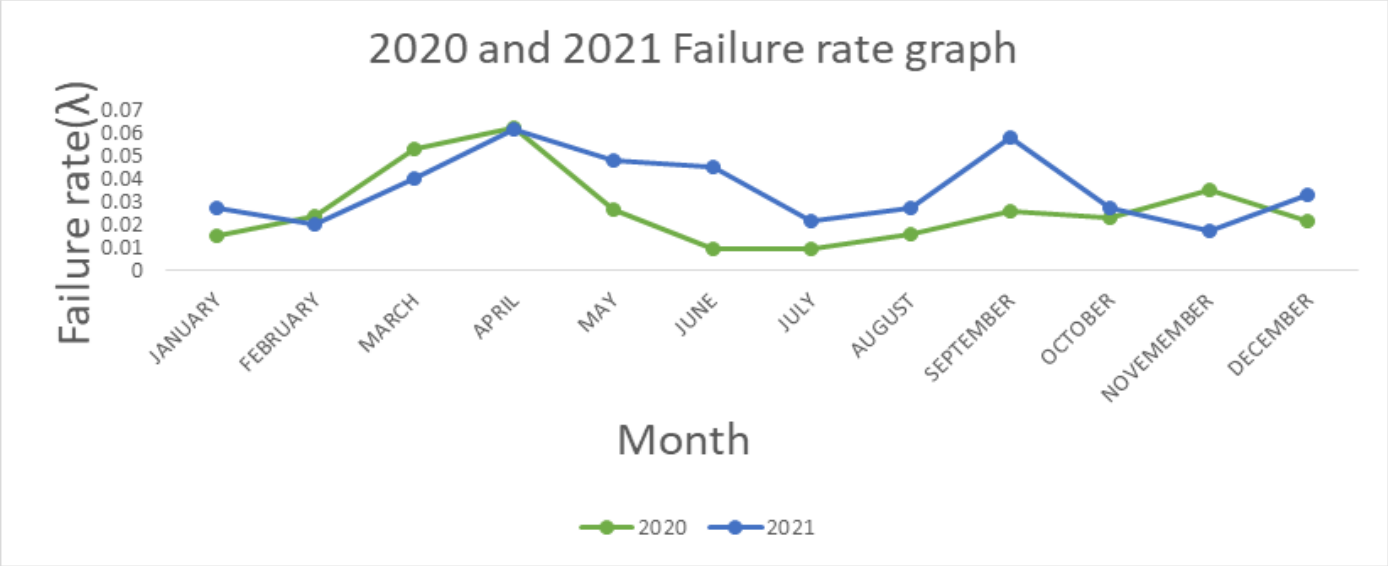

Fig 4 Ihama 11kv Feeder Failure rate Graph

Figure 4 shows that the failure rate September 2021 is far greater than that of September 2020. The increase in failure rate translates to increase in the rate of occurrence of failures (ROCOF) which can be as a result of obsolete equipment which some of them might have exceeded their Economic life or an unforeseen circumstance in the month(s) concerned.

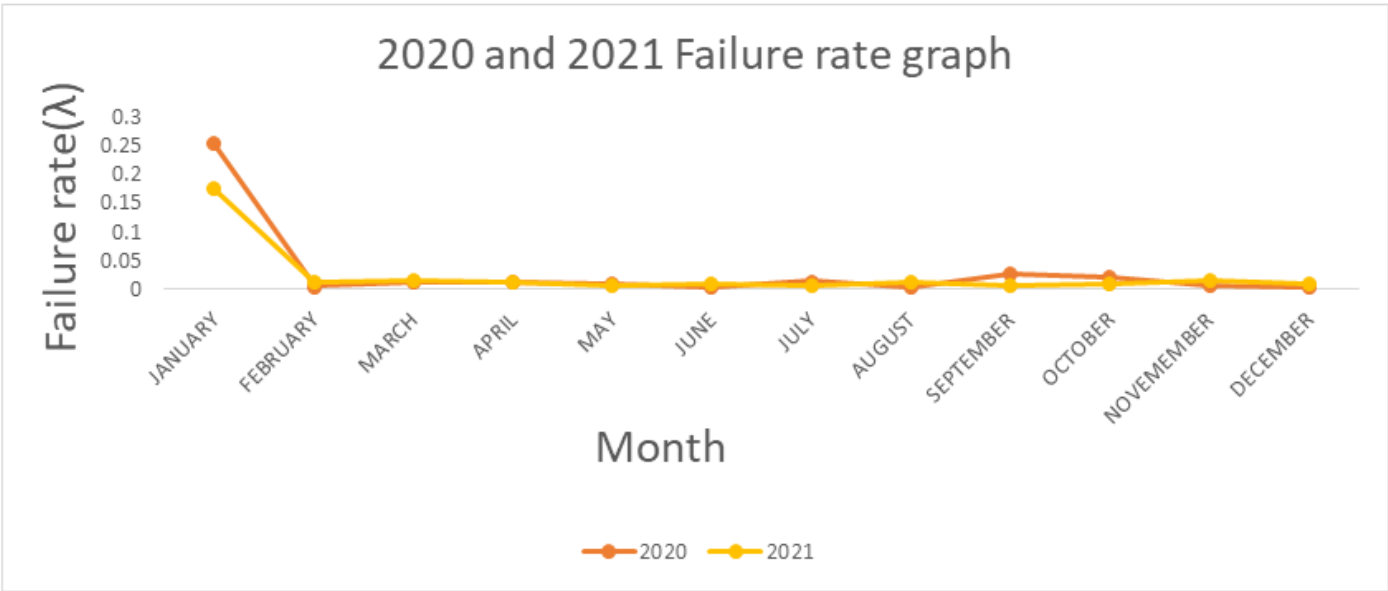

Fig 5 Oko 11kv Feeder Failure rate Graph

Figure 5 describes that the failure rate for 2020 and 2021 followed almost the same trend. There was decrease failure rate (DFR) from January to February after which the system maintained almost a constant failure rate (CFR). In other words, it can be concluded that 2020 and 2021 almost followed a Bath Curve pattern except that there was no visible and tangible increase in failure rate.

Table 1 MTBF and Failure Rates

YEAR	2020		2021	
FEEDERS	**MTBF**	**Failure Rate(λ)**	**MTBF**	**Failure Rate(λ)**
G.R.A Etete	57.71	0.0173	48.5	0.0206
Ihama	38.82	0.0258	28.8	0.0347
Oko	99.33	0.0101	99.3	0.0101

Table 1 shows that there were increase in failure rate in the year 2021 compare to the year 2020 for the three feeders. These imply that the performance of the feeders are better in the year 2020. These could be attributed to the Covid-19 lock down whereby there were not much loads on the feeders. It can also be said that the Business Units in charge of the three feeders in charge of the three feeders made more revenue in the year 2020.

IV. 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, failure time and causes of outages,) were collated and collected from their Injection sub-stations. 'failure time' were computed from the data collected after which mean time between failures (MTBF) and failure rate (λ) were calculated and plotted for the year 2020 and 2021. There were increase in the failure rates for the year 2021 when compared with the year, 2020 which implies that the year 2020 had a better performance than the year 2020. This can be attributed to Covid-19 lockdown whereby many factories were not in operation thereby resulting to lesser loads on the feeders,

REFERENCES

[1]. Alvarez-Alvarado M.S., Donaldson D.L, Recalde A.A., Noriega H.H., Khan Z.A., Washington V. and Rodriguez-Gallegos C.D. (2022). Power System Reliability and Maintenance Evolution: A Critical Review and Future Perspectives, Open Access Journal, Vol 10, pp 51922-51950

[2]. Adejumobi, I.A. (2021), Electricity, Man, and Development: The Complexity of the Distribution System Management in a Power Network, FUNAB Inaugural lecture, Series No 64, Pp.7-81, ISBN: 978-978-992-948-1

[3]. Akpan,P (2006), Electricity and Water supply in Nigeria: A case study of Markudi Town. Journal of Historical Society of Nigeria, Vol.16, pp. 48-71

[4]. Nweke, J.N., Gusau, A.G, and Isah, L. M. (2020), Reliability and Protection in Distribution Power System considering Customer-Based Indices, Nigerian Journal of Technology (NIJOTECH), Vol.39, No 4, pp.1198-1205

[5]. Akpojedje F.O., Abu Y.O., and Onowighose. O. (2021). Tripping Profile Analysis of the 33KV Feeder of Ugbowo 2 x 15 MVA, 33/11 kV Injection Substation, Equity Journal of Science and Technology, Vol 8 No 1, pp 19 – 26, ISSN 2354-1814; E-ISSN 2682-5961, Available online at www.equijost.com

[6]. Ohajianya, A.C., Abumere, O.E., Owate, I.O., and Osarolube, E. (2014), Erratic Power Supply in Nigeria: Causes and Solutions, International Journal of Engineering Science and Innovation, Vol 3, Issue 7, and pp.51-55, ISSN: 2319 – 6726

[7]. Momoh Z., Anuga J.A., and Obidi J.A. (2018). Implications of Poor Electricity Supply on Nigeria's National Development. Vol.6, No.2, PP.31-40, ISSN (p): 2312-5659 DOI:10.18488/journal.73.2018. 62.31.40

[8]. Olajuyin E. A. and Eniola O. (2022). Reliability and Maintenance of Assets in Electric Power Distribution Network, Current Journal of Applied Science and Technology, Volume 41, no 9, pp 8-17, *Article no.CJAST.80761* ISSN*: 2457-1024*

[9]. Mirhosseini M. and Keynia F. (2021) Asset management and maintenance programming for Power distribution systems: a review. Pp 2287–2297 https://doi.org/10.1049/gtd2.12177

[10]. Mirhosseini M., Azim Heydari1 A., 2 · Davide Astiaso Garcia D. A., Mancini F. and Keynia F (2022). Reliability based maintenance programming by a new index for electrical Distribution system components ranking, Optimisation and Engineering, Research Article, pp 2315-2333, https://doi.org/10.1007/s11081-022-09767-8

[11]. Oseni, M.O., & Pollitt, M.G., (2015). A firm-level analysis of outage loss differentials and self-generation: Evidence from African business enterprises. Energy Economics (52).

[12]. Airoboman A. E., Salihu-Ango H., Ibrahim, S. O and Ahmed H. (2021). Risk Assessment of Injection Substation within Kaduna Metropolis using Failure Mode and Effect Critical Analysis (FMECA), Journal of Sciecnce Technology And Education, Vol 9, No 2, pp 308-319, ISSN: 2277-0011; Journal homepage: www.atbuftejoste.com

[13]. Airoboman A.E. (2022). Reliability Assessment of Power System Network: A Detailed Review, International Journal of Engineering Technologies-IJET Vol.7, No.4, pp90-103

[14]. Olusuyi K., Oluwole A.S., Temitope Adefarati T. and Babarinde A.K. (2014). A fault analysis of 11kv distribution system (a case study of ado Ekiti electrical power distribution district), American Journal of Electrical Power and Energy Systems.Volume 3,No 2, pp. 27-36. doi: 10.11648/j.epes.20140302.13

[15]. Log Book Data Outages of Benin Electricity Distribution Company Plc, G.R.A Unit., 2020 and 2021 (G.R.A, Etete, and Iyekogba Injection Sub-station).

[16]. Adediran, Y. A. (2014). Introduction to Reliability Engineering. Finom Associates, ISBN: 978 – 978 - 52341- 2-1, First Edition,

[17]. Lewis, E.E. (1994), Introduction to Reliability Engineering, John Wiley and Sons, Inc, 2nd Edition, Pp.1-9; 145-153

[18]. Marko, C. (2011), Assessment of Power System Reliability (Methods and Application), pp.28, 52-56, 215-224, ISBN: 978-0-85729-687-0, DOI: 10.1007/978-0-85729-688-7

[19]. Troyer, D.D. (2019), Reliability Engineering Principles for Plant Engineers, Article, pp.1-13

[20]. Urdhwareshe, H. (2020), Weibull Distribution, Online Video, Institute of Quality and Reliability