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Evaluation of Power System Reliability for Effective Repositioning of the Industrial Sector

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ABSTRACT: *It has become imperative to provide power supply that is very reliable since industrial growth largely depends on power system that is sufficient. Reliability indices such as System Average Interruption Duration Index (SAIDI), System Average Interruption Frequency Index (SAIFI) and Customer Average Interruption Duration Index (CAIDI) were adopted to evaluate the reliability of the power system geared towards the repositioning of the industrial economy of the nation. In doing this, six 33kV feeders at Port Harcourt Town Transmission Station that supply power to the Port Harcourt Electricity Distribution Company in Nigeria were considered for reliability evaluation. The feeders are UST/Secretariat, Rumuolumeni, UTC, Borikiri, Silver Bird, and T1B 33kV feeders respectively. Silver Bird 33kV feeder has the highest system average interruption duration index of 519.56hrs followed by Rumuolumeni 33kV feeder having 451.94hrs, Borikiri 33kV feeder having 409.81hrs, T1B 33kV feeder having 407.03hrs and UTC 33kV feeder the least having 292.56hrs. Also, Borikiri 33kV feeder has the highest system average interruption index of 80.25 interruptions per customer followed by UTC 33kV feeder having 71.57 interruptions per customer, UST/Secretariat 33kV feeder having 66.10 interruptions per customer, T1B 33kV feeder having 58.44 interruptions per customer, Rumuolumeni 33kV feeder having 44.98 interruptions per customer and Silver Bird 33kV feeder having 44.84 interruptions per customer. Consequently, Silver Bird 33kV feeder has the highest customer average duration index of 11.59hrs followed by Rumuolumeni 33kV feeder having 10.05hrs, T1B 33kV feeder having 6.96hrs, UST/Secretariat 33kV feeder having 5.75hrs, Borikiri 33kV feeder having 5.11hrs and UTC 33kV feeder having 4.09hrs. This shows a clear indication of power system insufficiency in relation to load demand. Strategies to improve the power system reliability have been stated to include protection of the system from imminent failure, adequate networks reinforcements, quick response to faults clearing and complete elimination of avoidable load shedding. The reliability indices are efficient in the determination of power system reliability.*

KEY WORDS: *Power system reliability, Reliability indices, Power supply network, Voltage fluctuation, Feeder service reliability.*

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I. INTRODUCTION

For a system to be reliable, the system is said to be consistently producing the desired output. By this, it means standards, procedures and quality are not compromised. With special reference to power system, it can be said that a reliable power system has enough generation, demand response and network capacity to supply customers with the energy that they demand with a very high degree of confidence. It can further be said that a power system is reliable if it adequately makes power supply available and at the same time power quality is not adversely affected. The degree to which power supplied by the utility conforms to pure sinusoidal waveforms being power quality is not compromised. That is to say, characteristics that affect power quality such as voltage fluctuation, harmonic distortion, voltage unbalance, flicker, supply interruptions, voltage sags, voltage swells and transients are almost totally eliminated. By this, a good power quality which is a steady supply voltage that stays within the prescribed range, steady AC frequency close to the rated value, and smooth voltage curve waveform (which resembles a sine wave) is achieved.

The importance of power system reliability is demonstrated when electricity supply is disrupted, whether it decreases the comfort of customer's free time at home or causes the shutdown of companies and results in huge economic deficits. A reliable power system provides investors with confidence and allows for business expansions as industrial operations especially production requires a reliable power supply. A power failure or a problem related to poor power quality can mean an expensive disruption to operations. For operations like data centers, hospitals, airports and manufacturing facilities, a loss of power is more than a nuisance, it represents a significant financial risk and can even be responsible for loss of life. To check the service reliability of the power system, three most commonly used measurements of electricity supply reliability are the System Average Interruption Duration Index (SAIDI), System Average Interruption Frequency Index (SAIFI) and Customer Average Interruption Duration Index (CAIDI) [1].

There are various reliability indices to ascertain the reliability of a system. For short, System Average Interruption Duration Index (SAIDI), System Average Interruption Frequency Index (SAIFI) and Customer Average Interruption Duration Index (CAIDI) are generally adequate to check how reliable a power system would be [2]. In Nigeria, power generation has been hovering around 4000MW and this is not adequate as Association of Nigerian Electricity Distributors (ANED) pegged the estimated demand at 17000MW. Next to generation deficit in Nigeria is the problem of overstressed transmission and distribution networks. Six 33kV feeders were selected as a test case to carry out reliability measurement in a power system. The data required for the study were collected from the Port Harcourt Electricity Distribution Company (PHEDC). Durations of availability and unavailability of power, feeder names, and customer population were the basic data for this study. The reliability of six 33kV feeders radiating from Port Harcourt Town transmission station (Zone 4) was evaluated using reliability indices. The reliability indices were used on UST/Secretariat 33kV feeder, Rumuolumeni 33kV feeder, UTC 33kV feeder, Borikiri 33kV feeder, Silver Bird 33kV feeder and T1B 33kV feeder accordingly. The first feeder is a combination of two separate 33kV feeders (UST/Secretariat) tied to a 30MVA transformer known as T2A 30MVA because the station lost UST 33kV 30MVA transformer while the rest are tied to a 60MVA transformer known as T1A 60MVA.

II. RELATED WORKS

Kumar et al. [2] stated that reliability indices are generally useful in checking or ascertaining the reliability of a power system. Apart from the fact that Nigeria's electricity is faced with very notable power generation deficit the power supply chain has very numerus challenges such as overstressed transmission and distribution networks, energy theft, poor network maintenance, regular network and equipment vandalism, and absence of modern control systems leading to high rates of power failure [3].

A reliable power supply is viewed as the product of the standards and processes which drives the power system [4]. It is generally recommended to attain a high degree of reliability as it is the bases for the cost of every investment to the power network [5].

Under normal circumstances, micro grid reduces the duration and frequency of blackouts which would have resulted from increase in population of electricity users [6]. Reliable access to power supply enhances people's lives in rural areas, for enhanced standard of living, healthcare, education, and for growth within local economies [7].

III. MATERIALS AND METHOD

3.1 Reliability Indices Utilization in Power System

In the course of carrying out a comprehensive evaluation on the reliability of the power system, reliability indicator data on all the 33kV feeders and their 11kV connected feeders covering the year 2022 were collected. Specifically, all 33kV feeders radiating from Port Harcourt Town transmission station (Zone 4) were considered in this work.

Knowing that System Average Interruption Duration Index (SAIDI) is necessary in determining the reliability of a power system, it will be pertinent to express that:

$$\text{SAIDI} = \frac{\textit{Sum of all customer interruption durations}}{\textit{Total number of customers served}} \quad (3.1)$$

Which implies that:

SAIDI = $\frac{\sum_{i=1}^{n} \lambda_i \; N_i}{\sum_{i=1}^{n} \; N_i}$ (3.2)

Where N_i is number of customers per load
λ_i = Total number of customer's interruption duration
Also very imperative is System Average Interruption Frequency Index (SAIFI). This can be mathematically expressed as:

SAIFI = $\frac{Total\ number\ of\ customer\ interruption}{Total\ number\ of\ customers\ served}$ (3.3)

SAIFI = $\frac{\sum_{i=1}^{n} U_i \; N_i}{\sum_{i=1}^{n} \; N_i}$ (3.4)

Where N_i is number of customers per load
U_i = Total number of customer's interruption
It is customary to consider Customer Average Interruption Duration Index (CAIDI) in the following way:

CAIDI = $\frac{Sum\ of\ all\ customer\ interruption\ durations}{Total\ number\ of\ customer\ interruptions}$ (3.5)

CAIDI = $\frac{SAIDI}{SAIFI} = \frac{\sum_{i=1}^{n} \lambda_i \; N_i}{\sum_{i=1}^{n} \; N_i} / \frac{\sum_{i=1}^{n} U_i \; N_i}{\sum_{i=1}^{n} \; N_i}$ (3.6)

3.2 UST/Secretariat 33kV Feeder Reliability Indices

From among the several reliability indices, preferred are SAIDI, SAIFI and CAIDI. The reliability indices selected were to provide the feeder performance in terms of reliability assessment.

3.2.1 System Average Interruption Duration Index (SAIDI)

Considering the equation

SAIDI = $\frac{\sum_{i=1}^{n} \lambda_i \; N_i}{\sum_{i=1}^{n} \; N_i}$

SAIDI = $\frac{Sum\ of\ all\ customers\ interruption\ durations\ (UST/Secretariat\ Line\ Load + UST + Wokoma + Rumueme + Eagle\ Island + NPA + Churchill + Amadi\ North + Station\ Rd)}{Total\ number\ of\ customers\ served}$

Data collected show that UST/Secretariat 33kV line load has approximately 1125 customers and 25 hours of interruption duration (Mgboshimini and Secretariat). Also, UST, Wokoma and Rumueme 11kV feeders attached to originally UST 33kV feeder have 165, 524 and 492 hours of interruption durations respectively with 554, 1030 and 1012 customers respectively whereas Eagle Island 11kV feeder tied to Eagle Island 33/11kv injection substation still on UST 33KV feeder has 567 hours of interruption duration with 783 customers while MPA, Churchill, Amadi North, and Station Road 11kV feeders attached to Secretariat 33kV feeder have 286, 462, 464 and 448 hours of interruption durations respectively with 480, 513, 852 and 612 customers respectively, giving a total of 6961 customers, then:

SAIDI = $\frac{(1125 \times 25)+(554 \times 165)+ (1030 \times 524) + (1012 \times 492) + (783 \times 567)+ (480 \times 286)+(513 \times 462)+ (852 \times 464)+ (612 \times 448)}{6961}$

SAIDI = $\frac{(28{,}125)+(91{,}410)+ (539{,}720)+ (497{,}904) + (443961)+ (137{,}280)+ (237{,}006)+ (395328)+ (274176)}{6961}$

SAIDI = $\frac{2644910}{6961}$

SAIDI = 379.96hrs

3.2.2 System Average Interruption Frequency Index (SAIFI)

From the equation

SAIFI = $\frac{\sum_{i=1}^{n} U_i \; N_i}{\sum_{i=1}^{n} \; N_i}$

Data collected show that UST/Secretariat 33kV line load has 18 interruptions. Also, UST, Wokoma, Rumueme, Eagle Island, NPA, Churchill, Amadi North and Station Road 11kV feeders, respectively have 65, 122, 81, 44, 69, 72, 66 and 58 interruptions, then:

SAIFI = $\frac{(1125 \times 18)+(554 \times 65)+ (1030 \times 122)+ (1012 \times 81) + (783 \times 44) + (480 \times 69)+ (513 \times 72)+ (852 \times 66) + (612 \times 58)}{6961}$

SAIFI = $\frac{(20250)+(36010)+ (125660)+ (81972) + (34452)+ (33120)+ (36936) + (56232) + (35496)}{6961}$

SAIFI = $\frac{460128}{6961}$

SAIFI = 66.10 Interruptions/Customer

3.2.3 Customer Average Interruption Duration Index (CAIDI)
Using the equation

CAIDI = $\frac{SAIDI}{SAIFI} = \frac{\sum_{i=1}^{n} \lambda_i\ N_i}{\sum_{i=1}^{n}\ N_i} / \frac{\sum_{i=1}^{n} U_i\ N_i}{\sum_{i=1}^{n}\ N_i}$

CAIDI = $\frac{379.96}{66.10}$

CAIDI = 5.75hrs

3.3 Rumuolumeni 33kV Feeder Reliability Indices

From among the several indices, preferred are SAIDI, SAIFI and CAIDI. The reliability indices selected were to provide a far-reaching solution to poor power system reliability.

3.3.1 System Average Interruption Duration Index (SAIDI)
From the equation

SAIDI = $\frac{\sum_{i=1}^{n} \lambda_i\ N_i}{\sum_{i=1}^{n}\ N_i}$

SAIDI = $\frac{Sum\ of\ all\ customers\ interruption\ durations\ (School\ of\ Nursing + Abacha\ Road)}{Total\ number\ of\ customers\ served}$

Data collected show that School of Nursing and Abacha Road 11kV feeders tied to School of Nursing 33/11kV injection substation have 534 and 379 hours of interruption durations, respectively with 456 and 513 customers, respectively, giving a total of 969 customers, then:

SAIDI = $\frac{(534 \times 456)+ (379 \times 513)}{969}$

SAIDI = $\frac{(243504)+ (194427)}{969}$

SAIDI = $\frac{437931}{969}$

SAIDI = 451.94hrs

3.3.2 System Average Interruption Frequency Index (SAIFI)
From the equation

SAIFI = $\frac{\sum_{i=1}^{n} U_i\ N_i}{\sum_{i=1}^{n}\ N_i}$

Data collected show that School of Nursing and Abacha Road 11kV feeders, respectively have 44 and 53 interruptions, then:

SAIFI = $\frac{(534 \times 44)+(379 \times 53)}{969}$

SAIFI = $\frac{(23496)+(20087)}{969}$

SAIFI = $\frac{43583}{969}$

SAIFI = 44.98 Interruptions/Customer

3.3.3 Customer Average Interruption Duration Index (CAIDI)

Considering the equation

CAIDI = $\frac{SAIDI}{SAIFI} = \frac{\sum_{i=1}^{n} \lambda_i \; N_i}{\sum_{i=1}^{n} \; N_i} / \frac{\sum_{i=1}^{n} U_i \; N_i}{\sum_{i=1}^{n} \; N_i}$

CAIDI = $\frac{451.94}{44.98}$

CAIDI = 10.05hrs

3.4 UTC 33kV Feeder Reliability Indices

From among the several indices, preferred are SAIDI, SAIFI and CAIDI. The reliability indices selected were to provide a far-reaching solution to poor power system reliability.

3.4.1 System Average Interruption Duration Index (SAIDI)

From the equation

SAIDI = $\frac{\sum_{i=1}^{n} \lambda_i \; N_i}{\sum_{i=1}^{n} \; N_i}$

Data collected show that UTC 33kV line load has 33 customers and 28 hours of interruption duration. Also, Azikiwe Road and Abonnema Wharf 11kV feeders tied to UTC 33/11kV injection substation, respectively have 198 and 189 hours of interruption durations, respectively with 795 and 412 customers while Navy and Harbour Road 11kV feeders tied to Reclamation 33/11kV injection substation still on UTC 33kV feeder have 556 and 565 hours of interruption durations, respectively with 225 and 247 customers, respectively, giving a total of 1712 customers, then:

SAIDI = $\frac{Sum\ of\ all\ customers\ interruption\ durations\ (UTC\ Line\ Load + Azikiwe\ Road + Abonnema\ Wharf + Navy + Harbour\ Road)}{Total\ number\ of\ customers\ served}$

SAIDI = $\frac{(33 \times 28)+(795 \times 198)+(412 \times 189)+(225 \times 556)+(247 \times 565)}{1712}$

SAIDI = $\frac{(924)+(157410)+(77868)+(125100)+(139555)}{1712}$

SAIDI = $\frac{500857}{1712}$

SAIDI = 292.56hrs

3.4.2 System Average Interruption Frequency Index (SAIFI)

Considering the equation

SAIFI = $\frac{\sum_{i=1}^{n} U_i \; N_i}{\sum_{i=1}^{n} \; N_i}$

Data collected show that UTC 33kV line load has 21 interruptions. Also, Azikiwe Road, Abonnema Wharf, Navy and Harbour Road 11kV feeders, respectively have 94, 68, 42 and 39 interruptions, respectively, then:

SAIFI = $\frac{(33 \times 21)+(795 \times 94)+(412 \times 68)+(225 \times 42)+(247 \times 39)}{1712}$

SAIFI = $\frac{(693)+(74730)+(28016)+(9450)+(9633)}{1712}$

SAIFI = $\frac{122522}{1712}$

SAIFI = 71.57 Interruptions/Customer

3.4.3 Customer Average Interruption Duration Index (CAIDI)
Using the equation

CAIDI = $\frac{SAIDI}{SAIFI} = \frac{\sum_{i=1}^{n} \lambda_i \ N_i}{\sum_{i=1}^{n} \ N_i} / \frac{\sum_{i=1}^{n} U_i \ N_i}{\sum_{i=1}^{n} \ N_i}$

CAIDI = $\frac{292.56}{71.57}$

CAIDI = 4.09hrs

3.5 Borikiri 33kV Feeder Reliability Indices

From among the several indices, preferred are SAIDI, SAIFI and CAIDI. The reliability indices selected were to provide a far-reaching solution to poor power system reliability.

3.5.1 System Average Interruption Duration Index (SAIDI)
From the equation

SAIDI = $\frac{\sum_{i=1}^{n} \lambda_i \ N_i}{\sum_{i=1}^{n} \ N_i}$

Data collected show that Borikiri 33kV line load has 92 customers and 27 hours of interruption duration. Also, Harold Wilson, New Road, Marine Base and Eastern By-Pass 11kV feeders, respectively have 481, 448, 436 and 246 hours of interruption durations, respectively with 1208, 1094, 1075 and 967 customers, respectively, given a total of 4344 customers, then:

SAIDI = $\frac{Sum\ of\ all\ customers\ interruption\ durations\ (Borikiri\ Line\ Load+Harold\ Wilson+NewRoad+Marine\ Base+Eastern\ By\ Pass)}{Total\ number\ of\ customers\ served}$

SAIDI = $\frac{(92 \times 27)+(1208 \times 481)+(1094 \times 448)+(1075 \times 436)+(967 \times 246)}{4344}$

SAIDI = $\frac{(2484)+(581048)+(490112)+(468700)+(237882)}{4344}$

SAIDI = $\frac{1780226}{4344}$

SAIDI = 409.81hrs

3.5.2 System Average Interruption Frequency Index (SAIFI)
From the equation

SAIFI = $\frac{\sum_{i=1}^{n} U_i \ N_i}{\sum_{i=1}^{n} \ N_i}$

Data collected show that Borikiri 33kV line load has 24 interruptions. Also, Harold Wilson, New Road, Marine Base and Eastern By-Pass 11kV feeders, respectively have 104, 96, 78 and 33 interruptions, respectively, then:

SAIFI = $\frac{(92 \times 24)+(1208 \times 104)+(1094 \times 96)+(1075 \times 78)+(967 \times 33)}{4344}$

SAIFI = $\frac{(2208)+(125632)+(105024)+(83850)+(31911)}{4344}$

SAIFI = $\frac{348625}{4344}$

SAIFI = 80.25 Interruptions/Customer

3.5.3 Customer Average Interruption Duration Index (CAIDI)

Using the equation

CAIDI = $\frac{SAIDI}{SAIFI} = \frac{\sum_{i=1}^{n} \lambda_i \ N_i}{\sum_{i=1}^{n} \ N_i} / \frac{\sum_{i=1}^{n} U_i \ N_i}{\sum_{i=1}^{n} \ N_i}$

CAIDI = $\frac{409.81}{80.25}$

CAIDI = 5.11hrs

3.6 Silver Bird 33kV Feeder Reliability Indices

From among the several indices, preferred are SAIDI, SAIFI and CAIDI. The reliability indices selected were to provide a far-reaching solution to poor power system reliability.

3.6.1 System Average Interruption Duration Index (SAIDI)

From the equation

SAIDI = $\frac{\sum_{i=1}^{n} \lambda_i \ N_i}{\sum_{i=1}^{n} \ N_i}$

SAIDI = $\frac{Sum\ of\ all\ customers\ interruption\ durations\ (Nsukka + Udi)}{Total\ number\ of\ customers\ served}$

Data collected show that Nsukka and Udi 11kV feeders have 521 and 518 hours of interruption durations, respectively with 1106 and 1019 customers, respectively, giving a total of 2125 customers, then:

SAIDI = $\frac{(1106 \times 521)+(1019 \times 518)}{2125}$

SAIDI = $\frac{(576226)+(527842)}{2125}$

SAIDI = $\frac{1104068}{2125}$

SAIDI = 519.56hrs

3.6.2 System Average Interruption Frequency Index (SAIFI)

From the equation

SAIFI = $\frac{\sum_{i=1}^{n} U_i \ N_i}{\sum_{i=1}^{n} \ N_i}$

Data collected show that Nsukka and Udi 11kV feeders, respectively have 41 and 49 interruptions, then:

SAIFI = $\frac{(1106 \times 41)+(1019 \times 49)}{2125}$

SAIFI = $\frac{(45346)+(49931)}{2125}$

SAIFI = $\frac{95277}{2125}$

SAIFI = 44.84Interruptions/Customer

3.6.3 Customer Average Interruption Duration Index (CAIDI)
Considering the equation

CAIDI = $\frac{SAIDI}{SAIFI} = \frac{\sum_{i=1}^{n}\lambda_i \ N_i}{\sum_{i=1}^{n} \ N_i} / \frac{\sum_{i=1}^{n}U_i \ N_i}{\sum_{i=1}^{n} \ N_i}$

CAIDI = $\frac{519.56}{44.84}$

CAIDI = 11.59hrs

3.7 T1B 33kV Feeder Reliability Indices

From among the several indices, preferred are SAIDI, SAIFI and CAIDI. The reliability indices selected were to provide a far-reaching solution to poor power system reliability.

3.3.1 System Average Interruption Duration Index (SAIDI)
From the equation

SAIDI = $\frac{\sum_{i=1}^{n}\lambda_i \ N_i}{\sum_{i=1}^{n} \ N_i}$

SAIDI = $\frac{Sum\ of\ all\ customers\ interruption\ durations\ (Amadi\ Residential + Old\ Diobu + Amadi\ South + Mile\ 1/Owerri\ Road)}{Total\ number\ of\ customers\ served}$

Data collected show that Amadi Residential, Old Diobu, Amadi South, and Mile 1/Owerri Road 11kV feeders, respectively have 490, 286, 437 and 444 hours of interruption durations, respectively with 1011, 2009, 2015 and 2674 customers, respectively, giving a total of 7709 customers, then:

SAIDI = $\frac{(1011 \times 490) + (2009 \times 286) + (2015 \times 437) + (2674 \times 444)}{7709}$

SAIDI = $\frac{(495390) + (574574) + (880555) + (1187256)}{7709}$

SAIDI = $\frac{3137775}{7709}$

SAIDI = 407.03hrs

3.3.2 System Average Interruption Frequency Index (SAIFI)
From the equation

SAIFI = $\frac{\sum_{i=1}^{n}U_i \ N_i}{\sum_{i=1}^{n} \ N_i}$

Data collected show that Amadi Residential, Old Diobu, Amadi South, and Mile 1/Owerri Road 11kV feeders, respectively have 54, 42, 71 and 63 interruptions, then:

SAIFI = $\frac{(1011 \times 54) + (2009 \times 42) + (2015 \times 71) + (2674 \times 63)}{7709}$

SAIFI = $\frac{(54594) + (84378) + (143065) + (168462)}{7709}$

SAIFI = $\frac{450499}{7709}$

SAIFI = 58.44Interruptions/Customer

3.3.3 Customer Average Interruption Duration Index (CAIDI)
Considering the equation

CAIDI = $\frac{SAIDI}{SAIFI} = \frac{\sum_{i=1}^{n}\lambda_i \ N_i}{\sum_{i=1}^{n} \ N_i} / \frac{\sum_{i=1}^{n}U_i \ N_i}{\sum_{i=1}^{n} \ N_i}$

$$CAIDI = \frac{407.03}{58.44}$$

CAIDI = 6.96hrs

IV. RESULTS AND DISCUSSION

4.1 Reliability Evaluation Result Summary

The results obtained from the reliability evaluation of the selected 33kV feeders at Port Harcourt Town transmission station are shown in Table 4.1. For purpose of simplicity system average interruption duration index on the 33kV feeders, system average interruption frequency index on the 33kV feeders, and customer average interruption duration index on the 33kV feeders are shown in Figures 4.1- 4.3 respectively.

Table 4.1: Calculated Reliability Indices of the Selected 33kV Feeders

33kV Feeder	SAIDI (Hrs)	SAIFI (Interruptions/Customer)	CAIDI (Hrs)
UST/Secretariat	379.96	66.10	5.75
Rumuolumeni	451.94	44.98	10.05
UTC	292.56	71.57	4.09
Borikiri	409.81	80.25	5.11
Silver Bird	519.56	44.84	11.59
T1B	407.03	58.44	6.96

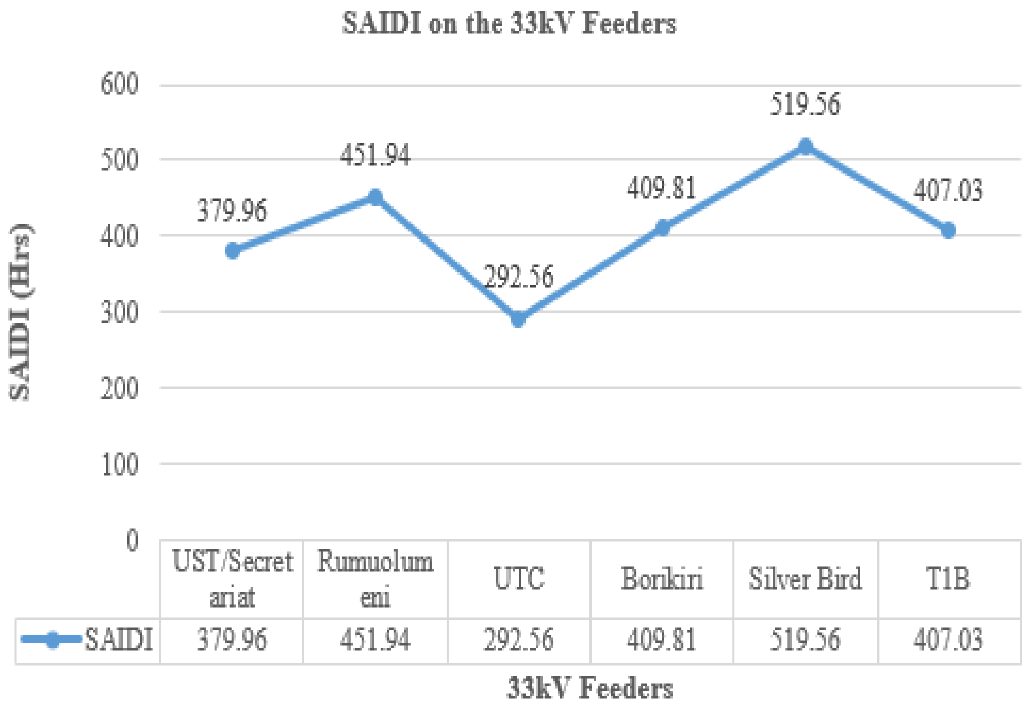

Figure 4.1: Chart of SAIDI on the 33kV Feeders

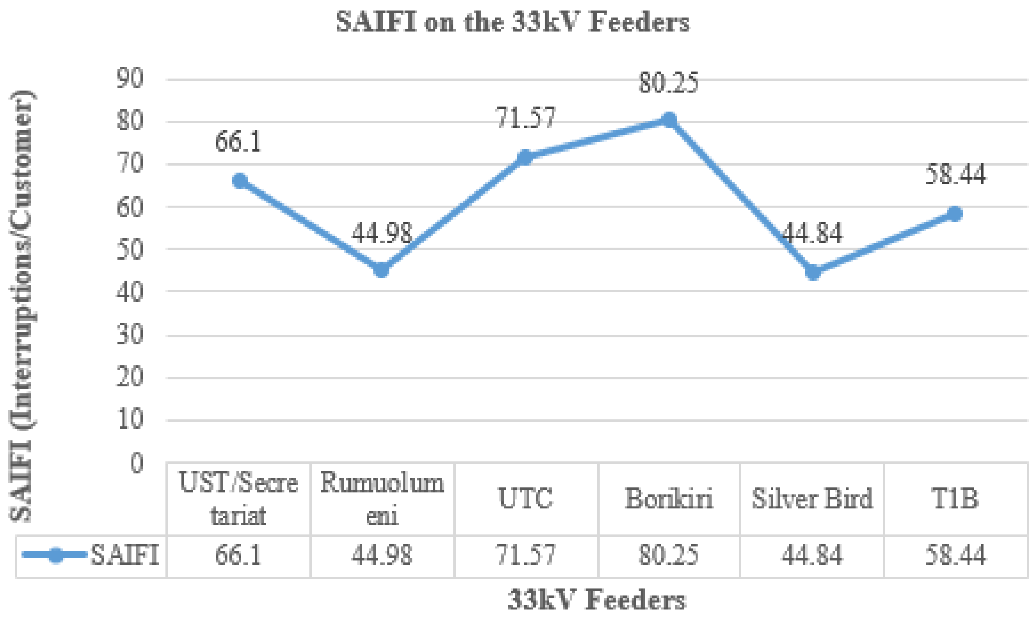

Figure 4.2: Chart of SAIFI on the 33kV Feeders

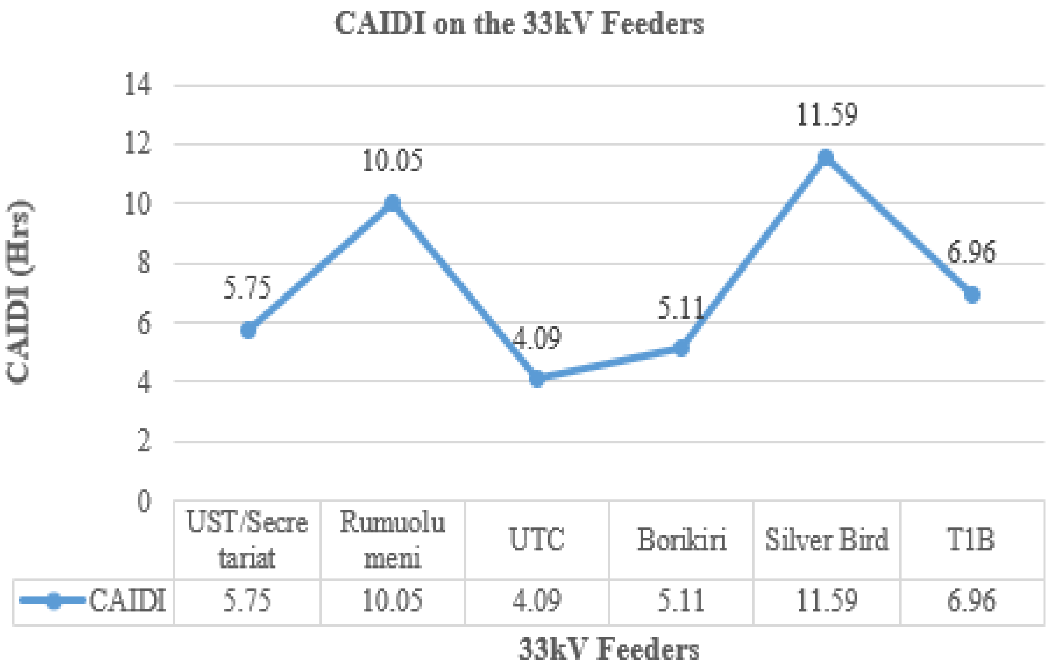

Figure 4.3: Chart of CAIDI on the 33kV Feeders

V. CONCLUSION

5.1 Conclusion

Six 33kV feeders were used to evaluate the reliability of power system and consequently proffer solution for adequate repositioning of the industrial sector. The results of the evaluation provide that System average interruption duration indices became: 379.96hrs on UST/Secretariat 33kV feeder, 451.94hrs on Rumuolumeni 33kV feeder, 292.56hrs on UTC 33kV feeder, 409.81hrs on Borikiri 33kV feeder, 519.56hrs on Silver Bird 33kV feeder, and 407.03hrs on T1B 33kV feeder.

System average interruption frequency indices became: 66.10 interruptions per customer on UST/Secretariat 33kV feeder, 44.98 interruptions per customer on Rumuolumeni 33kV feeder, 71.57 interruptions per customer on UTC 33kV feeder, 80.25 interruptions per customer on Borikiri 33kV feeder, 44.84 interruptions per customer on Silver Bird 33kV feeder, and 58.44 interruptions per customer on T1B 33kV feeder. Also, customer average interruption duration indices became: 5.75hrs on UST/Secretariat 33kV feeder, 10.05hrs on Rumuolumeni 33kV feeder, 4.09hrs on UTC 33kV feeder, 5.11hrs on Borikiri 33kV feeder, 11.59hrs on Silver Bird 33kV feeder, and 6.96hrs on T1B 33kV feeder.

Finally, it was noted that Silver Bird 33kV feeder has the highest system average interruption duration index followed by Rumuolumeni 33kV feeder, Borikiri 33kV feeder, T1B 33kV feeder and UTC 33kV feeder. Also, Borikiri 33kV feeder has the highest system average interruption index followed by UTC 33kV feeder, UST/Secretariat 33kV feeder, T1B 33kV feeder, Rumuolumeni 33kV feeder and Silver Bird 33kV feeder. Summarily, Silver Bird 33kV feeder has the highest customer average duration index followed by Rumuolumeni 33kV feeder, T1B 33kV feeder, UST/Secretariat 33kV feeder, Borikiri 33kV feeder and UTC 33kV feeder. The values realized point to the fact that there was minimal system failure but with high frequency of fault in the various power distribution networks and slow response to fault clearing coupled with load shedding plan of the distribution company. Reinforcement projects geared towards attaining the desired power quality and at the same time increasing power availability should be encouraged. Quick response to fault clearing for feeder service reliability and efficient power supply services should be encouraged.

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