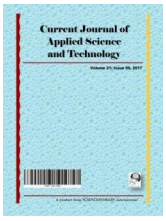

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Economic Implication of Unreliable Power System in Nigeria: A Case Study of Ota 132/33 Kv Transmission Station

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The impact of Power system reliability on the economy of a nation cannot be underestimated or overemphasized. The quality of power supply to customers is measured of how reliable the available power supply is used with respect to time. Hence, an analysis of the economy based on the supply of electricity is very important to provide the quantitative results and comprehensive information about how the energy use affects economic growth and development of Ota. The power system in Ota experiences high downtime due to the fact that the substation does not have the capacity to accommodate the rapid population growth and industrial development in the area. The increasing downtime leads to blackout in most part of the city resulting in serious economic damage and industrial problems. This paper presents the economic impact of unreliable power system in Nigeria. Ota 132 kV substation was selected for the study. The performance and operations problems of the substation were investigated which include frequent power outages, assumed to be caused by environmental factors such as moisture, temperature or heat, ageing, mechanical fracture, and operational faults, which result in outage of power to the designated feeder. These abnormal conditions trigger relays in the areas of overload, overvoltage, overheating, unbalanced

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loading and fire hazards. All these faults are reported daily as they occur. Provision of reliable power supply is, therefore, a problem in the current substation-load scheme. The study was undertaken to show the level of unreliability of supply in Nigeria, Ota Township a case study. The load loss in MW, failure rate, downtime and revenue loss of the feeders were computed analytically and graphically represented. The result from the study revealed that the downtime, after every fault resulted in heavy load loss and in turn causes a huge revenue loss.

Keywords: Economic implication; feeders; load loss; downtime; revenue loss; economic growth.

1. INTRODUCTION

To maintain the life of the human community, and in order to facilitate the life, many important inventions were discovered. There is no doubt that the most important of these inventions is electricity, which we depend on in the current modern time. We better understand the importance of electricity in our life during a few minutes of power outages we encounter. The people's social life almost stops in power outages. Electricity is a wheel that drives the economy of a nation. All over the world, the issue of the unreliability of the power system has been a great source of concern to both the regulators and other players (including consumers) in the sector. An unreliable power system poses serious challenges to the socio-economic and political structure of an economy. Some of these challenges include loss of welfare, pressure on governance, and loss of output among others. Because of these challenges, however, the affected consumers (especially industrial users) usually provide alternative measures in order to curtail the effects of the poor public provision on their economic activities. A prominent measure usually taken by industries is the generation of own electricity. Industries invest in backup generation in order to continue operations during power outages. Therefore, it is reasonable to expect the industries owning generators be able to curtail a greater portion of outage costs through this action [1].

The importance of electricity cannot be overemphasized in moving agriculture, commerce, manufacturing industry, mining industry forward. If Electricity is not readily available, there is a high possibility of incurring significant negative effect on the economy and other sectors. The communities and families under the low-income categories rely on wood fuel as the only alternative thereby aggravating the poverty problem. The Percentage of Nigerians that have access to electricity has declined due to fluctuation in the generation level. As at 2015, only 40% of Nigeria has access to electricity [2] yet the demand for power is increasing. The demand for power in 2004 is just 3400MW compared to demand in 2015 which is 30,000 MW [2] with only 1.5% of the total installed capacity from renewable energy and 83.5% from fossil fuel which is can be depleted and is unreliable [3].

The steady operation of a 3-pahse ac power system is balanced one but sudden external or internal changes in the system, disrupt this condition. Failure of insulation of the system at one or more points or coming of a live point contact with a conducting object results in a short circuit or occurrence of fault. The fault may be symmetrical or unsymmetrical. A fault involving all the three phases line with equal magnitude of current and 120^0 phase angle displacement while unsymmetrical fault occurs with an unequal fault current with unequal phase angle displacement [4]. From the very beginning, power interruptions due to an occurrence of system faults and inadequate of power generation constitute a major challenge to electricity consumers in. In modern society, continuous supply of energy is always expected but this is not possible practically due to random failures, which are generally outside the control of power system engineers. Other challenges facing Nigeria electricity are an absence of close proximity of generation to consumers resulting in excessive voltage drop. It is not always feasible and economical to generate electric power at the location of its use. Consequently, bulk energy generated in the generating stations must be transmitted over a long distance via an electric transmission network to a consumer. In power network, a fault can hinder the flow of bulk power. Bulk power move on the grid or transmission links. From the grid, power is then sub-divided into smaller blocks based on operating voltage level and fed into the sub-transmission portions of the power network. Finally, the individual small and large consumers are serviced from the distribution network [5].

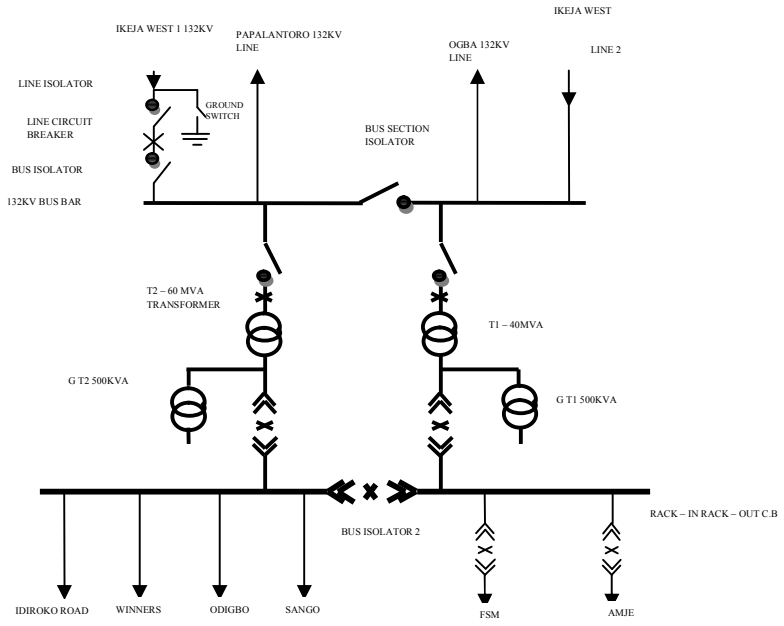

Fig. 1. One line diagram showing the bus and feeders in the substation (Source: IBDEC Ota transmission station

Hence, the need for this paper which is to investigate the problems of operation and service delivery on 132 kV/33 kV transmission station using Ota transmission station a case study. However, over the years, Ota has been experiencing erratic supply of electricity and of poor quality, which has made many industries to fold up in the area [6].

Similarly, due to accelerated growth and industrial development in Ota and the increase in load demand, there is the need for more transmission station connected to the grid in Ota. The substation should be designed and operated to meet customers' needs at the lowest possible cost commensurate with the quality of service desired. Hence, this paperwork is to analysis the economic implication of unreliable power supply associated with the economic activities in Ota.

1.1 The Study Area

Ota transmission substation is located in Ota, one of the major industrial cities in Ogun State, Nigeria. It situated within the coordinate of 07° 57^{1} 0^{11}N, 4° 47^{1} 0^{11} E. It has two incoming transmission lines coming from Ayobo in Ikeja West area of Lagos state namely Ikeja west line 1 and 2. The power transformer in the substation is 100 MVA rated capacity comprises 40 MVA (T_1) and 60 MVA (T_2). It has six numbers of outgoing feeders namely; Idiroko, Winner, Odigbo, Sango, FSM and Amje. The lines are interconnected so that there can be supply to all feeders in the station in case of a fault on one line or transformer or during normal maintenance as shown in Fig. 1. There are line isolators, line circuit breaker, bus isolator and one 500kVA transformer [7].

2. METHODOLOGY

A comprehensive study of 132/33 kV transmission substation network in Ota of the Ibadan Electricity Distribution Company was carried out in this paper. Monthly outage event, frequency of outage, energy supply to the station in megawatts and consumption from the outgoing feeder were collated and analyzed. The collated data were used to calculate frequency of out, downtime, load loss and revenue loss.

3. RESULTS EVALUATION AND ANALYSIS

In order to calculate the outage rate, reliability, and availability, duration of outages, frequency of outages were calculated and tabulated. The results obtained on causes of frequent power outage are presented in Tables 1-3 and their corresponding figures.

Table 1. Feeder-by-feeder overall monthly frequency of outage

Month	IDIROKO	WINNER	ODIGBO	SANGO	FSM	AMJE
January	20	14	13	24	10	27
February	30	19	18	32	16	25
March	24	13	21	28	13	25
April	23	17	18	28	16	28
May	41	18	20	29	34	29
June	31	15	15	24	28	23
July	36	24	26	33	22	29
August	42	38	39	42	18	39
September	30	17	18	25	24	29
October	34	15	17	28	18	29
November	25	11	12	21	16	21
December	32	11	14	25	21	28
Total	**368**	**212**	**231**	**339**	**236**	**332**

Table 2. Overall feeder-by-feeder load loss in megawatts

Time (HR)	IDIROKO	WINNERS	ODIGBO	SANGO	FSM	AMJE
1	4	10	7	12	6	10
2	4	10	7	12	7	7
3	5	10	9	12	9	7
4	7	10	8	12	6	6
5	13	11	9	12	6	6
6	10	11	11	10	7	6
7	9	12	13	11	12	7
8	8	15	10	20	5	12
9	6	15	10	21	7	14
10	8	13	11	20	7	11
11	15	14	8	5	6	11
12	10	9	5	11	5	12
13	18	13	11	15	7	11
14	18	12	13	15	9	10
15	16	12	13	15	11	9
16	17	13	16	15	13	11
17	17	14	15	15	11	12
18	18	14	17	16	13	13
19	19	14	19	18	11	17
20	18	16	12	18	11	17
21	18	14	11	20	15	17
22	17	14	13	20	15	16
23	17	10	12	19	10	14
24	6	10	12	14	10	10
Total	**298**	**296**	**272**	**358**	**219**	**266**

Table 3. Average feeder-by-feeder Annual revenue loss

	Feeders	Annual load loss (mw)	Annual load loss (kw)	Annual revenue loss (#)
1	IDIROKO	298	298000	10510460
2	WINNERS	296	296000	10439920
3	ODIGBO	272	272000	9593440
4	SANGO	358	358000	12626660
5	FSM	219	219000	7724130
6	AMJE	266	266000	9381820
	TOTAL	1709	1709000	60276430

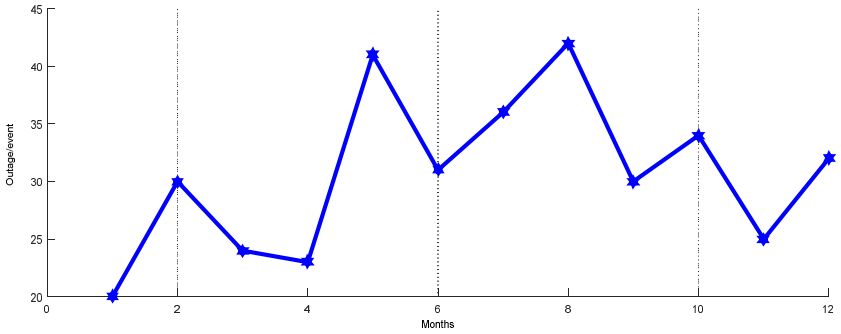

Fig. 2. Frequency of outage on Idiroko feeder

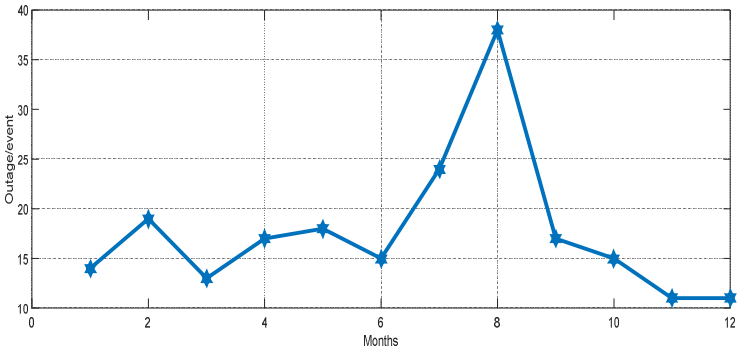

Fig. 3. Frequency of outage on Winners feeder

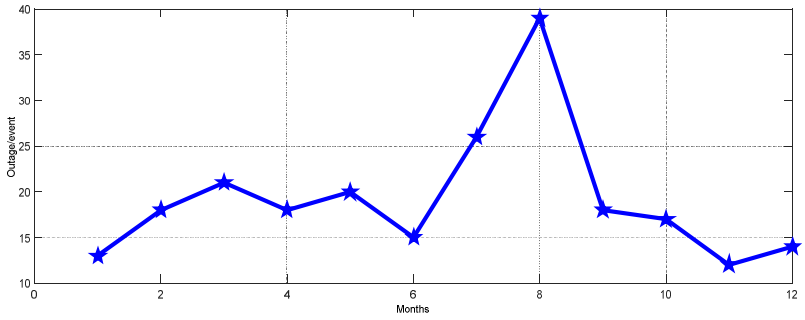

Fig. 4. Frequency of outage on Odigbo feeder

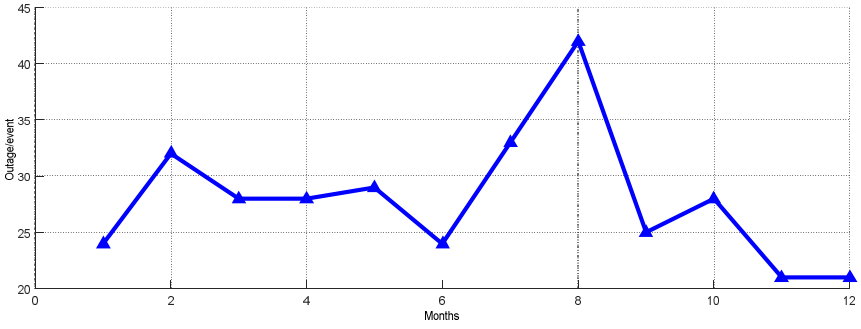

Fig. 5. Frequency of outage on Sango feeder

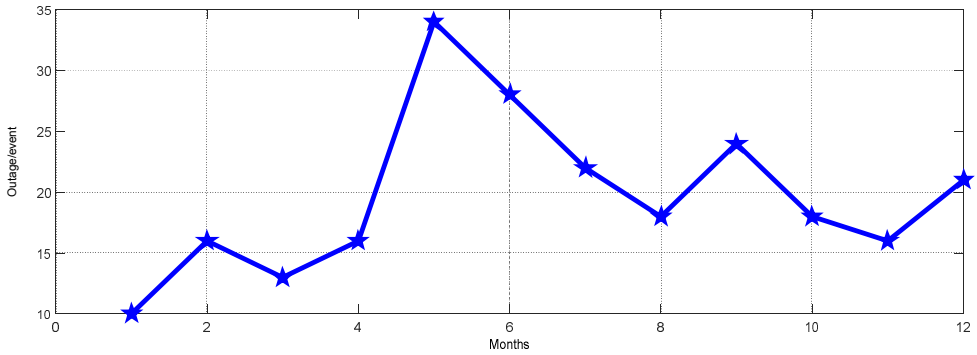

Fig. 6. Frequency of outage on FSM feeder

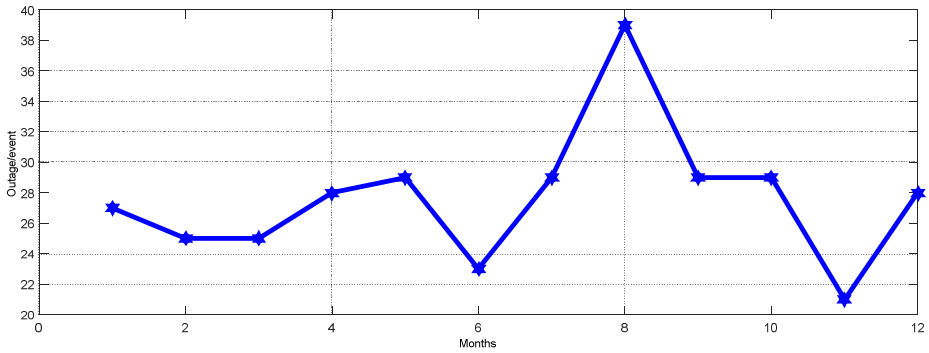

Fig. 7. Frequency of outage on Amje feeder

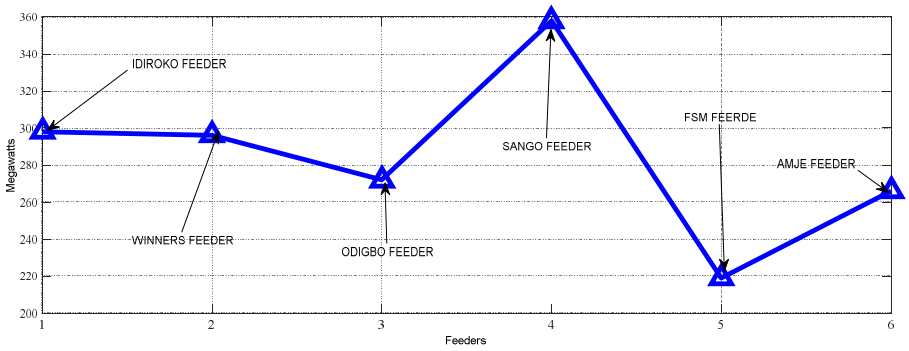

Fig. 8. Feeder-by-feeder load loss curve

4. DISCUSSION

A comprehensive study of 132/33 kV Transmission Substation in Ota network was carried out in this paper. Frequency of outage, outage/feeder and power supply to the station was collated. From the collated fault data, downtime, load loss and revenue loss were calculated. The results show that downtime, load loss and revenue loss are very high which make it difficult for both small and medium scale enterprise and even industries to breakeven. The following assessments were conducted as reported below:

4.1 Downtime Time Assessment

The frequency of outage for each feeder was collated. From Table 1, it was revealed that Idiroko has the highest number of outage with

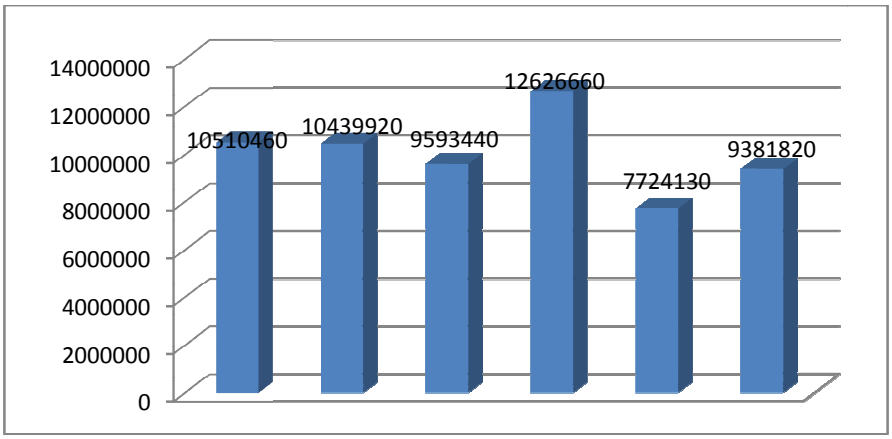

Fig. 9. Feeder-by-feeder annual revenue loss

368 outage/event follow by Sango which recorded 339 outage/event while Amje, FSM, Odigbo, Sango, and Winners have 321, 236, 231 and 212 outage/event respectively. The graphical representation of the frequency of outage is shown in Fig. 2-7.

4.2 Load Loss Analysis

Feeder-by-feeder load loss was evaluated and the result of evaluation was shown in table 2 while the corresponding graph was shown in Fig. 8. The table revealed that load loss was predominant in the substation which was due to faults and low generation. The customers both household, small and medium enterprise and industries were predominantly in darkness most of the time. With this situation, people are relying on backup to meet up with the electricity needed for the day-to-day activity. The table shows that sango feeder recorded the highest number of load loss of 358 MW, Idiroko 298 MW, winner 296 MW, Odigbo 272 MW, Amje 266 MW and FSM with lowest load loss has 219 MW.

4.3 Economic Implication

Table 3 shows the revenue loss by each feeder and with losses recorded, it will be very impossible for the economy of Ota to grow until there is an improvement in electricity supply to the area. Power outage has been the major setback to Ota economy so bad that companies in these areas cannot survive due to excessive expenses in providing electricity to power their equipment and voltage drop leading to insufficient voltage. The use of generator has been the alternative means of providing electricity to power their equipment for production. Table 3 shows the load lose and its corresponding annual revenue loss. It was shown in Fig. 9 that an average sum of sixty million two hundred and seventy six thousand, four hundred and thirty (# 60,276,430) naira is being lost to outages annually with Sango feeder carries the largest percentage of revenue loss. The result proved that power outage impacts negatively on both capacity utilization and labour productivity growth of the manufacturing industries in Ota which has contributed to their relocation into neighboring countries where power supply is adequate and reliable. The huge amount of money being lost yearly is an indication of harsh economy on the electricity distribution company. The amount being lost by the energy provider company is very small compared to what household and industries are spending to provide backup energy in buying, generator, fueling and services. Regular power supply is directly proportional to economy growth of any nation without which no meaningful development can be achieved.

5. ELECTRICITY GROWTH VERSUS ECONOMIC GROWTH

A review of the World Bank Data on Electric power consumption (kWhr per capita), for Nigeria and China, between 1971 and 2015, indicates that the widening gap between China and Nigeria in terms of economic growth could be strongly correlated to the widening gap for electric power consumption. In 1971, China had an electric power consumption of 151.98 kWhr per capita, while Nigeria had 28.49 kWhr per capita. Of note, is that by 2013 China had aggressively grown its electric power consumption to 3,762.08 kWhr per capita, while Nigeria had marginally increased to 141.87 kWhr per capita. Currently, the Chinese economy is ranked the second biggest economy in the world, in terms of GDP [8]. Electricity has

direct effect on the economic growth of a nation. A reduction in power supply imposes a negative effect on the economy while an increase in power supply improves the economy of a nation. A constant supply of energy is vital tool for economic growth in order to meet the fundamental requirement to measure the standard of living in relation to the cost of living.

6. CONCLUSION

This paper discussed the economic implication of implication of unreliable power system in Nigeria. The results obtained showed that huge sum of money is lost to power outage annually. Also, high cost of maintenance and of fuelling the generators as an alternative source of power is one of the reasons why a company cannot easily break even. This has led to, unemployment, low standard of living, high cost of living, and reduction in country's productivities. Thus, for the reliable power system in Nigeria, it is therefore recommended that all the transmission and distribution substations in Nigeria should be evaluated as this will give the exact problem in all the substations.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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