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RESEARCH ARTICLE

Performance Evaluation of PHED Company in Nigeria

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Abstract

In the present study, we report on the performance evaluation of the Port Harcourt Electricity Distribution Company (PHEDC) using the reliability index (System Average Interruption Frequency Index (SAIFI), System Average Interruption Duration Index (SAIDI), Customer Average Interruption Duration Index (CAIDI), and Customer Average Interruption Frequency Index (CAIFI)). A total of 10 sub-stations were used for the investigations. The results show that there is frequent power interruptions/outage in the study area. In particular, it is only in 25% of the stations, that the population of affected customers $\leq$ 1000 per station is recorded, indicating that urgent steps should be taken by the company for improved performance and service delivery to her customers.

Introduction

Energy availability plays a vital role in the economic growth and development of a nation. The economy growth of any nation strongly depends on the long term supply and availability of energy at low cost rate. The future economic growth of a nation also largely depends on the long-term availability of energy from sources that are affordable, accessible, and environmentally friendly. Energy availability is directly linked to the all-round security of a nation, climate change, social stability and economic stability, and environmental sustainability. According to Rai, (2004), the per capita energy consumption is a measure of the per capita income as well as a measure of the prosperity of a nation. Sustainable development is closely tied to energy availability. In the developed nations that have replaced human and animal labor with more convenient and efficient sources of energy and technology , energy is always available and this makes her economy to be fast-growing. In the literature, Rosen (2009) asserted that "no country in modern times has succeeded in substantially reducing poverty without adequately increasing the provision and use of energy to make material progress. Nigeria is a West African country, richly blessed with abundant renewable energy resources such as hydroelectric power, solar, wind, tidal, and biomass, hence there is a need to harness these resources and develop a new energy future for Nigeria. Different research groups have reported on the availability of renewable energy resources in Nigeria with a view to establishing their viability in the country (Oyedepo, 2012, 2014; Nwofe 2013[a-c]; Nwofe 2014[a-d]; Nwofe and Ekpe 2014; Nwofe 2015[a]; Okpani et. al. 2015). The acute shortage of energy is ubiquitous in Nigeria with every State having her own share. Power outage is a common phenomena that is almost as old as Nigeria. Subsequent Government has attempted to address this issue but to no avail. Currently, privatization of the Power Holding Company of Nigeria (PHCN) has led to the proliferation of power generating companies in Nigeria. Although this has contributed in no small measure in improving power availability in some areas, the situation still needs more and thorough improvement. It is in this regard that this research is aimed at, i.e. to evaluate the performance of one of the power generating companies (Port Harcourt Electricity Distribution Company (PHEDC)) in Nigeria using standard criteria according to the literature (Willis. 2004).

Reliability index plays a significant role in the management of power generation/distribution systems or companies (Willis, 2004; Hoang, 2003). The major aim of this study is to evaluate the performance of Port Harcourt Electricity Distribution Company (PHEDC) using the reliability index (System Average Interruption Frequency Index (SAIFI), System Average Interruption Duration Index (SAIDI), Customer Average Interruption Duration Index (CAIDI), and Customer Average Interruption Frequency Index (CAIFI)) as contained in the literature (Yeddanapudi, 2003; Willis. 2004), as the evaluation criteria in the respective power station within the company. The power stations are; Garden City Main (GCM), Paradise City (PC), Garden City East (GCE), Promise City South (PCS), Promise City North (PCN), Garden City New (GCN), Garden City Centre (GCC), Garden City Industrial (GCI), Promise City Main (PRCM), and Glory City Main (GACM). The paper then suggest possible steps to address the setbacks for improved performance of the company, and for increased energy availability in the her service areas.

Material and Methods

Data was collected from the PHEDC. The data contained the reliability indices. The reliability indices as contained in the literature (Willis, 2004) are: System Average Interruption Frequency Index (SAIFI), System Average Interruption Duration Index (SAIDI), Customer Average Interruption Duration Index (CAIDI), and Customer Average Interruption Frequency Index (CAIFI). The reliability indices for each station was plotted and useful deductions were made.

Result and Discussion

As indicated earlier, reliability index were used for the analysis. The System Average Interruption Frequency Index (SAIFI) is commonly used as a reliability indicator by electric power utilities and is usually defined as the average number of interruptions that a customer would experience (Willis, 2004). The formula is given as;

$$SAIFI = \frac{\sum \lambda_i N_i}{N_T} \quad (1)$$

In equation (1), λ_i is the failure rate, N_i is the number of customers for a given location i, and N_T is the total number of customers served. Equation (3) is further expressed as,

$$SAIFI = \frac{total\ number\ of\ customer\ interruptions}{total\ number\ of\ customers\ served} \quad (2)$$

SAIFI is generally measured in units of interruptions per customer. It is usually measured over the course of a year. According to IEEE Standard 1366-1998, the median value for North American utilities is approximately 1.10 interruptions per customer. Research work by Samuel et al (2013) has attempted to establish SAIFI values for Nigeria. The System Average Interruption Duration Index (SAIDI), is the average power outage duration for each customer served, and is calculated as:

$$SAIDI = \frac{\sum U_i N_i}{N_T} \quad (3)$$

In equation (3), N_i is the number of customers and U_i is the annual power outage time for location i, and N_T is the total number of customers served. Equation (3) is further expressed as,

$$SAIDI = \frac{sum\ of\ all\ customer\ interruption\ durations}{total\ number\ of\ customers\ served} \quad (4)$$

SAIDI is measured in units of time, either in minutes or hours. SAIDI is also measured over the course of a year, and according to IEEE Standard 1366-1998, the median value for North American utilities is approximately 1.50 hours. Currently in the literature, there is no established, unified value of SAIDI in Nigeria. However recent work by Okorie and Abdu (Okorie and Audu, 2015), reported on the Reliability Evaluation of Power Distribution Network System in Kano Metropolis of Nigeria. The Customer Average Interruption Duration Index (CAIDI) is a reliability index that is related to SAIFI and SAIDI and is given as;

$$CAIDI = \frac{\sum U_i\ N_i}{\sum \lambda_i\ N_i} \quad (5)$$

In equation (5), λ_i is the failure rate, N_i is the number of customers, and U_i is the annual outage time for location i. Equation (5) is further expressed as,

$$CAIDI = \frac{sum\ of\ all\ customer\ interruption\ durations}{total\ number\ of\ customers\ served} = \frac{SAIDI}{SAIFA} \quad (6)$$

CAIDI indicates the mean power outage duration that any given customer would experience. CAIDI can also be understood as the average restoration time. CAIDI just like other reliability index is also measured in units of time, often in minutes or hours. CAIDI is also measured over the course of a year, and according to IEEE Standard 1366-1998 the median value for North American utilities is approximately 1.36 hours. However, Okorie and Abdu, (2015) reported on similar variables in Kano, Nigeria.

The Customer Average Interruption Frequency Index (CAIFI) is a reliability index that is designed to show the trends in customers interrupted and helps to show the number of customers affected out of the whole customer base. However it does not take account of the customer class distinction. CAIFI is given by the relation (Willis, 2004);

$$CAIFI = \frac{Total\ \ Number\ \ of\ Customer\ Interruptions}{Number\ \ of\ \ Distinct\ Customers\ \ Interrupted} \quad (7)$$

Figure 1 gives the variation of the reliability indices (SAIFI, SAIDI, and CAIFI) at the respective stations. The power stations are; Garden City Main (GCM), Paradise City (PC), Garden City East (GCE), Promise City South (PCS), Promise City North (PCN), Garden City New (GCN), Garden City Centre (GCC), Garden City Industrial (GCI), Promise City Main (PRCM), and Glory City Main (GACM).

From Figure 1, it is clearly shown that there is incessant interruptions .ie power outage in all the base stations. However a maximum power outage was recorded at Promise City Main station, followed by Garden City Centre and Garden City New power station. The behavior exhibited in Fig. 1 is similar to that reported by other authors in the literature (Okorie and Abdu, 2015). This trend can be attributed to varying weather conditions (storm, lighting, outdoor temperature and air humidity), contamination, vegetation, animals, human, excessive load, lack of maintenance, and equipment ageing in those stations. Another disturbing factor that also contributes immensely to the poor service delivery of the power companies to her customers is that of "energy theft". This is endemic in that individuals, communities, government agencies, and business organisations are all involved in delay/non-payment of electricity bills. The managing director of PHED has lamented on this ugly trend (Edevbie, 2014).

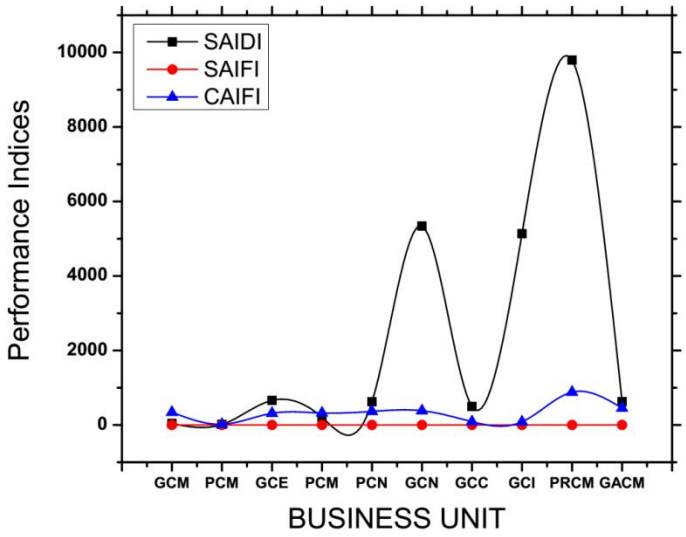
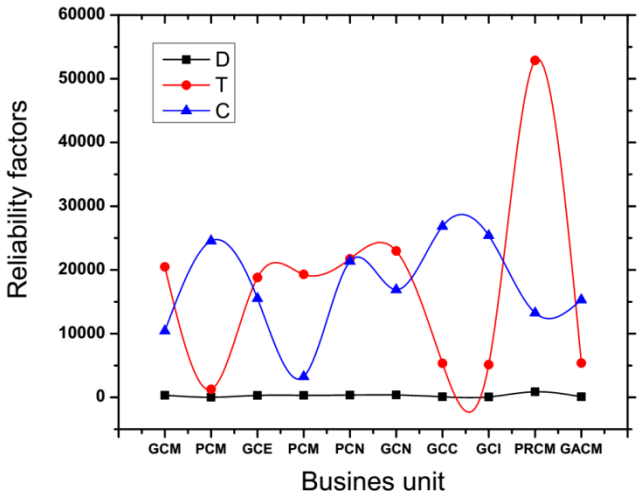


Figure 1 gives the variation of the reliability indices (SAIFI, SAIDI, and CAIFI) at the respective stations.

Figure 2 show the variation of the reliability factors at the base stations. The total number of customers affected T, at the respective stations as indicated in Fig. 2, show that PCM had the best result in that it showed the least number of customers while PRCM exhibited very large number of affected customers. However 25 % of the stations had number of customers ≤ 1000 as the unaffected customers.



C = Customer population, T = Total number of customers affected, D = Durations of interruptions (min).

Figure 2. Variation of the reliability factors at the base stations.

In the present investigation, critical analysis of power outages were evaluated for the substations within Port Harcourt Electricity Distribution Company (PHEDC) using the reliability index (System Average Interruption Frequency Index (SAIFI), System Average Interruption Duration Index (SAIDI), Customer Average Interruption Duration Index (CAIDI), and Customer Average Interruption Frequency Index (CAIFI)). The result show that 75% of the substations have not satisfied their customers in that the number customers affected by power interruptions are exceedingly high. The causes of this shortfalls are attributed to a variety of factors which includes but not limited to; energy theft, environmental and weather factors, (lightning discharge, storm, wind, trees, birds, animas, fire,

outdoor temperature and air humidity), vegetation, moisture, excessive load, lack of maintenance, ageing, wear-out and design amongst other factors. It is strongly recommended that if these issues are addressed, it will improve the service delivery of the stations significantly.

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