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STATISTICAL ANALYSIS OF THE CONSTANCY AND QUALITY OF POWER SUPPLY IN IKORODU AND SURULERE LOCAL GOVERNMENT AREAS, LAGOS STATE NIGERIA

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ABSTRACT
Access to stable and sufficient electricity supply has remained elusive in Nigeria over the past decades. This paper considered generally electricity supply in Nigeria and focused specifically on the quality and constancy of power product and services supplies in two selected Local Government Areas in Lagos State. A self – designed questionnaire was adopted for data collection from 218 residents purposively sampled from Ikorodu and Surulere under Ikeja and Eko power distribution companies respectively. Results showed that 81% of the residents have power supply for not more than 6 hours daily and experience outages about thrice daily on average. Also, households on average consume 232.6kw and pay ₦7,114.70 monthly bill. Statistical test showed that there exists a significant difference in power supply and service delivery between Eko and Ikeja distribution companies ($p < 0.05$). It was concluded that power supply in Ikorodu and Surulere was not constant and of very low quality among the residents and customers of Eko and Ikeja distribution companies and that a significant number of the households own and operate power generators due to electricity shortfalls in their area with its characteristic air and noise pollutions.

KEYWORDS: Constancy, Distribution companies, Households, Power supply, Residents

INTRODUCTION
Electricity power or energy is the bedrock for economic growth and industrialization of any country. The process of setting up of an electricity generating system is costly and time consuming but once it is in place, it is expected to experience a decreasing average costs as the output expands. Also, the system is expected to innovate and make use of advances in knowledge and technology. These learning and experiences so far gained on the production process should enable the system expand and produce better output than previously as a result of the existence of the economy of scale as well as the learning effects.

In spite of Nigeria's huge resource endowment in energy and the enormous investment in the provision of energy infrastructure, the performance of the power sector has remained poor, in comparison with other developing economies.

Nigeria is a nation splendidly blessed with energy sources like solar, wind, hydro, thermal energy and bio-energy. Perhaps the greatest infrastructural problem challenging both households and businesses is the low performance and poor-quality service distribution of the power sector. This is the current discuss of stakeholders in Nigeria as sufficient supply and distribution of electricity is a dominant factor of economic growth in the country. According to Accram (2005), about 928 million people live in shantytowns all over the world and most of them are in emerging economies. The challenges are profuse because the slum

world breed mass poverty, unemployment and degradation. Odumosu (2005) noted that most stakeholders in the power sector concurred that the best way to swift development is through adequate delivery of electricity. Wiesmann, Azeredo, Feno, & Fernandez (2011) discovered that households and residence characteristics had significant effect on residential electricity consumption in Portugal. The results also showed that the direct impact of income on electricity consumption was low and decreases when more applicable variables were involved in the analysis. Future demand of electricity would be significantly influenced by drifts in socio-economic factors and changes in the construction standard. They concluded that formulation of policy measures towards reducing electricity consumption should consider these trends.

Nigeria as a country is tremendously endowed with huge volume of non-renewable and renewable primary sources of energy which when harnessed appropriately will birth steady energy supply to all residents. The natural gas reserves in the nation is estimated at 185 Tn cubic feet, crude oil at 35bn barrels and coal reserves at 2.75bn metric tons (Uzoma, Nnaji, & & Nnaji, 2012; Ibitoye & Adenikinju, 2007; Iwayemi, 2008). According to Uzoma, Nnaji, & Nnaji (2012) Nigeria has a potential of producing an expected total useable large-scale hydropower of over 36,000 GWH of electricity yearly. Other sources of energy available for improving electricity in Nigeria comprises of wind energy and biomass (Ibitoye & Adenikinju, 2007). Despite all these huge sources for power generation in the country, Nigeria presently rely hugely on gas-fired thermal and hydropower stations for generating power which created a very big chasm between the load demand in the nation and volume of power generated and (Senbanjo & Coker, 2013; Simolowo & Oladele, 2012). However, the Nigeria power sector according to Azodo (2014) is characterised by its irregular supply and frequent interruptions, total power failure, inadequate power supply, etc. The high rate of transmission losses in Nigeria despite very low generation is a very big challenge to bot only power generation companies but the transmission companies also.

Residential power consumption remained at the top in the hierarchy of electric power usage in the country. The owner and types of appliances and electrical equipment by households differ significantly, hence the difference in utilisation characteristics (Herath, Gebremedhin, & Fletcher, 2011). Individual household power demand is derived from the use of different numbers and types of household appliances and equipment (Ekpo, Chukwu, & Effiong, 2011; Reiss & White, 2005). Evaluation of residential energy consumption showed that almost half of household electricity is used for lighting, television, radio, air conditioning, refrigeration, ironing, etc. (Makonin, Ellert, Bajic´, & Popowich, 2016). With the swift progresses in technological revolutions coupled with the growth in the domestic electrical appliance engineering, there seems to be no complete domestic chore that does not encompass the use of an electrically operated device in some way.

The Nigerian Government at the start of 2012, undertook to increase electricity production to 10,000MW by the end of the year. This anticipation was founded on various official restructurings, like the unbundling and privatisation of the then Power Holding Company of Nigeria (PHCN), to ensure seamless and unobstructed supply of gas to the Independent Power Projects (IPPs) and National Integrated Power Plants (NIPPs), create an economically workable metering system and sustain the prevailing price for electricity supply, among others. Power generation in Nigeria is characterised by excess volume and insufficient supply that made spontaneous load shedding, as well as lengthy and sporadic outages recurrent occurrences (Ukoima & Ekwe, 2108; Ezirim, Eke, & Onuoha, 2016; Ohajianya, Abumere, Owate, & Osarolube, 2014; Ayara, Essia, & Ubi, 2013). Similarly, a

poorly - inspired staff, vandalism, robberies, chance destruction of supply lines, unlawful connections and resulting congestion of distribution lines are also accountable for sluggish advancement of the sector. It is anticipated that the ongoing deregulation of the sub-sector will change the condition being experienced. According to Ayara, Essia, & Ubi (2013), Nigeria's power generation swings between 4,000MW and 2,000MW. The instable power supply is attributable to overall system failure, which account for below par performance of all the power generating plants in the country operating at less than 40% capacity. According to Oke & Subair, (2008), about 45% of the population were connected to the national grid, but only 30% of their power demand was met. About 35% of Nigerians enjoyed steady electricity for up to 50% of the time, which negatively impacted on living standards and industrial output and efficiency, as growing number of industrial and residential customers provide electrical power privately at enormous costs to themselves and the Nigerian economy (Oke & Subair, 2008).

The purpose of the study was to establish the quality and consistency of electricity power supply to the residents of Lagos State. Power, like other utilities consumed in households, is a derived demand through the energy required for the running and functioning of various electrical appliances and equipment in the household (Reiss & White, 2005). Hence, the objectives explored in this study include: to determine the supply and power consumption pattern, to determine the availability and quality of PHCN product and services, to determine factors that affect customer satisfaction and to compare service delivery between Eko Distribution Company and Ikeja Distribution Company.

MATERIALS AND METHODS

This study adopted a cross - sectional survey research design which used the majority opinion to generalise about the characteristics of the research population (Abe, 2002). The study population comprised households that uses electricity in Surulere (Akerele Extension) and Ikorodu (Odo-nla) Lagos State based on the two distribution companies in Lagos State. The inclusion criteria for this study was all consenting individuals who are residents of the Odo-nla in Ikorodu and Akerele Extension in Surulere LGAs at the time of the study and willing to participate. The instrument for data collection was a self - designed questionnaire. Purposive sampling technique was adopted in selecting the 225 households studied. The reliability of the instrument measured the consistency, stability, dependability, predictability, precision and accuracy and the Cronbach's Alpha reliability coefficient of 0.61 was obtained for the research instrument. The quantitative and qualitative data that were gathered from the field were analysed using different methods. Descriptive (frequency distributions) and inferential statistical (chi square tests) were used to analyse the quantitative data with the aid of Statistical Package for Social Sciences (SPSS 23).

RESULTS

The results of 218 properly filled and recovered responses which amount to 97% response rate were analysed and the results are presented in tables and charts in this section.

Table 1: Consumption patterns of residents

		Frequency	Percentage
Number of people residing in the apartment	1 – 3	47	21.6
	4 – 6	96	44.0
	7 – 10	57	26.1
	11 & above	14	6.4
	Total	**218**	**100**
Distribution company	Eko DC	113	51.8
	Ikeja DC	105	48.2
	Total	**218**	**100**

Have an electrical meter in your house	Yes	193	88.5
	No	25	11.5
	Total	**218**	**100**
Kind of meter installed	Prepaid/card meter	102	52.8
	Postpaid meter	91	47.2
	Total	**193**	**100.0**
Average monthly power consumption	100 - 200kw	142	65.1
	201 - 400kw	58	26.6
	401 - 800kw	12	5.5
	Over 1200kw	4	1.8
	No Response	2	0.9
	Total	**218**	**100.0**
	Mean = 232.6 kw		
Average monthly electricity bill?	₦ 1000 – ₦ 5000	108	49.5
	₦ 5001 - ₦ 10000	63	28.9
	₦ 10001 - ₦ 17000	31	14.2
	₦ 17001 – ₦ 25000	16	7.3
	Total	**218**	**100.0**
	Mean = #7114.7		

Table 1 revealed the consumption pattern of residents and show that 22% of the households have 1 - 3 persons, 44% of them have 4 - 6 persons, 26% have 7 - 10 person living within and only 6% have more than 10 persons living within the apartment. The residents within the two distribution companies were made up of 52% from Eko Distribution Company and 48% from Ikeja Distribution Company. The results also show that 88.5% of the households have an electricity meter, while 53% use prepaid meters, 47% of them use postpaid meters. Monthly power consumption among these residents was between 100 – 200 kw among the majority (65.1%), 201 – 400 kw (26.6%) while the monthly average consumption among them 232.6 kw. Lastly, the average monthly electricity bills among these residents was #7,115 distributed as #1000 - #5000 (49.5%), #5001 - #10000 (28.9%), above #10000 (21.5%). The average monthly residential power consumption of 232.6 KWh in Lagos is slightly higher than 90 – 135 KWh per month reported by Olaniyan, McLellan, Ogata, & Tezuka (2018) but just one quarter of the average power consumption 930.4 KWh in United States (Alberini, Gans, & Lopez-Velez, 2010).

Table 2: Constancy and Quality of power supply and service

Issues		**Frequency**	**Percentage**
Average number of hours of power supply daily	6 hrs or less	177	81.1
	7 – 12 hrs	33	15.1
	13 – 18 hrs	8	3.7
	Total	**218**	**100.0**
	Mean = 4.53 hours		
Frequency of power failure at home daily	Once	8	3.7
	Twice	22	10.1
	Thrice	46	21.1
	More than thrice	142	65.1
	Total	**218**	**100.0**
	Mean = 2.82 ≈3		
Length of power failure daily	6 hrs or less	80	36.7
	7 - 12hrs	60	27.5
	13 - 18hrs	40	18.4
	19 - 24hrs	14	6.4
	Over 24hrs	24	11.0
	Total	**218**	**100.0**

	Mean = 10.6 ≈11 hours		
Frequency of low current or partial power supply at home	Daily	55	25.2
	Bi-weekly	19	8.7
	Monthly	20	9.2
	Quarterly	124	56.9
	Total	**218**	**100.0**
Contacted distribution company to resolve issues related to power supply or metering	Yes	130	59.6
	No	88	40.4
	Total	**218**	**100.0**
Means of reporting faults in your area to distribution company	Telephone	23	10.6
	Visit to distribution company	182	83.5
	On site	8	3.7
	No Response	5	2.3
	Total	**218**	**100.0**
Length of time it takes for faults to be rectified	1 – 12 hrs	19	8.7
	12 – 24 hrs	64	29.4
	2 - 3 days	57	26.1
	1 - 2 weeks	16	7.3
	Beyond 2 weeks	62	28.4
	Total	**218**	**100.0**

Table 2 shows the constancy and quality of power supply and services. It reveals that over 80% of the residents have power supply for 6 hours and below daily, with an average of 4.5 hours daily. Also. over 80% of the households experience power failure three or more times daily. In addition, almost 35% of the residents reported power failure for more than half the day in their residence with an average 11 hours power outage in their locality. Also, the quality of power supply was flawed as one quarter of the residents reported having low current or partial power supply in their residence daily, while an approximate 9% have such experience bi-weekly and monthly. Furthermore, 60% of the residents have contacted their distribution company to resolve issues related to power supply or metering. The majority of residents (83.5%) visited the distribution company offices while a sizeable proportion (11%) contacted them on phone to make their complaints or resolve issues. Lastly, over 60% of the residents reported that it takes a day or more before reported issues to the distribution companies are resolved.

These results agree with the observations of numerous studies on the very low electricity utilisation in Nigeria (Nurudeen, Nafiu, & Jibo, 2018; Emordi & Yusuf, 2015). This study also found that the average number of hours of electricity per day was 4.5 hours was lower than the findings of Olaniyan, McLellan, Ogata, & Tezuka (2018) that the average number of hours was 5 – 8 hours and 5 hours from NBS (NBS, 2016). It also reveals that Nigeria is performance was at per with the standard as the length of time to resolve reported issues is almost same as that recommended by CEER (Seršen & Voršič, 2008; CEER, 2001). The average length of power failure was 11 hours which was lower than the 15 hours observed in Cross River State in 2009 but above 7 hours in 2011 in the same state (Ayara, Essia, & Ubi, 2013).

Table 3: Consumer preference and beliefs

Service issues	**Yes (%)**
Preference for estimated bill	111 (50.9)
Belief that the ongoing reforms will improve power supply in the country	87 (39.9)
Privatising the power sector has brought about improvement in power supply	139 (63.8)

Table 3 shows that 51% of the residents prefer to get estimated bill having working meter in their residence. Also, only 40% of the residents believe that the ongoing reforms in the power sector will result in improved power supply in the country. Lastly, 64% of the residents expressed belief that privatising the power sector has brought about improvements in power supply. These results agreed with the findings of Ukoima & Ekwe (2108) where 68% rated electricity supply as improved after the reforms but negated the observations of Agbo (2014) that the power sector has not really achieved its objectives after privatisation because of lack of political will among policy implementers and lack of policy continuity. Some of the identified factors responsible for poor power supply in these areas include in order include corruption (70.6%), vandalism (44.5), poor infrastructure (42.2%), poor maintenance (39.4), inconsistent government policy (24.8%), inadequate funding (19.7%), aging workforce (19.3%) and lack of expertise (14.2%) (see fig. 1 below). This agreed with the submissions of other studies (Emordi & Yusuf, 2015; Etukudor, Abdulkareem, & Ayo, 2015; Onochie, Egware, & Eyakwanor, 2015; Ohajianya, Abumere, Owate, & Osarolube, 2014; Omoleke, 2011)

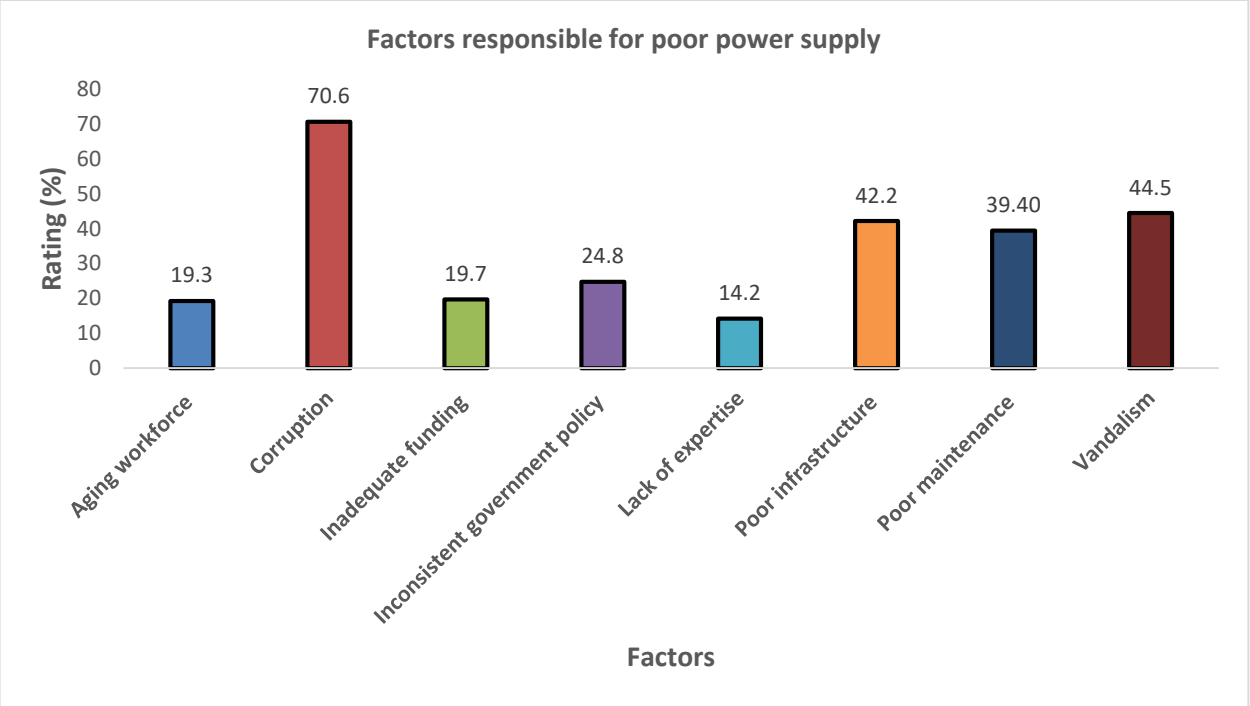

Fig. 1: Factor responsible for poor power supply in Surulere and Ikorodu LGAs in Lagos State

Hypotheses Testing

H_0^1: Monthly power consumption is not dependent on number of people residing in a house.

Table 4: Cross tabulation of average monthly power consumption and number of people residing in a house

		Average monthly power consumption			
		100 – 200 kw (%)	**201 – 400 kw (%)**	**401 & above (%)**	**Total (%)**
Number of people residing in the apartment	**1 – 3**	28 (59.6)	19 (40.4)	0 (0.0)	**47 (100)**
	4 – 6	61 (64.2)	27 (28.4)	7 (7.4)	**95 (100)**
	7 – 10	44 (78.6)	4 (7.1)	8 (14.3)	**56 (100)**
	11 & above	6 (42.9)	8 (57.1)	0 (0.0)	**14 (100)**
	Total	**139 (65.6)**	**58 (27.4)**	**15 (7.1)**	**212 (100)**
	χ^2 - value = 27.149; df = 6; p < 0.001				

Table 4 revealed that the Chi Square value obtained was 27.149 at 6 df with p - value of 0.000 which implied that average monthly power consumption is significantly dependent on number of people residing in a house ($p < 0.05$). This shows that the more the number of persons in a household, the more power they will consume monthly and this result aligns with the conclusions of Olaniyan, McLellan, Ogata, & Tezuka (2018).

H_0^2: The length of time it takes for faults to be rectified is not dependent on the distribution company involved.

Table 5: Cross tabulation between how long it takes for faults to be rectified and the distribution company

Distribution Company	**Length of time it takes for faults to be rectified**					**Total (%)**
	1- 6 hrs (%)	**12 – 24 hrs (%)**	**2 – 3 Days (%)**	**1 – 2 Weeks (%)**	**> 2 weeks (%)**	
Eko DC	8 (7.1)	15 (13.3)	29 (25.7)	10 (8.8)	51 (45.1)	**113 (100)**
Ikeja DC	11 (10.5)	49 (46.7)	28 (26.7)	6 (5.7)	11 (10.5)	**105 (100)**
Total	**19 (8.7)**	**64 (29.4)**	**57 (26.1)**	**16 (7.3)**	**62 (28.4)**	**218 (100)**
$\chi^2 = 45.127$; df = 9; p - value = 0.000						

Table 5 showed that the Chi Square value obtained was 45.127 at 9 df with p - value of 0.000 which showed that the length of time it takes for faults to be rectified is significantly dependent on the distribution company involved ($p < 0.05$). The table shows that Eko Distribution Company takes significantly longer time to resolve reported issues than Ikeja Distribution Company. This result is indeed novel as I could not find another study that compared the services of the two distribution companies in Lagos Nigeria.

H_0^3: Average number of hours of power daily power supply does not differ significantly in the two distribution companies.

Table 6: Crosstabulation of average number of hours of daily power supply by Distribution Company

Distribution company	**Number of hours of daily power supply**			**Total**
	0 – 6 (%)	**7 – 12 (%)**	**13 - 18 (%)**	
Eko DC	93 (82.3)	16 (14.2)	4 (3.5)	**113 (100)**
Ikeja DC	84 (80.0)	17 (16.2)	4 (3.8)	**105 (100)**
Total	**177 (81.2)**	**33 (15.1)**	**8 (3.7)**	**218 (100)**
$\chi^2 = 0.195$; df = 2; p - value = 0.900				

Table 6 showed that the average number of hours of daily power supply in Eko and Ikeja distribution companies is not significantly dependent on the distribution company (χ^2_2 **= 0.195;** $p > 0.05$). Also, this result could not be compared with any other literature in the public domain.

CONCLUSIONS

This study came up with the following conclusions: On average, the residents of Eko and Ikeja distribution companies consume 232.6kw per month and pay #7,115 for electricity bill monthly. Also, residents in both Local Government Areas in Lagos do not have constant power supply with less than an average 6 hours daily supply and power failure for more than thrice daily. The quality of power supply was also poor as majority still experience low current in their residence. Poor service delivery bedeviled this distribution companies as the distribution companies took long periods to rectify reported power related faults. Factors identified as responsible for poor power supply in these areas in order include corruption, vandalism, poor infrastructure, poor maintenance, inconsistent government policy, inadequate funding, aging workforce and lack of expertise. The quantity of power consumed is significantly associated with the size of the households. Lastly, service delivery differs significantly between Eko DC and Ikeja DC but power supply was the same between them.

RECOMMENDATIONS

The study provides the following recommendations for both regulators and investors:

Firstly, the activities of the distribution companies need to be regulated by the Nigeria Electricity Regulatory Commission (NERC) to ensure that better services are rendered to power consumers. Secondly, the government should ensure that the demand for electricity is met in the residential, commercial and industrial sectors of the economy by raising the energy generation and addressing the infrastructural deficiencies. Also, different sources of power like biogas, wind and solar radiation which are abundant in the country should be explored and developed in each consumption areas. In addition, the Federal Government have devolved to private sector participation in the distribution of electricity the by privatising the sector and eliminating all barriers to their operations. Same hand should be extended to the generation of electricity that will meet the demands in the residential, commercial and industrial sectors of the Nigeria's economy. Furthermore, Government should fast-track actions on policy formulation and execution in order to implement prepaid metering system tradition in Nigeria. Finally, governmental and non-governmental bodies ought to educate and inform the general public on good energy consumption lifestyle to foster low consumption society and investment in developing the technical expertise needed in the industry to ensure that better service is rendered to consumers at affordable rates is a must - do.

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