Efficiency in Public Service Delivery in Nigeria: Lessons for Theory and Practice in the Electric Power Sector

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Abstract

The recent concern on improving public service delivery in Nigeria provides an important lesson to advance efficiency in the power sector. The objective of this paper is to examine efficiency in power service delivery in Nigeria, Africa's largest economy. The methodology is based on an appraisal of efficiency indicator models (EIMs) which seeks to understand the current challenge of efficiency in power supply in Nigeria between 1999 to 2017. The model builds on the data envelopment analysis and qualitative data retrieved from national energy agencies by the International Energy Agency (IEA). The study examined three key indicators namely accountability, corruption and equitability in power distribution. Each indicator was specifically disaggregated to provide robust evidence. A direct field survey from a five-point Likert scale was also conducted. Findings suggest evidence of inefficiency in the power sector. In the alternative, the paper argues that reframing dominant practices on power delivery service is critical and made some recommendations.

Keywords; Public Service Delivery, Efficiency, Accountability, Power Sector,

Introduction

At the turn of the century, the question of improving public service delivery becomes a growing concern in public administration (Denhardt, 1999; Lorde, Waithe, Francis 2010). This centres largely on efficiency in public service delivery particularly in most developing societies (Lee, 2008; Grandy, 2009; Bulecaa & Murab, 2014). Public service delivery in the power sector is important in Nigeria as Nigeria's Power Baseline Report (2015) reveals, Nigeria is the biggest economy in Africa, with a GDP of USD569 billion (2014). However, its power sector performs poorly. More than half of the population (55%) has no access to grid-connected electricity those connected to the grid experience extensive power outages (PBR, 2015). The sector accounts for over 78% of total economic activities in the country (NBS, 2017).

Electric power emerged as a public service sector in Nigeria in 1898 under the colonial administration which set up the foremost generating plant with the Public Works Department (PWD) (Okoro & Chikuni, 2007; Awosope, 2014). In 1950 a colonial ordinance established the Electricity Corporation of Nigeria (ECN) responsible for generating, distributing and transmission of electricity. At independence in 1960 much emphasis was laid on improving the Dams in Nigeria for enhanced power provision. This resulted in the setting up of Niger Dam Authority through an act of parliament in 1962. The Act provided for the construction and maintenance of dams and the generation of electricity through water power.

In 1972 following a military decree, Electricity Corporation of Nigeria and Niger Dam Authority were merged and they became known as National Electric Power Authority (NEPA) for efficiency in power service production and delivery (Ekwue,1989; Ayo,2002, Babatunde & Shaibu, 2008). In 1973, NEPA became operational and was responsible for generating, transmitting and distributing electricity in Nigeria. In 1999 the federal government embarked on power sector reform following the Electric Power Sector Reform (EPSR) Act 2005. The reform aims to actualize the deregulation of the Electricity Supply Industry (ESI). Its key focus among others includes making electricity generation and supply available to consumers, making the power sector investor-driven and deconstructing the monopoly of NEPA (Ayo, 2002; Inugonum, 2005).

Equally, the Act provides for the setting up of the Nigeria Electricity Regulatory Commission (NERC) which was established in November 2005 and charged with the regulation of power including tariffs and quality of service (Inugonum, 2005). The reform had other provisions which included the setting up of Rural Electrification Agency (REA), the National Electric Liability Management Company (NELMCO) and a Power Consumer Assistance Fund (POLAF) to meet the demands of low-income consumers (Awosope, 2014).

Despite these efforts, the problem of the power sector persists. This points to the urgency of efficiency in power service delivery. The value for Electric power consumption (kWh per capita) in Nigeria was 144.48 as of 2014 (OECD/IEA, 2014).'Over the past 43 years, this indicator reached a maximum value of 156.73 in 2012 and a minimum value of 28.57 in 1971'(OECD/IEA,2014). Against the backdrop of inefficiency in the power service delivery system, this study offers the capacity to provide alternative approaches which would enhance efficiency in public service delivery in Nigeria. It will follow transparency for the development administration thesis and tool of analysis of the systems theory to justify Nigeria to evolve a public service system that could meet the core existential needs of the people. The study argues that the efficient power sector underscores self-sufficiency and the use of a minimal amount of resources to provide an adequate power supply. An efficient power sector can mitigate complex pressures of service provisioning and materials or resources used in the process of providing the services while maintaining or enhancing effective or quality service delivery systems.

While studies linking efficiency in public service delivery to theory and practice are scant, there is consensus among scholars on the need for efficiency in public service delivery. Azhar Manzoor (2014) argued that a key imperative of public administration is the achievement of efficiency at all levels. The contention as Manzoor (2014) observed is that there is a need to provide necessary and affordable public goods and services to the citizens without discrimination. Performance should not only be cost-effective but value driven. The general aims of this paper are met by investigating the following research objectives:

i. to evaluate the problem of accountability in power service delivery in Nigeria;

ii. identify the incidence of corruption in power service delivery in Nigeria in the period under review (1999 to 2017); and

iii. examine whether effective power distribution can provide a policy tool capable of improving the power sector.

To provide a wide-ranging answer to these objectives, this study adopts the systems theory, extensive qualitative review of seminal data and field data to deepen knowledge on the subject of efficiency in public service delivery and importantly identify salient scholarly gaps.

Theoretical Framework

The theoretical model for this study is built on the systems theory popularized by David Easton. The systems theory is the most commonly used framework for systems analysis. Easton (1965) argued that a political system is a complex set of certain processes or interactions which transforms particular inputs into outputs of authoritative policies, decisions, and implementation. The theoretical model underlies the definition of the outcome variable of the study namely inefficiency in public service delivery. In this theoretical analysis, the power sector is a sub-system within the wide Nigeria social system. Inefficiency in the power sector of the economy affects the entire system because society functions as a system with interrelated component units. Inefficiency arising from accountability or corruption in the power sector could result in poor power supply which might undermine the function of the health or educational sectors. In particular, systems analysis relies on the interaction of the component units with each other and the wider social system and how such interactions affect the system as a whole. In our particular case, the systems theory explains how poor power service delivery affects the other sectors that make up the system including households, firms and other public sector organizations.

Adopting the systems approach, several methods could be used to understand the systemic effects of inefficiency in the power sector. Data Envelopment Analysis (DEA), a model, formally developed by Charnes, Cooper & Rhodes (1978) is one such model. Within the DEA model, efficiency is defined as a ratio of the weighted sum of outputs to a weighted sum of inputs, where the weights structure is calculated through mathematical programming and constant returns to scale (CRS) are assumed. In 1984, Banker, Charnes and Cooper developed a model with variable returns to scale (VRS). This study specifically accesses the level of inefficiency in the power sector with the incidence of accountability, corruption and inequitable distribution of power.

The issue is how to determine whether the level of power production (output) by the power sector meets the demands of the end users. There is the basic assumption of the input/output relationship by David Easton (1965) which suggests that there is a need to evaluate salient indicators and interacting variables between input and output and the necessary supports. The essence is that all systems involve various kinds and levels of interaction. The power sector as a system has a hierarchy and command structure within which some level of interactions exist such interactions could be internal and /or external, however, whether internal or external it takes place within a specific environment and experiences some level of social interactions.

Although the systems theory of social interaction is the most commonly used method for corporate systems analysis, it has limitations in the context of quantifying efficiency. Another limitation is the flawed notion of interrelatedness in a system where some parts (in a formal) sector might subtly or deliberately delink from the entire system, resulting in systemic dysfunction. However, the interrelated assumptions and interactions in a system
makes for inclusive growth, adaptability and reciprocity, which informs the basis for the efficiency question.

Literature Review

Recent research interest in exploring efficiency in public service delivery is informed by several factors which include the need for insights into new public administration (NPA), adoption of a
cost-effective modality in power delivery etc. The term efficiency in public administration looks at how specific functions of the public sector are performed (Lee, 2008). There are several works on efficiency in public administration. Traditional debates and scholarship such as Taylor (1836) stressed the need for efficient officials to conduct the work of government and also provided a framework for organizing government offices with such officials. Gulick (1937) provides important tenets of efficiency in administration as he posits that efficiency is the first principle. Gulick (1937) points out that there may be conflicts between other values and efficiency, stressing

that efficiency has primary importance for administration. Hebert Simon (1976) contends that being efficient underscores "taking the shortest path, the cheapest means, toward the attainment of the desired goals. Simon (1976) asserts that efficiency is a "basic criterion," for organizational management particularly where it is deployed for maximization of production.

Frederickson (2010) points out that "equitable, efficient, and economical" constitute "three pillars" of public administration. Schachter (2007) identifies the implicit notion of efficiency in public administration which has been contentious among scholars of public administration. This includes the Weberian model of 'ideal type' bureaucracy. This school sees public administration as structured largely along bureaucratic lines (Wilson, 1989; Stivers, 2000). The bureaucratic thesis has been largely criticized. J. S. Mill (1859) cautioned against an efficient bureaucracy as a danger to the democratic values of the government because it gave uncontrollable power to it.

The non -bureaucratic or multiple goals thesis argues that public administration entails the pursuit of several goals in a public setting including public accountability, planning etc. (Chasukwa, & Chinsinga, 2013). Thus, the literature on efficiency in public administration transcends the use of resources to the question regarding accountability and transparency in public service delivery. Critical thesis on efficiency seeks to find answers to the question regarding "efficiency" for what? (Waldo,1984). The argument is that there must be justification for the pursuit of efficiency.

Related stimulating interests include works suggesting the quantification of the efficiency of public administration. Specifically, Jan Buleca and Ladislav Murab (2014) justified the basis for data envelopment analysis in exploring efficiency in public administration. This has increasingly reinforced the need for a scholarly evaluation of public service delivery.

Some studies have discussed various aspects of public service delivery (Neil, Day, & Klein, 1994; Boston & Pallot, 1997; World Bank, 2005). Carvalho, Brito & Cabral (2010) examined the conceptual model for assessing the quality of public service. However, there are scant studies discussing efficiency in power service delivery, particularly in developing societies. With growing concern to meet the basic public needs, and satisfy the people and firms, it has become expedient to explore public service delivery to understand the services and the need to improve the quality (Roy & Seguin, 2000).

In Nigeria, a major objective of the public sector is to make public services affordable to the citizenry. Such basic needs cannot be met without efficiency in public service delivery.

Among several existing published works in Nigeria, Adenikinju (2008) points out that the objective of power sector efficiency is a reduction of waste in energy consumption for the maintenance of consumer satisfaction. Some of the major power plants in Nigeria are Gereku, Omotosho, Olorunsogo and Alaoji. A common indicator of power efficiency is the index of power intensity which measures the quantity of power required to generate one-dollar unit of aggregate output. The lower the value of power intensity, the more efficient an economy is (IEA, 2017).

Table 1: Possibilities of Efficiency Quantification

Type of method	Name of method	Utilization
Input-output methods	CMA (cost minimization analysis) CBA (cost-benefit analysis) CEA (cost -effectiveness analysis) CUA cost-utility analysis)	- single criterion decision making, e.g. removal and disposal of municipal waste
Methods of financial analysis	NPV (net present value) PB (pay back method) IRR (internal rate of return)	- investment project decision making, outputs can be expressed in financial units, e.g. waste dump construction
Decision making supporting methods	methods of managerial science: - calculation of critical path method - linear programming - dynamic programming - numerical simulation, etc.	support analysis of final decision making, time dynamics and expected consequences (simulation) etc.
Methods of evaluation and comparison of performance and quality / services	benchmarking (comparison studies) BSC (balanced scorecard) ISO etc.	evaluation of performance and quality of provided services, reorganization and performance evaluation of organizational units of the municipality

Sources: Buleca & Mura (2014); Ochrana (2004)

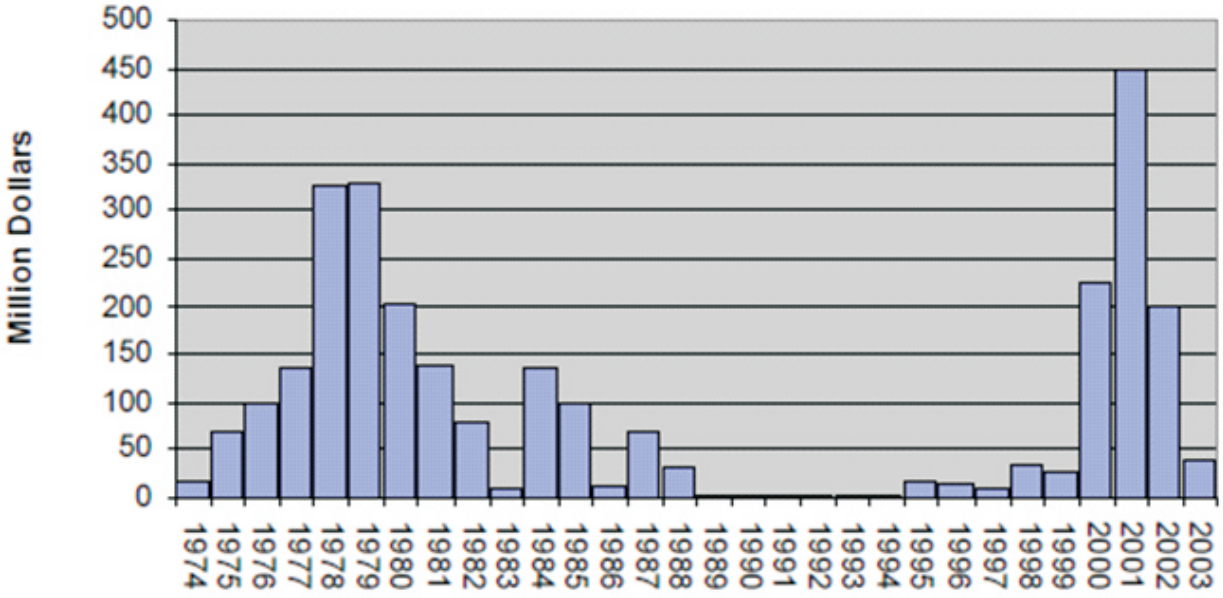
In Nigeria among the studies that we reviewed on efficiency in public service delivery, Belonwu, Ojara & Ojoko (2013) found that 27% of the power supply in Nigeria were epileptic based on inadequate access to a stable power supply. A particular study on 435 households in three geographical zones in Nigeria based on the regularity of power supply found that persistent disparity existed in the level and volume of power supply (Adenikinju,2008; Awosope, 2003).

The literature reviewed largely associated poor power supply with corruption in Nigeria (Amadi & Alapiki, 2012; Okoloba & Ismail, 2013). Others identified poor structural planning of both the urban and rural power supply systems in Nigeria and poor maintenance culture (Bamgboye, 2006; Onohaebi & Lawal, 2010). A high level of inequality between high and low-income earners also results in unequal power supply and distribution (Uwaifo, 1994; Eberhard, Foster, Briceno-Garmendi, et al. 2008). Several resultant economic indices were linked to a poor power supply such as poverty, reduction in economic activities and disempowerment (Sada, 2007). This resulted in the debate on designating a regional grid system (Yusuf, Boyi & Muazu, 2007).

Reported inefficiency was higher in rural areas than in urban areas (Nigeria Power Baseline Report, 2015). Also, very large households are often confronted with distributional challenges as there are incidences of uneven power distribution (Idemudia & Nordstrom, 2016), and those living in slum settlements are often denied legal power supply. 'Furthermore, unreliable power supply forces both households and industry to rely on privately owned generators such as hospitals, universities, Banks etc. These generators are more than twice as expensive (NGN 62 - 94/kWh) than grid-based power (end user tariff of NGN 26 - 38/kWh) (NPBR,2015:7). There is hardly any organization or public institution in Nigeria to date that relies on the national power supply. Both small, medium and large-scale businesses thrive with alternative power supplies. Industries and multinationals in the areas like the Niger Delta and commercialized cities like Lagos and Port Harcourt rely on alternative power sources.

Despite the large population of Nigeria, another factor as the literature suggests is infrastructure funding including transparency in the reading of meters (Eke, 2014; Etukudor, Abdulkareem, & Ayo, 2015) and neglect of the power sector as Fig.1 shows.

Fig. 1: The Low Growth Rate in the 80s and 90s was Due to Poor Funding & Neglect of the Nigerian Power Sector



Sources: Makoju (2007); Adegbulugbe & Adenikinju (2008); Adenikinju,(2008)

In Nigeria, there is a scant study on the accuracy and systemic reading of power supply. The pre-paid meters are increasingly replacing conventional meters, however, it is yet to be commonplace in the country. There are problems with metered and unmetered billing systems leading to estimated bills to consumers who were not legally issued electric meters (Ofonyelu & Eguabor, 2014). Electricity bills do not often reflect the exact consumer rates (Darma & Ali, 2014). Studies on alternative power supply suggest that the use of inverters or solar systems could provide more clean, efficient and sustainable alternatives however the cost is higher (NPBR, 2015).

The question regarding government ineptitude has been among the main reasons for the absence of an efficient power sector delivery system in Nigeria. There are challenges of leadership failure and lack of political sensitivity on the part of Nigerian leadership leading to the issue of 'politicization' of the power sector. While inadequate power management is another problem, the

limited available power as recent studies and reports indicate suggests that power service delivery has been largely epileptic (Nwankwo & Njogo, 2013).

The contradictions of poor power supply and high bills have repeatedly resulted in agitations against power distribution companies in Nigeria (Etukudor, Abdulkareem, & Ayo, 2015). A more recent study on the privatization of the power sector in Nigeria showed that over 70% of the privatized agencies including the power sector are inefficient as a result of a lack of transparency in the process (Odiaka, 2006). Beyond this, studies on Nigeria's power supply index(PSI) indicated low levels of power voltage among the Nigerian population.

The foregoing review reinforces high rates of poor power supply in Nigeria which calls for further investigations and efficiency in power supply research among Nigerians both at the household level, firms and similar end users. In particular, the studies reviewed showed that different power consumption levels have different socio-economic implications, both at the household levels and among firms and industries. This may yield different economic results among the various end users, this points out the need for more efficient approaches in the power sector in Nigeria.

Research Methodology

The work is based on the appraisal of efficiency indicator models (EIMs) which seeks to understand the efficiency variables in the power sub-sector in Nigeria between 1999 to 2017. The model builds on the data envelopment analysis (Buleca & Mura, 2014). Data Envelopment Analysis (DEA) is a very powerful service management and benchmarking technique originally developed by Chames, Cooper & Rhodes (1978) to evaluate non-profit and public sector organizations. It is used to measure the productive efficiency of decision-making units (DMUs). DEA has since been proven to locate ways to improve service not visible with other techniques. Data on electric power production and consumption were largely qualitative and retrieved from national energy agencies by the International Energy Agency (IEA) and adjusted by the researcher to meet international definitions. Data are reported as net consumption as opposed to gross consumption. Net consumption excludes the energy consumed by the generating units. The total electric power consumption is equal to total net electricity generation plus electricity imports minus electricity exports minus electricity distribution losses. Data for the efficiency indicator models (EIMs) were collected through an annual power sector survey which contains more than thirty indicators.

According to the International Energy Agency (IEA), energy supply includes access to power, and availability of power (IEA,2017). Due to limitations of the dataset utilized, access to power in this study was calculated based on the households' access to grid supply. Moreover, according to the IEA definition, regular and uninterrupted power supply includes the consistent provision of power for both domestic and industrial uses (IEA,2017).

The IEA makes these estimates in consultation with national statistical offices, oil companies, electric utilities, and national energy experts. The IEA also developed a manual on energy efficiency data and indicators, *Energy Efficiency Indicators: Fundamentals on Statistics*; and another manual on how to use indicators to inform policies, *Energy Efficiency Indicators: Essentials for Policy Making* (IEA,2017). In particular, Peter Smith (1990) provided some justifications for the use of performance indicators in the public sector.

Charnes, Cooper & Rhodes (1978) and Banker, Charnes & Cooper (1984) developed a model with variable returns to scale (VRS). They assume that we have the following data: Unit 1 produces 100 items per day, and the inputs per item are 10 dollars for materials and 2 labour-hours
Unit 2 produces 80 items per day, and the inputs are 8 dollars for materials and 4 labour-hours
Unit 3 produces 120 items per day, and the inputs are 12 dollars for materials and 1.5 labour-hours

To calculate the efficiency of unit 1, we define the objective function as maximize efficiency = ($u1 \cdot 100$) / ($v1 \cdot 10 + v2 \cdot 2$) which is subject to all efficiency of other units (efficiency cannot be larger than 1):
subject to the efficiency of unit 1: $(u1 \cdot 100) / (v1 \cdot 10 + v2 \cdot 2) \leq 1$
subject to the efficiency of unit 2: $(u1 \cdot 80) / (v1 \cdot 8 + v2 \cdot 4) \leq 1$
subject to the efficiency of unit 3: $(u1 \cdot 120) / (v1 \cdot 12 + v2 \cdot 1.5) \leq 1$
and non-negativity:
all u and $v \geq 0$.

But since linear programming cannot handle fractions, we need to transform the formulation, such that we limit the denominator of the objective function and only allow the linear programming to maximize the numerator (See. Charnes, Cooper & Rhodes,1978; Banker, Charnes & Cooper 1984; Cooper, Seiford & Tone,2007).

So the new formulation would be:
maximize efficiency = $u1 \cdot 100$
subject to the efficiency of unit 1: $(u1 \cdot 100) - (v1 \cdot 10 + v2 \cdot 2) \leq 0$
subject to the efficiency of unit 2: $(u1 \cdot 80) - (v1 \cdot 8 + v2 \cdot 4) \leq 0$
subject to the efficiency of unit 3: $(u1 \cdot 120) - (v1 \cdot 12 + v2 \cdot 1.5) \leq 0$
subject to $v1 \cdot 10 + v2 \cdot 2 = 1$
all u and $v \geq 0$. (Cooper, Seiford & Tone, 2007).

The indicators for this study include accountability, corruption, and effective distribution of power. Each model was specifically disaggregated and tested with qualitative data to provide substantive evidence. Primary data were also collected through a questionnaire built on a five-point Likert scale of Very High (HV), High (H) Medium (M), Low (L)and Very Low (VL) of inefficiency in the power sector among 160 respondents. The household was our primary unit of analysis. Responses from the survey provided sufficient information to determine whether the power sector has provided efficient services required by legislation or not.

Table 2: Dimensions of Indicators and Efficiency thresholds in power Delivery (Households)

Dimensions	Indicator	Evident Efficiency Threshold
Accountability	This indicator refers to mandatory reporting and disclosures by public sector agencies and statutory authorities	Minimum evidence of accountability on the magnitude of power service delivery either daily or monthly
Corruption	This indicator refers to the diversion of public res ource for private gains.	Evidence of minimum level of diversion of public power resource for other uses other than that which it is meant to be used by legislation
Documentation	This indicator refers to periodic inventory, filling, receipts and book keeping	Minimum evidence of lack of inventory, documentation, reporting or proper receipts for service delivery

Transparency	This indicator refers to openness, disclosures and integrity in power service delivery	Minimum threshold of dishonesty either in terms of hidden charges, exorbitant meter system or over rater or under rated cost of power service delivery
Power Distribution	This indicator refers to involvement of all relevant stakeholders in power service distribution	Alienation of a section or all the community from power service provision.
Consistent power supply	This indicator refers to the understanding of the extent power is supplied in given period of time.	Minimum incidence of irregular or poor power service delivery within a specific period of time either a week, month or a year.

Source: Field Data,2017

Variables

Efficiency in public service is the outcome variable of the study, and, as discussed, it is defined by the systems theory. Besides evaluating efficiency in public service delivery based on the theory, the study explores the impact of inefficiency based on accountability, corruption or bureaucratic corruption, and effective distribution of power. In this context, the outcome variable, inefficiency in public service delivery remains persistent and progressional, and its impact in the power sub-sector as an independent variable remains definitive. Specifically, the indicators of the variables and their impact on firms, households and industries, as independent variables, are categorical. The level of efficiency in power service delivery would be examined with an analysis of our three key research objectives in line with these core elements in the context of linkages between theory and practice. This is aimed at finding answers to the overall objective of the study which seeks to determine the level of efficiency in the power sector in terms of accountability, corruption, and effective distribution of power across various levels of end users.

Objective 1: To evaluate the problem of accountability in power service delivery in Nigeria. The denominator of the objective function in Nigeria's power sector in our analysis includes variables such as reporting, auditing, recording, bookkeeping, filling etc. These variables aid in answering the question regarding accountability in the power sector. According to Hebron (2014), documentation in Nigeria's power sector has been a major challenge. A study on Nigeria's power system reported that 50% of the power supply is either unaccounted for or in short supply (Ofonyelu & Eguabor, 2014). Related qualitative data suggest that accountability has been a persistent problem as 30-40 per cent of the power supply in Nigeria is never billed (Tallapragada & Adebusuyi, 2008). Electricity tariffs are below the cost of service and there is a poor revenue collection system (Adenikinju, 2008). Ofonyelu, & Eguabor (2014) identified challenges of accountability linked to poor meter systems including metered and unmetered billing and how it results in accountability and unequal billing challenges.

Objective 2: To identify corruption in power service delivery in Nigeria
in the period under review (1999 to 2017).

Corruption in the power sector in Nigeria has taken several dimensions. In line with this objective, the study seeks to substantiate evidence or prevalence of corruption in the power sector within the period under review. After providing some qualitative data salient case scenarios will be explored. A particular study found that the power sector incurs a cash loss of around US$ 2 billion per month. Over US$400 million annually is spent by the Federal Government of Nigeria as an annual subsidy to cover losses and investment, an amount that is higher than the Federal budget for health (Tallapragada & Adebusuyi, 2008; Adenikinju,2008).In their study on the power sector in Nigeria, Okobolo & Ismail, (2013) found that like many other public-owned institutions, corruption, inefficiency and managerial incompetence prevailed and the electricity industry showed inconsistent policy direction and lack of strategic framework for its sustainable development, policy decisions by past government in the ESI were based on political or administrative interest instead of efficient resource allocation and cost recovery necessary for economic development and the strategic energy policy for the country was never implemented.

The number of unplanned outages in Nigeria was also 30 times more than what was obtained in other low and middle-income countries (Eberhard, Foster, Briceno-Garmendi, et al. 2008; Adenikinju,2008). In Nigeria, the self-generation of power from costly generators was double that of grid-supplied electricity. The history of Nigeria's power sector was one of inefficient monopolies, missteps, and corruption (Werker, Ezekwueche, Igun & Wei, 2012).

Objective 3: To examine whether effective distribution of power could provide a policy tool capable of improving the power sector.

The Nigerian power sector has four key segments of the value chain namely, generation, primary energy, transmission and distribution. This section examines distribution. The question of distribution in power service delivery is another key indicator of inefficiency in power sector delivery in Nigeria. To test this variable in objective three of our study, both qualitative and primary data were generated. There are 11 electricity distribution companies (Discos) in Nigeria. Following the return to civil rule in 1999, there was the adoption of the Electric Power Sector Reform (EPSR) Act 2005. The reform was largely aimed at effective deregulation of the Electricity Supply Industry (ESI). It was markedly informed by distributional trajectories as its key objective to make the power sector pro-investor and inclusive. In 2009, the electricity generating station installed capacity in Nigeria was 5000Mw, but only 2900Mw was generated as of November 2009 (Babalola, 2009). The scenario has not changed to date. Similarly, Uwaifo (1994) identified a vortex of challenges associated with electric power distribution and planning in Nigeria.

According to the Nigeria Power Baseline Report (2015:3) 'Nigeria's distribution companies suffer significant losses, with ~46% of energy lost due through technical, commercial and collection issues'. In most locations in Nigeria, the distribution network is poor, the voltage profile is poor and the billing is inaccurate. As the department that interfaces with the public, the need to ensure adequate network coverage and provision of quality power supply. Nigeria Power Baseline Report (2015:5) revealed that '95 million Nigerians (55% of the population) have no access to electricity and those who are connected to the grid face extensive power interruptions'.

At 45%, Nigeria's electrification rate is low – much lower than that of Ghana (72%) and South Africa (85%) (NPBR,2015:5). 'There are three stages in the delivery of power to customers: generation at the power plant (requiring a source of primary energy, i.e., water or gas), transmission to the distribution companies and distribution to the end user. Only ~25% of Nigeria's 12,522MW of installed capacity reaches the end user' (Nigeria Power Baseline Report (2015:5). 'Widespread inefficiency means that only 3,879MW of this capacity is operational (average January to 15 August 2015), with ~3,600MW transmitted and ~3,100MW distributed'(NPBR,2015:5).

Table 3: Percentage Load Allocation 11Discos

S/N	DISCO	PERCENTAGE LOAD ALLOCATION
1.	Abuja Distribution Company	11.5%
2	Benin Distribution Company	9%
3	Eko distribution company	11%
4	Enugu Distribution Company	9%
5	Ibadan Distribution Company	13%
6	Ikeja Distribution Company	15%
7	Jos Distribution Company	5.5%
8	Kaduna Distribution Company	8%
9	Kano Distribution company	8%
10	Port Harcourt Distribution Company	11.5%

Bells (2008) reports that only about 40 per cent of Nigerians have access to electricity. This is consistent with our five-point Likert scale on inequitable distribution in the power sector. Darma & Ali (2014) argue that the distribution/delivery of public services in Nigeria just like many other developing economies is often fraught with discrimination, low quality and access, and lack of fairness and equity between urban and rural. This discrimination in the provision of public services is responsible for the gap in development between urban and rural areas in Nigeria presently

Table 4: Status of Government Owned Power Plants and Availability

Station	Initial Capacity (MW)	Capacity Available (MW)	Capacity operational (MW)	Comments
1. Gereku	414	414	140	Insufficient gas supply. Additional 434MW planned
2. Omotosho	335	300	75	Insufficient gas supply. Additional 700MW planned
3. Olorunsogo formerly Papanlato	335	300	75	Insufficient gas supply. Additional 700MW planned
4. Alaoji	515	0	0	Under construction Additional 1000MW planned
Total	1599	1014	290	

Sources: Oke (2008), Adenikinju (2009)

Results and Discussion

Nigeria's power service delivery was examined based on the Data Envelopment Analysis (DEA), qualitative and field data to evaluate efficiency in the power sector. Nigeria's power sector efficiency was based on some key indicator models. The efficiency model for our study measures accountability in power service delivery in Nigeria, corruption based on the diversion of public resources for private gains (World Bank, 2005; Amadi & Alapiki, 2012) and effective power

distribution. However, due to the limitations of the dataset in this study, corruption was calculated based on the distortions in the minimum level of power supplied monthly per household and firm. Underutilization of power and diversion of power service delivery were proxy indicators for power sector corruption.

The minimum required level of power supply was determined based on the Energy efficiency indicators of the IEA which examines residential and industry energy indicators. For the present study, these estimated minimum required power supply were adjusted with the level of national grid services of Nigeria and the recent report of the Federal Ministry of Power, providing the understanding of the required minimum level of power supply per household and firm in both urban and rural areas.

At the household level, there is a disparity in power supply. A surveyed household report from low, middle and high-income households found that disparity in power supply makes the need for a more harmonized power system inevitable (PSBR,2015).

The analysis of our three objectives to: evaluate the problem of accountability in power service delivery in Nigeria, identify the incidence of corruption in power service delivery in Nigeria in the period under review (1999 to 2018) and examine whether effective power distribution can provide a policy tool capable of improving the power sector, several pieces of evidence suggest inefficiency in the power sector in Nigeria.

The indicators of the surveyed efficiency models showed in-efficiency, meaning that the requisite demands of the indicators have not been met in power service delivery in Nigeria. Again our qualitative data provided robust evidence of corruption, poor accountability and inequitable power distribution. This is consistent with related comparative data provided by Maigida (2008) who observed that between 1985 and 2000, electricity generation capacity grew by a mere 10 per cent in Nigeria compared to 332 per cent in Vietnam, 142 per cent in Iran, 237 per cent in Indonesia, 243 per cent in Malaysia and 205 per cent in South Korea.

Similarly, our finding is corroborated by the Nigeria Power Baseline Report (2015:5) which found that 'at 126kWh per capita, Nigeria lags far behind other developing nations in terms of grid-based electricity consumption. Based on the country's GDP and global trends, electricity consumption should be four to five times higher than it is today. Nigeria Power Baseline Report (2015:5shows that 'Ghana's per capita consumption (361kWh) is 2.9 times higher than that of Nigeria, and South Africa's (3,926kWh) is 31 times higher'.

Despite the reform, efficiency in power distribution remains a challenge. Of the 79 generation units in the country, only 19 units were operational. The average daily generation was 1,750 MW. No new electric power infrastructure was built between 1989-1999. The newest plant was completed in 1990 and the last transmission line was built in 1987 (Power Baseline Report, 2015). An estimated 90 million people were without access to grid electricity. Accurate and reliable estimates of industry losses were unavailable but were believed to be more than 50% (Adenikinju, 2008). There is evidence of power theft which increasingly undermines efficiency and equitability in the power supply.

Table 5: Selected Power Sector Indicators of Performance for Nigeria and Africa, (2004-05)

Indicators	**Nigeria**	**Average Africa**	
		Low Income Countries	**Middle Income Countries**
1.Technical efficiency:			
(i) In generation capacity (MW)	598	918	13651
(ii) MW per million pop.	42	32	404
(iii) MW in operation condition as % of installed capacity	61	84	97
(iv) Per capita (kWh/cap)	173	141	1912
(v) Self-generated as % of electricity generated	42	10	0.7
2. Effective residential tariff (cents/kWh)	4.1	12	32
3.Quality Number of unplanned outages per year	1059	3082	39
4.Efficiency			
(i) Labour efficiency (ann. labour costs as % of operational expenses)	48	29	11
(ii) Average revenue (cents/kWh)			
5. Efficiency ratios (%)			
(i) T & D losses)	30	25	13
(ii) Cost recovery (based on effective tariff)	36	64	56
(iii) Implicit collection (based on effective tariff)	52	83	95
6. Tot al hidden costs of inefficiencies			
(i) as % of GDP	1.4	2.0	0.6
(ii) as % of utility revenue	229	125	13

Source: Derived from Eberhard, A., V. Foster, C. Briceno -Garmendia, F. Ouedrao go, D. Camos & Scharatan, M. (2008),

Table 6: **Percentage Scale of Ranking of Inefficiency in the Power Sector in Nigeria**

Scales	Very High (VH),	High (H),	Medium (M),	Low (L) ,	Very Low (VL).	Total
Reporting	56 35%	56 35%	20 12.5%	20 12.5%	8 5%	160 100%
Lack of adequate accounting system	58 36.25%	57 35.63%	26 16.15%	10 6.25	9 5.63%	160 100%
Inequitable distribution of power	59 36.88%	58 36.25%	19 11.88%	15 9.38%	9 5.63%	160 100%
Issues of transparency	57 35.63%	56 35.00%	19 11.88%	8 5.00%	20 12.5%	160 100%
Corruption	60 37.5%	59 36.88%	20 12.5%	9 5.63%	12 7.5%	160 100%

Source: Field Analysis (2017)

From the five-point Likert scale of Very High (HV), High (H), Medium (M), Low (L) and Very Low (VL) inefficiency in the power sector among 160 respondents, represented in Table 6, corruption ranked the highest (37.5%), followed by inequitable power distribution (36.88%), while accounting was (36.25%).

Conclusion

This attempted to create new insights into power service delivery in Nigeria and approaches towards addressing the persistent problems of inefficiency in power supply. The key lesson in the particular case of Nigeria is that the power sector reform of the 2000s has not delivered much-expected efficiency in the power sector. The model adopted in this study provided much useful insight. It was on the premise that accountability, corruption, or documentation and unequal electricity distribution are key indicators suitable to understand inefficiency in power service delivery in Nigeria against the operational parameters for the power delivery system, that this study derived such a conclusion. Thus, these indicators are administrative components which justify the basis of public service delivery and in particular consistent with the tenets of public administration as meticulous implementation or application of public law or policies. Utilization of the indicators in line with the systems model and data enveloping examine the variation index of power service delivery. The household was the unit analysis which provided on-the-ground evidence of challenges of efficiency in power service delivery.

The analysis provided a clearer understanding of the problems of accountability, corruption and inequitable power service delivery system in Nigeria. In particular, the study suggests that despite the power sector reforms of the 2000s, there is evidence of inefficiency in the power delivery system. Alternative approaches which could enhance the policy thrust of efficiency in public service delivery were recommended.

Recommendations

Efficiency in the power sector has had a strategic importance for the overall economic and social stability of Nigeria. Thus, Nigeria's overall economic development relies largely on efficiency in the production and consumption of electricity.

Despite some institutional reforms and structures put in place by the government since 1999 to ensure competitiveness in the power sector such as the Nigerian Electricity Regulatory Commission (NERC), the privatization policy, the National Electricity Master Plan, and the Electricity Reform Act, our findings point out the need for urgent policy response and overhaul of Nigeria's power sector as efficiency has been elusive.

Efficiency in Nigeria's power sector can contribute to the advancement of knowledge in resourceful and equitable power consumption. It can equally stimulate knowledge of policy gaps which can promote new statutory responses for more eco–efficient power distribution.

The industry requires a combination of different sources of power to grow. It is not enough to rely solely on the traditional methods of generating power such as gas and hydro. There is a need to diversify and invest in renewable energy, gas pipelines, power plants and transmission network.

Findings from this study highlight poor and inequitable power distribution despite the privatization of the sector since the 2000s. Efficiency in public service delivery could be fostered through a bottom-top approach and a more inclusive and responsive model. Despite the reform of the power sector, the use of obsolete equipment such as transformers, feeders, sub-stations and others, undermines the effective and equitable distribution of power. They should be replaced with new ones by power distribution companies (DisCos) to enhance the supply of power to end users. This will engender professionalism, empower public servants, and consumers and enhance the overall economic development of Nigeria.

An efficient power supply will be cost-effective, sustainable and less carbon-intensive. Maintaining energy efficient system will increasingly decarbonize Nigeria's power sector which has been a key challenge for developing societies all over the world. In Nigeria, accountability and transparency have undermined public service delivery as our findings suggest. This has particularly undermined the growth of the power subsector. Thus, to mitigate the challenge of accountability, we recommend a smart meter system as used in most developing societies where power supply and consumption rates are adequately and transparently measured with pay- as you go meters.

To strengthen economic growth through energy use, there is a need for equitability in power distribution to meet the various needs of the end users including the rural areas and low-income households. Energy use has been growing rapidly in low- and middle-income economies, the basis for an inclusive power service delivery system is to stimulate inclusive economic growth both at the urban and rural areas and importantly at the household level. Governments and all relevant stakeholders could put in place intervention measures for more inclusive energy consumption thereby making more efficient use of the power sector. Improved efficiency in the power sector is inevitable as most economic activities derive from the sector

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