



MITIGATING POOR ELECTRIC DISTRIBUTION NETWORK IN NIGERIA VIA GEOGRAPHICAL INFORMATION SYSTEM APPLICATION

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Abstract:

The usefulness of Geographical Information System GIS, in the electric distribution network in some countries of the world is appreciated in the literatures. This is viewed among others in the capacity of the tool to solve the spatial planning problem of electric distribution network that is seemingly intractable. Similarly, its potentialities for production of accurate updated information database about any spatial feature make this system become imperative as panacea. Absence of adequate information database had been one of the major problems hindering effective electricity service delivery before and after privatisation in Nigeria. The aim of this paper is to highlight the GIS application as a solution to the poor electricity service delivery being experienced in the country. Objectively, the paper asserts the absence of inadequate electric facilities' distribution information database and the need for a specific technique to stand in the gap from the literature. Content analysis of some authors contribution on this issue form the methodology adopted in this paper. Finally, the paper suggests the application of GIS method as a veritable tool to cure problem of spatial distribution network by mapping the consumers to corresponding electric facility network with reference to the transformer, pole, wire and cable, substation, feeder switches and auto circuit breaker. This would not only enhance availability of accurate information database but would

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guarantee proper control, easy monitoring, appropriate maintenance and eventual effective service delivery even under privatization.

Keywords: electricity-service-delivery, information-database, GIS, Nigeria

1. Introduction

The usefulness of GIS has been expressed in the literature as exceptionally valuable in the electrical facility distribution framework. The spatial arrangement issues of electrical facilities distribution system framework can be comprehended by utilizing new techniques that is capable of providing adequate and accurate information database about the pattern of electrical facilities distribution network and their functional condition. GIS helps in discovering the potentialities of any utility for possible investments and forestalling the likely challenges that may pose threat to its viable acquisition by the investor. The forgoing also become possible, because of the proven workability of GIS in the development of geo-referenced electrical facilities network and consumer relevant information database that captured facility control, billing system, energy balance and monitoring of load flow studies. Additionally is possibility of assessing costumer information, alongside with asset management and maintenance^{1,2,3}. In effect, the imperative of the utilizations of GIS is in its cutting edge possibility to facilitate adequate electric facilities spatial arrangement of the network, investigation and control within each neighbourhood. This is also in conjunction with making available all - encompassing and comprehensive spatial database information about the component of electric power sector in its entirety from the generation, transmission, and distribution/sale section.

2. Background

Light is as essential as life, just as availability of electricity in any nation is tantamount to economic development and national growth given its attendant unparalleled benefits⁴. Similarly, as one of the basic infrastructure all the sectors such as agricultural and agro-allied, commercial, industrial, transport and residential among others are developed through its uninterrupted supply. The indispensability of electricity makes it so critical to a host of essential services which if take for granted can lead to the clog in the wheel of national development in all the sectors just as is been experience in the case of Nigeria as a nation. In Nigeria, electricity sector was under the state owned enterprise. Its ineffective service delivery led to consideration of adopting privatisation

as panacea just as is being done in some other countries^{5, 6, 7, 8, 9}. However, the adoption of privatisation was ill-conceived^{10, 11} and a misplacement of priority^{12, 13} as the privatisation policy option would not immediately transformed into a better solution^{14, 15}, without consideration of the fundamental issue of electricity service delivery.

This paper stress that fundamental issues of electricity service delivery should be an in-depth consideration for electric facilities' distribution network and functional condition as essential to effective electricity service delivery ahead better performance in privatisation and hence consider the introduction of Geographical Information System (GIS) application in this respect as imperative for remedy.

3. Problem Statement

The power sector in Nigeria has long been facing serious problems mostly in the distribution/sale section right from its ownership under the government, such as; Rapid population increase has accelerated the electricity demand with the passage of each day¹⁶. Electricity supply crises are escalating every minute on daily basis and incessant load shedding is being observed not the supply of only in electricity but also in other aspect of power sector. This situation of poor electricity service delivery has led to economic decay and has reduced the recovery of taxes. The escalating rates of the energy sector is a back breaking burden which is scaring away investors, thus creating a scarcity of job opportunities, leading to deterioration in the economic as well as social sphere; as observed by,^{17, 18, 19, 20, 21},

Generally, in the developing countries, huge losses both in technical and commercial - non-technical terms are very common in the electricity service delivery system as observed by^{22, 23, and 24}. Electricity theft that results from illegal connection is very prominent among the common crimes in developing countries and even in some of the developed countries,^{25, 26, 27, 28, 29, 30}. It is observed in the case of Nigeria that the use of modern technology as a technique needed for collection and provision of database information for guaranteeing effective performance of electricity service delivery before adoption of privatisation policy. It is high time now the introduction of modern technology in all sectors of public and private service delivery, especially in the utility sector such as electricity service delivery became imperative, as supported by³¹.

Hence, this paper proposed the use of GIS for effective electricity service delivery and eventual better performance in privatisation of power sector in Nigeria. The aim of this paper is to mitigate electricity service delivery failure with the use of GIS as efficient tool for provision of information database. The objectives of this paper are firstly; to ascertain absence of adequate database information about electrical facilities

distribution network and their functional condition as the bane of effective electricity service delivery. Secondly is, to develop practicable information database framework using (GIS) spatial modeling for better electric service delivery privatization performance. Out of myriad issues and challenges of electricity service delivery in Nigeria, the thrust of the paper is on imperative of the need for adequate and accurate database information within the scope of electrical facilities' distribution network and functional condition as essential to effective electricity service delivery ahead better in performance in privatisation. The electrical facilities in consideration are; the distribution transformer, electric pole, wire and cable among other electrical facilities. The factors of consideration are the use of the modern technology-GIS tool in making available database information about the electric facilities, pattern of distribution functional efficiency for controlling, monitoring, and maintenance of to achieve effective service delivery based on population of consumers' geo-referenced data and existing electrical infrastructure facilities, in order to pave way for a spatial assessment of the quantum of electricity requirement and socio-economic development, the foregoing was the aim at solving Pakistan electricity problem by ³².

4. Methodology

A review of several literatures was carried out on the existing situation of electricity service delivery before privatisation and the experience of consumers after privatisation of the service delivery in Nigeria of this utility. The experiences of some selected countries in the world that had passed through the similar situation of their electricity service delivery being privatized were looked into to unearth the reason for failure or success of the said utility and also explain the impact of the adoption of modern technology of GIS to effective electricity service delivery. The constant content analyses of the findings from the literatures were the basis on which the conclusion of this paper and its recommendations were drawn. That is, need for database information and the usefulness of the GIS tool to for adequate and accurate collection of this database information for effective service delivery of electricity in Nigeria.

5. Literature Review

5.1 Pre-Privatisation situation of electricity service delivery in Nigeria

The existing situation of things prior to privatization dated back to post independence during the era of the oil boom in the 1970s The nation had been struggling to meet the demand of electricity supply for the people. Attributable reason for this has been the

failure to access adequate and accurate information on the existing power infrastructure facilities.

The poor functional condition of electric facilities and service delivery of electricity could be attributed to insufficient development of Infrastructure in the power sector for over a long period of years. During these periods the ageing distribution transformers, weak electrical poles, deteriorated cables and other accessories were not replaced and maintenance of the existing ones were not adequately done. This results into worsening state of electricity supply as submitted by ^{33, 34}.

Above scenario resultant effect directly led to ineffective electricity service delivery and its eventual poor performance after privatisation. The effect of inadequate service delivery of electricity in Nigeria has been viewed from various quarters in the literature³⁵, opined that, the development of a nation hinges mostly on adequate supply of electricity, as it serves as a virile source of human empowerment for self-engagement, self-reliance and self-development. Electric facilities do not reflect the colossal budgetary expenditures on this sector over a decade of years, ³⁶. As x-rayed by ³⁷, that more than half of the Nigerian populace are not only deprived of the power supply, but averred that cost incurred on fuelling generating sets is more than \$13billion annually. Itemised below in table 2 are the summary of the existing situation of electricity service delivery before privatization.

Table 1: Highlight of Existing Situation electricity service delivery

The Highlights	Sources
Government owned establishment were conduit of budget syphon.	38, 39, 40, 41, 42, 43, 44.
Increased cost, without commensurate outcome in terms of performance.	
Infectiveness owing to poor operating system void of due diligence,	
Engagement of quack, inexperience and unqualified personnel in corporation.	
Ill-conceived government policies, unfriendly investment opportunity and	
Inadequate funding of hitherto government enterprises	
Failure to comply with qualitative supply of power infrastructure.	
Insufficient development of Infrastructure for over a long period of years,	
Ageing distribution transformers, electrical poles, cables and other accessories were not replaced. Inadequate maintenance of electrical facilities	
Worsening state of electricity supply.	

5.2 Post-Privatisation situation of electricity service delivery in Nigeria

Outcome after privatisation is drawn from the experience of the consumers across the country from the pages of newspapers, the response and contributions of many authors in publications are indicative of ineffective of privatization strategy to electricity service delivery in Nigeria, ^{45, 46, 47, 48, 49}. (Oyelami, and Adewumi 2014; Olusuyi et, al 2014;

Akhalumeh and Ohiokha, 2013; Onime and Adegboyega, 2014; IseOlorunkanmi, 2014). Itemised below are the causes for poor outcomes of privatisation approach to electricity service delivery in Nigeria.

Generally, in the power sector, both in the generation, transmission and distribution section, a lot of factors had contributed to its failure under privatisation. Among the reasons for the ineffective discharge of electricity service delivery as experienced by Nigerians even after the privatisation are itemised in the Table below.

Table 2: Highlight of Current Situation

The Highpoints	Sources
Poor funding and insufficient investment in the power sector over the years.	50, 51, 52, 53, 54, 55, 56, 57, and 58.
The assets need huge investment to upgrade the assets to standard that will ensure smooth running of the equipment.	
Inadequate gas supply and infrastructure vandalism	
Upgrade the assets to standard need huge investment	
Inadequate due diligence in privatization process	
No comprehensive information detailing the assets and liabilities of the erstwhile PHCN	
Lack data base on assets/liabilities of the erstwhile PHCN	
Non proper reconciliation of assets/liabilities of PHCN and Workforce	
Consumers and Technicians' fraudulent practices,	
Socioeconomic issues such as affordability to pay for the bill by the low income earners	
Non determination of socioeconomic status of the end user tariffs,	

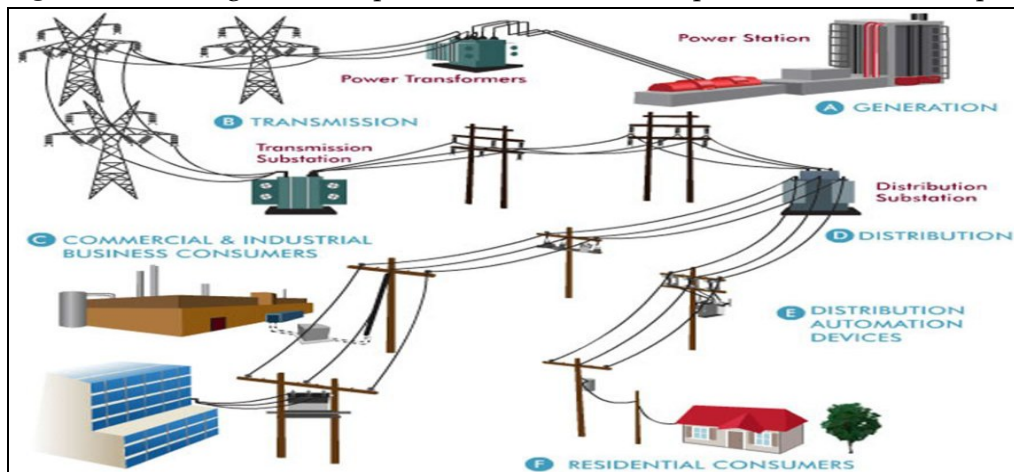
5.3 Application of GIS model tools in Electrical Facilities Distribution Networks GIS Incorporation

Giving the scope of this paper, certain aspects of the electrical facilities of the distribution system have been identified as required to be integrated into the application of the GIS for proper documentation of information database to facilitate effective electricity service delivery in Nigeria. Hence, the following aspects of the utility applications are required to be incorporated with the GIS application;

- a) Electrical service delivery facilities such as; distribution transformer, electric pole, wire and cable among other electrical facilities.
- b) Facilities Management and Maintenance System.
- c) Customer Information database quantum of consumption and population expansion statistic.
- d) Customers cum service Providers communication Management System.
- e) Control and Monitoring of electricity supply and consumption rate.

The application of GIS in this respect must display now the electric facilities distribution network element and their attributes. The Customer Information data provides information of the consumer and the network connection map leading to the service provider from which the customer is supplied electricity. This information via GIS application can be used for energy audit and energy balance, load flow, load growth studies and load management, network planning and analysis.

Figure 1: Showing electrical power network, with respect to distribution aspect



Source: Adapted from ⁵⁹

This paper posit that all the electrical facilities of the distribution networks be geo-referenced as it is obtainable in the developed nations and in some developing countries of the world. The outcomes of this introduction of GIS tools among other modern technologies were the reasons behind the record of success in electricity service delivery both before and after adoption of privatisation policy on the utility in those countries, ⁶⁰, ⁶¹, ⁶², and ⁶³.

5.4 Some Selected countries' Electric Facilities' Distribution Network and the influence of information tools for performance

In order to support the essentiality of adequate data base information of electric facilities for effective electricity service delivery, this study presents the experience of some selected countries that had privatised their electricity while looking at how availability of data base information of the electric facilities' distribution network and functional condition before and after privatisation is influential to the performance evaluation of electricity service delivery.

Table 3: Showing summary of selected countries’ Electric Facilities’ Distribution Network and the influence of information tools for performance

Condition of Electric Facilities’ Distribution Network and performance				
Country	B/privatisation	A/privatisation	Success/Failure	Any use of database information tool?
Selected North, Latin and South America				
Canada	Already Planned	Adequate	Successful	Yes
U S	Already Planned	Adequate	Successful	Yes
Mexico	Already Planned	Adequate	Successful	Yes
Chile	Unplanned yet	Adequate	Successful	Yes
Argentina	Already Planned	Adequate	Successful	Yes
Selected European Countries				
U.K	Already Planned	Adequate	Successful	Yes
France	Already Planned	Adequate	Successful	Yes
Germany	Already Planned	Adequate	Successful	Yes
Italy	Already Planned	Adequate	Successful	Yes
Selected Asian Countries				
Pakistan	Poorly Planned	Inadequate	Failure	Latter Recommended
India	Poorly Planned	Inadequate	Failure	Not Fully Introduced
China	Poorly Planned	Inadequate	Failure	Not Fully Introduced
Malaysia	Already Planned	Adequate	Successful	Yes
Selected African Countries				
Morocco	Poorly Planned	Still in Progress	Towards Success	Latter Recommended
Cameroon	Poorly Planned	Inadequate	Failure	Not Fully Introduced
S A	Already Planned	Adequate	Successful	Yes
Ethiopia	Poorly Planned	Still in Progress	Towards Success	Latter Recommended

Source: Author’s intuition (2016).

6. Summary of Findings

The finding from the literatures shows that there is no appreciable improvement on the electricity service delivery both in the pre-privatisation and in the post-privatisation. The findings from the literatures such as; ^{64, 65, 66, 67, 68, 69, 70, 71, 72, 73, and 74}, explored right from the technical aspect, economic aspect, and political view inter alia, on electricity service delivery were all reacting to ineffectiveness of electricity service delivery in Nigeria has been caused majorly by lack of information about the electricity supply in relation to the consumers.

Hence, the gap been filled by this paper is the need for adoption of GIS tool as a veritable modern technology for production of information database of the electrical facilities distribution network in connection with the electricity consumers to ensure effective electricity service delivery in Nigeria.

In the first instance, it is purposed that. *“Privatization must result in better service at lower prices as desired by consumers who, oftentimes, are not much bothered about economic*

philosophies” as averred by ⁷⁵. As such, a sensitive issue, connected to public social-welfare like this deserves both public and academic assessment as it is being embarked on by these researches works ⁷⁶. Secondly, the importance of sufficient information and adequate data base, ⁷⁷, of functional condition and distribution pattern of electric facilities for effective service delivery of electricity to the growth of physical and socio-economic development of a particular region or community cannot be over-emphasized. The consequence of proper consideration of these facilities initially would prepare the utility in a proper shape and create conducive environment for its privatization, ⁷⁸. Similarly, the outcome of the implementation of eventual privatisation, would make easy control, maintenance, and monitoring of electric facilities, for effective service delivery for better standard of living of the Community dwellers ⁷⁹, and consequently serve as the propelling force for nation’s economic growth and development, ⁸⁰.

7. Recommendation

This paper, from its findings thereby suggests that;

- There should be identified patterns of electricity facilities distribution and functional condition in respect of each neighbourhood.
- An information database comprising the power demand and quantum of consumption is needed to guarantee adequate supply of electricity. This will provide an indicator of power demand for electricity planning at district level.
- Geo-referenced data of all the electricity service delivery facilities are direly needed to checkmate the menace of illegal connections and commercial losses that are detrimental to efficient service delivery electricity.
- GIS master database would incorporate the cross-sectorial spatial view of the energy demand patterns, using electrical physical facilities data and available country statistics.
- The use of GIS model tools would make possible for assessment of the power demand scenario, identification of priority areas for investment, and the subsequent supply of electricity to the targeted areas.
- Based on geo-referenced data of population and existing infrastructure, a spatial assessment of levels of energy requirement and socio-economic development is possible.
- The adoption and the application of GIS model tools becomes imperative to be based on the spatial conditions of the local area and need assessments the

development of a profitable electricity distribution system among the different residential densities and other users would be possible.

- The implementation of the GIS adoption across the country must be through direct exercise to save a huge of money on contractual exercise of geo-referencing the electrical facilities system all-over the country.
- The human and the physical resources to carry out the geo-referencing all the electrical facilities are adequately available within the nation Nigeria and must be maximally employed to the actualization of this geo-referencing via GIS tools.
- That an amalgam of all the survey equipment and facilities in all the higher institutions, relevant state and Federal Ministries, and corporate bodies and relevant stakeholders across the country be harnessed pragmatically to the facilitation of this exercise as a strategic heuristic approach that the situation demands.
- The financial requirements could be sourced and raised through an endowment fund form the finance organisations, Banking Institutions, corporate bodies, and from individual business mogul. The money realized must be entrusted into the hands of faithful men as in ⁸¹, for it to be judiciously channeled to the actual purpose of the geo-referencing of the electrical facilities distribution networks in connections with the consumers.

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