FORUM GEOGRAFI
ISSN: 0852-0682 | E-ISSN: 2460-3945
HTTPS://JOURNALS.UMS.AC.ID/INDEX.PHP/FG/

Leveraging Geospatial Technology for Enhanced Utility Management: A Case Study in Electrical Distribution Power Systems

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Citation:
Alausa, O. A., Adaradoun, O. S., Adekunle, G. T., Priyono, K. D. (2023). Leveraging Geospatial Technology for Enhanced Utility Management: A Case Study in Electrical Distribution Power Systems. Forum Geografi. 37(2), 164-177.

Article history:
Received: 17 April 2023
Accepted: 13 October 2023
Published: 26 December 2023

Abstract
Over the years, electricity has developed into a crucial commodity for any nation. The need to evaluate the rate of electricity consumption in regard to utility management and the spatial distribution of major devices to facilitate appropriate planning within the estate is the motivation for this research. This study used geospatial technology to evaluate the electricity distribution to support planning and management in Omole Estate (Phase One) and environs within the city of Lagos, Nigeria. The focus was on determining the land use in study area, geolocations of the transformers, along with the cost of energy consumed per household. Spatial data for the research area was collected through a Hand-held GPS. A Google Earth image was downloaded to supplement the data, and a comprehensive analysis of administered and recovered questionnaires was conducted to enrich the dataset. ArcGIS 10.6.1 software was employed to create the database and depict the area, whilst modifying all of the details required within. The result confirms that 72% of the respondents use electricity for domestic use, 18% for commercial use while 10% utilise it for domestic and commercial use. A significant portion of homes (33%) still use outdated postpaid meters and 35% of respondents do not know how much power they use at home each month or the cost per unit of that electricity. Regarding the respondents, 67% have a prepaid card/electrical meter installed (per kilowatt). Concerning cost, 10% of the respondents spends between N1000-N5000 for their monthly electricity consumption, 27% of the respondents between N5,000 and N10,000, 38% between N10,000 and N17,000, 24% between N17,000 and N25,000 and 2% above N25,000 per month on electricity. These findings will assist effective power distribution within the estate and provide guidance on charge rates for commercial power users which is approximately 28% overall.

Keywords: electricity, geospatial technology, spatial data, Lagos.

1. Introduction

Electricity plays a central role in our continent nowadays, and the transfer between the source and the user provides an optimal method of use. The integration of electricity systems involves the generation of power and subsequently its transmission. Finally, the electric power is distributed to consumers (Albadi, 2017). For society to thrive and function correctly, power utilities are crucial. These utilities promote not only the economy but also people's general well-being. A nation's ability to manage its development goals and maintain its growth is exceedingly dependent on the effective operation of its electricity utilities (Mwada *et al.,* 2020). The need to build a sustainable power system delivering sufficient electricity has been one of the major goals of many African nations; currently the Nigerian government is budgeting billions of naira annually to improve and sustain electricity needs in the country. In 2022, the federal government spent N120 billion subsidising electricity consumers in selected bands and has allocated 239 billion for the power sector in 2023. This is undoubtedly required due to several sectors being negatively impacted by a lack of electricity across the country. In agriculture, most irrigation systems are powered by electricity; therefore, when electricity is unavailable, the crop yield falls. Despite the problems with electricity, manufacturers and domestic users must have access to it. More specifically, manufacturers may be required to implement more effective energy management strategies that boost productivity by means of preventive maintenance in order to balance the cost of the limited amount of electricity obtained at a higher price (Benalcazar *et al.,* 2023). Contemporary businesses are much more like to already have modern, electricity-powered manufacturing equipment (Paredes *et al.,* 2023). Furthermore, many businesses may have generated the electricity required to run their operations on-site (Amann *et al.,* 2021).

The distribution system is extremely important economically, whilst the size of the investment required makes thorough planning, design, construction and management essential to guarantee high growth rates and load densities (McGarry *et al.,* 2023). Comparing Nigeria's current distribution system to its generating or transmission systems, it is a weak link (Ashkezari *et al.,* 2018). The principal cause of the increased technical problems is the result of inadequate financial investment over the years in system improvement projects. This has generated unintended extensions of the distribution lines, the overloading of system components, such as transformers and conductors and a deficiency in reactive power support (Ezekwem *et al.,* 2023). Low metering efficiency, power theft and theft are primarily to blame for commercial losses.

Geospatial technology has been applied to address significant issues including energy dilemmas in several areas and diverse measures outside this study area (Eleiche *et al.,* 2023; White *et al.,* 2023). As the population rises, so does the need for energy, and as a result, more energy is needed to power activities (Gilmore *et al.,* 2022; Kumar *et al.,* 2023). Given that traditional energy sources cannot meet the needs of the expanding population, geospatial technology can be utilised to implement ideas for generating energy from the abundance of renewable energy that nature supplies (Farish *et al.,* 2023). The geospatial technology can be employed to accurately evaluate the rate of electricity use per household and visualise the spatial relationship between power supply devices (Hay *et al.,* 2011). Geospatial technology is a rapidly expanding field that uses geographic information to study the earth's surface using Geographic Information Systems (GIS), Remote Sensing (RS), in addition other ground information gathered from different devices and equipment such as Global positioning system (GPS) (Jumadi *et al.,* 2016; Alausa & Adaradohun, 2023). One of the geospatial technologies that is increasingly having an impact on a range of fields, including business, agriculture, science and public policy, is remote sensing (Dabas, Mondal and Thapar 2023; Wibowo *et al.,* 2023; Saputra *et al.,* 2022*;* Shirley *et al.,* 2021). With advances in sensor system technology, the field of remote sensing progressed from the interpretation of aerial images to the analysis of satellite data, and from small-area studies to worldwide assessments (Kurniawansyah *et al.,* 2023).

Several power distribution applications, including customer information systems, asset management, service call management, billing systems, energy audits and load flow studies, now require the development of geo-referenced consumer and network databases applying GIS. The management of the infrastructure development components are now run by GIS operating platforms (Miljković *et al.,* 2018). Likewise, regular updates to consumer data and relevant electrical network parameters are required from power distribution companies.

The most important part of the electricity supply chain is distribution, and managing the distribution sector effectively is where developments in the power industry would face obstacles. The geographical position and load magnitude of the distribution system should be evaluated in such a way that the distribution substation is scaled and placed to best handle the load while minimising the loss of the feeder and building costs (Rani *et al.,* 2018). The challenge of optimal distribution planning may be beyond the capacity of the unaided human mind to answer due to the restricted quantity of land accessible in urban areas and ecological considerations (Amann *et al.,* 2021).

Geographic Information Systems (GIS) have developed into a transformative tool that can revolutionise the data collection processes necessary for utility management. This study implemented GIS as a response to the limitations inherent in conventional methods of information storage and management (Khan, Kim and Seo, 2023). To ascertain the land use patterns within a defined estate, this study employed remote sensing and GIS tools (Dano *et al.,* 2020). Concurrently, the research area's transformers and other electrical infrastructure components' spatial data were systematically recorded using conventional survey methods (Yassin *et al.,* 2023). Additionally, questionnaires covering both traditional sources of energy and alternate approaches, for example, generators were used judiciously to gather a comprehensive understanding of the complexities of power consumption. As Nigeria attempts to navigate the stages of economic development, a growing understanding of the fundamental need for rigorous planning and efficient administration has taken root. Notably, electricity plays a crucial part in the range of utilities and has a significant impact on the orderly and successful development of society. The distribution system is a key node in the flow of electrical energy, charged with the primary responsibility of providing the energy required to satisfy consumer needs (Nkwunonwo *et al.,* 2023). This study develops within this paradigm, highlighting the numerous intricacies present in electrical distribution power systems through the use of geospatial technologies. This research with the assistance of intelligent geospatial analysis presents details on the land use dynamics in the studied area. The precise delineation of the division between residential and industrial sectors reveals the various land use patterns (Fang *et al.,* 2023). Geospatial visualisation, a powerful visual tool, is also exploited in this study to display the positions of the transformers that are distributed around the study area. Consequently, this enhances the management and comprehension of this crucial infrastructure (Lumwaya *et al.,* 2023). By using direct surveys with a specific purpose, the research also reveals important aspects of electricity utilisation. These questions cover a variety of topics, from different charging methods to how much electricity is used. The result is a collection of ideas that significantly aid in understanding and resolving the complexity that underlies the power consumption patterns (Kasprzyk *et al.,* 2022; Sevilla *et al.,* 2022).

This study provides a crucial way to employ geospatial technology to surmount the complexity of electrical distribution power systems. It incorporates a wide range of procedures, including remote sensing, customary survey methods, together with the skilful administration of questionnaires. The result is a diverse corpus of knowledge that reveals a complex tapestry by connecting the dots between infrastructure visualisation, power consumption analysis and land use evaluation, providing a detailed viewpoint with regards to the effective management of energy.

2. Research Methods

2.1. Study Area

Ikeja (Figure 1), a study area in Lagos, Nigeria, is a major urban settlement in the nation because of its extensive industrial activity (Aliu *et al.,* 2021; Farinmade *et al.*, 2018; Soyinka *et al*., 2016). A sizable fraction of the industries in the Lagos region are housed in the Ikeja Industrial Estate, which is home to over 70 different enterprises. The Ikeja core, Opebi, Allen Avenue, Awolowo Way, Alawusa, and Agidingbi are among the neighborhoods that make up the research area (Oduwaye & Enisan, 2011). Because of the substantial industrial establishment in the area, the Ikeja Industrial Estate environmental evaluation is very important. Ikeja, Lagos, Nigeria, has a population that fluctuates slightly depending on the source and the time period. The population, as of the 2006 census, was 313,196 (Amusa *et al.*, 2017).

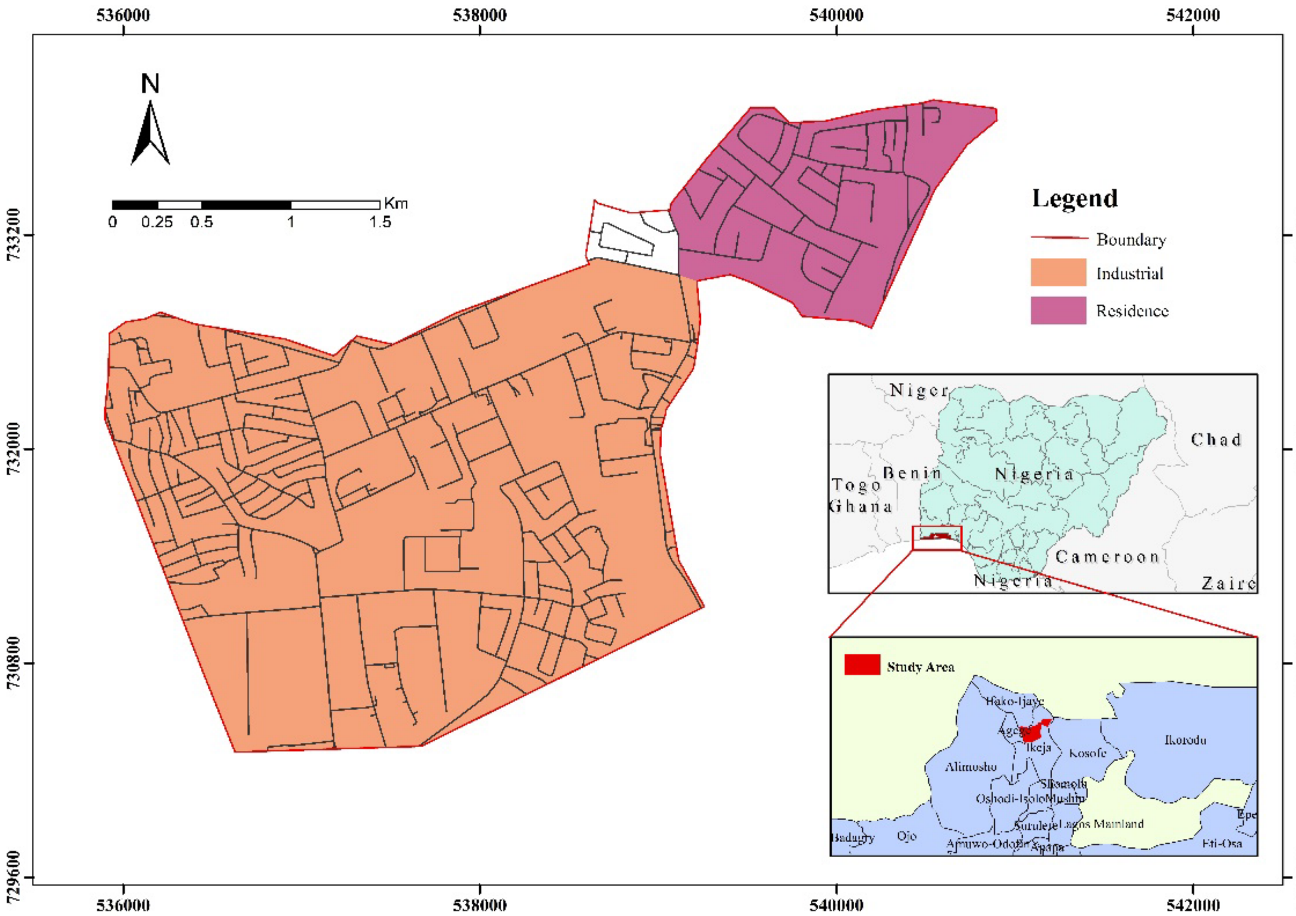

Figure 1. The study area map of Omole Estate Phase 1 and the Industrial area of Ikeja, Lagos, Nigeria (ArcGIS data, 2022).

2.2. Overview of Methods

The methods applied in this study are intended to overcome the constraints of standard information storage and management systems. A Geographic Information System (GIS) was employed as a revolutionary tool to improve utility management operations. This decision was based on an understanding of the revolutionary capabilities of GIS and its potential to address the complex issues involved with utility management (Mentis *et al.,* 2016). GIS was chosen as the cornerstone of the research due to its exceptional spatial analysis and visualisation capabilities (Hay *et al.,* 2011). The research methodology was created to comprehensively harness the power of GIS, altering the approach to energy utility management.

2.3. Data Collections

The study used a multi-pronged method for data collection, database building, data processing and visualisation (see Table 1). Google Earth photos from 2021 are one of the data sources used to examine the map, the road system, and land use. Data from questionnaires in 2021–2022 give information on rates of consumption; data from the electric network in 2021, gathered via self-reporting and Ikeja Electric employees, gives information on distribution.

Table 1. Data, Sources and Usage.

Data	Year	Source	Usage
Google Earth Image	2021	Google image	Study area map, road network, land use
Questionnaire	2021-2022	Field data	Consumption rate
Electric Network Data	2021	Self and Ikeja Electric, staff	Electric Network Distribution information
GPS Location Electric Infrastructures	2022	Field data	Electric Infrastructure network map
Interview	2021-2022	Residence and Ikeja Electric, staff	Catchment Area

The spatial and non-spatial data were captured using a global positioning system and direct questioning in the field, respectively. Data collection for this study primarily involved two sources: primary and secondary.

(1) Spatial Data: The spatial data used for the research study include the following.

- Base Map: The base map consists of the road network and catchment area.
- GPS Data: GPS collection points on the available Ikeja Electric facilities (transformer, poles, etc.) are acquired from the field of study using a handheld GPS.
- Questionnaire: This survey was given to the residents of Phase One of Omole Estate and industrial companies in the Ogba area of Ikeja Local Government.

(2) Non-Spatial Data: The non-spatial data include the following information acquired from the Ikeja Electric Head Office and the consumers.

- Electric Networks Details: Information on the electric networks, for instance the transformer, poles, etc.
- Transformer Details: The details pertaining to the transformer and other related facilities.

(3) Primary data: This involves obtaining first-hand information from the study area. The primary data obtained include the geometric coordinates of the electric infrastructure locations using a handheld GPS (Garmin). Attribute data were acquired with the assistance of Ikeja Electric. The following is the primary data collection process (see Figure 2).

(4) Secondary Data: The Google Earth image (Quick Bird Satellite Imagery) was downloaded from the Google Earth platform (see Figure 3).

Figure 2. Data collection obtained from the transformer (Field Data, 2022).

In downloading the image, the boundary of the study area was used in Google Earth to simplify the download (Fournier *et al.,* 2023). The red boundary displays the extent of the project area. The longitude and latitude of the top left corner and bottom right corner were marked on Google Earth as Omole 1 and Omole 2. The coordinates of the top left and bottom right points are illustrated in Table 2.

Table 2. The coordinates of the top left and bottom right points are presented below.

	Easting	Northing
Omole 1	534394	734111
Omole 2	540554	730248

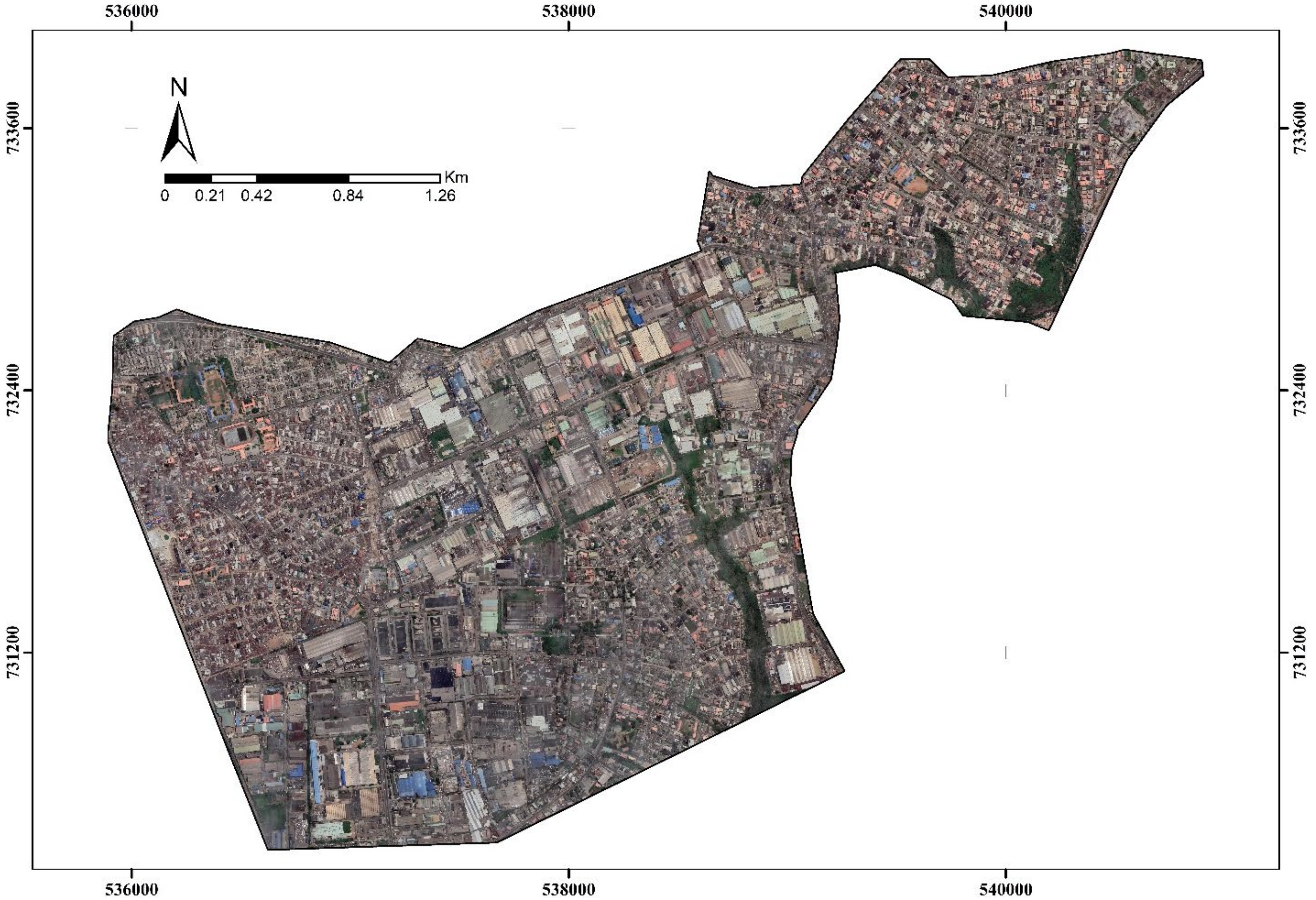

Figure 3. Google Earth image of the area (Google Earth, 2021).

2.4. Questionnaire Population and Sample

To select a representative subset of respondents from the larger target population for the questionnaire, a direct survey was utilised as the sampling strategy. These respondents were particular members of households, businesses or other entities within the study area. This strategy seeks to collect precise and valuable data, with effective resource and time management.

The research was carried out in Omole Estate (Phase One) and the industrial area of Ogba, Ikeja Local Government. One hundred questionnaires were disseminated to the residents of Omole Estate (Phase One) and 10 companies in Ogba were mapped. The companies are: Cadbury Nigeria, Dangote Agro Sacks, Guinness Nigeria Plc, Nigeria Bottling Company, FrieslandCampina WAMCO Nigeria Plc, Pivot Engineering Company Limited, Universal Steel Limited, Dunlop Nigeria, May and Baker Nigeria, Nigeria Wire Industrial Plc.

The following questions were asked.

- How many people reside in your house?
- How do you use electricity in the house (for what purpose)?
- What type of meter do you use?

- What is your average consumption rate monthly?
- What is your average electricity bill monthly?
- How much do you spend on running the power generator weekly?

2.5. Land Use Classification

Land use dynamics is critical for managing any area, given that it provides various essential services for people (Ray *et al.,* 2023; Hartling *et al.,* 2021). The land use was produced using ArcGIS 10.6.1. Where the Google Earth image seen in Figure 4 was georeferenced, digitised and updated, the study area was classified into the following, specifically Residential, Commercial and Bare ground.

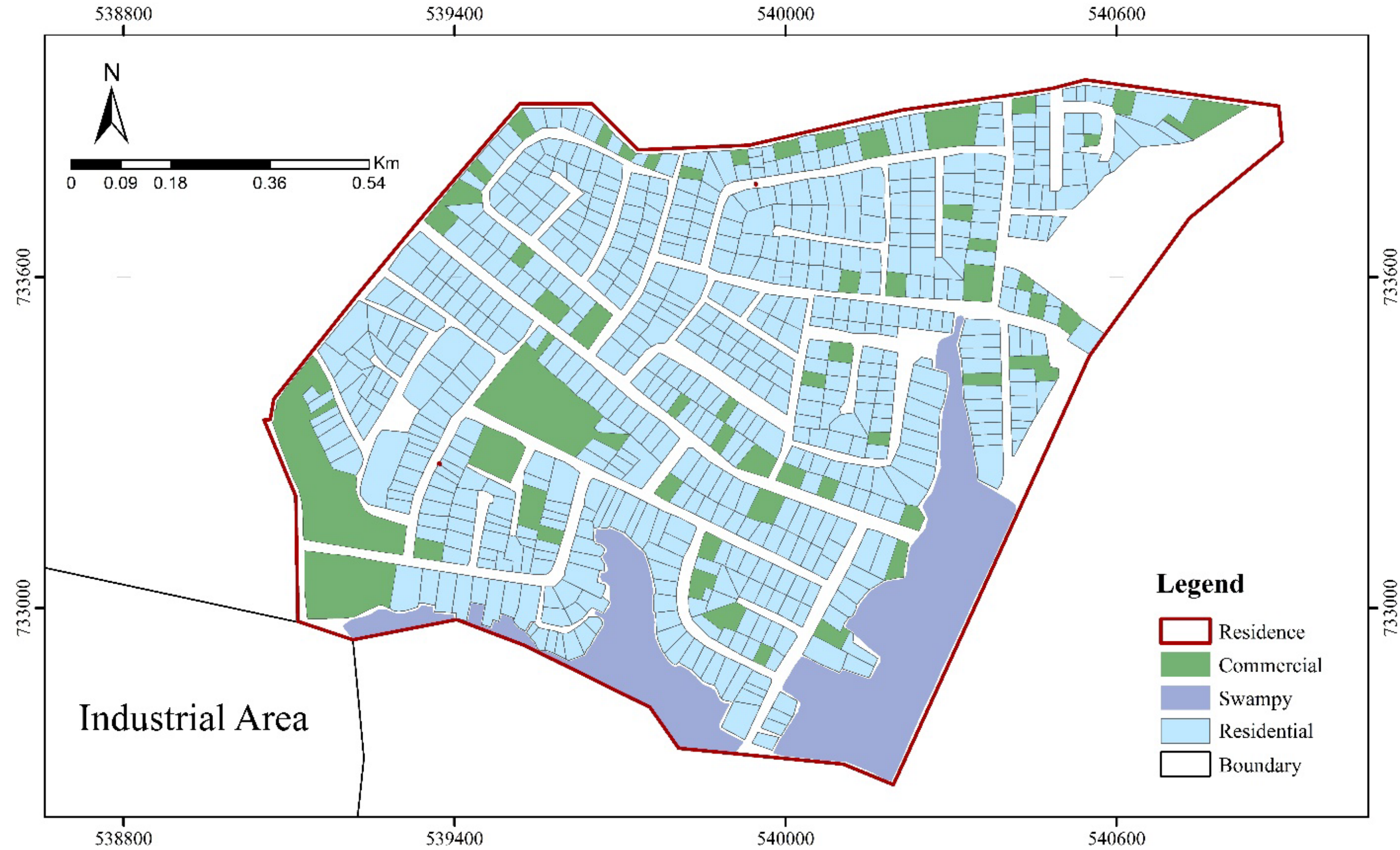

Figure 4. Land Use in Omole Estate

2.6. Attribute Data on Electricity Distribution

During the past few decades, Nigeria has faced significant obstacles with the distribution of electricity throughout the nation; distribution systems act as a conduit from the distribution substation to the consumer (Azedou *et al.,* 2023; Telesca *et al.,* 2023). Across the service area, this system delivers the safe and dependable conveyance of electric energy to a variety of clients. The conventional distribution system starts as a medium voltage three-phase circuit, typically between 30 and 60 kV, and ends at the customer's premises, usually at the meter, at a lower secondary three- or single-phase voltage, generally below 1 kV. From the station, branching laterals of an overhead and underground distribution feeder circuit connect to a variety of clients.

Concerning the primary distribution network, the medium voltage network is undoubtedly at the core of the electric distribution network (Khan *et al.,* 2023). Does the network begin at the terminal of the HV? MV substation feeder breakers extend both overhead and underground. Its devices are mounted on poles and routed via underground conduits in the vault and manhole (Oyedotun *et al.,* 2021). Medium voltage feeders travel city streets and country roads and cross rivers and streams to deliver power to the voltage network, which, in turn, delivers power directly to end-use consumers (Albadi, 2017). The physical components of electricity distribution for operational control and analysis of data required are explained below:

- High-voltage to medium-voltage substation: This is where the distribution network begins
- The medium voltage electric network including medium voltage substations and sub-transmission lines

- The low-voltage network includes any electric equipment operating at 1000 volts and under, comprising lighting networks
- The structures, including cabinets, manholes, substation buildings and poles: the equipment that supports or carries the electric equipment

2.7. Database Design and Creation

An object-oriented vector data model is supported by the database used for this study. The road, pole, building, etc., were all represented in this model as objects with different qualities and interactions. In the ArcMap environment, the data were formally inserted into the corresponding tables that had been prepared in the Arc Catalogue. Officials at the Ikeja Electricity Distribution Company (IKEDC) were extremely helpful in gathering information on the transformers' identity, capacity and operation. Information was provided on the number of customers connected, the phase of the transformer upon which they are attached, together with the consumers connected to each transformer (Helmi *et al.,* 2018). These establish individual relationships which were then populated with their attribute values into the ArcGIS 10.6.1, which is commonly used to attain spatial distribution in many areas of study (Avtar *et al.,* 2019). The data stored in the database form the information base. Once the layer was digitised, the non-spatial data were then added as attributes to the digitised feature.

3. Results and Discussion

3.1. Electricity Distribution

Having completed the coordination and mapping of the electrical distribution facilities (transformer and distribution line), which was performed using geospatial tools. The attributes of the transformers and distribution lines were populated to generate a spatial database using ArcGIS software, as shown in Figures 5. Figures 5a in the study depicts the building footprint on Omole Estate, offering insights into the distribution of the population under examination. This figure likely provides a visual representation of the spatial arrangement of buildings within the estate. On the other hand, Figures 5b illustrates the transformer catchment area in Omole Estate. This figure is likely to showcase the geographic coverage and extent of the area served by a specific transformer, providing valuable information for understanding the electric infrastructure network and its reach within the estate. These figures provide the contrasts between residential and industrial sectors' land use, and their functional relationships. The red boxes in the figures highlight the exact locations of the transformers on the ground, providing a visible illustration of their actual existence (Adoghe *et al.,* 2023).

Meanwhile, Figure 6 presents additional information on the distribution of industrial areas in Ikeja. When calculating the power output ratios required, which is essential for efficient resource allocation to satisfy the demands of the devices within these industrial clusters and cost, this spatial data has a crucial role to play (Said *et al.,* 2023). These spatial datasets were also used in the calculation of energy consumption as presented in Table 3.

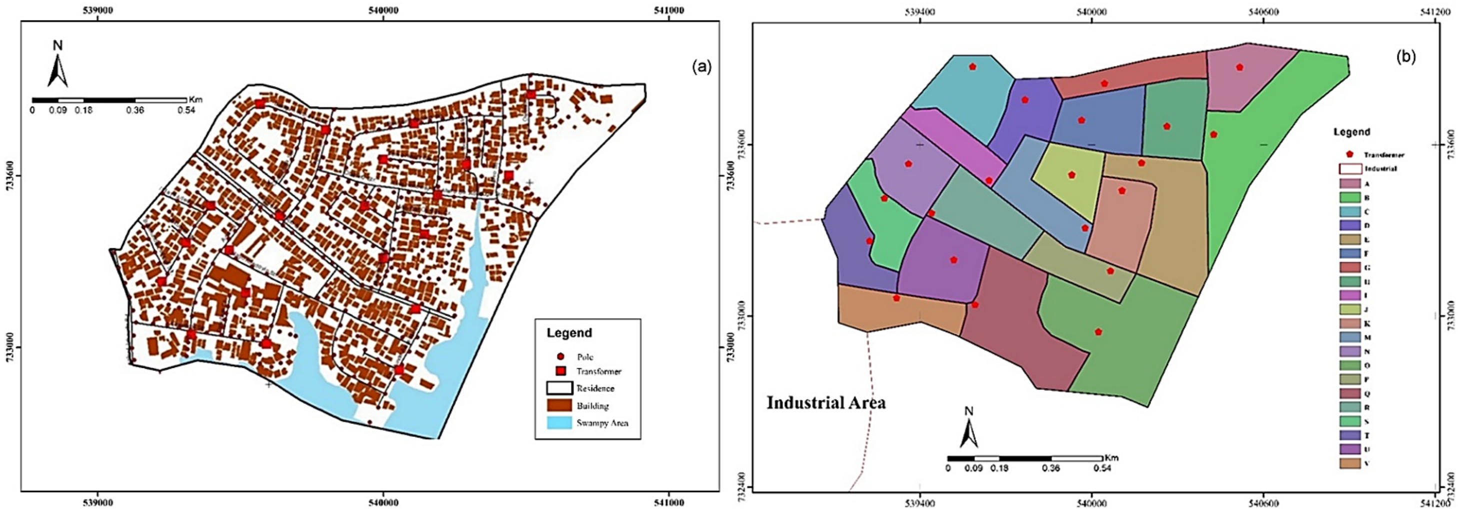

Figure 5. Transformer Distribution. (a) Building a footprint on Omole Estate, (b) transformer catchment area in Omole Estate.

Table 3 demonstrates how households in the higher kilowatt consumption bands budget for public lighting and generator power differently, with expenses increasing in line with use. Households divide their spending between grid- or generator-powered public lighting, depending on their electricity use patterns. The table highlights the financial benefit of public electricity over generator-supplied power by showing the costs associated with consumption in homes with different energy supply levels (Lim *et al.,* 2023). This emphasises the likelihood of growing demand and customer interest if a dependable public electricity source is made available. This change could increase revenue for the power utility provider while reducing the noise and maintenance costs related to the use of generators.

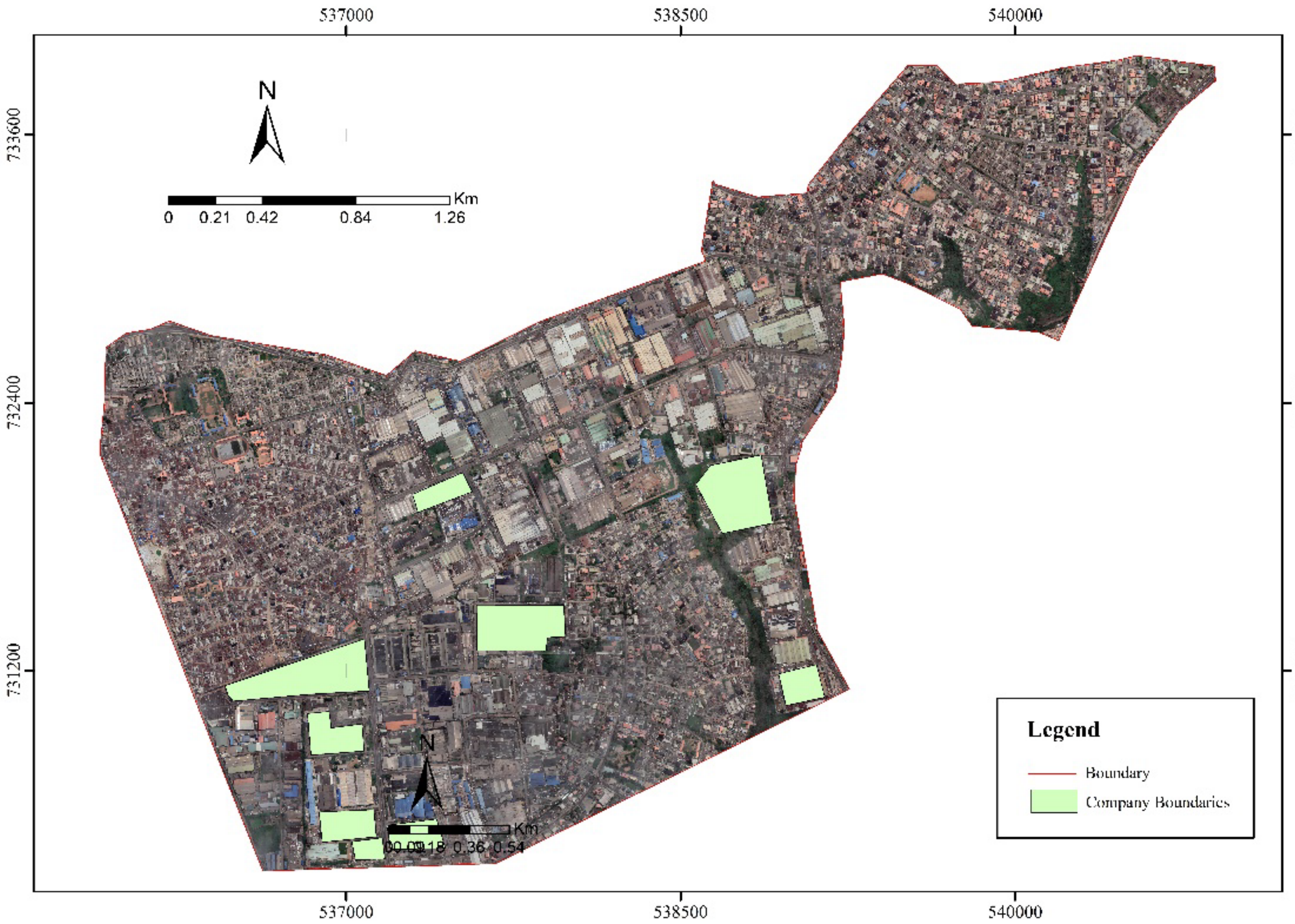

Figure 6. Industrial location within the study area.

Table 3. Cost Disparity in Generating Electricity Per Month (2021-2022).

Kilowatt Quantity Per Household	Percentage of Users	Amount Spent on Public Light (Grid)	Generator Power Cost
Unaware	35%	-	-
100kw-200kw	3%	<5000	<2000
201kw-400kw	15%	5100-1000	2100-4000
401kw-800kw	21%	10100-17000	4100-20000
801kw-1300kw	16%	17100-25000	20100-40000
1301kw above	10%	25100 above	40000 above

3.2. Electricity Consumption

The results of the questionnaires for the residents of Omole Estate were computed statistically and presented in Figure 7, 8, and 9. Figure 7 highlights the different levels of electricity consumption among the residents, while Figure 8 illustrates the corresponding electricity bills. This research serves as a framework for focused initiatives that are meant to encourage sustainable development and energy efficiency in the neighbourhood. It was discovered that 99% of the respondents have an electric meter in their residence while 1% do not have an electric meter in their residence. The composition of the households within the estate is specified in Figure 7a. According to the analysis, 19% of the respondents live in households with 0 to 3 people, 56% reside in households comprising 4 to 6 people, 21% are part of households containing seven to ten people, whilst 11% live in households with 11 or more people. This distribution provides important information regarding household sizes and their accompanying patterns of power consumption. A breakdown of the uses for electricity is shown in Figure 7b. It is notable that 72% of the respondents claimed that they use power primarily for domestic needs, highlighting how commonplace residential consumption is. Meanwhile, 10% of people use power for both household and commercial purposes, whereas 18% use it for business purposes, demonstrating how common electricity use is within society. In Figure 7c, the emphasis is now on meter types (Siddik *et al.,* 2023). Considering the fact that the majority of respondents (67%) use prepaid cards or electrical meters, a sizeable percentage (33%) continue to use the more traditional postpaid meters. Despite the countrywide switch to more sophisticated metering systems, postpaid meters continue to exist, indicating a need for increased awareness about and the utilisation of contemporary technology. An interesting finding involving knowledge of energy consumption can be found by examining Figure 7d. A third or 35% of respondents are unaware of how much energy they use each month or how much each unit costs. This knowledge gap suggests that there may be room for improvement in attempts to conserve energy, principally among consumers who do not regularly track their use. The last section in this analysis considers respondents' typical monthly electricity use. According to the data, 3% of participants use between 100 and 200 kW, 21% use between 210 and 400 kW, 8% use between 410 and 800 kW, 16% use between 810 and 1,310 kW, while 10% use more than 1,310 kW.

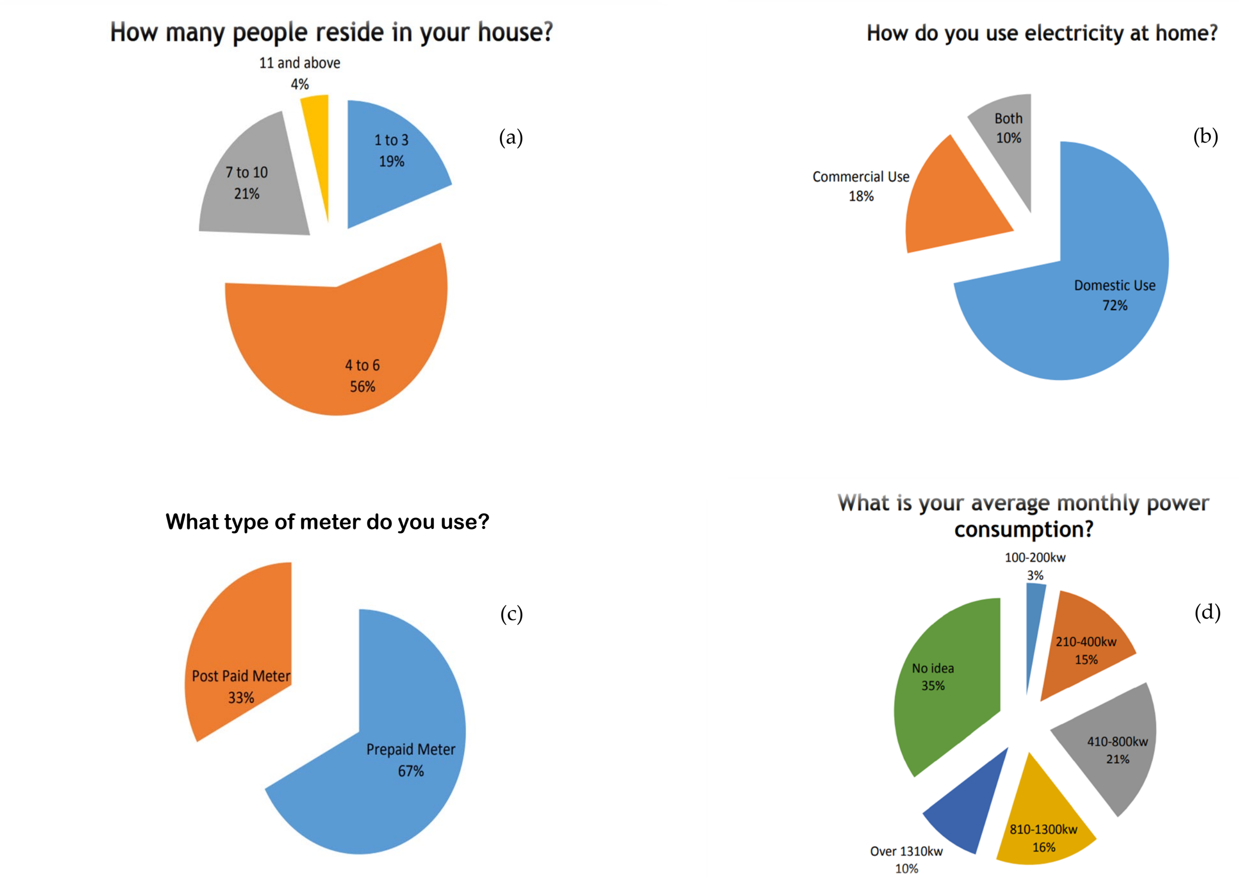

Figure 7. Electricity consumption levels among the locals.

Of those who responded to the study, 10% said that they spend between N1,000 and N5,000 per month on energy. This group of people falls under the category of maintaining a reasonably low monthly expenditure on energy consumption. Regarding 27% of the responses, the next spending range, from N5,000 to N10,000, attracts the most interest. This significant percentage underlines the fact that a sizeable majority of survey respondents place their financial resources within this mid-range spending range, which represents a level of use that is relatively common and cost-effective. The bar graph reveals a rising trend in electricity consumption, with 38% of respondents having monthly incomes between N10,100 and N17,000, indicating a larger portion spending more on power. Concerning the respondents, 24% are in the N17,100 to N25,000 bracket, indicating more demanding households or specific needs, whereas 2% of the respondents reported spending over N25,000 on electricity, signifying high-end use and costs. This information highlights the financial costs associated with power use and provides useful information for utility management, pricing tactics and resource allocation in the context of electricity supply (see Figure 9). The result of the amount spent on running the generator weekly between 3-6 hrs shows that 2% of respondents spend between N0 to N500 per week running their generators, 8% spend between N501 to N1000, 54% spend between N1001 to N5000, 24% spend over N5001-N10000 while 12% spend above N10000.

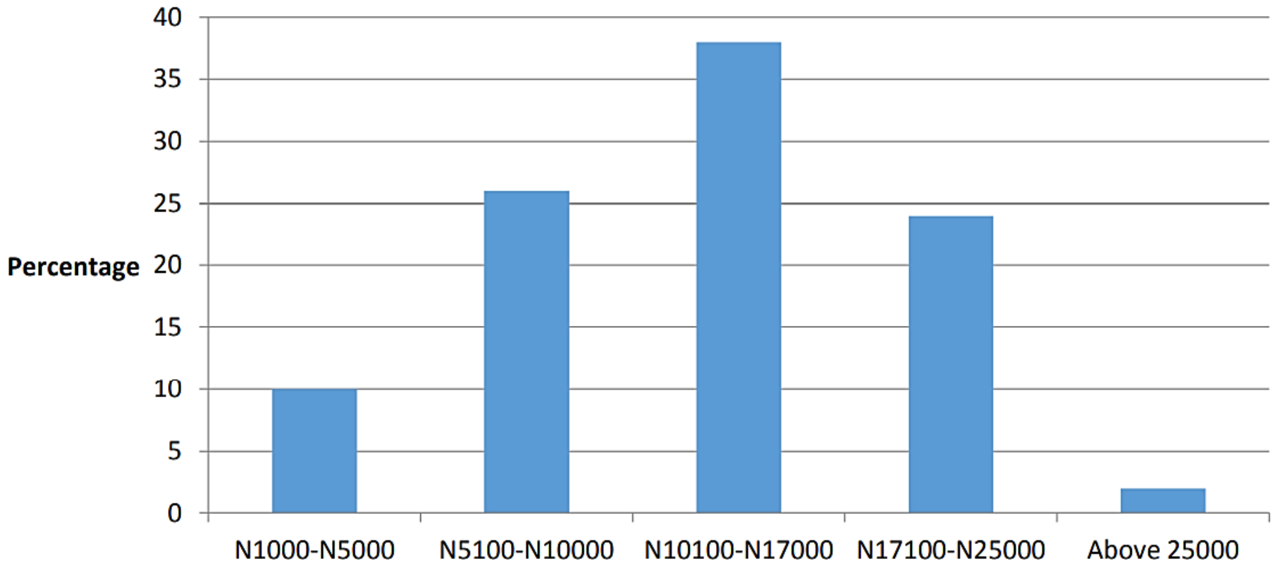

Figure 8. Electricity Bill Table.

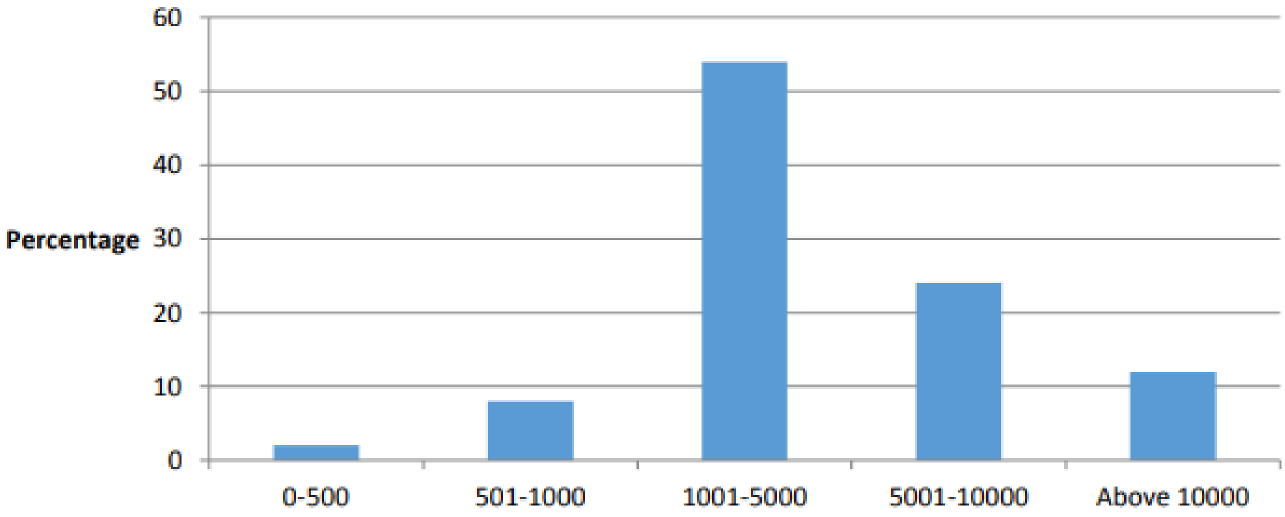

Figure 9. Weekly costs incurred in operating the power plant.

3.2. Discussion

This extensive study has provided a thorough understanding of utility management and trends in power usage in the studied area. Decision-makers, specifically the IKEDC authorities, now have a revolutionary instrument in the form of the incorporation of geospatial technology. The position of transformers is precisely mapped, underscoring their strategic importance in voltage management and enabling effective electricity transmission and distribution. The availability of a database to support analysis such as buffering would help in defining coverage areas and computing voltage drop and energy losses, all of which are essential for improving energy management. A foundation for strategic resource allocation, calculating electricity output and developing infrastructure is also provided by geospatial analytics.

With respect to the IKEDC authorities, this geographic representation is an exceedingly valuable resource that provides the crucial information they need to make informed future planning decisions (Jamil *et al.,* 2023). Transformers perform a critical intermediary role in ensuring that voltage levels are optimal for effective power transmission over a range of distances. They make it easier to convert electrical generators' high voltage to lower voltage which is acceptable for domestic items, for instance toys and doorbells (Filonchyk *et al.,* 2023). Consequently, this sophisticated voltage control enables efficient and reliable power distribution, minimising energy loss and guaranteeing that a substantial clientele is served by fewer power plants.

The precise coverage range of the transformers can be determined by performing a buffering study (Alobaid *et al.,* 2017). Calculating voltage drop and energy losses over predetermined distances is enabled with the assistance of this analytical tool. The querying of the 500kVA transformer in particular confirms the viability of remote identification, obviating the need for on-site visits. Additionally, this allows for later extensive analysis, with the aim of improving and optimising the electrical delivery process (Landera *et al.,* 2023).

Essentially, these figures function as a dynamic visual toolset that provides decision-makers and stakeholders with useful information (Huseien *et al.,* 2022). Informed planning, the optimisation of efficiency and enhanced electrical supply procedures are aided by the incorporation of accurate transformer locations, variations in land use, in conjunction with industrial geolocation data. This combination of geospatial technology and comprehensive data analysis improves existing operations while also paving the way for tactical improvements in utility management and service provision (Burke *et al.,* 2023).

4. Conclusion

This study improves utility management's current operations while laying the groundwork for future improvements by combining GIS technologies with meticulous data analysis. Decision-makers are given actionable insights by the dynamic visualisations in these numbers, which improves strategic planning, operational effectiveness, besides service delivery. In addition, this research demonstrates how geographical information may significantly improve the management and planning of power within Omole Estate. Geospatial technology integration speeds up data management, processing, analysis and display, acting as a reliable system to support decisions. Given its importance as a societal necessity, electricity demands careful supervision from production through distribution. The study, which provides a detailed perspective of electrical activity, stresses the need for GIS in this procedure. The results underline the significance of electricity as regards society and even indicate how the revenue generated can be increased based on increased supply to meet the demand sort for elsewhere, as this will then facilitate economic growth. Notably, 38% of households set aside significant budgets, between N10,000 and N17,000, for government-provided electricity, whereas 54% of households use generators, incurring high costs, this can be channelled back to the IKEDC. This pattern highlights the rising expenses of electricity usage, which calls for effective resource management. According to the data derived, 3% of participants use between 100 and 200 kW, 15% use between 210 and 400 kW, 8% use between 410 and 800 kW, 16% use between 810 and 1,310 kW and 10% use more than 1,310 kW. With the quantity identified planning is therefore enhanced.

Consistent and detailed planning emerges as a fundamental guideline in light of the demand of stable electricity. The paper explains how effective planning, decreased power loss and improved electricity distribution are related. To ensure high-quality, continuous and cost-effective energy provision and consequently support Nigeria's economic viability, ongoing planning efforts are essential. Therefore, we suggest several strategies to improve the electrical distribution system's efficiency. First, awareness efforts emphasizing the advantages of real-time monitoring and increased billing accuracy are used to shift from postpaid to prepaid metering systems. In order to combat the lack of knowledge about energy consumption and provide consumers the ability to track and control their usage for more efficient distribution, it is imperative that energy-saving education be prioritized. It is advisable to gather and analyse data continuously in order to quickly identify trends of electricity use and enable well-informed decision-making. Hiring geomatics experts to remedy the lack of a distribution mapping system and put in place a corporate GIS for efficient planning and administration is the suggested method for implementing spatial intelligence planning. Lastly, improvements in voltage, reliability, network capacity, and power system factors are recommended to minimize losses and ensure the distribution network operates at its peak level, thereby enhancing overall efficiency.

Acknowledgements

We acknowledge the support of Ogba Lagos' IBEDC staff who supplied us with resourceful data that aid the completion of this research and also the quality assistance of the Forum Geografi journal team at all stages.

Author Contributions

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