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RESEARCH ARTICLE

Spatial Analysis of Electrical Power Consumption Patterns of Unmetered Customers in Agboju, Lagos State

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ABSTRACT

Using geospatial techniques, this study investigates the electrical energy consumption patterns of unmetered Eko Electricity Distribution Company (EKEDC) customers that receive energy from a 500kvA public distribution transformer in Agboju, Lagos State. The study identified and mapped all the electrical infrastructure within the study area and classified the unmetered customers by level of energy consumption as well as land use and revenue collection efficiency. It also analysed the energy consumption patterns in kilowatt-hour of unmetered customers and ultimately determined the priority for metering within the study area. Alongside Spatial Inequality Theory, studies from previous research were reviewed in order to provide a wholesome understanding of discussions in the electricity consumption space. Fieldwork was conducted to collect spatial data on buildings and electrical infrastructures. The secondary data on energy consumption was sourced from EKEDC. The study adopted a quantitative methodology, with spatial autocorrelation technique utilized to determine spatial associations in energy billing and revenue collections of the unmetered customers. To determine metering priority, the researchers used an ordinal scale of measurements to categorise the customers from A to H. None of the unmetered customers made Category A and only six customers made Category B. The study concludes that spatial patterns in energy consumption or revenue collection efficiency are random, given the results of the spatial autocorrelation analysis. Thus, electricity distribution organizations can maximize revenue by strategically prioritizing meter deployment in high-potential locations through thorough evaluation and mapping of unmetered consumers.

Keywords: Energy consumption, Electrical infrastructure, Kilowatt-hour, Unmetered customers, Transformer, Spatial inequality

1.0 Introduction

Nigeria's commercial hub, Lagos State, is home to a sizable number of manufacturing and service sectors. The state accounts for about 30% of the country's GDP and 50% of the GDP outside of oil. Less than 1,000 megawatts (MW) of electricity are used to power this, with the two electrical distribution firms (DisCos) in the state receiving their supply from the National Grid (Lagos State Ministry of Energy and Mineral Resources, 2021).

High- and medium-voltage (33kV and 11kV) networks from primary and sub-primary substations make up the major distribution system used within Lagos State, with high-voltage transmission lines connecting these substations to one another. Large industrial customers, such as steel rolling mills, breweries and cement factories, typically obtain their supplies from the primary distribution system (11kV), which is equipped with transformers, switchgears and breakers (Mgbemena et al., 2011).

According to Mgbemena et al. (2011), the low-voltage feeder networks, which are offsets from the injection substations, are built beside major roadways and make up secondary distribution systems, which feed the distribution transformers. Thereafter, uprisers (0.415kV), which emanate from the distribution transformers, are used to connect the networks' feeder lines to specific customers with service cables (0.220kV).

High demand loads combined with deficient distribution networks have contributed to a rise in technical losses in electricity distribution (Emodi & Yusuf, 2015). This situation is worsened by network malfunctions resulting from accidents, vandalism and deteriorating infrastructure. Inevitably the DisCos are prevented from relaying electricity even when it is available on the national grid, resulting in load shedding and extended power outages.

In all of this complex system the electricity meter is a vital device that quantifies the energy consumption of respective electricity users, ultimately determining the cost of consumption based on the tariff system applied. Depending on the metering technology available, different electricity meters can be used for this purpose (Dahunsi et al 2021). Electric meters are designed to monitor and document the amount of energy that consumer units use, thereby providing data that is typically used for customer billing, operation management and systems planning.

According to Bademosi (2023), a total of 7,017,809 electricity customers in Nigeria are still on estimated billing despite various interventions by the government to bridge the metering gap. No doubt, the absence of a database for energy consumption per service unit breeds mistrust between the electrical power providers or the distribution companies (DisCos) and their customers.

The lingering unavailability of prepaid meters for most electricity users has led to the continuation of post-paid or estimated billing from the DisCos. Operators in the power industry have consistently blamed the illiquidity in the sector, mostly occasioned by shortfalls in billing collection, for the thinning investment in the Nigerian power sector (Addeh, 2023); therefore, aggregate commercial losses are always factored into the revenue expectations of every month, hence the annual revenue shortfall. Just about 450,000 meters are captured in the Eko Electricity Distribution's Company license area, which makes up 63% of its total customer base (Aghogho, 2024). So far, efficient technology, such as GIS, has not been deployed in the electricity network across the nation (Mentis et al., 2015). As such, substation managers are unable to view real-time data on any GIS platform in a context of over or undergeneralization in power distribution. To address an aspect of the metering issue in Nigeria's electricity sector, this study undertakes a spatial analysis of the electrical energy consumption patterns of unmetered customers that are fed from a 500kVA public distribution transformer in the Agboju area of Lagos State.

2.0 Literature Review

2.1 Understanding Spatial Inequality

Across the globe spatial variations in resource distribution and access leads to unequal development and opportunities. Accordingly, the concept of spatial inequality was generated to describe the uneven distribution of resources, opportunities and services across geographical regions. The complex matter of spatial inequality has historical, economic and social roots. An apparent illustration of how geographical variations in resource distribution can result in unequal development and opportunity is the differential distribution of electricity access and affordability around the world. Indeed, high prices of electrical infrastructure impede economic development, educational attainment and the fundamental quality of life in many areas. This divide widens already-existing inequalities in electricity and electrical infrastructural access by disproportionately affecting underprivileged people, rural areas and poor countries. While achieving universal access to electricity is still a significant difficulty on the African continent, coverage ranges from 95% to

100% in Asian and Latin American cities (IEA, 2017).

Universal physical access to networked facilities, including water and electricity, is frequently portrayed in Global South cities as facilitating the eradication of spatial and social disparities. Most conversations in these cities have centred on the barriers to the growth of networked infrastructure, but the greater generalization of the physical electrical network has received less attention (Pilo, 2019). In Lagos, as elsewhere, metering constitutes a crucial value chain in affordable energy access for electricity consumers. At present social disparity has been institutionalized with the band categorisation of 33kV and 11kV feeders, which serve the energy distribution companies.

The theory of spatial inequality suggests that the random electrical consumption pattern found in the case-study area of Agboju actually masks deeper geographical disparities, where the lack of metering prevents underserved areas from transitioning into a formal, equitable energy market. Consequently, the proposed ranking system, which aims to maximize revenue for the DisCos, means that focusing on revenue collection efficiency may inadvertently bypass the most vulnerable populations, thus reinforcing the cycle of energy poverty and spatial neglect.

2.2 Electricity Consumptions Patterns and Determinants

Measuring electricity consumption is not as simple as it seems. This is because electricity travels through closed loops, or circuits, of electrical appliances. When appliances are not using electricity, very little power flows through the home circuit. In order to power electrical items when they are turned on, electricity needs to flow through the house. To measure the flow of electricity, electricity companies use kilowatt hours, with a kilowatt hour (1,000 watts) being the total force flowing through a meter in an hour.

Nigerians mostly use electricity for domestic purposes, with households reportedly consuming close to 60,000 terajoules of power in 2021(Sasu, 2024). The amount of electrical energy utilized for public and commercial services was approximately 27,800 terajoules, while the amount consumed by industry was roughly 14,200 terajoules. It is important to understand consumption patterns when suggesting solutions to the many issues plaguing Nigeria's power sector. It should be noted that the biggest problem in the sector is the inadequate provision of services to customers, as reflected in persistent power outages, even as demand continues to outstrip provision owing to rapid urbanization and business/industrial growth (Arimah, 2008).

Voulis et al. (2018) classified and analysed the demand profiles and energy-user compositions of different urban scales. That study identified three broad groups: residential, business, and mixed. Using data from the Netherlands, the researchers built their scale from almost 15,000 neighbourhoods, districts and municipalities. At every scale these regional categories differ statistically from one another pairwise. The researchers suggested including both domestic and non-household energy users in energy transition studies as only a small portion of the roughly 15,000 urban areas examined had a residential-type demand profile.

Towards designing better sustainable and knowledgeable energy policy decisions, Ubani (2024) critically examined the empirical factors that influence residential electricity determinants in Nigerian cities. A structured questionnaire was distributed to electricity users of prepaid meters in five major Nigerian cities. A multistage cluster area sampling technique was used to select the residential consumers of electricity who utilized installed prepaid meters in Nigeria's five most populous cities of Abuja, Lagos, Enugu, Kano, and Ibadan. Located in five of the country's geopolitical zones, these cities were fitting choices because of their histories and populations.

Ubani (2024) found that the aggregate of the 15 predictor variables (socio-economic and physical variables) influenced household electricity consumption in Nigeria. However, out of the 15 identified socio-economic and physical variables, the parameters that were quite significant were household monthly income, type of house, number of hours that people stay outside the house, number of teenagers at home, hours that electrical appliances are used, weather condition, number of household electrical appliances, age, and the building location.

2.3 Electrical Metering in Distribution Operations

According to Makanjuola et al. (2015), metering can be regarded as 'installation of equipment that makes it possible for a utility to determine the amount of electric power a particular customer has consumed'. Typically, electricity meters are calibrated in billing units of kilowatt hour (kWh). The study reported that the Nigerian government had initiated metering in 2005 in an effort to minimize consumer complaints of overbilling and other associated problems.

The use of electronic meters has several advantages, such as reduced power usage, increased precision, temperature independence, storage capacity, remote connectivity, and security. Given the low hourly per capita income of Nigerians, the government may not achieve much with the current policies and infrastructure. It is certain, however, that prepaid electricity meters will guarantee revenue collection and eliminate government subsidies for electricity use. Besides, having an efficient metering system will curtail energy wastage, thus increasing the amount of electric energy available to all (Dahunsi et al., 2021).

In Nigeria, as of 2010, Unistar was the sole company assembling PPMs. Now, however, companies like Mojec Ltd. and MBH Power have become major meter producers in the country. It is worth noting that the Nigeria Electricity Regulatory Commission (NERC) has mandated Electricity Distribution Companies to provide 60,000 meters yearly to customers (Aghogho, 2024). Thus, if this target is met by the eleven DisCos the country will have 660,000 annual electric meter installations.

Aghogho (2024) further reported that NERC's third-quarter report for 2023 showed that the overall metering rate among Distribution Companies (DisCos) stood at 44.51%. While Ikeja DisCo had the highest rate at 72%, Yola DisCo had the lowest at 18%. Thus, out of the 12.82 million customers, approximately 5.70 million have been metered, leaving 7.11 million without meters. As of September 30, 2023, this amounts to a metering gap of 55.49%. The failed deployment of metering for all electricity consumers can be largely attributed to a lack of policy implementation. NERC has come under criticism for its failure to enforce its regulatory power over all parties involved, especially the DisCos' laxity in implementing the different regulations that will guarantee the metering of electricity users.

3.0 Methodology

As already noted, the study adopts a quantitative methodology, which involves collecting and analyzing numerical data in the bid to establish patterns and averages, make predictions, test causal relationships and generalize results to wider populations (Bhandari, 2023). Being quantitative data, energy consumption was the basis of the spatial analysis of electricity consumption patterns. The methodological flowchart for this study is shown in Figure 1.

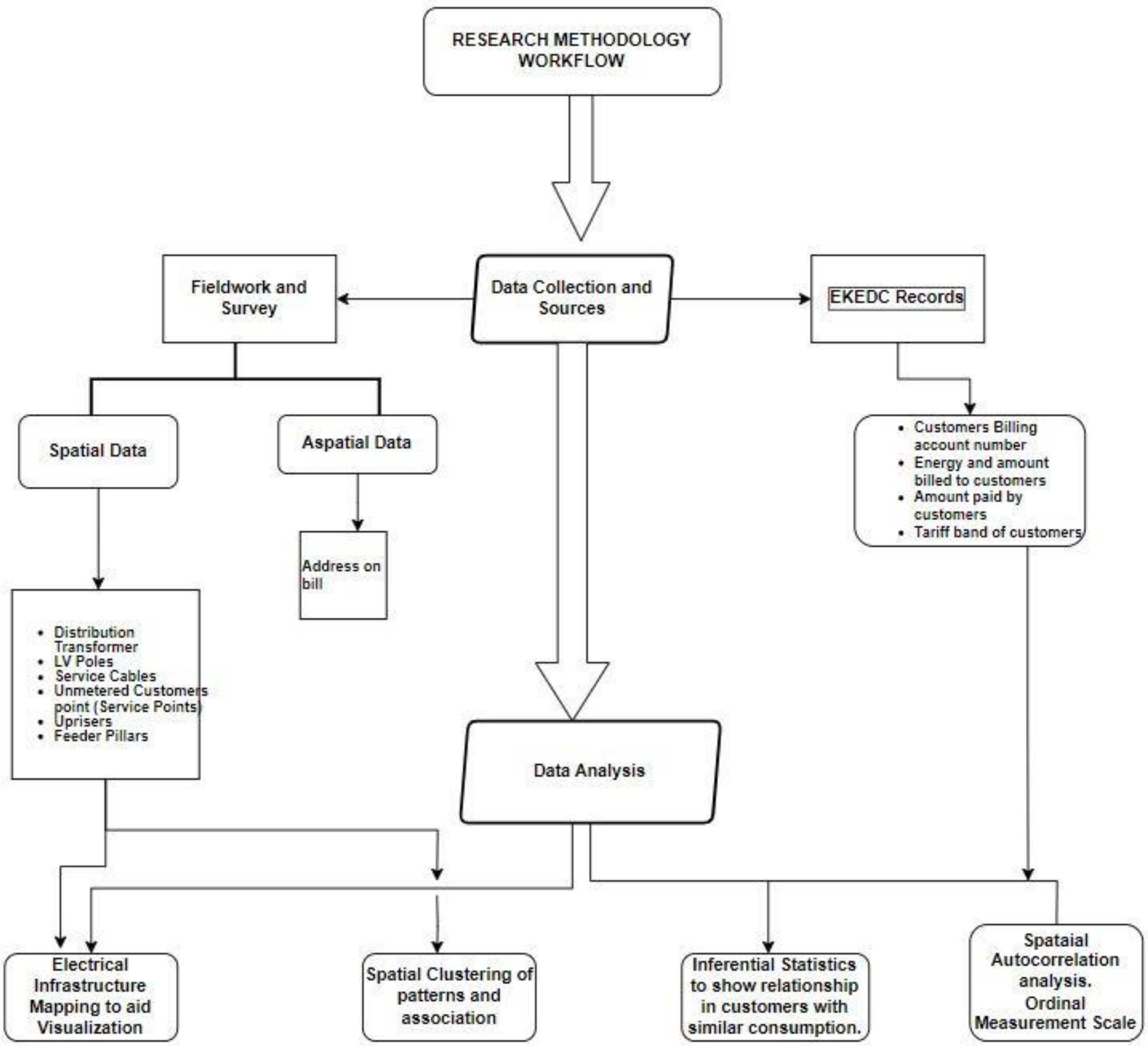


Figure 1: Research Methodology Flowchart

3.1 Data Types, Sources, Sample and Characteristics

This study utilized spatial and aspatial data, with the former gathered by conducting fieldwork and the latter by scouring the records of Eko Electricity Distribution Company (EKEDC) (see Table 1). Purposive sampling was used to capture the categories of energy users and public transformers serving metered and unmetered customers that were on a feeder band with more than 12 hours of supply (i.e., a minimum of Band C).

Not all the population (i.e., the distribution transformers) met the selection criteria. The distribution transformers were categorised into public and private. For this study, public distribution transformers were deemed to be the best fit because the target samples were unmetered customers, who tend to be served by public transformers. Therefore, a 500kVA transformer having forty-four (44) unmetered customers was selected for this study. This sample met the criteria set by the sampling technique.

Table 1: Data Types and Characteristics

S/N	Data Required	Data Type	Data Source	Vector Model Classification
1	LV Network (Uprisers)	Spatial	Fieldwork	Point
2	Unmetered customers (Service point)	Spatial	Fieldwork	Point
3	Customers billing account number	Aspatial	EKEDC Energy	Nil
4	Energy and amount billed to customers	Aspatial	EKEDC	Nil
5	Location address (geocoding)	Spatial	Fieldwork	
6	Buildings	Spatial	Fieldwork	Polygon
7	Amount paid (Collection)	Aspatial	EKEDC	Nil
8	Distribution Transformer (Location and Features)	Spatial	Fieldwork	Point
9	Tariff Band of Customers	Aspatial	EKEDC	Nil
10	Feeder Pillars	Spatial	Fieldwork	Line
11	LV Service Wires 220volts	Spatial	Fieldwork	Line
12	LV Support Structures	Spatial	Fieldwork	Point

The schema used in building the database, i.e., the ArcGIS PRO 3.2 software, is shown in Figure 2.

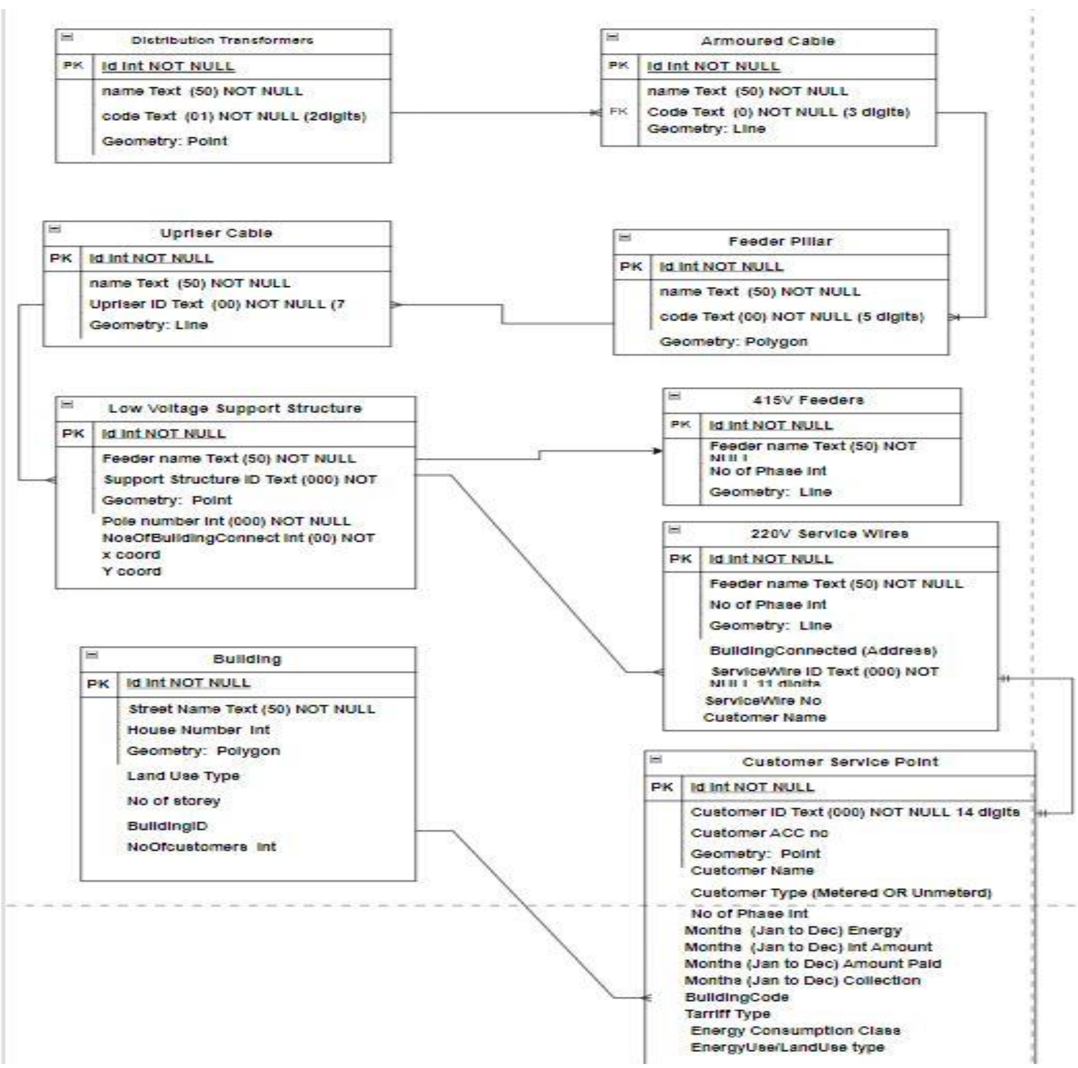


Figure 2: Geodatabase design

3.2 Data Processing and Analysis

To map all the electrical infrastructure emanating from the distribution transformer to the service points (Unmetered Customers), a field survey was conducted using ArcGIS Field Maps to collect and then display all the infrastructure in map form. This enabled easy spatial query and overlay for spatial analysis purposes.

To classify unmetered customers attached to the selected public distribution transformer, data on energy consumed, land-use type and collection efficiency was collected as attribute data, with the hierarchy determined for proper classification. The Energy consumed was ranked in three categories: high energy consumers, medium energy consumers and low energy consumers. The kilowatt hour consumed annually by the unmetered customers was the basis of their classification into three classes. The high energy consumers had an annual energy consumption greater than 18,000kWh (1,500kWh monthly). The medium energy consumers had an annual energy consumption range of 6,001kWh to 18,000kWh, while the low energy consumers had an annual energy consumption rate falling below 6,000kWh (500kWh monthly).

The four land-use types adopted by this study for the unmetered customers' billing classification are residential, commercial, industrial, and mixed. The residential land use need land for habitation purposes. The commercial land use require land primarily for business purposes, e.g., retail, office space, service provision, and entertainment. Industrial land-use customers use land primarily for manufacturing, production, fabrication or assembly processes. It also includes ancillary services such as warehousing, storage and distribution. Mixed land-use customer categories combine multiple land uses, such as residential and commercial land use. on a single bill.

To analyse the energy consumption patterns in kilowatt hour of customers by revenue collection efficiency and energy consumed, inferential statistics was used to identify and analyse relationships between consumption, amount billed, land use and collections. Correlation coefficient between annual energy consumption and annual amount billed was done to uncover the linear relationship between the two variables.

A Customer Response Rate (CRR), which is the average annual collection efficiency per customer, was also computed. Thus, any customer with a response rate (CRR) of 0% to 4% is categorised as low, while 35% to 69% is rated as medium and 70% to 100% is classified as high. Thereafter, a code was used to generate an ordinal value of categories A to G based on the collection efficiency, as depicted in Table 2.

Table 2: Ranking energy consumption and collection efficiency

S/N	Category	Energy Consumption	Collection Efficiency
1	A	High energy consumption	High collection efficiency
2	B	Medium energy consumption	High collection efficiency
3	C	High energy consumption	Medium collection efficiency
4	D	Low energy consumption	High collection efficiency
5	E	Medium energy consumption	Medium collection efficiency
6	F	Low energy consumption	Medium collection efficiency
7	G	Low energy consumption	Low collection efficiency
8	H	Medium energy consumption	Low collection efficiency
9	I	High energy consumption	Low collection efficiency

In determining priority for metering, a Moran's I spatial autocorrelation analysis was used to conduct a spatiality check for the factors that are most important in associating the consumption patterns of unmetered customers within the study area. The customer response rate developed for this study was singled out as the most important factor or variable for prioritising a customer for metering.

A Moran's I value significantly different from 0, combined with a low p-value, indicates that there is a statistically significant spatial pattern in a data set. This information can be valuable for understanding the underlying processes and relationships in a study area.

Moran's I Spatial Autocorrelation formula:

$$I = \frac{\sum(zi - \bar{z})(wj - \bar{w})}{\sum(zi - \bar{z})^2}$$

- I: Moran's I statistic
- zi: The value of variable z at location i
- $\bar{z}$: The mean of variable z across all locations
- wj: The value of variable w at location j (often the value of z at a neighbouring location)
- $\bar{w}$: The mean of variable w across all locations
- $\sum$**:** The summation operator

With a p-value set at 0.05, Moran's I was used to measure the degree of clustering or dispersion of revenue collection efficiency and energy billed to the unmetered customers.

4.0 Results

4.1 Mapping of Electrical Infrastructure and Customers

As presented in Figure 3, all of the electrical infrastructure emanating from the 500kVA public distribution transformer has two armoured cables connected to the feeder pillar it serves. The feeder pillar itself has three upriser cables. The three upriser cable which serves the entire study area connects the 415V support structures. The count of 415V voltage poles within the network is 80, with the total length being 1.085km.

The total number of buildings connected to the 415V support structures are 80 out of the 90 buildings captured in the study area. The maximum number of buildings connected to one support structure being 5, the sum of length of service wires connecting the support structures to customers in the buildings is 1.986km. Ultimately 74 metered customers and 44 unmetered customers were captured within the study area, making it a total of 118 metered and unmetered customers.

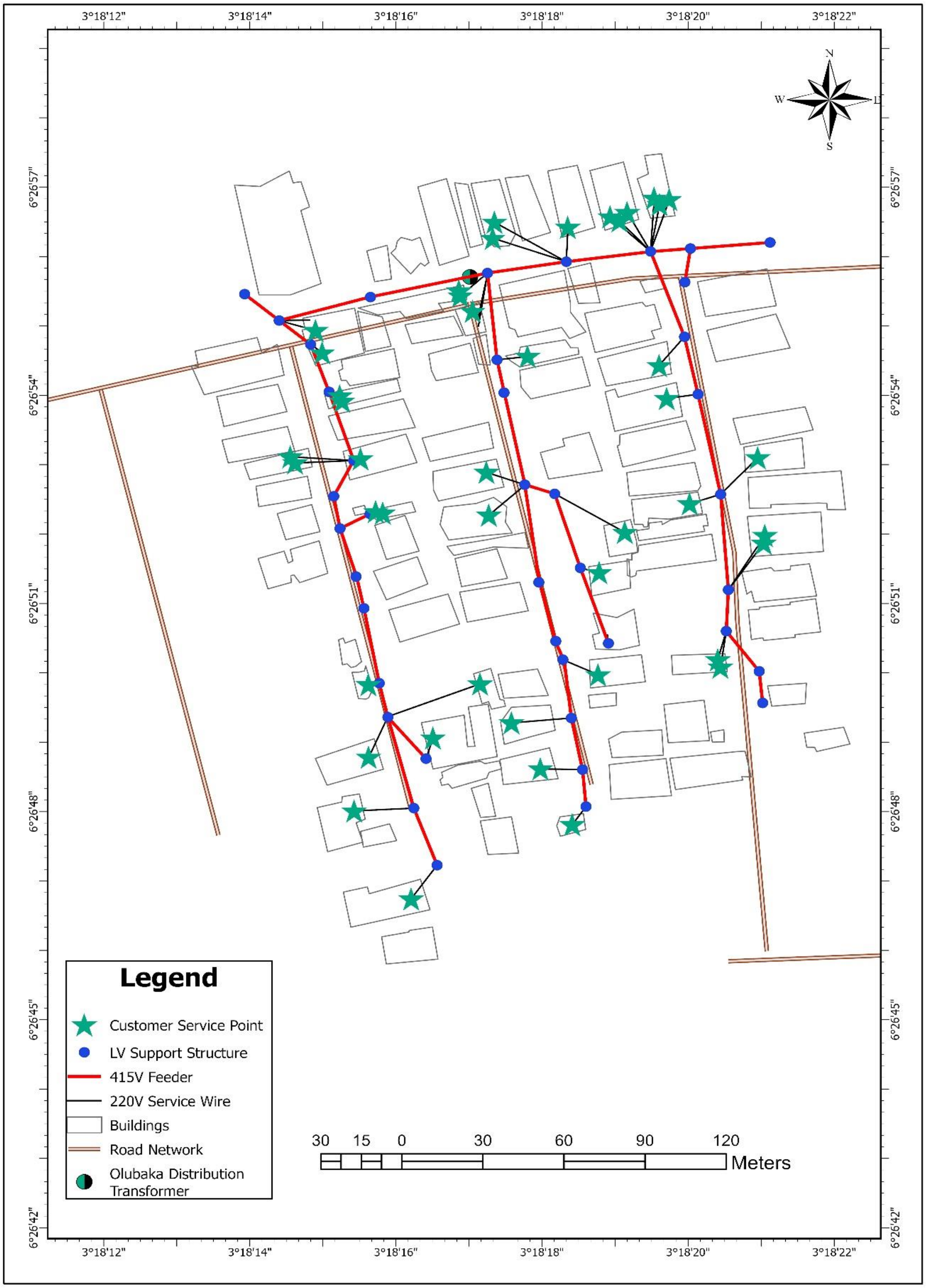


Figure 3: Electrical infrastructure within the study area

Three of the four land-use types were found in the study area. Figure 4 shows the occurrence of each of the land-use type, the most frequent being residential with 65 buildings, mixed use buildings with 16, commercial buildings with seven (7) and special-use buildings with two (2). This means that land use in the study area is mainly residential.

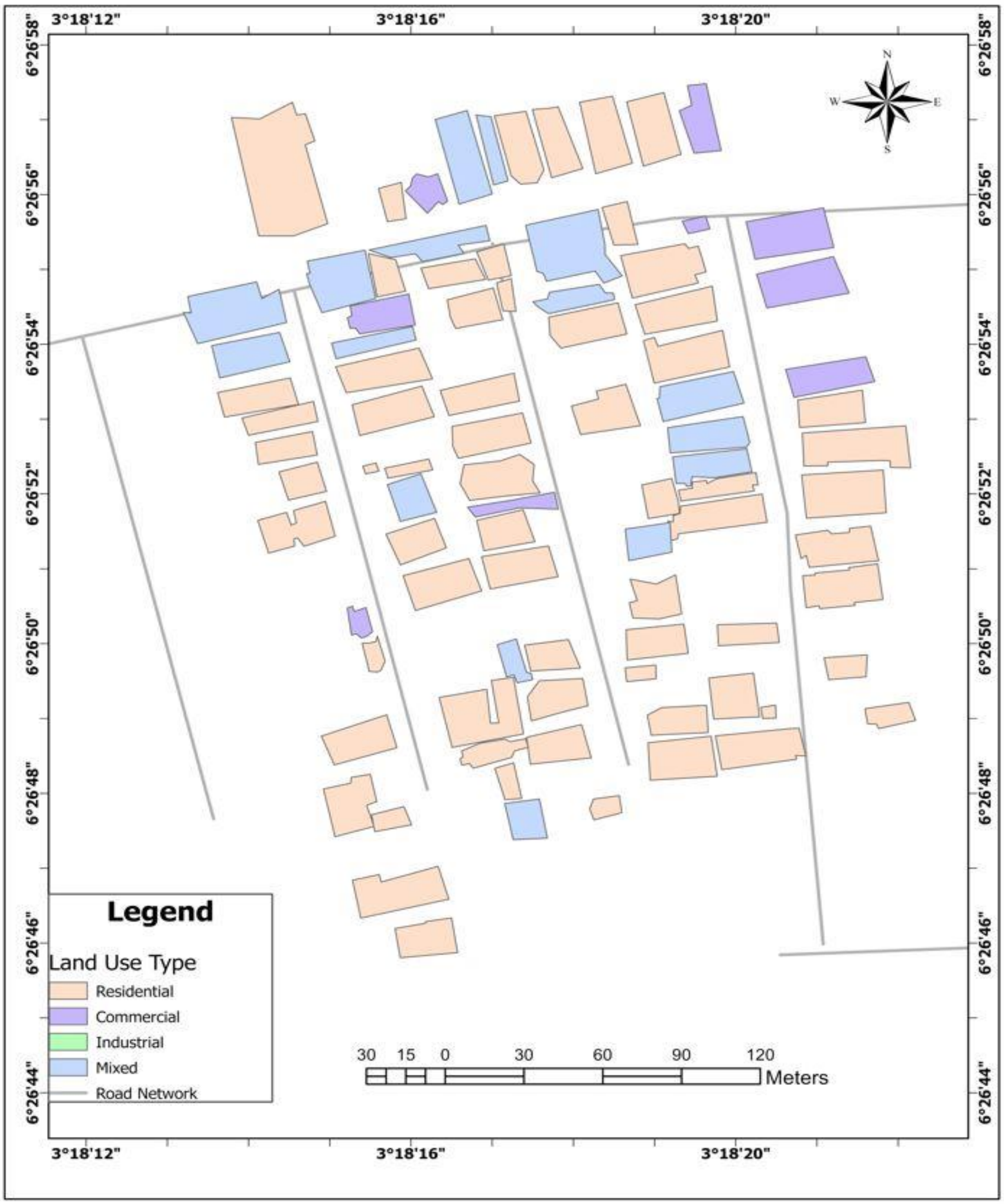


Figure 4: Land Use Type of Buildings

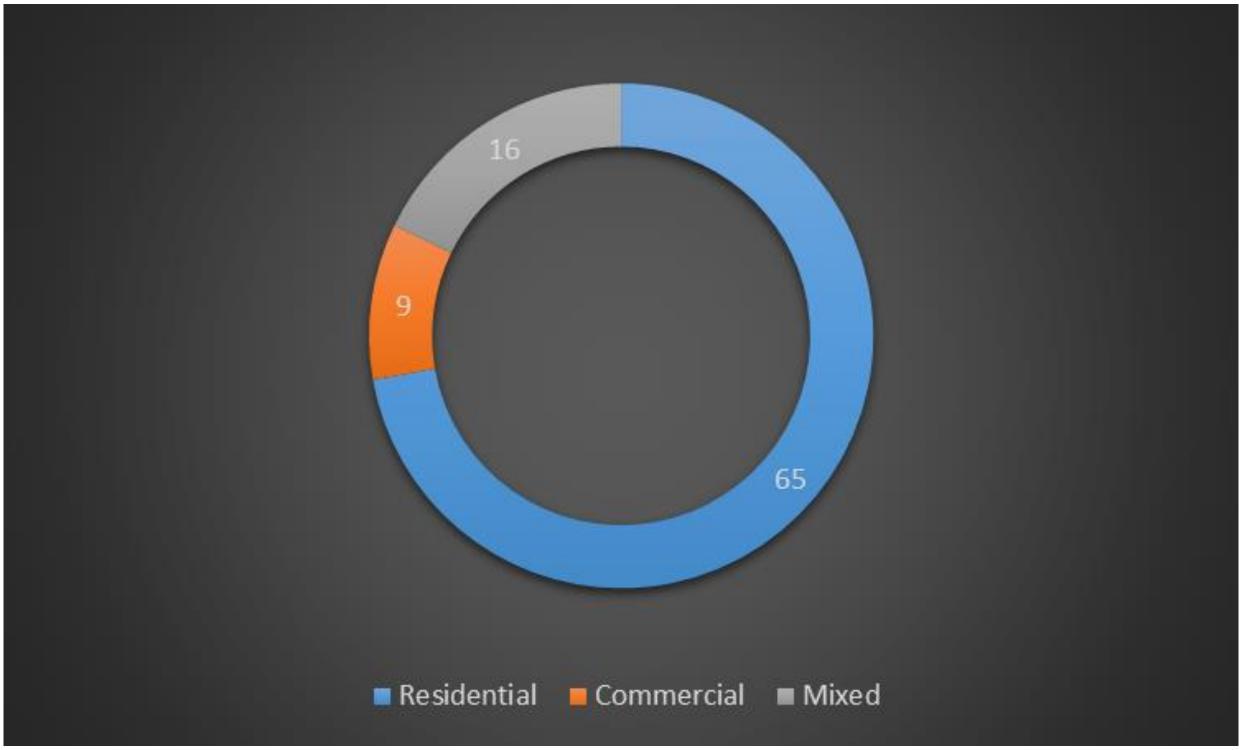


Figure 5: Land Use Type of Buildings

4.2 Classification Based on Land Use

Land-use classification according to the billing of the unmetered customers shows that there are 37 residential customers, 2 commercial customers and 5 mixed land-use customers (see Figure 6). The residential customers, commercial customers and the mixed-use customers reportedly consumed 247,507kWh, 36,460 kWh and 10,645kWh respectively in the year of study. In percentage this is represented as 84.01% for residential land use, 12.38% for mixed land use and 3.61% for commercial land use.

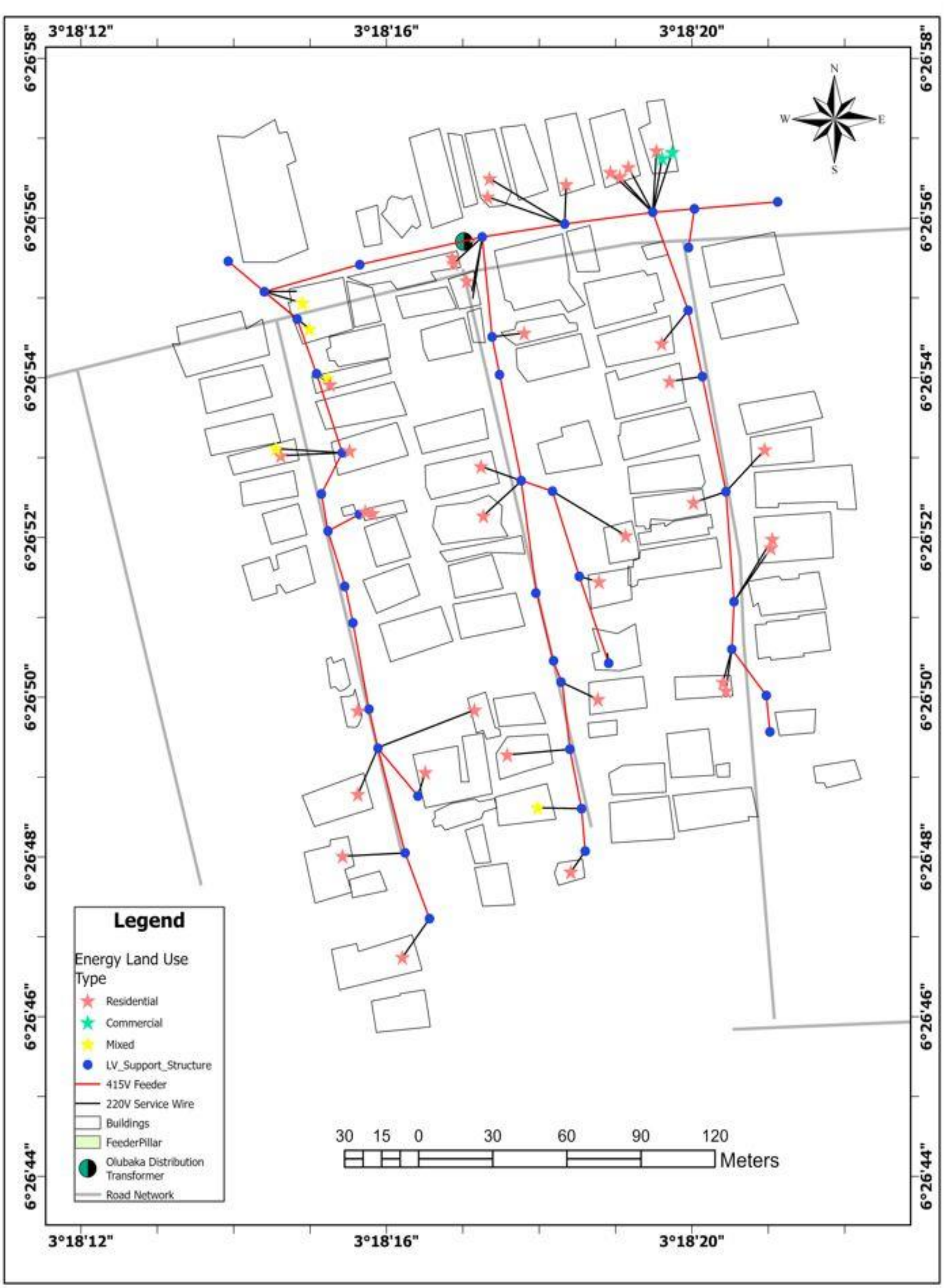


Figure 6: Land Use Classification of Unmetered Customers

4.3 Classification Based on Energy Consumed

As Figure 7 shows, the majority of the unmetered customers are medium energy consumers (22), followed by low energy consumers at 21 and only 1 unmetered customer in the class of high energy consumer.

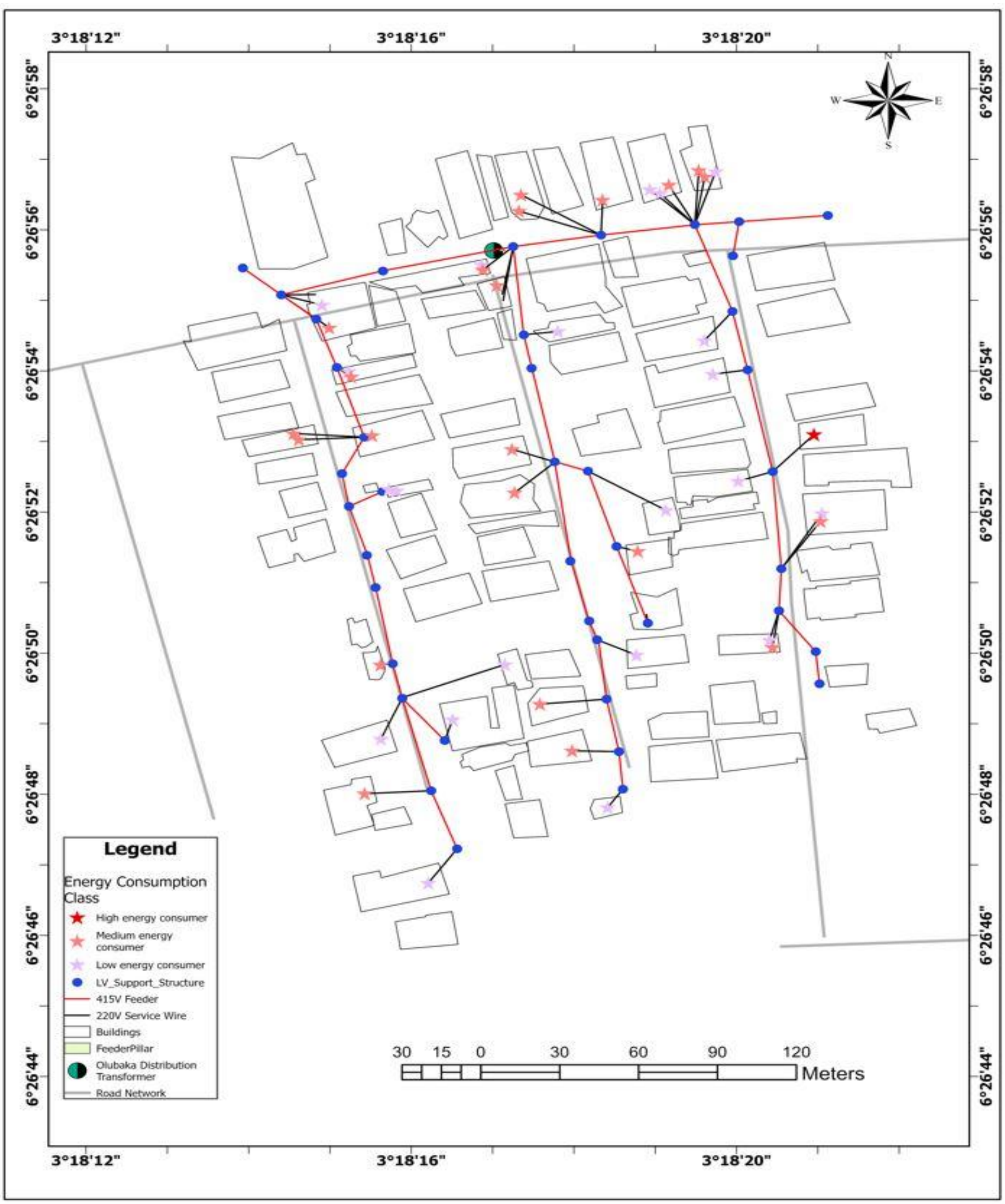


Figure 7: Classification of Unmetered Customers by Energy Consumption

4.4 Energy Consumption and Amount Billed

As presented in Figure 8, the correlation value is 0.99, which shows a very positive correlation between amount billed to the customers and the energy they consumed on an annual basis. Therefore, the kilowatt of energy consumed is commensurate to the amount billed as it is similar within the unmetered customers from the public distribution transformer

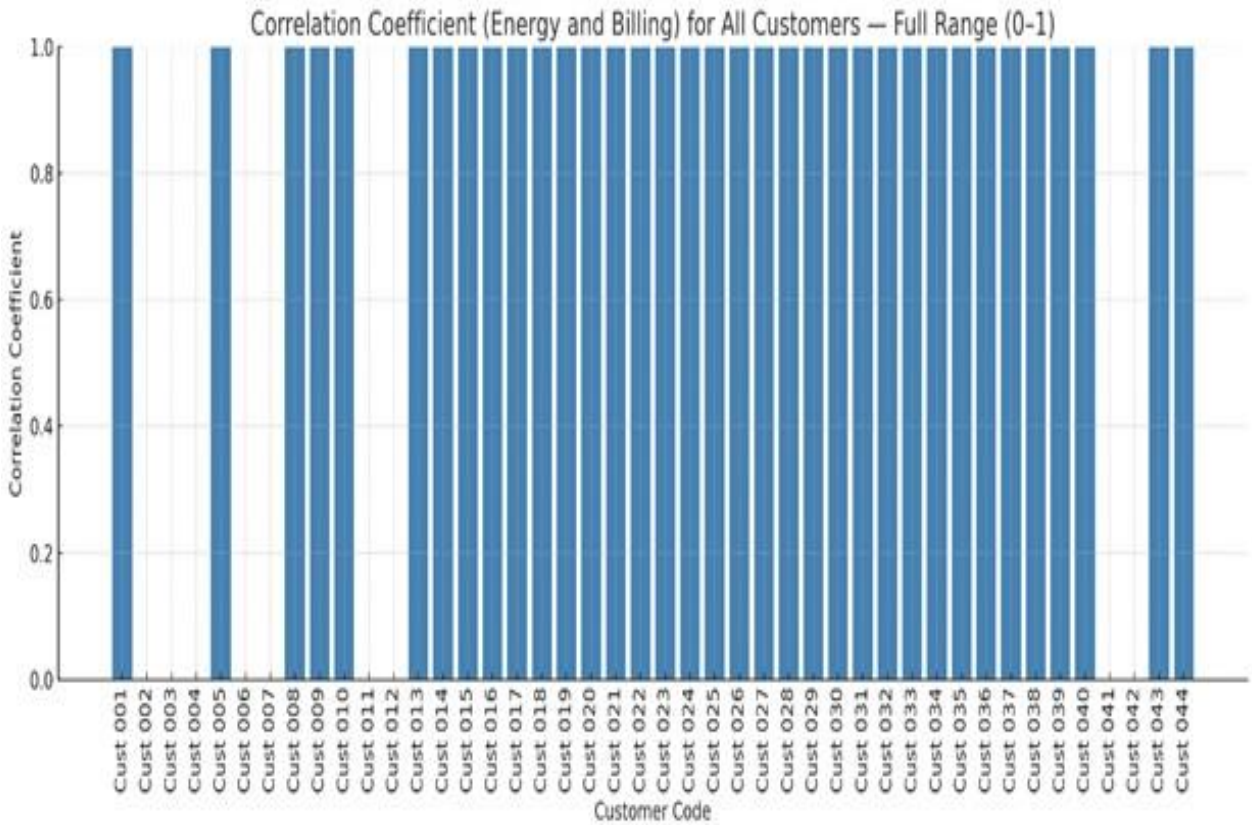


Figure 8: Correlation Coefficient between Customers Consumption and Billing

4.5 Energy Consumption Class by Collection Response Rate

Figure 9 below shows that the only high energy consumer has a medium response rate. The medium energy consumers majorly have a medium response rate, which implies they pay less than 70% of their electricity bill all through the year. Overall, the medium energy consumer class has the most customers that are regarded high in customer response rate. On their part, the low energy consumers have the lowest response rate, which implies that they pay less than 34% of their electricity bill.

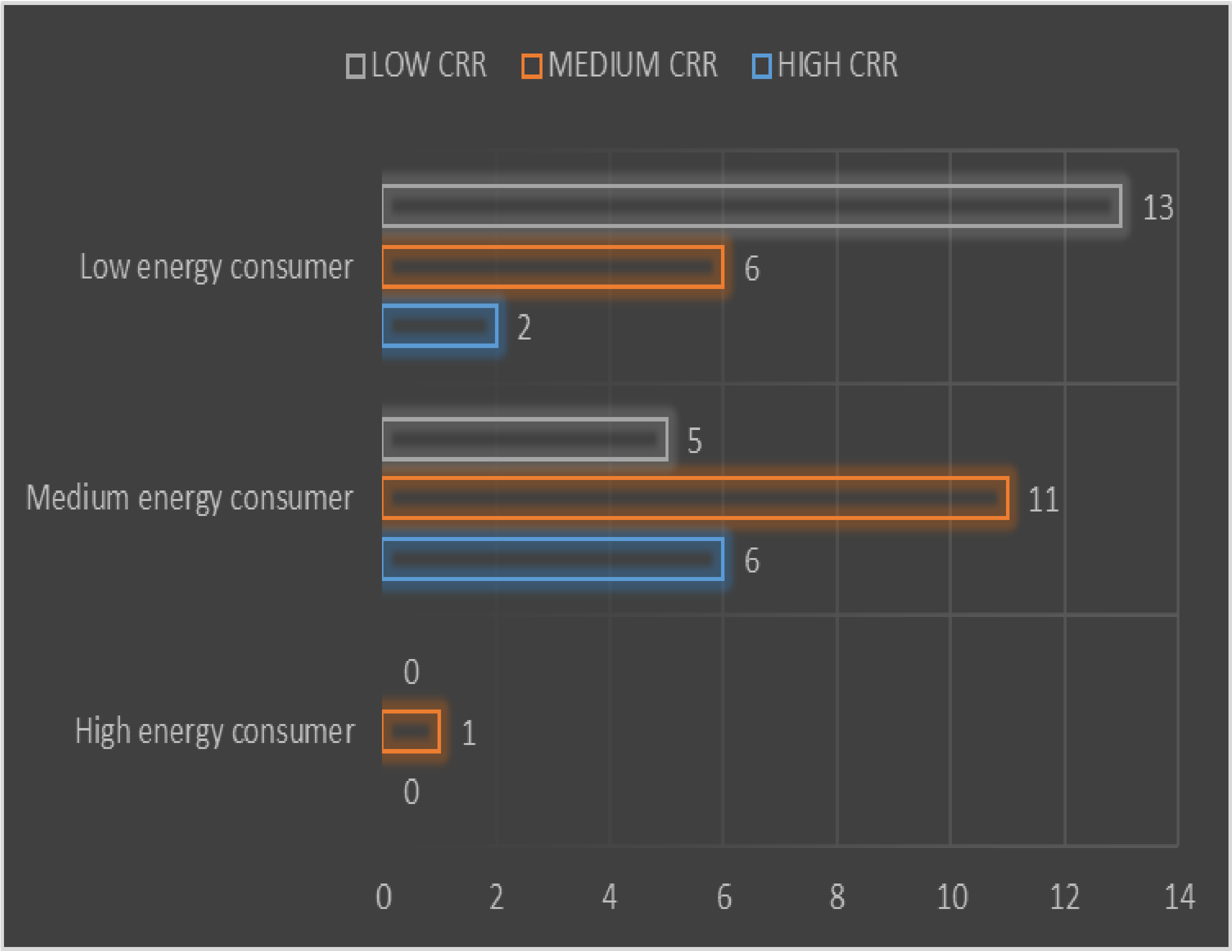


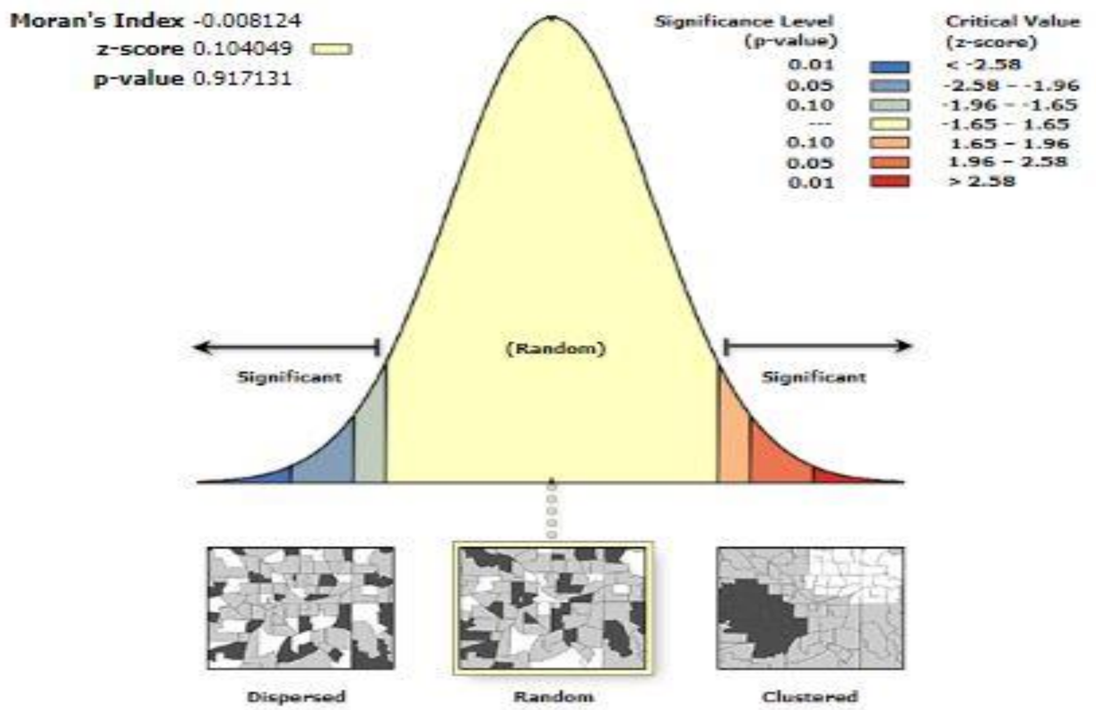
Figure 9: Energy Consumption Pattern by Collection Response Rate

4.6 Spatial Autocorrelation of Average Collection Efficiency

Figure 10 depicts the spatial autocorrelation of the average collection efficiency values of the unmetered electricity consumers. The correlation result indicates that the collection values are spatially random and therefore the collection efficiency values cannot be the only factor used to prioritise a customer for metering.

With a p-value set at 0.05, the p-value of Figure 10 below of 0.91 is above the set 0.05, thus indicating that the variable (Average Collection Efficiency) has no spatial significance in determining priority for metering. This means that Moran's I, which measures the degree of clustering or dispersion of attribute data, has shown randomness in the collection efficiency in this study area.

Spatial Autocorrelation Report



Given the z-score of 0.104049, the pattern does not appear to be significantly different than random.

Global Moran's I Summary

Moran's Index	-0.008124
Expected Index	-0.023256
Variance	0.021149
z-score	0.104049
p-value	0.917131

Dataset Information

Input Feature Class:	Customer Service Point
Input Field:	L1CUSTSERVPOINT.AVGCOLLECTEFFIC
Conceptualization:	INVERSE_DISTANCE
Distance Method:	EUCLIDEAN
Row Standardization:	True
Distance Threshold:	46.2685 Meters
Weights Matrix File:	None
Selection Set:	False

Figure 10: Spatial Autocorrelation of Collection Efficiency

4.7 Ordinal Categorisation of Metering Priority

The ascertainment that there is no spatial correlation between the energy consumption and collection efficiency by the unmetered customers ensured that an ordinal ranking was developed to prioritise unmetered customers. This ranking takes its consideration from the collection efficiency and energy consumption by the unmetered customers. The higher the consumption from an unmetered customer, the more the collection realized will prioritise the customer for metering.

Table 3: Categorisation of Metering Priority

Customer	Energy Consumption Class	Customer Response Rate	Priority
Customer001	Low energy consumer	2	G
Customer002	Low energy consumer	1	D
Customer003	Low energy consumer	2	F
Customer004	Medium energy consumer	2	E
Customer005	Medium energy consumer	2	E
Customer006	Low energy consumer	3	G
Customer007	Low energy consumer	3	G
Customer008	Medium energy consumer	1	B
Customer009	Medium energy consumer	3	H
Customer010	Low energy consumer	2	F
Customer011	Medium energy consumer	2	E
Customer012	Low energy consumer	3	G
Customer013	Low energy consumer	3	G
Customer014	Low energy consumer	1	D
Customer015	Low energy consumer	3	G
Customer016	Low energy consumer	3	G
Customer017	Low energy consumer	3	G
Customer018	Medium energy consumer	1	B
Customer019	Low energy consumer	3	G
Customer020	High energy consumer	2	C
Customer021	Low energy consumer	2	F
Customer022	Low energy consumer	2	F
Customer023	Medium energy consumer	2	E

Customer024	Medium energy consumer	2	E
Customer025	Low energy consumer	2	F
Customer026	Medium energy consumer	3	H
Customer027	Low energy consumer	2	F
Customer028	Medium energy consumer	1	B
Customer029	Medium energy consumer	3	H
Customer030	Low energy consumer	3	G
Customer031	Medium energy consumer	2	E
Customer032	Medium energy consumer	2	E
Customer033	Medium energy consumer	2	E
Customer034	Medium energy consumer	3	H
Customer035	Medium energy consumer	1	B
Customer036	Medium energy consumer	3	H
Customer037	Low energy consumer	3	G
Customer038	Medium energy consumer	1	B
Customer039	Medium energy consumer	2	E
Customer040	Low energy consumer	3	G
Customer041	Low energy consumer	3	G
Customer042	Medium energy consumer	2	E
Customer043	Medium energy consumer	2	E
Customer044	Medium energy consumer	1	B

Key for Customer Response Rate	
1	High
2	Medium
3	Low

The eight (8) priorities of customers, as shown in Table 3 above, ranges from A to H, with A being the top priority and H being the least. Six customers have the most priority since no unmetered customer has the Category A priority. These six customers are medium energy users with a high customer response rate. The six customers are Customer008, Customer018, Customer028, Customer035, Customer038 and Customer044.

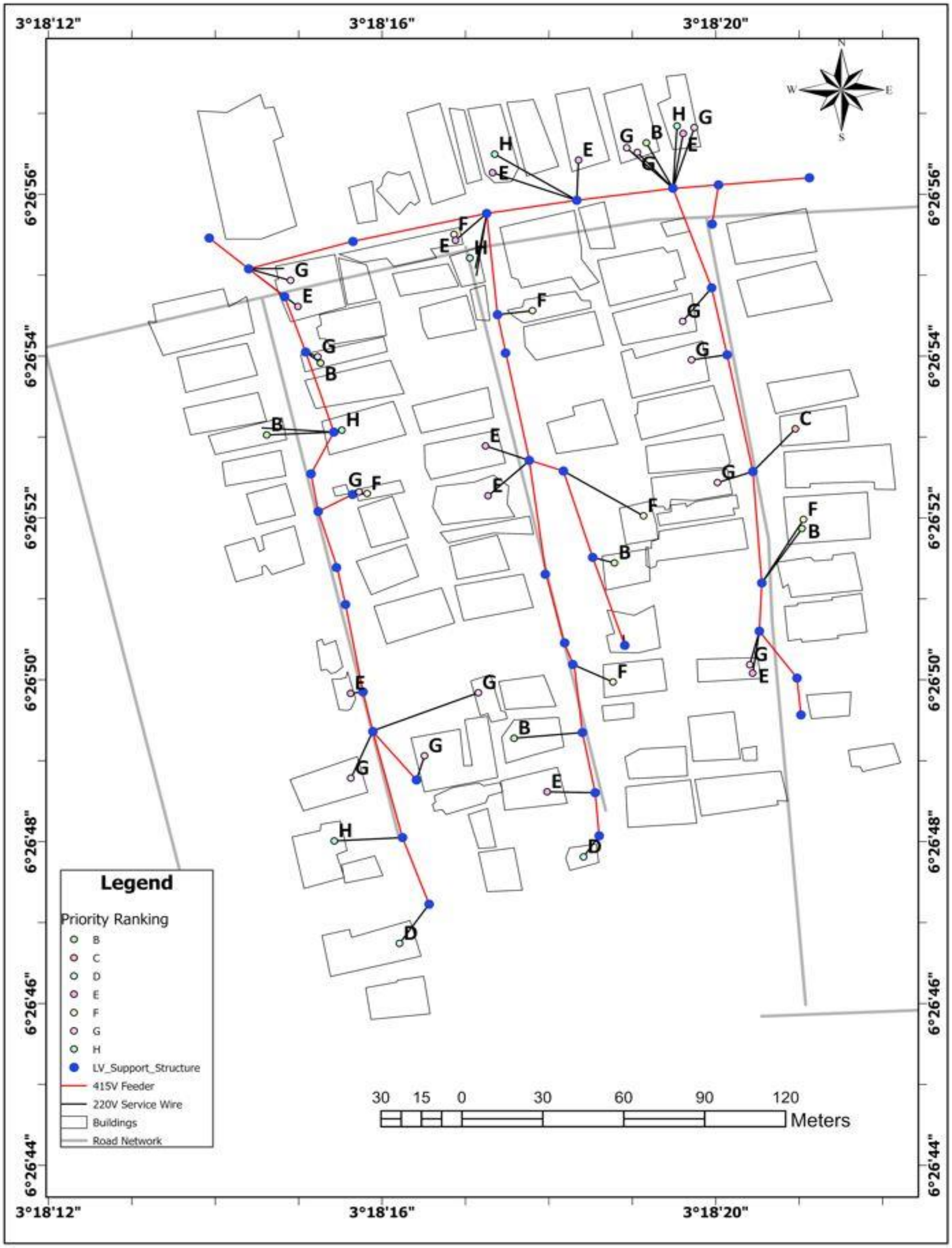


Figure 11: Customer's Metering Priority

5.0 Discussions

This study identified a total of forty-four (44) unmetered customers distributed within the study area. The sum of length of service wires connecting the support structures to customers in the buildings is 1.986km. This discovery strengthens the findings of Onyinyechi (2022), which noted that electricity distribution information systems are needed for the planning and management of a good network. Out of the five land use types adopted for the study, only four were utilised for the actual research, with predominantly residential land usage. There are 37 residential customers, 2 commercial customers and 5 mixed land-use customers. Majority of the unmetered customers are medium energy users consuming between 6,001kWh and 18,000kWh annually. The energy consumption categories revealed that 22 unmetered customers are medium consumers, while 21 are low and just 1 unmetered customer is a high energy consumer. The correlation coefficient between annual energy consumption and annual amount billed showed 0.99, which is a very strong coefficient value implying that the bill issued to them is commensurate to the energy they consumed.

The residential land use dominates the billing land-use type of the customers, with just very little commercial and mixed land use. It was found that the medium energy consumers mainly had a medium response rate, which implies they pay less than 70% of their electricity bill all through the year. As Oyedepo (2012) found, Nigeria's metering system is ineffective and discourages customer payment. It bears noting that the medium energy consumers have the most customers that are regarded high in customer response rate. Spatial autocorrelation analysis was carried out to see if there is a spatial pattern to revenue collection efficiency. However, the p-value of 0.91 shows no spatial autocorrelation and a randomness in the pattern. Therefore, an ordinal ranking was developed to prioritise unmetered customers, in line with Chicco et al. (2006), which found that the recent evolution of the electricity business regulation has given new possibilities to electricity providers for formulating dedicated tariff offers. This ranking takes its consideration from the collection efficiency and energy consumption by the unmetered customers in light of their eight priorities of customers ranging from A to H, with A being the top priority and H being the least. Consequently, only six unmetered customers in Category B are identified to be prioritised for an electrical meter.

6.0 Conclusions

The electrical energy consumption trends of unmetered customers in Lagos State's Agboju area was examined in this study. It was found that spatial patterns in energy consumption or collection efficiency are very random, according to the spatial autocorrelation analysis carried out. To prioritise unmetered consumers for metering based on revenue collection efficiency and energy usage, an ordinal ranking system was created.

One of the major contributions from this study is the development of a framework to prioritise unmetered customers for metering, which would be a solution to the DisCos metering challenges. The findings of this study therefore point to the need for improved revenue generation and reduction of energy theft. The study also highlights the problem of estimated billing while generally calling for the nationwide provision of meters. Indeed, the study may be regarded as a situation report from the unmetered customers littered across the EKEDC distribution network.

7.0 Recommendations

Given the findings of the study, it would be necessary to undertake a proper mapping of metered and unmetered customers across the network in order to provide a detailed metering infrastructure inventory. The classification of unmetered customers would help electricity distribution companies know the revenue collection rate on the different levels of energy consumers. Therefore, a review of all unmetered customers needs to be done. Ultimatey, prioritising metering would help to target the limited meter infrastructure to areas with the greatest potential for revenue generation.

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Finally, I assert that this work is original as no Artificial Intelligence tool or application was used in any part of its production.

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