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Research Paper

Utility Mapping of Electricity Distribution of the Federal Polytechnic Ado-Ekiti, Ekiti State

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Utility networks like water and electricity are vital for the proper and smooth functioning of the modern society. This study focuses on proper working of electricity distribution infrastructure that can only be assessed and monitored by using Geographic Information System. To accomplish this, spatial data on electricity distribution network in the Federal Polytechnic Ado- Ekiti were acquired which involved updating the existing map of the area with DGPS observation, geo referencing and digitizing the map. Attribute data was acquired from the physical planningdirectorate ofthe institution. Designing and creation of database for electricity distribution was carried with the aid of relational database management approach.
KEYWORDS: Utility Mapping, Electricity Distribution, Federal Polytechnic, Ado-Ekiti, Ekiti State, Nigeria

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I. INTRODUCTION

The primary goal of any utility is to plan and manage the use of facilities to deliver a commodity such as water, natural gas, or electricity to its customers. The utility industry has always relied on hardcopy maps to manage facilities, so it was natural that electric, gas, and water companies should be among the first users of digital mapping software. However, with time, physical maps deteriorate, get lost or are misfiled. Where available, similar records are kept at different departments - (thus creating a waste of storage space); accessibility to data becomes insecure or impossible altogether. These shortcomings call for new tools and strategies, to not only drive down management costs, but also to improve on space management [1]and[2]..

Hence, Geographic Information System GIS is being employed to improve the processes of Data gathering and compilation needed for Utility management beating inherent limitations faced by traditional system of keeping and managing information.

Development of geo-referenced consumer and network database has become a necessity for a host of power distribution applications like customer information system, asset management, trouble call management, billing system, energy audit and load flow studies. The Power Distribution Companies constantly engage in updating their consumer data and thecorresponding electrical network attributes. Geographical Information System (GIS) technology plays an important role in mapping the consumers and electrical network assets [3]and [4]..

Electricity is an aspect of the utility sector that is very essential to the smooth and meaningful development of a society. The primary purpose of an electricity distribution system is to meet the customer's demand for energy after receiving the bulk electrical energy from transmission or sub transmission substation. Complexity of electrical distribution power system is the only reason for introducing new technologies such as RS and GIS technology. Database plays an important role in planning. The spatial visualization capabilities of GIS technology can be combined with remotely sensed satellite imagery and GPS to evaluate the effects of management practices and to assist resource managers and public decision makers in making knowledgeable decisions [5]. The core of the utility mapping comprises of CADD, Geographical Information Systems (GIS), and Global Positioning Systems (GPS) technologies. The digital utilities infrastructures are then linked to a database that carry detailed attribute information about each utility. Through query, information about each utility and its relationship to other utilities can be obtained for planning and management purposes. Usually the decisions made using utility mapping are not for analytical purposes but for allocating resources for service dispatching, inventorying, and maintenance. Nevertheless, analytical studies such as network analysis and catchments area analysis are possible with utility mapping systems [6].

The main objective of the study is to map spatial data of electricity infrastructures within the Federal Polytechnic Ado, Ado-Ekiti Main campus such as buildings, electric poles, transformers and generators, using remote sensing, Geographic Information Systems and GPS techniques.

i. Creation of database of the information concerning electricity infrastructures.
ii. Retrieval of the information for instantaneous use in decision making by the institution management, which should now be faster and easier.
iii. Identification of electricity infrastructures within the institution so as to establish which ones need immediate attention and which ones need to be added.

II. STUDY AREA

The Federal Polytechnic Ado Ekiti is situated in Ado-Ekiti; a Yoruba city in Ekiti State in the southwestern part of Nigeria. It is a beautiful polytechnic campus whose physical development over the years is based on a prepared master plan which made adequate provision for both present and future needs of the polytechnic. In addition to the prepared master plan, factors that contributed to the aesthetic beauty of the campus are; beautiful architecture, landscaping, beautiful walkways and open space.

It is one of the second generation Polytechnics and it was first founded as a College of Technology in Jos, Plateau State in January, 1977 and later that year moved to Akure, Ondo State by the then Federal Military Government. The Federal College of Technology, Akure was later converted into a fully fledged Polytechnic by decree No.33 of July 1979. By 1982, the Federal Government founded the Federal University of Technology at its site in Akure and thus relocated the Polytechnic to Ado- Ekiti. The relocation process which began in earnest from 1983 was completed in 1986.

The polytechnic lies within latitude 7º 35′N to latitude 7º 36′N and longitude 5º 12′E to longitude 5º 17′E within Ado Central Local Government Area in Ado Ekiti.

Land use pattern of the built-up area of the campus could be classified into three namely:

i. The central campus
ii. Halls of residences
iii. The staff quarters.

The academics area of the campus forms the hotspot of activities on the polytechnic comprising the Lecture theatres and the old and New Administrative blocks, churches, a mosque, a digital Library, recreational and sporting areas.

Halls of residence are mainly provided for students' accommodation. Male hostels are: Abuja and Annex hall, while female hostels are Lagos and part of Annex hall. The staff quarters are purely for residential purpose and comprise the accommodation facilities for staff; both academic and non-academic.

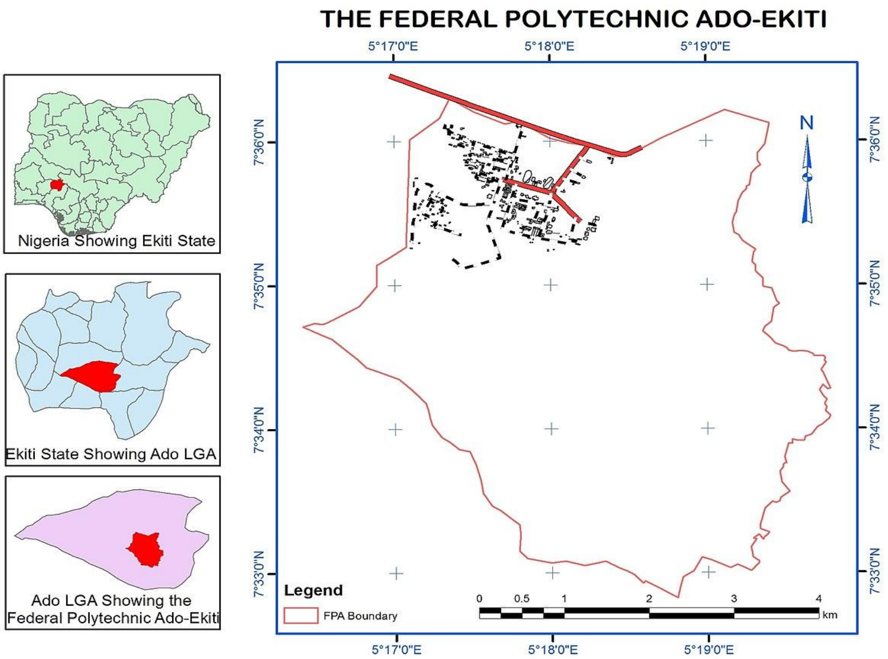

Figure 1.1:- Study Area Map(Source: Taiwo, 2018)

III. RESEARCH FLOWCHART

The methodological framework for this study involves the use of geospatial information system technology for data acquisition, database design, data processing and geo-visualization. The methodology adopted in adhering the general goal of this project includes Planning, Data Acquisition, Data Processing, and Geospatial Analysis. Planninginvolves making adequate preparation and takingdecision that will facilitate the realization or attainment ofset of objectives.

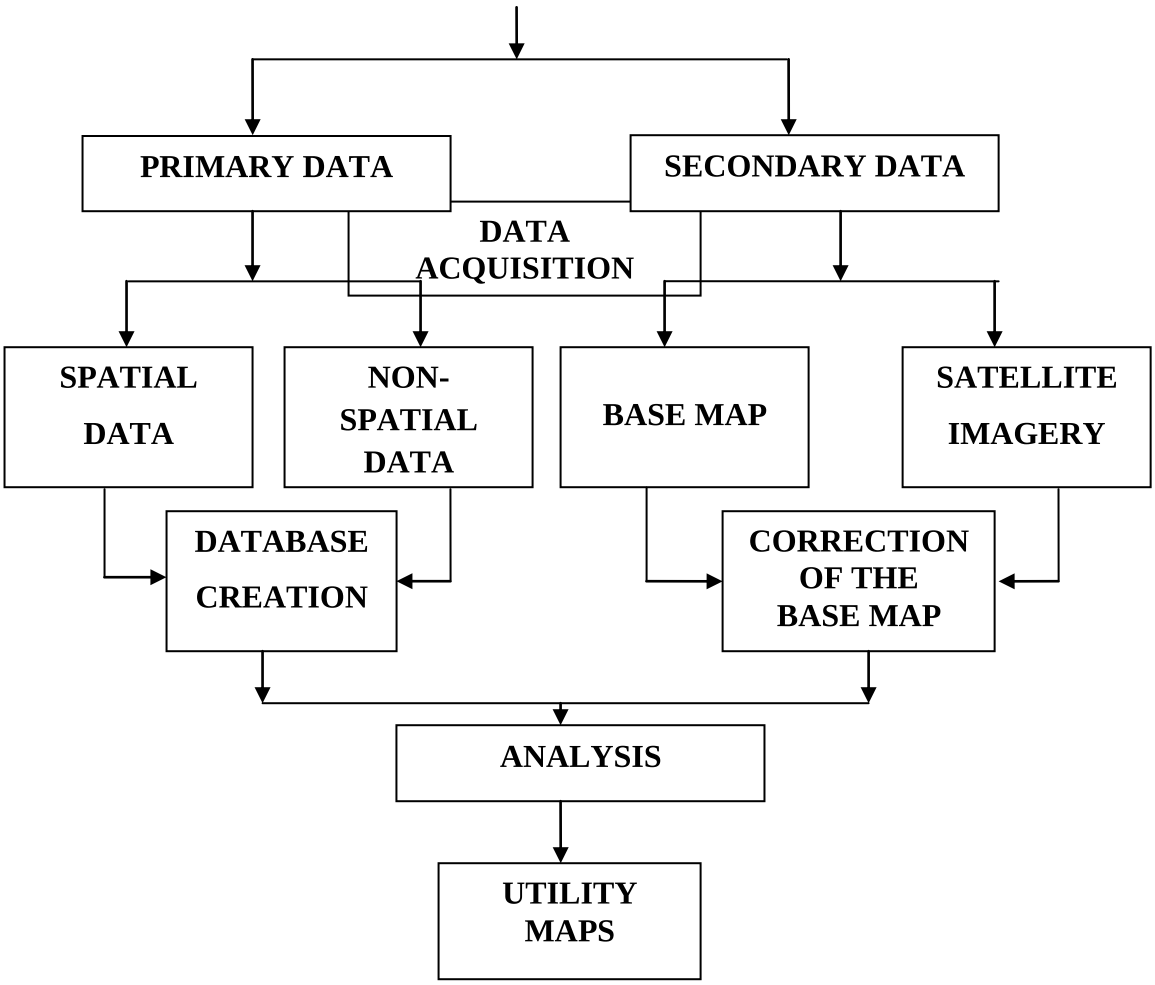

Figure 3.1: Flow chart of the Research

IV. DATA ACQUISITION

The Data acquisition began with the physical phenomenon to be measured. The first step in the methodology of this work was the collection of the required data from the study area. In this case, there were two ways of acquiring data for this mapping project; these are primary and secondary data acquisition.

PRIMARY DATA

The primary data acquisition includes both spatial and attributes data. The data set of the spatial data was acquired through the use of CHCNAV i50 (Differential GPS) and the attribute data was acquired through the help of the department in charge of electricity distribution in the study area (department of physical planning). It involves obtaining first-hand information from the study area.

- **Spatial Data:** The spatial data used for the research is GPS data. GPS collection points on the available federal polytechnic Ado-Ekiti facilities (Poles, Transformers, and Generators) are acquired from the field of study using a CHCNAV i50 (differential GPS).

- **Attribute Data:** The attribute data includes the information acquired from the department of physical planning, federal polytechnic Ado-Ekiti. Hence, the details information on the electric networks like transformer, poles and generators and the details about transformer capacities, cables and other related facilities.

SECONDARY DATA

This involves the information acquired from the satellite imagery downloaded and an existing base map. The base map consists of roads network and built-up areas only. The aim of using these two data was to update and rectify any form of error on the base map.

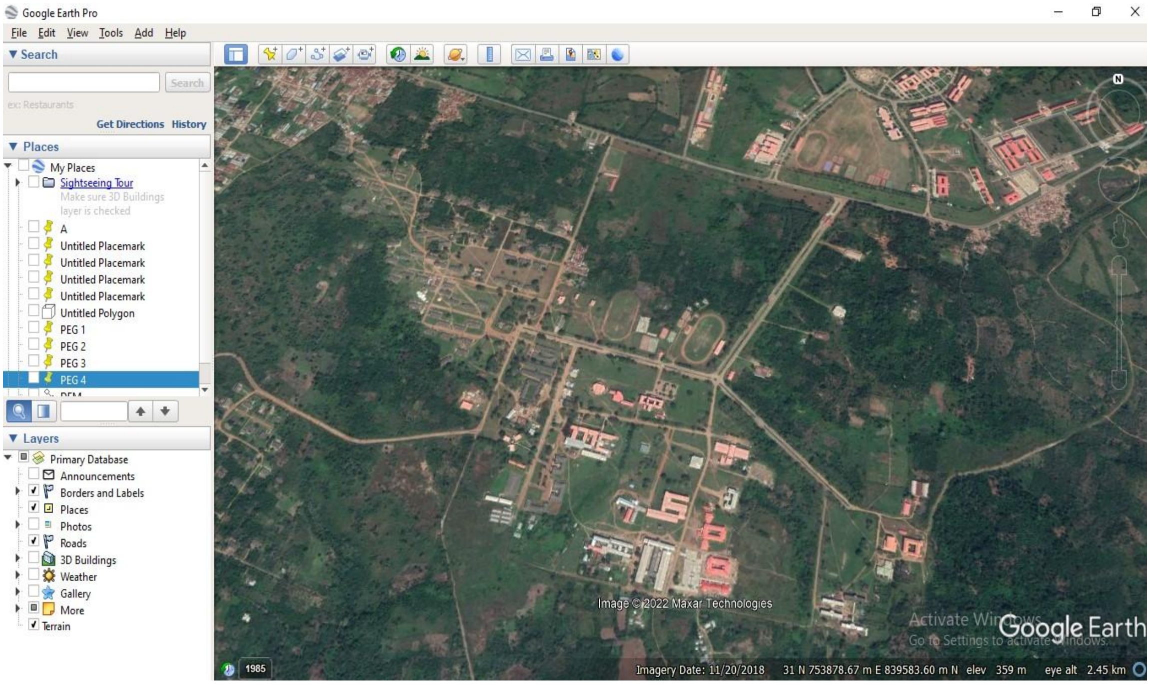

Figure 3.2. The satellite Imagery downloaded from Google Earth.

OBSERVATION PROCEDURE

These are necessary tasks; set of methods and principles adopted, and are performed in the field, for the acquisition of the required data. The procedures show how data are determined from various sources in other to achieve the objectives of the project and the mode use for the field of kinematic differential positioning. During this procedure, we make enquiries through the department of Surveying and Geo-informatics to the Department of physical planning in the institution about various locations of electricity infrastructure in the school.

CHCNAV i50 (differential GPS) was used in acquiring geometric data. The instrument base was set up on AGST 003 and all the necessary adjustment was carried out. The instrument was powered on and the job named. The coordinate of the controls were then inputted into the instrument. The coordinates of the station was set and orientation was performed in the instrument. After this process, the instrument base was connected to the rover. Then the rover was tested on the control point after which all needed features such as, electric poles, transformers and generator house were observed.

Figure 3.4. Personnel working on project site.

V. DATA PRESENTATION

The geographic location of each distribution poles, generator and transformer in the study area was acquired using CHCNav i50 (Differential GPS) instrument. It was found that there were 10 distribution transformers, 16 generators that are housed and 531 poles mounted. The details such as distribution transformer ID, its voltage capacity, pole structure, etc. was collected from the Department of Physical planning of the institution**.**

LOCATION OF TRANSFORMERS

A total number of Ten (10) transformers were coordinated. This is as shown in table 1.

Table 1: GPS COORDINATES SHOWING LOCATION OF TRANSFORMERS

S/N	EASTING (m)	NORTHING (m)
1	753847.8159	840033.7883
2	753369.5146	839813.0842
3	753157.4876	840174.1509
4	752624.5119	839507.962
5	752800.1311	840679.7641
6	753674.9311	839437.4845
7	754008.3992	839366.3879
8	753747.1478	839754.4842
9	755591.778	840831.763
10	753500.94	839916.29

The coordinate were plotted on the existing map to show their spatial relationship. (see figure 4.1).

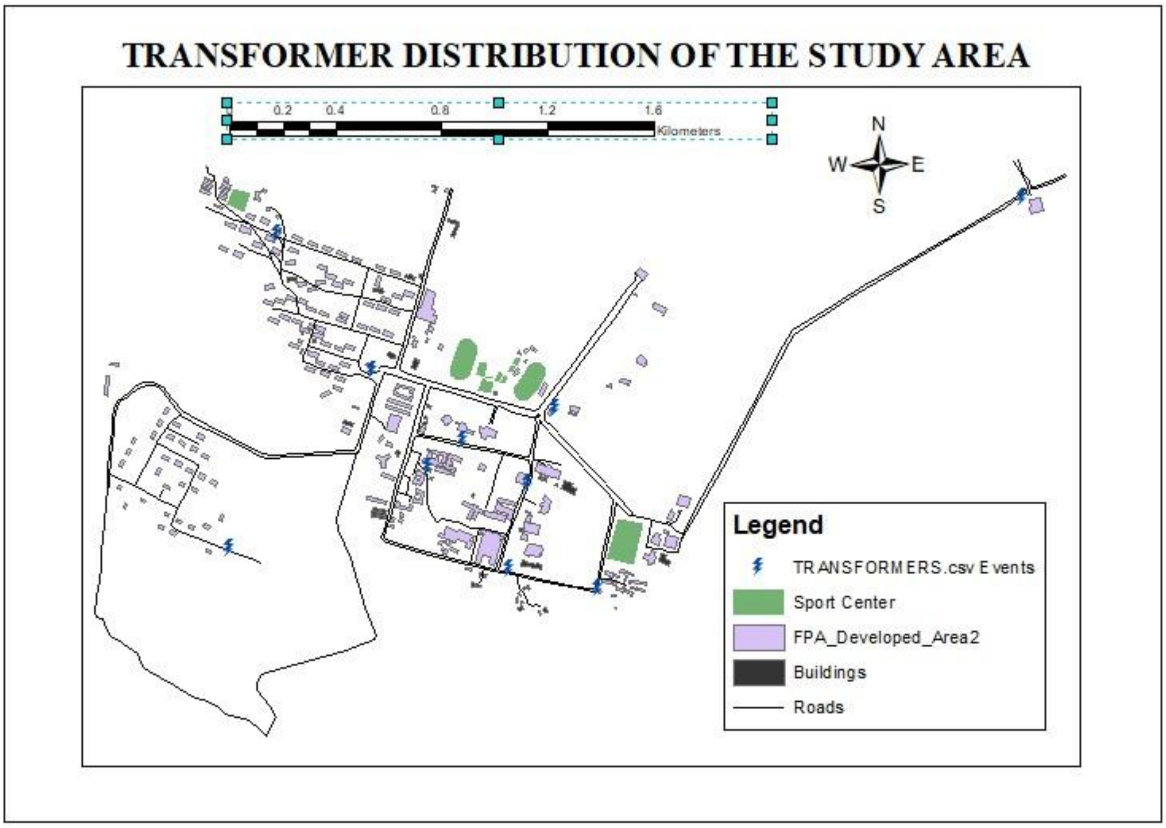

Figure 4.1 Map showing the distribution of transformer within the developed area in the study area.

VI. LOCATION OF GENERATORS

A total number of sixteen (16) generators were coordinated. This is as shown in table 2.

Table 2: GPS COORDINATES SHOWING LOCATION OF GENERATORS

S/N	EASTINGS (m)	NORTHINGS (m)
1	752805.1146	840693.5309
2	752598.6743	840726.4959
3	753061.2370	840570.2782
4	753138.2058	840193.5988
5	753372.9860	839772.4192
6	753376.7508	839801.6956
7	753609.5434	839599.5779
8	753675.6133	839444.2697
9	754009.6054	839375.1337
10	753814.0147	839756.5071
11	753790.5166	839792.0352
12	753832.1728	839678.6105
13	753579.1446	839793.2605
14	753620.9536	839922.1381
15	755685.1600	840812.3200
16	753369.2900	839804.4500

The coordinate were plotted on the existing map to show their spatial relationship. (see figure 4.2).

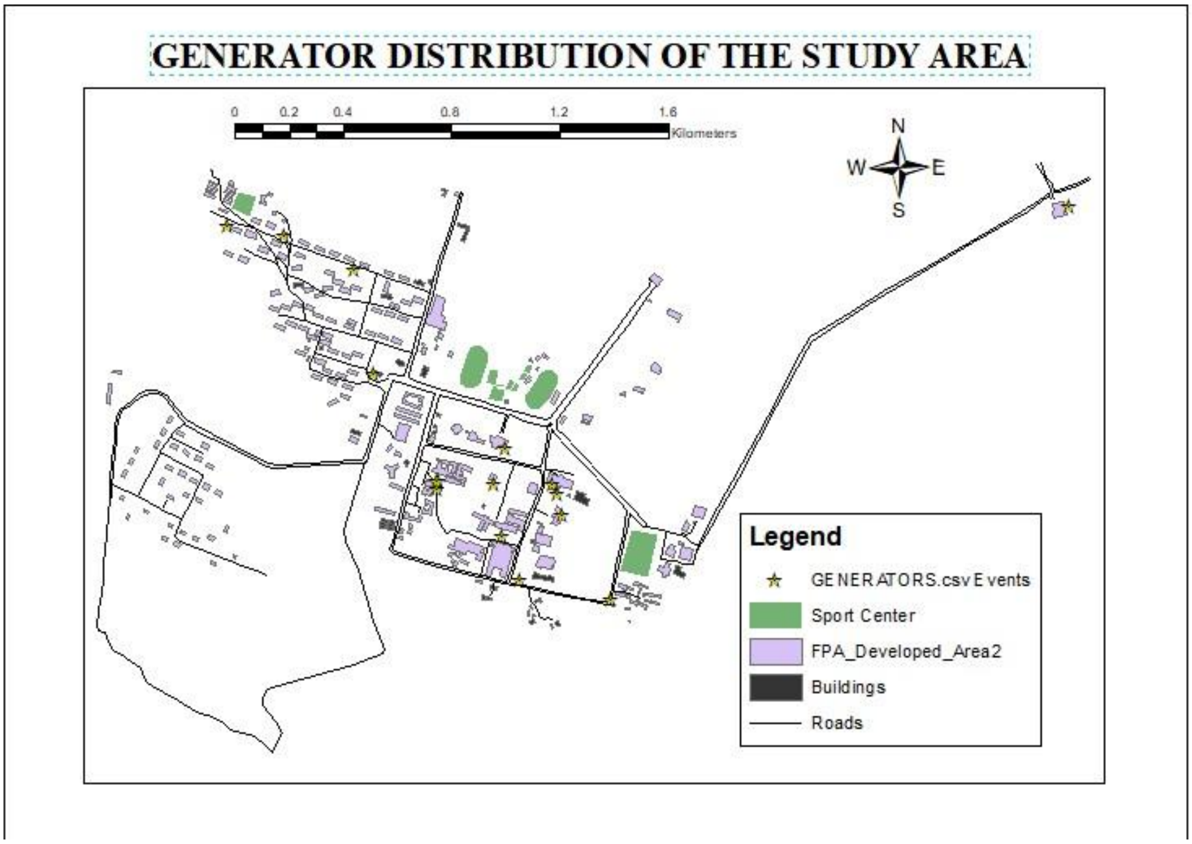

Figure 4.2 Map showing the distribution of Generator within the developed area in the study area.

LOCATION OF ELECTRICITY DISTRIBUTION POLES

Northing and Easting of five hundred and thirty-one (531) electricity distribution poles were determined (See Appendix I). The coordinate were plotted on the existing map to show their spatial relationship. (See figure 4.3).

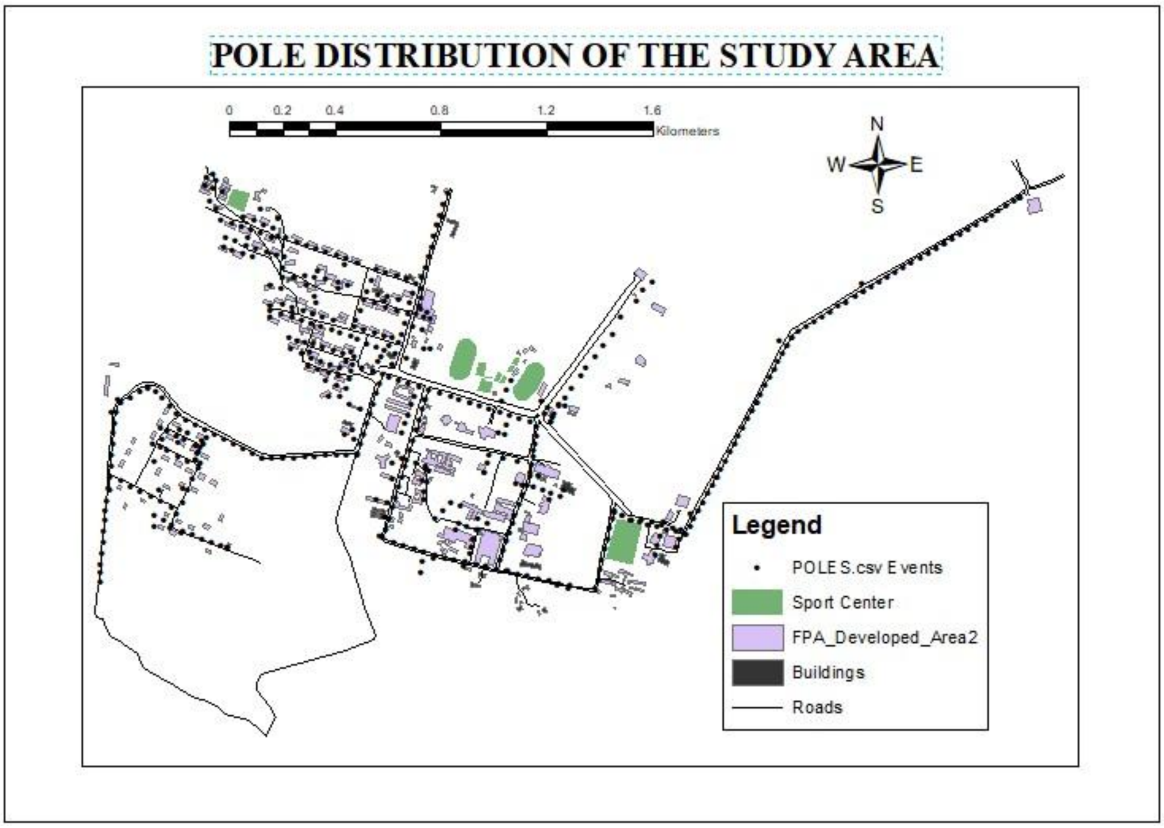

Figure 4.3 Map showing the distribution of poles within the developed area in the study area.

VII. FINDINGS, RESULT AND DISCUSSION

Geographical Information Systems have a distinctive disparity from other Information Systems, which is in the area of spatial analysis. The spatial search operation was carried out through query generation to retrieve the information stored in the database pertaining to certain systematically defined attributes within the database to answer spatially related questions. This operation involved the link between the database and the map of the selected area of interest. Spatial queries were generated to provide answers to the application use of GIS in developing a model (representation of reality) for the directorate of physical planning.

Data were formally entered into their respective tables, created in Microsoft Access. After the data entry process, the database was exported into ArcMap environment. A file geodatabase was created and saved in Arc Map in a folder for easy recovery, geo spatial analysis were carried out on them. The data stored in the database forms the information base. The attribute table was linked to the spatial themes containing geographic information. The database created included location and descriptive information for all the different components of the system.

There are a total of 10 transformers accounting for 100% of the overall Electricity distribution in the institution. Transformers in this category have different capacities, mostly ranging from 100kVA to 500kVA. They are purchased, installed and maintained by the distribution company (BEDC) for the general use in the areas located. They are spatially distributed across all parts of the study area in varying patterns due to the mixture of the urban land uses. This is due to the fact that the areas are mostly made up of residential and commercial buildings. The transformers are evenly distributed, however some transformers are overloaded.

Table

XYTRANSFOR

OBJECTID *	EASTING	NORTHING	LOCATION	CAPACITY	Shape *
1	753847.8159	840033.7883	SUB STATION	2.5MVA	Point
2	753369.5146	839813.0842	GLASS TECHNOLOGY TRANSFORMER	300KVA	Point
3	753157.4876	840174.1509	CENTRAL TRANFORMER	500KVA	Point
4	752624.5119	839507.962	RECTOR's VILLAGE TRANSFORMER	250KVA	Point
5	752800.1311	840679.7641	ANNEX TRANFORMER	300KVA	Point
6	753674.9311	839437.4845	ENGINNEERING TRANSFORMER	250KVA	Point
7	754008.3992	839366.3879	ABUJA TRANSFORMER	300KVA	Point
8	753747.1478	839754.4842	CICT TRANSFORMER	100KVA	Point
9	755591.778	840831.763	CEDVS TRANSFORMER	300KVA	Point
10	753500.94	839916.29	PTDF TRANSFORMER	100KVA	Point

0 (0 out of 10 Selected)

Figure 4.4.Table showing the information about each transformer.

A query was made to show the number of transformer greater than 100kva, out of 10 transformers it was only eight transformers that was greater than 100kva. The remaining two transformers were observed to be use for specific buildings, which is sufficient. While the other eight were observed to be overloaded. They are use for various purposes.

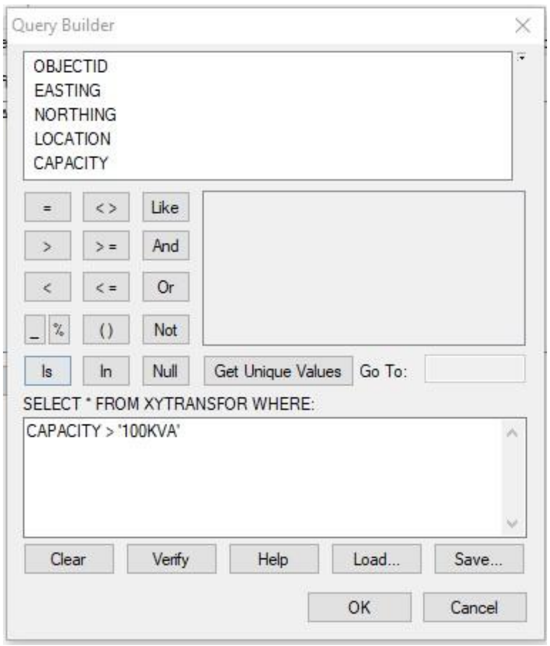

Figure 4.5. Query operation showing the numbers of transformer greater than 100kva.

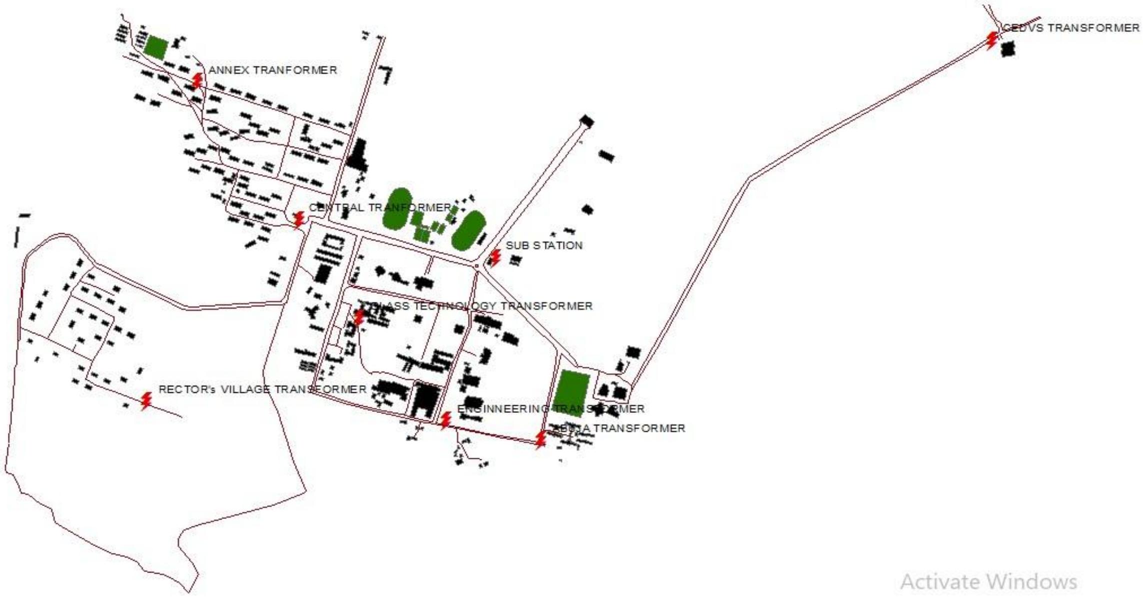

Figure 4.6. Map showing the result from the query operation.

The transformer indicating sub-substation, serves as the step-down transformer point round main sub-station of the polytechnic power supply from which all other energy transformers in the institution is serviced through. The transformer indicating central, glass technology, annex, and Abuja transformer were observed to be overloaded due to the various category of workload on it. The other transformers were observed to be used adequately. (See figure 4.4, 4.5 and 4.6)

The electricity distribution poles were properly distributed around the institution. A query was performed to show the numbers of wooden poles and concrete poles. The result shows that they were 45 wooden poles and 486 concrete poles. It was observed that majority of the wooden poles were not properly erected. It is understandable that the purpose for the wooden poles was for easy access of connection to structures. It was observed that majority of the concrete poles were carrying both high and low-tension cables and they are properly erected.

Figure 4.7. Map showing the distribution of wooden poles

Figure 4.8. Map showing the distribution of concrete poles

VIII. SUMMARY, CONCLUSION AND RECOMMENDATION

This study has shown the distribution of electricity infrastructure in the Federal Polytechnic Ado-Ekiti using geospatial information system procedure for analyzing and manipulating of the extracted data (i.e. the X and Y data on transformers, generators and poles). It was found that there were 10 distribution transformers, 16 generators that are housed and 531 poles mounted. The details such as distribution transformer ID, its voltage capacity, pole structure, etc was collected from the Directorate of Physical planning of the institution**.**

Electricity proves to be one of the most vital utilities to a society at large, as such its processes right from the source to consumption point is very important to all. It becomes pertinent to appropriately monitor electrical activities from generations, through transmission, up to distribution point. This becomes achievable with the inculcation of a GIS into the utility sector. It becomes evident from the embarked study that this geospatial technology has emerged as a powerful and imperative system when applied into electricity distribution planning and monitoring.

A digital method of data inventory and documentation of electric power distribution infrastructural facilities were achieved and corresponding maps were produced. Information pertaining to the state of each of the electricity infrastructure were acquired and stored in a database, which was used for analysis. The application of a GIS into electricity distribution reveals that it can greatly improve the efficiency in that utility sector, thus improving the reliability of both distribution network and the authority that manages it.

The continuous attention on growing power demand is highly essential in electricity distribution in Nigeria. Planning has to be continuously done in order to provide a quality, sustainable and uninterrupted power supply to the consumer especially by reducing the power loss. For this research, we recommend the following:

i. There should be involvement of spatial intelligence planning which could be achieved by employing the services of Geomatics experts. The current state of not having a proper distribution mapping system is not good for essential planning and management. Thus having a robust Geomatics section in the electricity industry and putting and enterprise, GIS in place cannot be over emphasized.

ii. The institution management should deploy more transformers, for efficient power supply. Regular maintenance should also be carried out on the existing transformers.

iii. Transformers that are in service for more than 25 years should be replaced with new one in order to avoid sudden breakdown in distribution.

iv. The institution management as should also build a comprehensive geodatabase of all its assets to improve information collection and analysis. This will help in decision-making.

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