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Geospatial Modelling and Analysis of Electricity Distribution in Nnamdi Azikiwe University, Awka Nigeria

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Abstract

Efficient electricity distribution is fundamental to the effective operation of higher institutions, where academic, administrative, residential, and research activities depend heavily on uninterrupted power supply. This study presents a geospatial modelling and analysis of the electricity distribution network within Nnamdi Azikiwe University using Global Mapper Mobile, Global Mapper Desktop, ArcMap 10.3, and Google Earth Pro. The objective was to develop a comprehensive geospatial database of electrical infrastructure, including transformers, transmission lines, solar grid plants, and major electricity consumers within the university environment. Spatial data were acquired through field surveys using Global Mapper Mobile and supplemented with a high resolution satellite imagery obtained from Google Earth Pro. The collected data were processed, geo-referenced, digitized, and analyzed in Global Mapper Desktop and Arcmap 10.3. Various geospatial analyses such as proximity analysis, network visualization, spatial querying, infrastructure distribution assessment, and service coverage evaluation were performed. The results revealed the spatial distribution of electrical facilities across the university, identified areas with inadequate infrastructure coverage, and demonstrated the usefulness of geospatial technologies in electricity asset management. The study concludes that integrating GIS-based electricity management systems into university infrastructure planning can significantly improve maintenance efficiency, fault detection, decision-making, and future expansion planning.

Keywords: Electricity Distribution, GIS, Global Mapper, Google Earth Pro, ArcMap 10.3, Utility Mapping, Spatial Analysis, Geospatial Modelling

Introduction

Electricity is one of the most important infrastructures supporting teaching, research, administration, and residential activities in tertiary institutions. The increasing dependence on electronic systems, digital laboratories, internet services, security infrastructure, and student accommodation facilities requires a reliable electricity distribution system.

Traditionally, electricity infrastructure records are maintained using paper maps, engineering drawings, and textual descriptions. These methods often lead to challenges such as poor documentation, difficulty in locating facilities, delays in maintenance operations, and inefficient planning.

Geospatial Information Systems (GIS) provide a powerful platform for capturing, storing, managing, analyzing, and visualizing utility infrastructure. Through GIS, electrical facilities can be accurately mapped and linked to attribute information, creating an intelligent database that supports planning and decision-making.

Nnamdi Azikiwe University, Awka, possesses a complex electricity distribution network comprising transformers, utility poles, distribution lines, generators, and solar grid plants. Proper documentation and spatial analysis of these facilities are essential for effective infrastructure management.

Study Area, Research Description and Methods

Study Area

Nnamdi Azikiwe University is located in Awka, Anambra State, south-eastern Nigeria. The university lies approximately between: Latitude: 6°11'N – 6°15'N and Longitude: 7°04'E – 7°08'E. The campus comprises of; Administrative areas, Academic buildings, Faculties, Hostels, Staff quarters, Health facilities, Commercial centers, Road networks.

The presence of these facilities necessitates a robust electricity distribution network.

Research Description and Methods

The methodology adopted in adhering the general goal of this project included.

1. Planning
2. Data Acquisition
3. Data Processing
4. Geospatial Analysis and Query (Spatial Data Creation)

Planning

Planning involves marking proper and necessary preparation and taking decision that will facilitate the realization or attainment of set of objective. Hence, the Hardware, software and other important materials needed for effective execution of the project were extensively considered.

Hardware

- Android Smartphone
- GNSS-enabled Mobile Device
- Laptop Computer
- Power Bank

Software

Global Mapper Mobile

Used for:

- Field data collection
- Feature positioning
- Attribute recording
- GPS tracking

Global Mapper Desktop and ArcMap 10.3

Used for:

- Data processing
- Geospatial database development
- Spatial analysis
- Map production

Google Earth Pro

Used for:

- Satellite image extraction
- Ground verification
- Feature identification
- Base map preparation

Data Acquisition

Primary Data

Field survey was conducted to collect coordinates of:

- Transformers
- Electric poles
- Solar grid plants
- Power distribution units

Using Global Mapper Mobile, each feature was recorded with:

- Unique ID
- Coordinates
- Type
- Condition
- Capacity
- Operational status

Secondary Data

Obtained from:

- Google Earth Pro imagery

Data Processing

Step 1: Import Satellite Imagery

Google Earth Pro imagery imported into Global Mapper Desktop.

Step 2: Georeferencing

Imagery was georeferenced to the WGS84 coordinate system.

Step 3: Digitization

Features digitized included:

- Roads
- Buildings
- Utility corridors
- Distribution lines
- Electrical installations

Step 4: Geospatial Analysis and Query (Database Creation)

The creation of a structured, digital database is the most important and complex task upon which the usefulness of the cadastral information system depends. Database design is the process of producing a detailed data model of a database (Hernandez, 2012) [2]. The design phase consists of three levels (Kufoniyi, 1998) [3]:

- Conceptual Design
- Logical Design
- Physical design

1. Conceptual Design

This is a representation of human conceptualizing of reality of the entire information content of the database. Here decision on how the view of reality was presented in a simplified manner and to the satisfaction of the information

2. Logical Design

This is another stage of the database design in which all the real world entities conceptualized were modelled into the real world using logical design. It is the representation of the conceptual design to reflect the recording of the data in the computer system using a relational database management system (RDBMS) (Effiong and Alagbe, 2012) [1]. In this phase, the entities, their attributes and their relationships were represented in a single uniform manner inform of relation in such a way that would be no information loss and at the same time no unnecessary duplication of data. For this study, relational data model was used due to its easy implementation and management. The conceptual data model developed in this study was translated into the relational data structure. In the relational data model, data are separated into tables. They

are found along rows and columns. The conceptual model was translated into a logical structure and the following relations were derived.

3. Physical Modeling Phase

This is the phase where the data structure is translated into built-in data of the chosen software. Nowadays, GIS software dictates most of the physical database design activities. The physical database design for each spatial entity has been completely defined by the vendor and the GIS designer does not have to do anything more for this part of data.

Results and Discussion

The geospatial model successfully integrated all mapped electrical infrastructure into a unified database.

Major findings include:

- Accurate locations of transformers were established.
- Distribution lines were successfully mapped.
- Service coverage gaps were identified.
- Spatial relationships among infrastructure components were visualized.
- Digital records replaced conventional paper-based documentation.

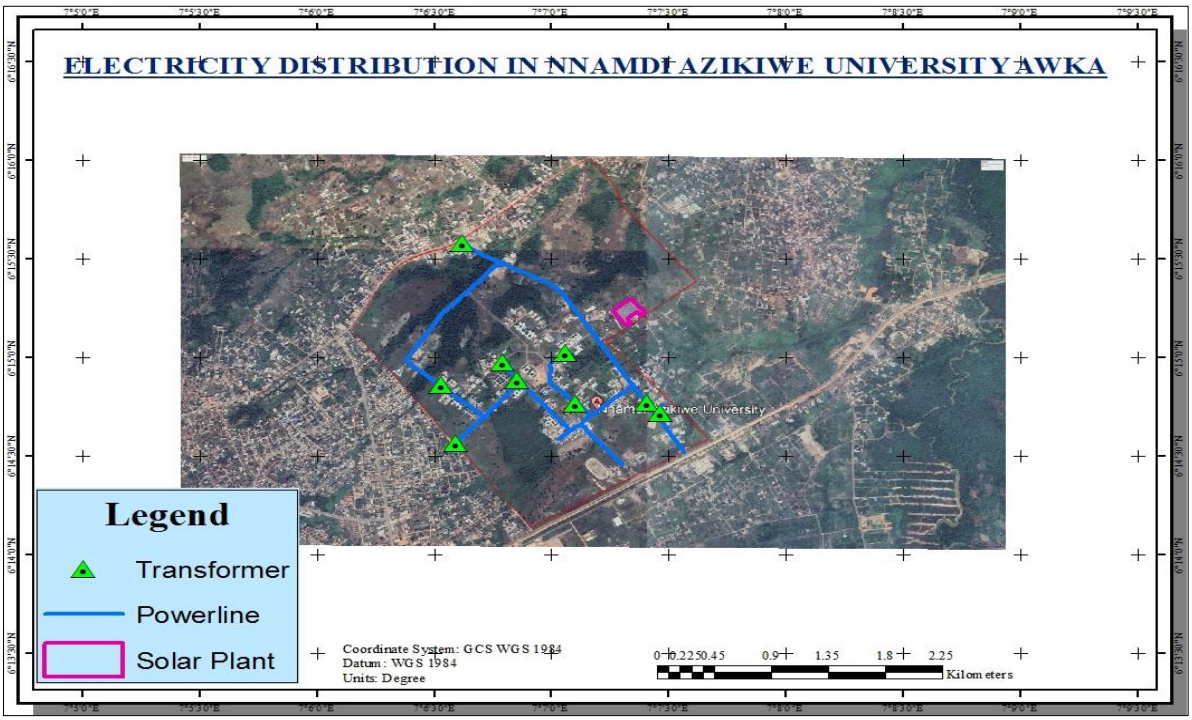

Fig 1: Geospatial Map Of Electricity Distribution In Nnamdi azikiwe University Awka, Anambra State

The figure above shows that totality of the project. This is the end result of Geospatial Electricity Distribution in Nnamdi Azikiwe University Awka, Anambra State in which different information are display on the map which can be easily identified through the use of the map's legend.

Such information are the Transformers, transmission lines and solar grid plants. it also shows the coordinates system (WGS 84) in which the features in the map falls in. Graticule type of grid was used for easy identification.

The study demonstrates that Google Earth Pro, Global Mapper Desktop, Global Mapper Mobile and ArcMap 10.3 provide efficient tools for utility mapping and management.

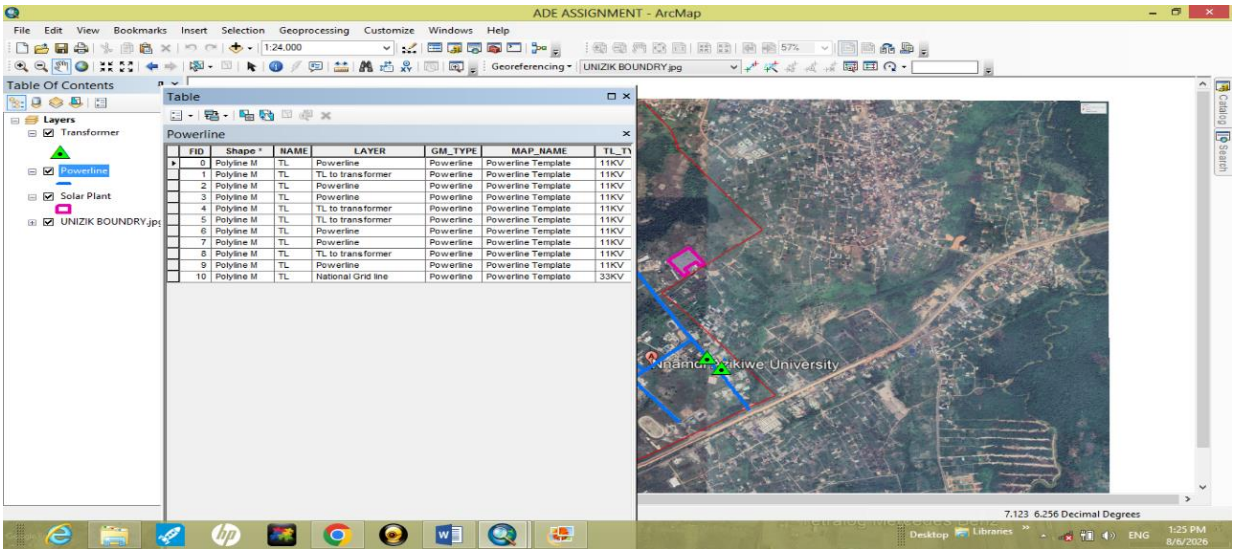

Fig 2: Attribute Query Result within the Study Area

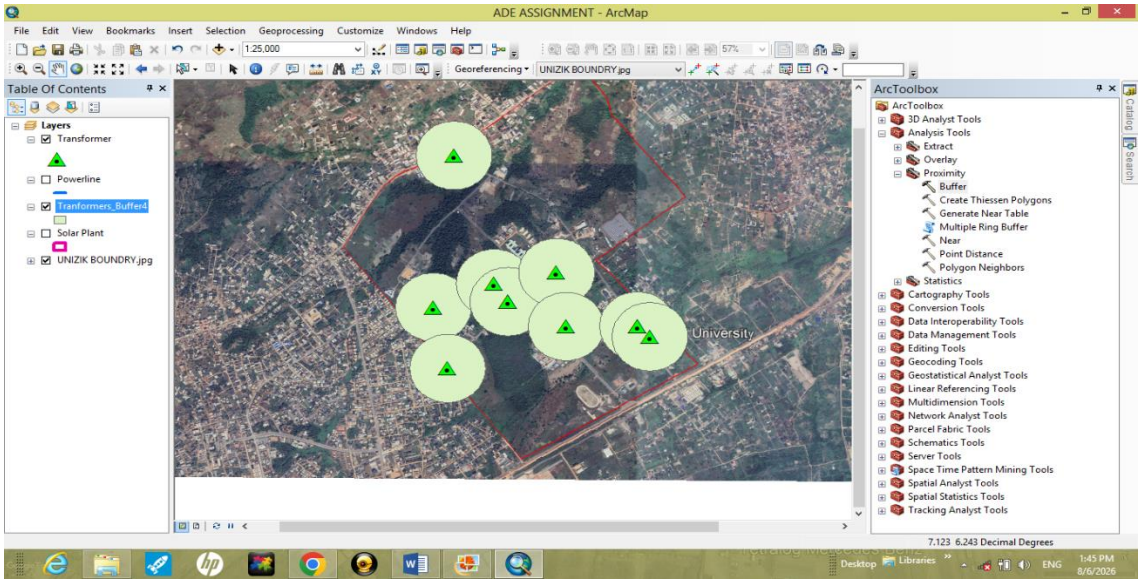

Fig 3: Proximity Analysis Query of Transformers within the Study Area.

A proximity analysis of 300meters around the transformer was also carried out. This process can also explain the fact that the electricity distribution in Nnamdi Azikiwe University Awka is a good one. With 300meters interval between transformers, one can deduce that the transformers for electricity distribution within the University premises can serve very well unlike areas (Institutions) with sparsely buffered transformers.

Conclusion

This study demonstrated the effectiveness of geospatial technologies in modelling and analyzing electricity distribution within Nnamdi Azikiwe University. The integration of Global Mapper Mobile, Global Mapper Desktop, and Google Earth Pro enabled the development of a comprehensive electricity infrastructure database and facilitated advanced spatial analyses.

The resulting geospatial model provides a decision-support framework for infrastructure planning, maintenance scheduling, fault management, and future network expansion.

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