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Digital Maps Based Customer Data and Asset Management System for Electric Power Sector in Nigeria.

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ABSTRACT

Electricity is one of the most important and basic needs of today's community. It is an aspect of the utility sector that is very essential to the smooth and meaningful development of any country's economy. Customers' data are tied to a property, asset, and the property owner which makes it difficult for meter transfer within the Local Distribution Company (LDC) Electricity utility network. Asset Registration data is fixed to a particular property and owner of a property which makes the problem of settling outstanding bills owed by customers while residing in a particular property difficult to recover thereby leaving the burden of payment of the debt to the property owner and LDC recovering its debt difficult. GIS maps the exact location and survey coordinates of an object in space to provide answer to queries using a computer system. For the purpose of this research work, GIS will be used to develop a detailed mapping where the assets and customers of a LDC are located at. This will help in fast and easier retrieval of information for instantaneous use in the area of planning, monitoring and management of their assets and customers. The research work is aimed at using hand-held Global positioning system (GPS) to obtain the geographic coordinates of all assets and customers other detailed information which will be used to build the attribute. Series of spatial search/query operation will be carried out on the electric poles, feeder pillars, buildings and transformers to provide answers to the pending questions that will lead to effective management of the assets and customers within LDC network.

Keywords: digital map, LDC, GIS, GPS, PHCN

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1. INTRODUCTION

Recent study shows that the major challenges facing PHCN as it concerns distribution of electricity power are lack of in-depth network mapping, lack of database system, lack of land use information, inadequate distribution networks planning, lack of database system, lack of land use information, inadequate distribution networks planning. For any this organization like Enugu Electricity Distribution (EEDC) to run optimally and run efficiently, it must know what assets it has, her customers, where they are, their condition and how they are performing. The information about the customers, the physical assets and easy access of the available data from anywhere around the globe is necessary in order to work strategically, effectively, smartly and make a sound decision backed up with available data.

Fortunately, the use of an online enhanced customer data and asset registration using geographical positioning system come in handy in tackling/solving these challenges mentioned above. OECDAR GPS is a valuable tool not only for mapping facilities but also in improved decision making about the customer and better infrastructure management. For the purpose of this research work, a GPS enabled device was used for capturing location data of the customer, asset location and stored in a cloud based NoSQL database

A typical power system consists of generation, transmission, and distribution. The basic structure of the power transmission and distribution system covers a huge network consisting of a wide range of equipment, feeders, and facilities. Large amounts of power are generated at power plants and sent to networks of high voltage (400kv, 220kv, or 110kv) transmission lines. These transmission lines supply power to medium voltage (eg 11kv or 33kv) distribution network (distribution primary system) which supplies power to still lower voltage (0.4kv) distribution networks (distribution secondary system). Both distribution network lines supply power to customers directly. Thus, the total network is a complex grid of interconnected lines. This network has the function of transmitting power from the points of generation to the points of consumption as shown in Figure 1

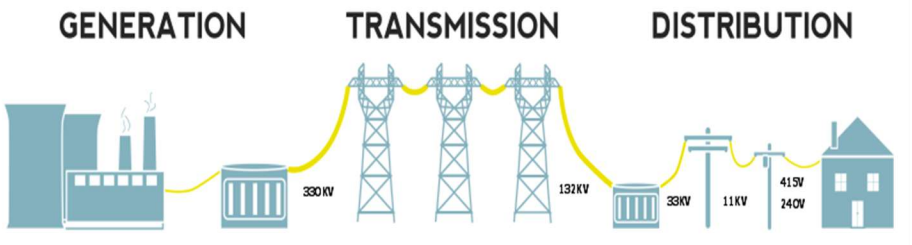

Figure 1 Electricity Generation Transmission and Distribution

It is the talk that Information Technology has come to stay in the 21st century, though it has been in existence for long little cognizance was paid to it. The aspect of Information Technology that is saddled with the usage of Computer wares to solve spatial problems is referred to as Geo-Information and Communication technology (Geo-ICT) or Geographic Information System (GIS). GIS is the computerized tool for capturing, storage, checking, integrating, manipulating, analyzing, and displaying geo-information.

Electricity distribution is the process of transporting electrical energy from the transmission point to the end users' points. Electricity is an essential part of our everyday lives that we often take for granted. We take it for granted, that is until we have to do without power for one reason or another. We don't often actually see them, but behind the scenes, many people are working to ensure that we have a clean, safe, reliable source of power; that we don't have unpredictable or inappropriate current to power our infinite variety of devices; and that the supply is there when we need it; and that it is, more or less, reasonably priced. The evolution of Geo-ICT has revolutionized the utility industries. Nigeria is not left out in the race of ICT, and so also is Geo-ICT. Power Holding Company of Nigeria, Plc is one of the vibrant utility industries in West Africa with over five (5) million subscribers. The ever-increasing numbers of subscribers to the services of electricity called for the re-engineering of the electricity distribution strategy using the appropriate technology – GIS

1.1 Statement of the Problems

Problems associated with customer data/asset registrations using Location of property in LDC are:

(a) Customers' data are tied to a property, asset, and the property owner which makes it difficult for meter transfer within the LDC Electricity utility network.
(b) Asset Registration data is fixed to a particular property and owner of a property which makes the problem of settling outstanding bills owed by customers while residing in a particular property difficult to recover thereby leaving the burden of payment of the debt to the property owner and LDC recovering its debt difficult.

1.2 Aim and Objectives of the Study

The aim of this research work is to appraise, analyze, and propose an online enhanced customer data and asset registrations using GPS enabled device for LDC. The above aim will be achieved with the following objectives in mind:

1. To create a module that separates the functions between the Customer data and asset data.
2. Use an online web-based system to capture customer data and GPS
3. Verify the legitimacy of customer Utility Identify number before payment
4. Capture the LDC asset's GPS location and make its transaction with customer data seamless.

2. LITERATURE REVIEW

2. 1 Distribution System

The distribution system consists mainly of two parts (Deshpande *et al*, 2020). These parts are;
Primary distribution system: would be the circuits supplying power at high voltage to large consumers such as industrial consumers and to distribution substations. The secondary distribution system would take the power to consumer such as residential consumers at distribution voltage (Mahta *et al.,* 2020). In a distribution system customers could be put into classes (Shoemaker *et al.,* 2002; Pansini, 2021). The classes consist of: Industrial customers, Commercial customers, Residential customer

Industrial customer

Most industries need 2,400 to 4,166 volts to run heavy machinery and usually own their substation or substations to reduce the voltage from the transmission line to the desired level for distribution throughout the plant area.They usually require 3- phase lines to power 3-phase motors (Shoemaker and Mack,2002)

Commercial customer

Commercial customers are usually served at distribution voltages, ranging from 14.4kv to 7.2 kv through a service drop line which leads from a transformer on or near the distribution pole to the customer's end use structure. They may require 3-phase lines to power 3-phase motors (shoemaker and Mack, 2002)

Residential customer

The distribution electricity is reduced to the end use voltage (120/240 volts single phase) via a distribution transformer. Power is delivered to the residential customer through a service drop line which leads from the distribution pole transformer to the customer's structure. According to (Desponded 2020) the main parts of electricity distribution system are: Sub transmission circuits, distribution substation Primary feeders, distribution transformers, Secondary distribution circuits, Consumers service connections, the distribution system may also be put into classes (Deshpande *et al*, 2020). These classes are as follows: Radial system, Parallel or loop system, Network or grid system of distribution.

2.2 Customer Data and Asset Data

Customer data is information held on file about customers by a store or other business, usually including names, contact details, and buying habits (collinsdictionary. com,2011). It relates to any information firms might collect from and about consumers that are used, or intended to be used, to support commercial activities. These data can be offered voluntarily by the customer through business transaction engagement or registering for a service, generated passively through social media, sometimes generated by firsthand and third parties through analysis or combination with other data. Customer data management (CDM) is a set of processes and technologies that enable the ethical collection, secure storage, and proper maintenance of customer information.

According to (Taft *et al.,* 2021) it is observed that 21st Century electric networks are rapidly evolving on multiple dimensions, including the development of energy information and operational platforms, in response to the adoption of a wide array of sensors, the penetration of significant distributed energy resources (including renewable resources and load management), and the enabling of market participation by millions of customers. This transition from a vertically oriented value chain to a hybrid, more horizontal industry structure creates the need for the convergence of data, controls, and transactions into a unified energy platform enabling reliable, secure market and grid operations.

The increasing pressure from both customers and regulators to maintain and enhance service reliability, while simultaneously controlling costs, has caused many utility distribution businesses to adopt Asset Management (AM) as their framework to balance the financial aspects with the reliability engineering and infrastructure aspects (Brown, 2021).

2.3 Geospatial Technologies

Geospatial Technology is a combination of GIS, GPS, and Remote sensing (Govindaraj,2019).it refers to a system that is used to acquire, store, analyze and output data in two or three dimensions, this data is referenced to the earth by some type of coordinate system such as map projection (Ali, 2020). Geospatial systems include thematic mapping, the global positioning system (GPS), remote sensing (RS), telemetry, and Geographic information system (GIS). Thematic mapping utilizes cartography, aerial photography, satellite imaging, and the plotting of data to interpret any area under investigation. GPS happens to be one of the geospatial tools for gathering and analyzing data. It is made up of satellite systems and a ground control station with a user segment. The ground station measures signals from the satellite and creates orbital models for each satellite. The models compute precise orbital data and clock corrections for each satellite. Remote sensing (RS) is the collection and interpretation of information about an object without being in physical contact with the object (NASA, 2020).

2.4 GPS/GIS Technology in Electricity Customer and Asset Data Management

GIS/ GPS Technology is used to identify the location of an electricity utility asset that is faulty during a power outage, it plays a key role in many utilities though electricity is one of them.Utility companies use GIS software to gather large sets of data about their customers, their service locations, their utility network, and even their repair crews, rather than wasting resources and time having someone manually collect all of this data, a simple GIS software program can gather and analyze it in a heartbeat. With GIS software, companies can map their assets, keep track of where their customers are located, and direct repair crews to service locations as needed (Ian, 2022).

3. ANALYSIS OF THE EXISTING SYSTEM

Billing system otherwise known as power billing system is the process of assessing and costing of customers' energy consumed. Power Billing System is an Executive Information System (EIS) that determines the consumed power per unit time and performs its computation based on the sale rate of power per unit time and other parameters. The importance of Power Billing System (PBS) cannot be over emphasized, because its calculation reflects the exact power consumption for the prospective consumers, and in monitoring the billing details of the electricity consumer. In the traditional system, LDC meters are registered and attached to property instead the user who might possibility not be the owner of the property

3.1 Limitations of the Existing System

The following are the limitations of the existing system. The problems associated with customer data and asset registrations using Property Location Model in LDC are dependent on:

1. The means of enrolment of Customers into the LDC database with respect to liability.
2. The techniques of customer data and asset registration and payment implementation.

3.2 Analysis of the Proposed System

In this system, LDC will know the customer and asset location using GPS. These will help the company to keep track of their customers who might have changed location or owing bills. Customer and asset data are uploaded into the system, a unique customer utility ID will be generated for each unique customer.

LDC assets will have a unique identification number to allow for easy identification and tracking of the GPS location of the asset. In the proposed system there will be 2 modules which are the Admin Module and the Simple Public Module. The project stores the list of clients, connections, billings, and etc. in this system, the management can create multiple electric connections data for a single client. Each connection has a unique connection code which serves as the connection identification for easy retrieval of the data for a specific connection. The Admin side can be managed by 2 types of users which are the Administrator and Staff. The Administrator can manage all the functionalities and features that the module does while the staff has only limited access.

The envisaged system will have the following modules:

Admin Module Features:

a. Secure Login/Logout: this will be a private login details for all users
b. Home Page: this is the page that is displayed once users successfully login
c. Manage Client List (CRUD): the admin can manage all client records
d. Manage Client's Connection List (CRUD): Manage all clients connections
e. Manage Electric Billing List (CRUD): manage electric bills
f. View Client's Data in a Modal with Connection and Billing List: view clients connection and billings
g. Manage User List (CRUD): Manage all registered staff
h. Manage application Information : Manage settings
i. Manage Account Credentials: Manage login details of all users
j. Finally track clients' asset using GPS: track client building or asset to know the actual location of the client.

Public or Client Features:

a. Home Page: this is the first page that is display once the client login successfully
b. Display Welcome Content: this is the welcome content showing on client dashboard
c. Display About the Company Content: this is about us content that will be visible to the client
d. Track/Display Client's Connection Data and Billing History: this is where the client can track his or her billing history.

3.3 Use Case Model of the Proposed System

Use Case can be a human or other external system. The Use Case Model describes the proposed functionality of the new system.

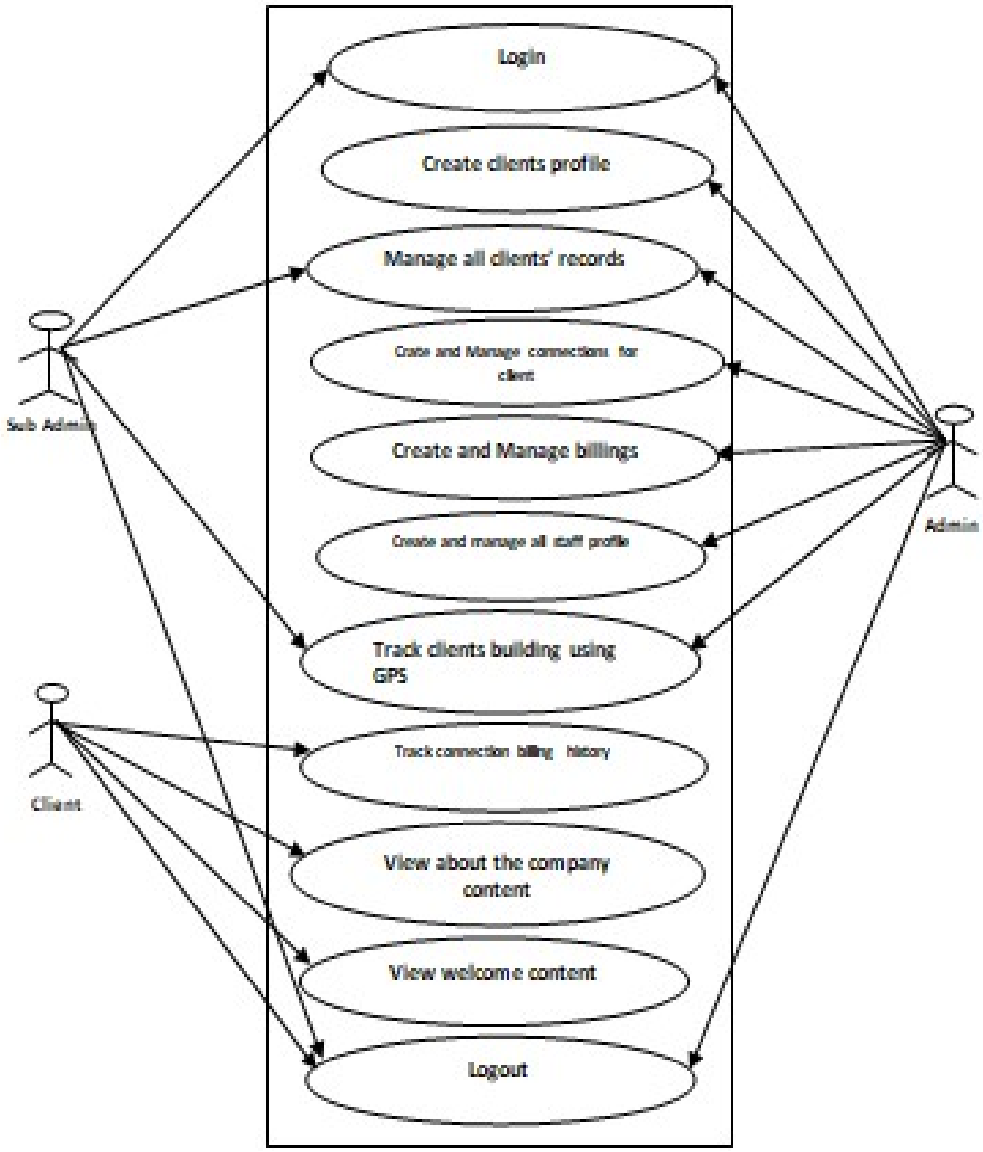

Figure 2: Use Case Diagram of the Proposed System

Figure 2: Describes The Use Case Diagram of the Proposed System and the Functions of the Various Entities

3.4 Sequence diagram

Sequence diagram establishes the roles of the object and provide essential information to determine class responsibilities and interface. The sequence diagram shown in Figure 3 explains the flow of information or data from one entity to another.

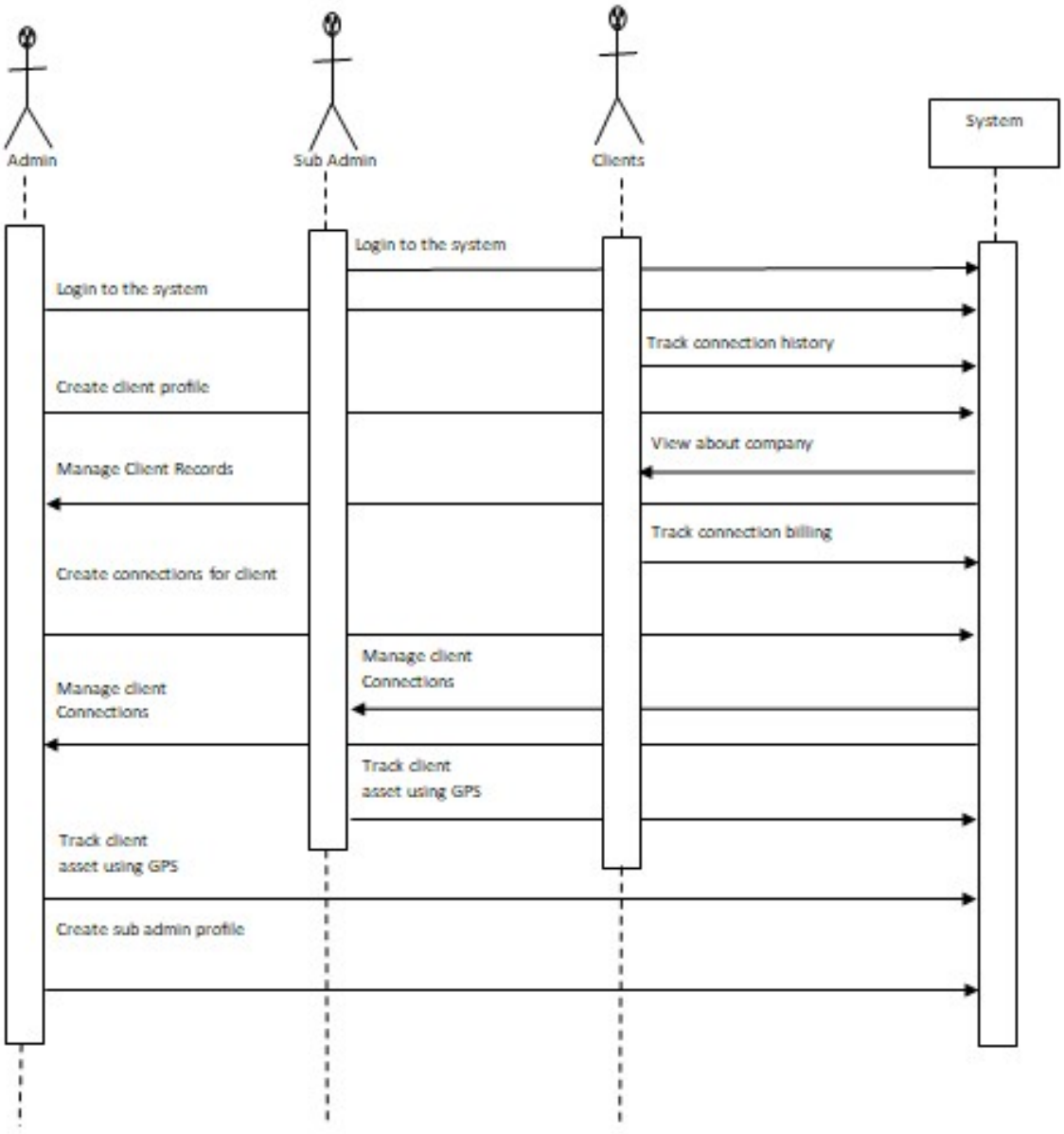

Figure 3: Sequence Diagram of the Proposed System

4. DESIGN METHODOLOGY

The Methodology adopted to carry out this research is Object Oriented Analysis and Design methodology, it was adopted because it is easy to understand and maintain, it provides re-usability, it reduces the development time and cost, and it improves the quality of the system due to program reuse.

4.1 Database Specification

Database specification specifies the structure of the database that will be used in the system. The name of the database used in the design is Custo_bill; it has two tables which comprises users table, customer bill. The database to be used is SQlite. The SQlite database server provides the ultimate in scalability, sporting the capacity to handle deeply embedded applications with a footprint of only 1MB to running massive data warehouses holding terabytes of information. Platform flexibility is a stalwart feature of SQlite with all flavors of Linux,

5. CONCLUSIONS

This study examines critical challenges within the Local Distribution Company (LDC) electricity utility network, particularly focusing on how customer and asset registration data are managed. One of the main issues identified is that customer data, electricity meters, and property ownership are all tightly interconnected. This rigid linkage makes it difficult to transfer a meter from one property to another when a customer relocates within the network. As a result, there is limited flexibility in managing customer accounts across different locations, which hampers operational efficiency and customer satisfaction. Another significant problem arises from the way asset registration is structured.

Since registration data is tied to both a specific property and its owner, it becomes challenging to recover unpaid electricity bills left behind by former tenants or residents. In many cases, the financial burden of these debts falls on the property owner, even though they were not the ones who consumed the electricity. This situation not only complicates the process of debt recovery for the LDC but also creates unfair liabilities for property owners. Our study therefore developed a model that:

1. Provides EEDC with a system that will help the institution track its debtors and recover their debt.
2. Capture customer complaints and be able to get location of customer reported fault.
3. Provide LDC with an in-depth network mapping and planning

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