ARDHI UNIVERSITY

DEVELOPING A WEB-BASED GEOGRAPHIC INFORMATION SYSTEM FOR PROPERTY TAXATION TRACKING

CASE STUDY BUILDING PROPERTY IN GOBA

CHRISTOPHER, ALESIUS

BSc. Geographical Information System and Remote Sensing (GIS & RS)

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DEVELOPING A WEB-BASED GEOGRAPHIC INFORMATION SYSTEM FOR PROPERTY TAXATION TRACKING

CASE STUDY BUILDING PROPERTY IN GOBA

By

CHRISTOPHER, ALESIUS

A dissertation submitted in the department of Geospatial Science and Technology in partial fulfillment of the requirements for the award of Bachelor of Science degree in GIS & RS at Ardhi University

CERTIFICATION

The undersigned hereby declare that, they have supervised and proof read the dissertation document and recommend for acceptance by The Ardhi University a dissertation document entitled "**Developing a web-based Geographic Information System for property taxation tracking, case study building property in Goba**" for University Examination

…………………………..	**…………………………**
Dr. Hayola Joseph	Mr. Maziku K Joseph
(Supervisor)	(Supervisor)
Date ………….............	Date…………………….

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I CHRISTOPHER, ALESIUS declare that this dissertation is my own original work and that to the best of my knowledge, it has not been presented to any other University for a similar or any other degree award except where due acknowledgements have been made in the text.

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DEDICATIONS

To my present parent Mr Christopher, Rugemalila and passed parent Mrs Magreth Christopher, who have been a constant source of support and encouragement during the challenges of school and life. Their strong prayers, love and support in my education have brought these achievements. May God bless him and let her soul rest easy.

ABSTRACT

TRA is a government institution that deal with revenue in Tanzania, TRA uses electrical meter for taxation purpose for every building and for those which have no electrical access uses control number for payment. Objectives of the study is to design and develop an interactive and friendly user interface for property tracking management, to determine the user requirements that tax collector need, developing a geodatabase for data storage and differentiate houses with electricity and those without electricity. Methodology used was first to create a project using Qgis software and customization of the application, also the data collection using Qfield mobile application. Property tax collector requirements was obtained in Kinondoni Head quarter office which was helpful in creating attribute form for data collection. The research focused on automation of building data collection and building data managements by creating a centralized geodatabase. This was done by customizing and integrating a web map on opensource Quantum GIS, HTML and PostgreSQL/PostGIS as a relational database. Leaflets APIs were used for the development of an interactive and friendly geographic user interface of a web-based GIS system. The output was a web-based Geographic Information System for property taxation tracking and valuation. In obtained output an admin who is tax collector can search for buildings that has electricity and those without electricity. The advent of the web has transformed everything around us and GIS in deed. GIS can now locate the exact position of building property and displaying them in a web map.

The research contributes on the determination of tax payer which have made significant contributions to property tracking and valuation by enhancing the efficiency and accessibility of property related data. The output comprises of authentication for user, list of customer information, registering new customer, dashboard for user options and importing a csv file in the system.

A developed web-based GIS system have a capability of accessing some one location, therefore TRA can use a developed system to access someone who have not paid. For the coming investigator or researcher should create a valuation tool within a system that can help in proper imposition of tax. This is because some of ordinary houses have different value but levied equal.

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LIST OF ABBREVIATIONS

HTTP	Hypertext Transfer Protocol
GIS	Geographical Information System
WWW	World Wide Web
ARU	Ardhi University
QGIS	Quantum Geographical Information System
RS	Remote sensing
GEOAI	Geospatial Artificial Intelligence
TRA	Tanzania Revenue Authority
LBS	Location Based Service
TANESCO	Tanzania Electric Supply Company Limited
TAMISEMI	Tawala za Mikoa na Serikali za Mitaa

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CHAPTER ONE

INTRODUCTION

1.1 Overview

This chapter will introduce what the research is about. The background of the research, Statemen of the problem, the objectives, and research questions, significance of the research and description of the study area will be discussed.

1.2 Background

A tax based on land and buildings was first introduced in Tanzania (then Tanganyika) under the Township Ordinance, Cap 101 of 1920 that imposed a 'hut' tax on indigenous property owners. This was followed by passing another legislation intended to develop the process of property rating on the assessed value of real property. The Municipalities Ordinance (Cap 105) 1946, authorised municipalities to impose a levy of 10% on the capital value of all buildings situated in municipalities except those exempted. Buildings occupied by the Governor, for example, were exempted from the property tax liability. In 1952 the Local Government (Rating) Ordinance (Cap 317) was passed, extending the property tax base to include unimproved site value. In addition, a house tax was levied under the Urban House Tax Act Cap. 457 of 1961, and the Municipal House Act of 1963. As such a tax on land and buildings was levied on properties held under long term leases/ right of occupancy, while properties held under short term right of occupancy or customary law were subject to the urban house tax (on buildings only). The Municipal House Tax was levied on houses in townships and minor settlements. This property tax system continued to independence time and thereafter. (Kayuza, 2006)

Before imposing monthly electrical payment, the collection of property tax was closely linked to billing and enforcement of compliance. Prior to collecting revenue, tax billing demands were sent to each property owner. Since the rating authorities operate a dual tax system, the bills were sent to property owners listed in the valuation rolls and on the flat rate levy registers. Delivery of the tax demand notices to individual ratepayer was done by post mailing, or by hand with the help of local leaders. Post mailing has proved to be unreliable as in most cases post addresses are found to be wrong. Moreover, the post mailing system in the country is not designed to deliver mails at physical addresses. Again, even if mails were delivered to physical addresses, land information system to support such practice is lacking. As such there were high reliance on delivery of tax demand notices by hand largely with assistance from local leaders under TAMISEMI. (Wan, 2014)

This shows the gap that exist between the past and a developed web-based GIS system due to the fact that the developed system can track the route of a customers which have not electricity power.

With the advent of internet and associated technologies such as mobile and wireless technology, internet based applications have proliferated, greatly lowering costs to the end consumers who do not need to procure expensive software to realize solutions to their problems (Mamai et al., 2017).

1.3 Statement of the research problem.

Goba is an administrative ward in Kinondoni district which has rapidly increase in population due to ward centralization. Property taxation process in Goba has been conducted for those who have electrical meter and those who do not have electrical meter. Becomes easy for those who have electricity because the meter numbers are linked with TRA and payment is done monthly per each ordinary house, and per floor for storey building. But becomes difficult for those who do not have access to electrical meter since the use previous method of self-surrendering or sending bill to property owner listed in the valuation roll under the assistance of local leader and post mail. The process become difficult for the customer who delay to pay tax. By using developed web-based GIS system, the location information for those who have not electricity can be obtained since data are collected first.

1.4 Objectives.

1.4.1 Main objective

The main objective of this study is to develop a web-based GIS system for property taxation tracking.

1.4.2 Specific objectives.

i. To design and develop interactive and friendly user interface for both management and tax collector.

ii. To determine the user requirements that tax collector needs when is direct in the field and when using the property taxation web map-based GIS system.

iii. To develop Geodatabase that include all attribute information for valuation and departmental use.

iv. To differentiate the houses that has electricity and those which do not have electricity.

1.5 Research questions.

In this study, the following questions will be answered

i. How does the user interface developed to enhance spatial data visualization?
ii. What are the needs of tax collector in field and in the developed property taxation system?
iii. How does a Geodatabase for both property taxation data created?
iv. Can the system differentiate the houses that have electricity and those without electricity?

1.6 Scope of the study

This research is base on the data collection by using Qfield mobile application, mapping and visualization, User friendly interface, data security, determining houses without electricity and route tracing. Also developing a web-based GIS that contain all the information that are required and important for reaching customer houses.

The study is limited in location accuracy, that for any web-based system allow four decimal places which can hinder the accuracy of house position.

1.7 Significance of the study

A web-based system can help reduce administrative costs associated with property taxation. Automated processes for data entry, reporting, and route tracing can lead to operational efficiencies. Also Qfield can facilitate building inspections by providing checklists, forms and inspection protocols within the application. Inspectors can use the mobile app to conduct inspections, record observation and generate the inspection report on site. This helps ensure compliance with building codes and regulations, and support precise taxation assessment.

1.8 Beneficiaries

Building tax collection will assist Tanzania Revenue Authority (TRA) in efficiently assessing and managing building taxes. The application enables field officers to collect precise data on properties, including their physical attributes, ownership details, and relevant tax information. This helps streamline the tax assessment process and ensures improved revenue collection for the government. Also, this mobile application will simplify the work of field surveyors and assessors responsible for gathering property data. The application allows them to access digital maps, record property information, capture images, and update property records directly on their mobile devices. By digitizing the data collection process.

1.9 Description of study area

The study area is Goba which is found in the Eastern part of Tanzania country. Goba area is found in Kinondini District at Goba ward which lies between the longitude 39.14 E and 39.34 E and latitude -6.6938 S and -6.6234 S, Goba is characterized by its breathtaking topography, including rolling hills, verdant valleys, and picturesque mountain ranges. Kinondoni is found at the elevation of 11.72 Meters above sea level. The selected region serves diverse customer types and consumption patterns ranging from individual customers, learning institutions, hotels, and factories. The region also has the highest number of customer connections translating to highest revenue collection for the authority. Figure 1.1 illustrates the location of the study area

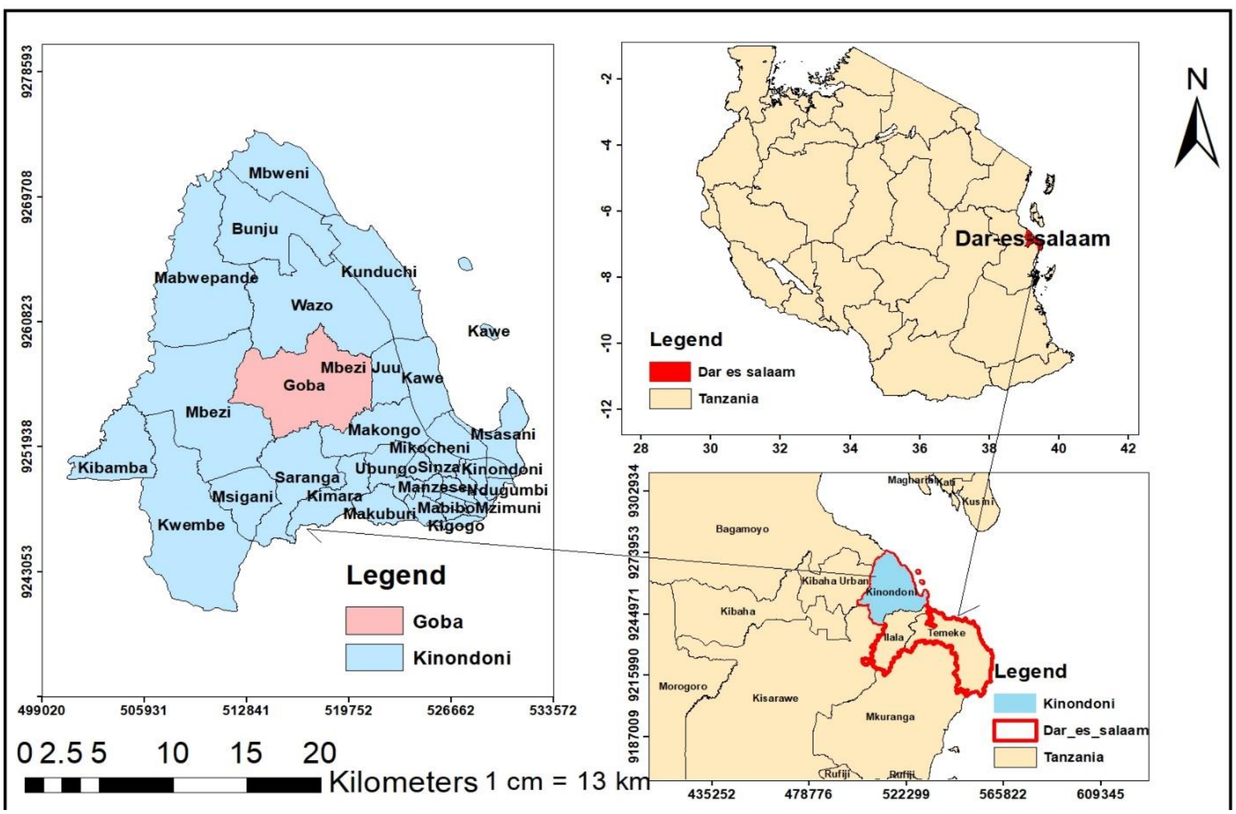


Figure 1. 1: Location of the study area

1.10 Dissertation organization

This dissertation consists of five chapters, explaining in detail all the methods, procedures and the results obtained by testing the usability of Qfield mobile application for building taxation data collection for Kinondoni, Goba region.

Chapter 1 explains the background of the study, which gave rise to the problem. The objectives, research questions, significance and beneficiaries of the research, together with the description of the study area.

Chapter 2 gives the review of the study. It explains all literatures and studies done in relation to building taxation. This chapter shows also how previously building taxation was conducted and currently how it is conducted.

Chapter 3 covers all the methods and techniques involved in the study.

Chapter 4 provides the analysis and discussion of the results. It shows the results obtained in this study and the results obtained by previous studies.

Chapter 5 contains the conclusion and recommendations for the study.

CHAPTER TWO
LITERATURE REVIEW

2.1 Overview

Studies in this chapter provides a literature review on the understanding of the study through Previous. It sets the course of the study through applying techniques used in previous researches and establish the gap. This chapter provides a review of literatures related to Building taxation and Location based services. How other surveyors and researchers think about integrating the tax collection procedures.

2.2 Qfield mobile application

QField is a mobile application designed for field mapping and data collection in geographic information systems (GIS). It is an open-source application that runs on Android devices, providing users with the ability to view, edit, and collect spatial data while working offline. QField allows users to load GIS data layers, including shapefiles and raster images, onto their mobile devices. It supports various data types, such as points, lines, polygons, and attributes, enabling users to create and update spatial data in the field. The application also supports the integration of GPS functionality, allowing for accurate positioning and data collection. (Ramos, Malanie , & Fabio, 2021)

One of the key features of QField is its synchronization capabilities with desktop GIS software, such as QGIS. Users can transfer data between the desktop and mobile devices, ensuring seamless data integration and collaboration between fieldwork and office environments. (Montagnetti & Giuseppe, 2018)

With the QField ecosystem, you can streamline your fieldwork processes and improve productivity. These products are designed to work together seamlessly, providing a complete solution for all your fieldwork needs. Whether you're collecting data in remote locations or managing large-scale projects, this application can cover it. (Ekberg, Nance, & Xiaoguo, 2014)

QField can be used to collect a variety of data types, including points, lines, polygons, and attributes. It also supports a variety of data entry methods, such as keyboard, touchscreen, and barcode scanner. QField is a powerful tool for collecting data in the field. It is easy to use and can be customized to meet the specific needs of your project. QField is also a free and open-source software, so you can be sure that your data is secure and accessible. Its functionalities is described in figure 2.1

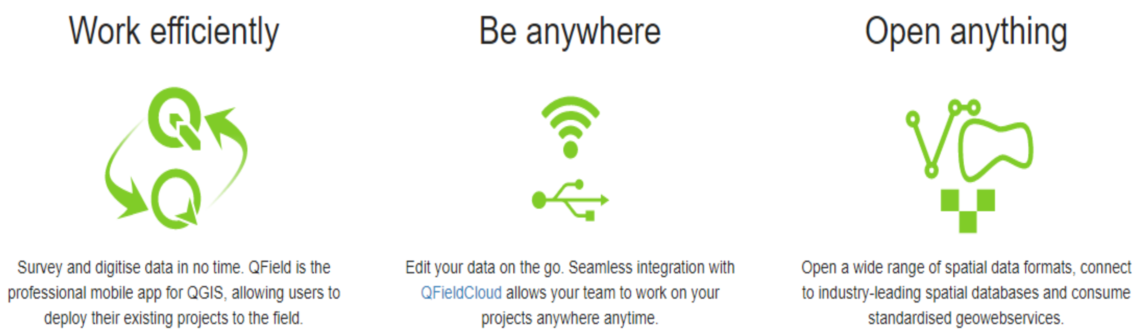


Figure 2. 1:Qfield application functionalities (Source: https://qfield.org/)

2.2.1 Main features of Qfield

QField is an Android app that can be downloaded from Google Play. This application, although it presents itself with a very simple interface, is rich in functions such as:

i. **Tools for digitization in the field;** are used to create and edit geospatial features directly in the field. These tools allow to capture points, lines, and polygons, along with their associated attributes, using your mobile device.

ii. **Geometry and attribute editing;** allow to modify and update both the spatial geometry and the associated attribute information of existing features within a layer.

iii. **GPS;** The GPS tool in QField is used to interact with the device's built in GPS capabilities, allowing to capture accurate geographic coordinates and use them for data collection and mapping.

iv. **Possibility to upload custom base maps;** QField provides the ability to use custom base maps, allowing to display your own background maps or imagery as a reference while collecting and working with geospatial data.

v. **Integration of smartphone/tablet's camera;** allow to capture photos and link them to specific geospatial features while collecting data in the field. This can provide visual context and additional information to the collected spatial data. (Montagnet & Giuseppe , 2019)

2.3 Property taxation

Property taxation refers to the system of taxing real estate properties within the country. It is an important source of revenue for local governments and plays a significant role in funding public services and infrastructure development. In Tanzania, property taxation is primarily governed by the Local Government Finances Act of 1982, as amended in subsequent years. This legislation provides the legal framework for property taxation and empowers local government authorities to assess, levy, and collect property taxes. (Stotsky, Ziihtii, & Parthasarathi, 1995)

The specific provisions and mechanisms of property taxation in Tanzania may vary across different local government authorities. However, some common aspects include:

2.3.1 Assessment

Local government authorities are responsible for assessing the value of properties within their jurisdiction. Property assessments may be based on factors such as market value, rental income potential, or a combination of both. (Walker, 1970)

2.3.2 Property Tax Rates

Property tax rates in Tanzania are typically determined by local government authorities within the limits set by the national government. The rates can vary depending on the type of property and its use (residential, commercial, industrial, etc.). (Youngman & Malme, 1994)

2.3.3 Tax Collection

Local government authorities are responsible for collecting property taxes from property owners or occupants. Property owners are usually issued tax assessment notices, and payment is typically made annually or in installments, depending on local regulations. (Zevenberg, 2002)

2.3.4 Revenue Allocation

The revenue generated from property taxation is allocated to local government budgets and is utilized for various purposes, including service delivery, infrastructure development, and local administration. (Mccluskey, 2004)

Property taxation in Tanzania has a rich colonial history that can be traced back to the German colonial rule when a simplistic “hut tax” or “house tax” was imposed on the indigenous people.

After the end of the First World War, Britain began its colonization of Tanganyika and introduced new finance structures, including a tax based on land and buildings. (Silayo, 2001)

2.4 GIS Trends.

Trend in GIS refers to the current and emerging developments and practices within the field. GIS is a rapidly evolving technology, and several trends have emerged in recent years that are shaping its application and advancement. Here are seven trends (Slack, 2000)

2.4.1 GIS in the cloud

With this development, "we can massively scale out problems. It also means, for planners, who are often not necessarily IT literate, we can actually use an outsourced environment more cheaply and use the resources of the cloud in various ways." (Shum, Dung, & Chen, 2009)

2.4.2 Real time GIS

"Think of this as maps that have things that move around on them. As we wire up the city for this digital transformation, and especially with the Internet of Things, basically everything that moves and changes will be fed into these GIS systems." (Herderson, 2004)

2.4.3 Raster Analytics

"Imagery from remote sensing, drones, aircraft, and even spacecraft is becoming more and more available, and GIS is providing the framework to manage all these images and also apply them in near-real time for various kinds of applications. This means that our challenges for gathering new data will become less and less." (Shin & Feuerborn, 2004)

2.4.4 3D reality capture

"This new technology allows me to fly over a city with a drone or aircraft and build a 3D picture. Integrated into this picture is all the vector data of who owns what, what land uses there are. This is a new way to show GIS and visualize GIS, and it's going to become very popular across the world in the next few years. A picture is worth a thousand words, but a smart picture, like GIS can provide, will be very engaging." These models can function as a digital twin of the real city, and places like Boston are already using it. (Virrantaus, et al., 2001)

2.4.5 Spatial analysis and Data science

"GIS analytics and spatial data science continue to advance with literally hundreds and hundreds of new tools. On the forefront, for example, is the ability to take all the data for an entire city, put it into a cloud-based data warehouse, and begin to do analytics of relationships and patterns and see things that we have never seen before. But more practically, we can do things like time series forecasting, GeoAI, machine learning, and statistical reporting this is all about creating a better understanding of the city." (Kristian, Armanto, & Frans, 2012)

2.4.6 GEOAI, machine learning and deep learning

"GISes are integrating or interfacing with a whole library of open-source AI and machine learning tools. And, you don't have to be an AI expert, you just need to know enough about it conceptually so you can use the power of relationship building and statistics to be able to make predictions or create new understanding between things." (Watter & Amound, 2003)

2.4.7 GIS in the field

This means being able to connect with every field worker in a city people doing inspections, censuses, tree counts. We can also use this for housing or building inspections or observations of social conflict." Bringing this information together and monitoring it on dashboards allows us to " better manage everybody in the field and better react to things like disasters or emergencies." (Association, 2021)

2.5 Location based service

A location-based service (or LBS) is a personalized service that is based on the location of a mobile information device user. (Junglas et al, 2009). The user needs to opt-in to receive a LBS. The service can identify the location of its users without the need for manual data entry and then offer the service of interest LBS allows users to use services available in their current geographic location (Huang & Gao, 2018)

Components of location-based service are Service provider's software application, mobile network to transmit data and requests for service, content provider to supply the end user with geo-specific information, a positioning component and the end user's mobile device (Silva & mateus, 2003).

2.6 Geodatabase

A spatial database is a general-purpose database that has been enhanced to include spatial data that represents objects defined in a geometric space, along with tools for querying and analyzing such data. Most spatial databases allow the representation of simple geometric objects such as points, lines and polygons (GISGeograph, 2022). In general, a database is used to store the geospatial data and the backend is used to query and get the required information in any web-applications. The backend can control and send the logic to the web-application. There are lots of programming languages and frameworks purely dedicated to backend. The most popular languages are, python, php, javascript, java, ruby, rust etc. There are also free software for creating the database which are like Postgresql and Its extension PostGIS.

i. PostgreSQL

   PostgreSQL, also known as Postgres, is a free and open-source relational database management system emphasizing extensibility and SQL compliance. It was originally named POSTGRES, referring to its origins as a successor to the Ingres database developed at the University of California, Berkeley. It is used as the primary data store or data warehouse for many web, mobile, geospatial, and analytics applications. (Kshetri & Jolaiya, 2021)

ii. PostGIS

   PostGIS is an open source software program that adds support for geographic objects to the PostgreSQL object-relational database. PostGIS follows the Simple Features for SQL specification from the Open Geospatial Consortium. Technically PostGIS was implemented as a PostgreSQL external extension (Kshetr & Jolaiya, 2021). PostGIS is a spatial database extender for PostgreSQL object-relational database. It adds support for geographic objects allowing location queries to be run in SQL.

iii. PostGIS schema

   Every database starts out with one schema, the public schema. Inside that schema, the default install of PostGIS creates the geometry_columns, geography_columns and spatial-_ref_sys metadata relations, as well as all the types and functions used by PostGIS. So users of PostGIS always need access to the public schema. (Kshetri & olaiya, 2021, july 18)

CHAPTER THREE

METHODOLOGY

3.1 Overview

In this chapter, methods implemented, techniques applied and data inputs used throughout this study are explained. This chapter describe overall method starting from need assessment up to expected buildings web map that shows the all the collected attributes of building property. This research involve testing the usability of Qfield mobile application for building property taxation which is final create the simplified web map for enhancing taxation method. These methods are summarized step by step in figure 3.1

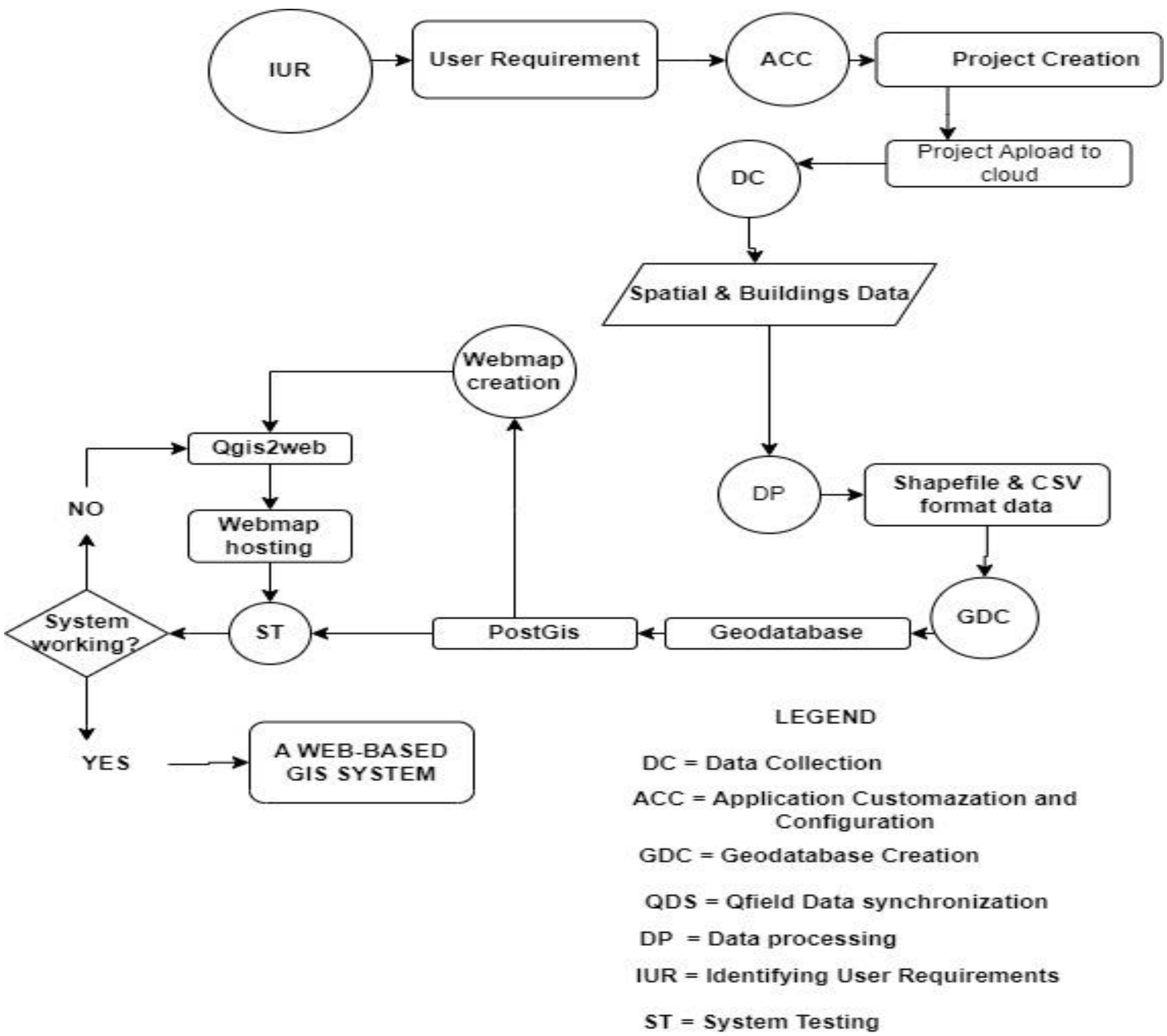


Figure 3. 1: workflow of the research

3.2 Identification of user requirements

Determine the specific data elements that need to be collected for property taxation. Use observation method was planned to ensure that all elements are constant surrounding the observation. By observing and asking questions employees of both property tax and rental tax departments, a process flow, steps, pain points and opportunities for improvement were identified. Interactions of these departments were investigated to check if they provided efficiency to TRA employees in connecting customers. This includes property details, ownership information, tax assessment values, tax classification, and any other relevant data. Identify the required fields, their formats, and any validation rules that should be enforced. Determine the primary user group for the application, such as tax assessors, building inspectors, or property owners. Consider their knowledge level, technical proficiency, and specific tasks they need to accomplish using the application. Evaluate any existing processes currently used for building taxation. Identify their strengths, weaknesses, and areas for improvement. This analysis can help uncover specific needs and gaps that the new tested Qfield mobile application should address. To understand the regulatory framework and legal requirements governing building taxation. Identify any specific features or functionalities the application must have to comply with these regulations.

3.3 Project creation

The project has created in Qgis software in which the account was created using QField Cloud platform (https://qfield.cloud) and setup of the project workspace done. Following the provided documentation and instructions to configure QField Cloud account, including adding users, defining project settings, and setting up data synchronization rules. Organizing and preparing spatial data layers and associated attribute tables in QGIS. Making sure that data is in a format compatible with QGIS and that it follows any necessary data structure requirements for synchronization with QField Cloud. Launching QGIS creating a new project that is going to be synchronized with QField Cloud. Ensuring that the project includes the necessary layers and styling for data collection. Installing and configuring the QFieldSync plugin in QGIS. This plugin enables synchronization between QGIS and QField Cloud. Checking the synchronization settings to ensure that the desired layers, attributes, and changes will be properly synchronized between QGIS and QField Cloud. A created project is shown in figure 3.2.

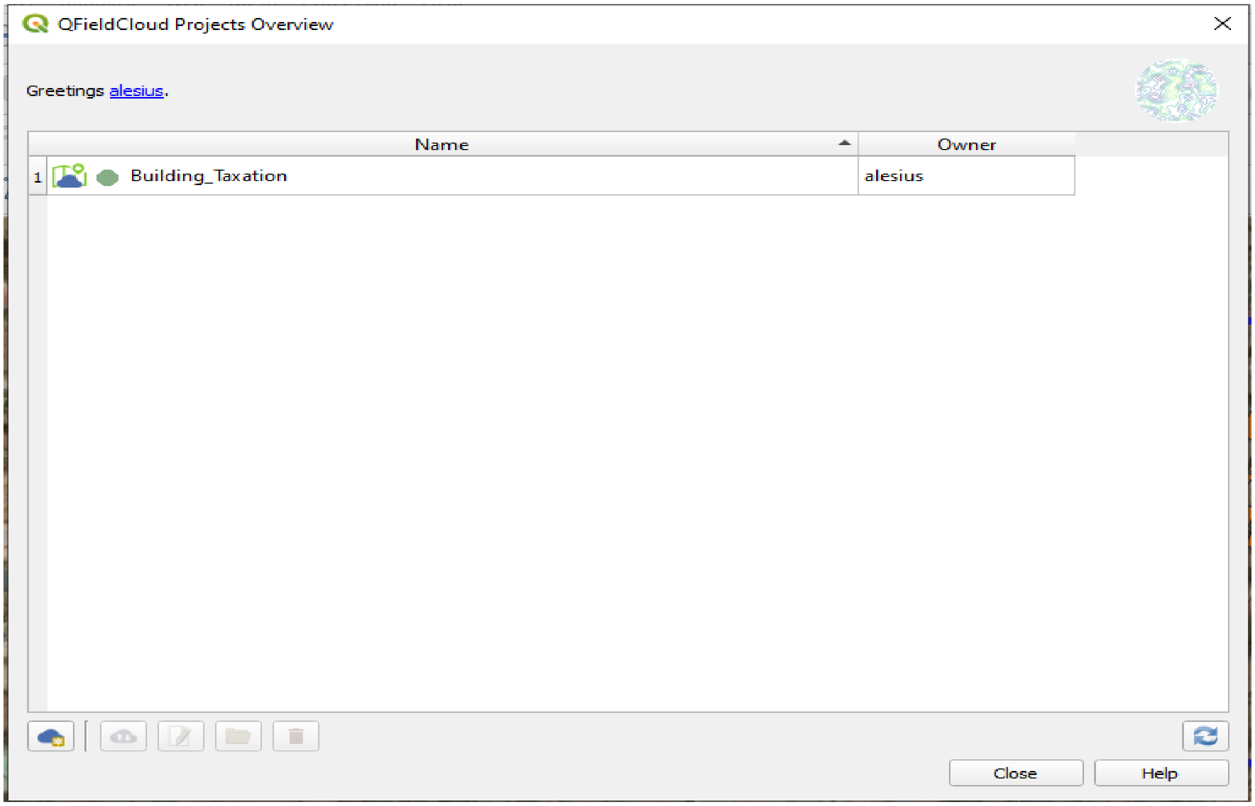


Figure 3. 2: Created project in Qgis desktop

3.4 Software selection

Software that were to be used for the whole property taxation process were selected by looking at their availability and their compatibility with the platform on which the Qfield application is developed. Table 3.1 show software package needed for testing the usability of Qfield mobile application for building taxation.

Table 3. 1: Software used

SN	SOFTWARE/TOOLS	FUNCTION
1	Qfield	Field data collection
2	Qgis	Spatial data creation and processing
3	PostgreSQL	Geo-database creation
4	PostGIS	Data conversion
5	Apache	Web Application manager
6	Leaflet	Development of geographical user interface

3.5 Data collection

The data collected include primary data and secondary data. These data were collected to facilitate completion of the research as explained below;

3.5.1 Primary data

Data was collected by using Qfield mobile application for the testing purpose of building taxation involves owner of the property, use of the property, type of the property, plot number, House number, property reference number, TIN number, electrical status and the date of data collection. The data collected involve both houses with electricity and those without electricity, but below sampled data shows only houses without electricity. The data was collected in Goba area which was my study area. Summary of data is portrayed in appendix A.

3.5.2 Secondary data

These data was collected by using Qgis software, the projected coordinates which is Northings and Eastings was extracted in Qgis software. Since the web-based search support geographical coordinates, the coordinates was changed to Latitude and Longitude. Secondary data collected are shown in table 3.3.

Table 3. 2: Secondary data collected

EASTINGS	NORTHINGS	LONGITUDE	LATITUDE	OWNER
518190.8211	9256228.244	39.16460238	-6.72879893	Flolian Kikwete
518198.2408	9256237.177	39.1646695	-6.728718099	Evans Kanondo
518419.7264	9256274.9	39.16667352	-6.728376177	Magreth Paul
518566.9679	9256245.607	39.16800594	-6.728640707	Hamis Mluma
518606.7217	9256296.28	39.1683655	-6.728182194	Anitha Mendson
518622.6818	9256266.87	39.16851001	-6.728448188	Revelian Agustin
518654.0215	9256173.283	39.16879388	-6.72929468	James Mkinga
518672.7454	9256308.062	39.16896289	-6.728075407	Queen Mzavaz
518660.9482	9256321.28	39.1688561	-6.727955874	Lewis Hamilton
518679.9004	9256334.053	39.16902755	-6.72784027	Claudia Simon
518715.2075	9256362.579	39.16934694	-6.727582112	Kassim Lewis
518726.5863	9256391.492	39.16944981	-6.727320529	Antony Julius
518520.2705	9256389.371	39.16758295	-6.727340359	Elius Thomas
518517.7843	9256401.393	39.16756042	-6.727231615	Maulid Brian
518553.1902	9256402.681	39.16788078	-6.727219854	Mjuni Mjuni
518493.0386	9256386.131	39.16733655	-6.727369752	Innocent Makila
518319.0195	9256388.658	39.16576191	-6.727347429	Venancy Juma
518303.9394	9256356.849	39.16562556	-6.72763522	Yolanda Kitama
518286.9927	9256319.332	39.16547233	-6.727974652	Fatuma Geoffrey
518151.9301	9256396.474	39.16424996	-6.727277235	Radius Sunday

After being creating the attribute form using Qgis software, the requirements that a tax collector need to obtained from the owner also are added. The figure below shows the how form is filled by tax collector by adding information like house number, owner, property reference number, electrical house or not and block number. Data collection by Qfield application is shown in figure 3.3.

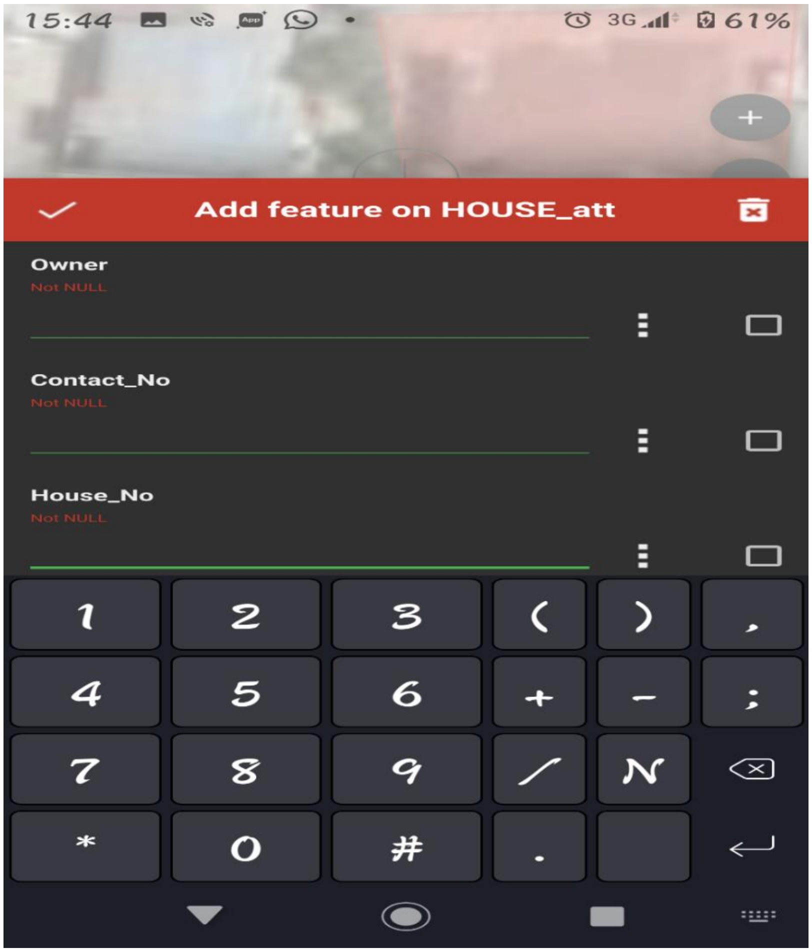


Figure 3. 3: Data collection by Qfield application

3.6 Data processing

This is the manipulation, analysis, and interpretation of the collected data to derive meaningful insights and evaluate the usability of the Qfield application. It involves various steps comparing to the data collected, these procedures can be to organize, clean, analyze, and draw conclusions from the data.

3.7 Geodatabase creation

Geodatabase was created by following these steps below;

3.7.1 PostgreSQL and PostGIS installation

PostgreSQL software was downloaded and installed from http://www.enterprisedb.com/products-services-training/. Port number for running the software was 5432 when installing. Then PostGIS extension was downloaded using stack builder by checking "Spatial Extension" option during the installation of PostgreSQL.

3.7.2 Loading Shapefile and CSV into the PostgreSQL database

Before importing the shapefiles and CSC file format to the database, PostGIS extension was added in the database. In pgAdmin4 v6, Database server in object explorer was connected. Then by right clicking the extension tab and later new extension to select PostGIS. Using SQL Editor the following command was run "CREATE EXTENSION PostGIS" and then extension was created. PostGIS Shape file Import/Export Manager was used to establish a connection by clicking on view connection details and connection parameters like owner, Plot-No, Building type and phone number were filled as it seen in figure 3.3. Connection was successfully made and then building shapefiles were added using Add File and import buttons found in this manager.

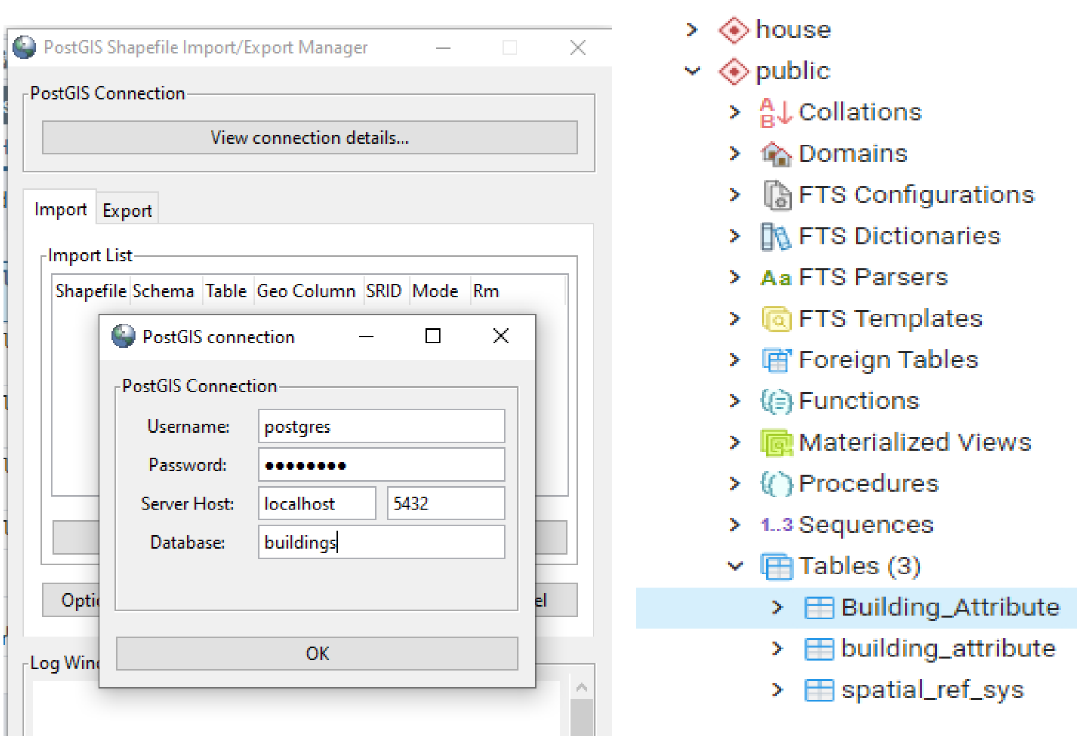


Figure 3. 4: PostGIS connect PostgreSQL and shapefiles view in the database

3.7.3 Loading buildings points (csv) into the PostgreSQL Database

Using the same database named buildings new empty tables of house point data with their respective columns were created. These tables had rows and columns with data type format similar to the columns prepared by excel Csv. After the framework environment was similar to the data that are in excels, building csv data were imported to the table columns and figure 3.4 show how the buildings coordinates data were presented in the database.

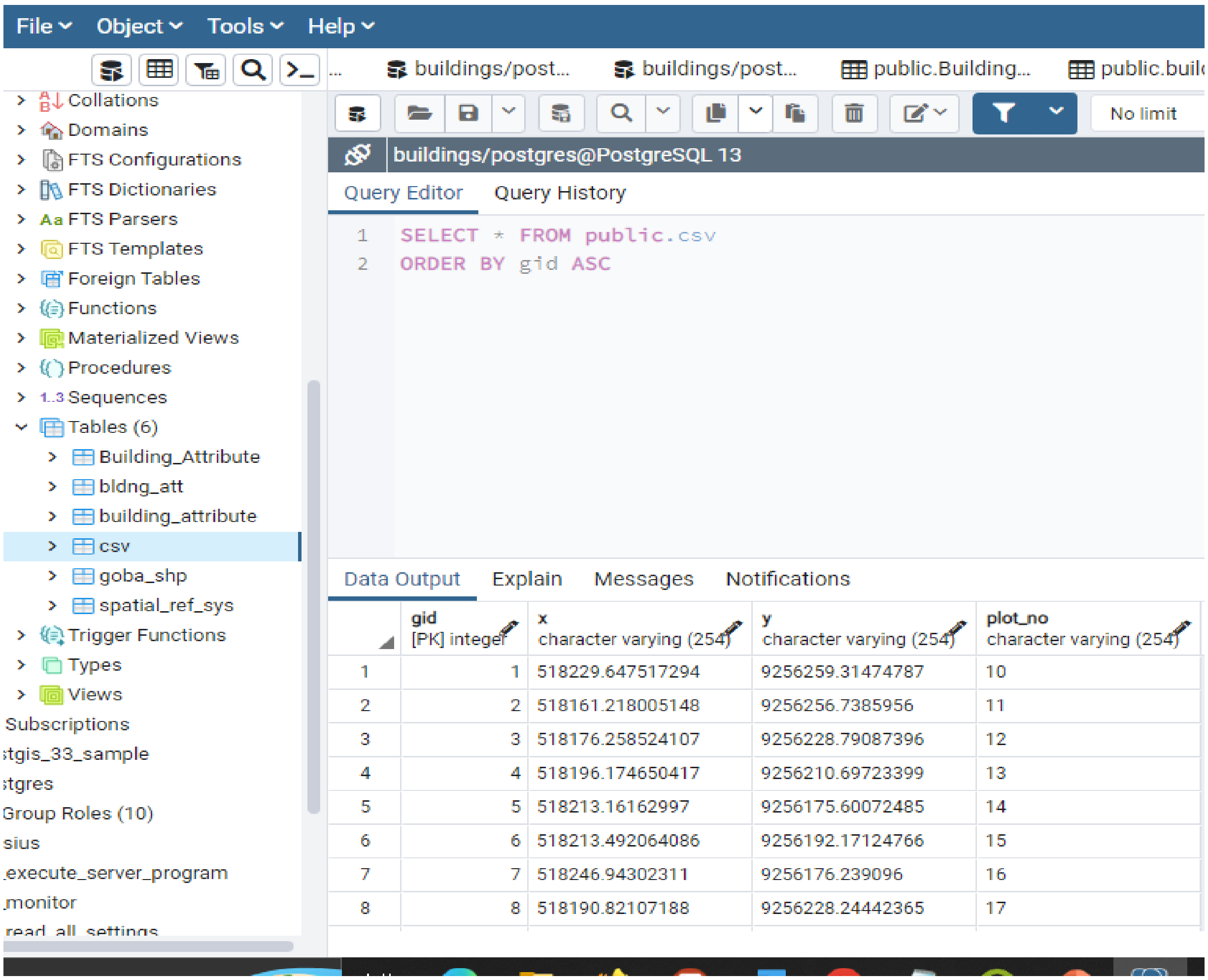


Figure 3. 5: Building coordinate data in the PostgreSQL database

3.8 Web map creation

Web map was created by using Qgis2web plugin which is a powerful tool that allows to create web maps directly from QGIS, a popular open-source desktop GIS software. It enables to export GIS data, including layers, styles, and attributes, into interactive web maps that can be easily shared and accessed online. Here's an overview of the web map creation process using the Qgis2web plugin:

3.8.1 Installing Qgis2web plugin

Opening QGIS and navigate to the plugin manager. Search for the "Qgis2web" plugin and installing it. Once installed, the plugin is found under the "Web" menu in QGIS.

3.8.2 Preparing map in QGIS

Loading the building attribute layers which are in a shapefiles and raster data format, into QGIS project. Style and symbolize the layers according to the preferences. Set up any labeling or classification that is relevant for displaying the web map.

3.8.3 Launching the Qgis2web plugin

Click on the "Web" menu in QGIS and select "Qgis2web." The Qgis2web plugin window will open, presenting you with various options for customizing the web map. Choose the export format for your web map. The export format selected for exportation was Leaflet.

3.8.4 Export the web map

Once the setting up is satisfied with the preview, click on the "Export" button in the Qgis2web plugin window. This will initiate the export process, generating the necessary HTML, CSS, and JavaScript files for the web map.

3.8.5 Publishing and sharing the web map

After the export is complete, now exist a set of files that make web map. Upload these files to a hosting platform that supports web maps, but on my side apache was used. Once published, a web map can be shared by providing the URL that is locally hosted.

3.9 System testing

After being hosting a web map verify that the system functions as expected and provides the necessary features and functionality. This includes testing map navigation, zooming, panning, layer visibility, attribute display, and interactivity such as pop-ups, tooltips, and query functionalities. Testing the web map on different web browsers such as Chrome, Firefox, Safari, and Internet Explorer, to ensure compatibility and consistent behavior across various platforms. Additionally, test the map on different devices (desktops, laptops, tablets, and smartphones) to ensure it is responsive and accessible across different screen sizes. Verifying that the data displayed in the web map corresponds accurately to the original collected building information. Checking for any discrepancies, missing data, or data alignment issues. The link below display the web map that shows a building and its attributes. http://localhost:8000/#16/-6.7309/39.1678

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Overview

In this chapter, the results obtained through the implemented research methodology and discussion are presented according to the intended objective of this research which was to test the usability of Qfield mobile application for building taxation.

4.2 User requirement

Table 4.1 illustrates are important features that users wanted implemented in the property tax web -based system after assessing the important needs of the web map.

Table 4. 1: User requirements

SN	DESIRED FUNCTION	STAFFS REQURING ITS IMPLEMENTATION
1	Current location tracking	Tax collector
2	Determining the position of houses which haven't electricity.	Tax collector
3	Satellite view	Tax collector and application developer
4	Recording a single customer information	GIS officers and Tax collector
5	Login and Logout functionalities	Tax collector/Assessor
6	Connecting spatial data with respect to targeted property	Tax collector
7	Recording and updating the buildings attribute information	Tax collector
8	Differentiate electrical house from non-electrical house	Tax collector

4.3 Design and structure of the system

Structure of the system was designed in order to meet the user requirements and the objective of this study. Figure 4.1 illustrates structure of Web based GIS system;

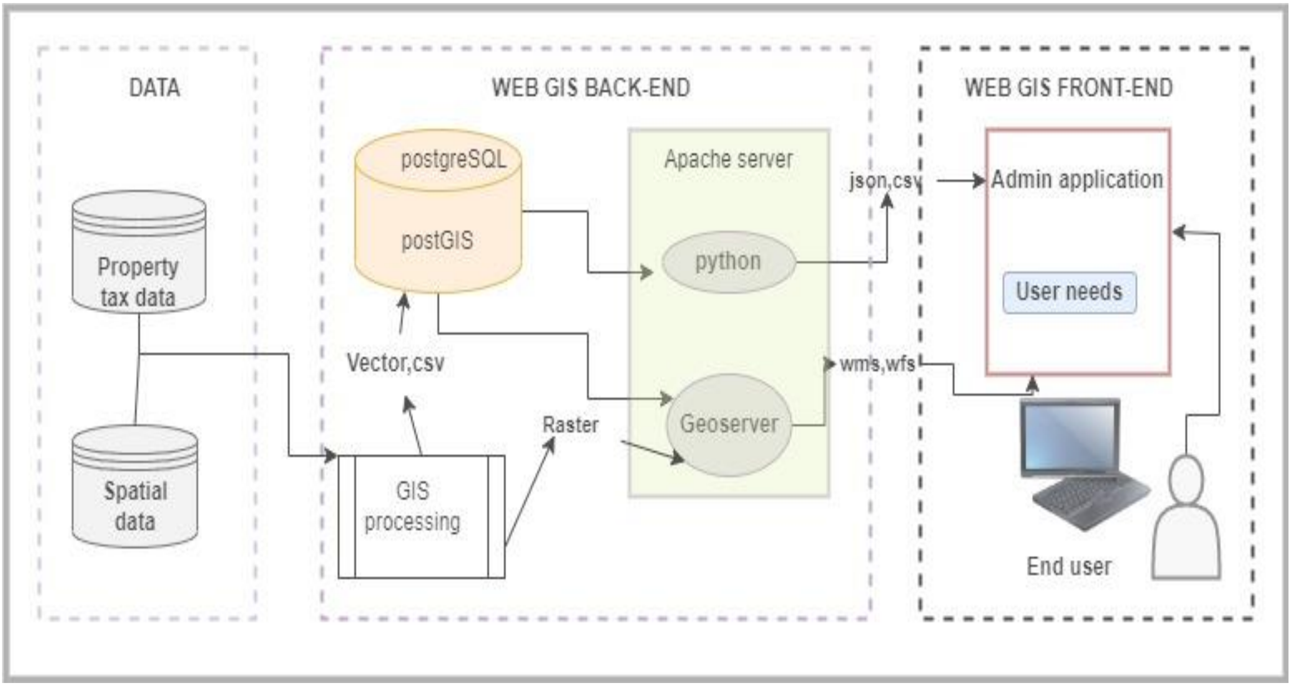
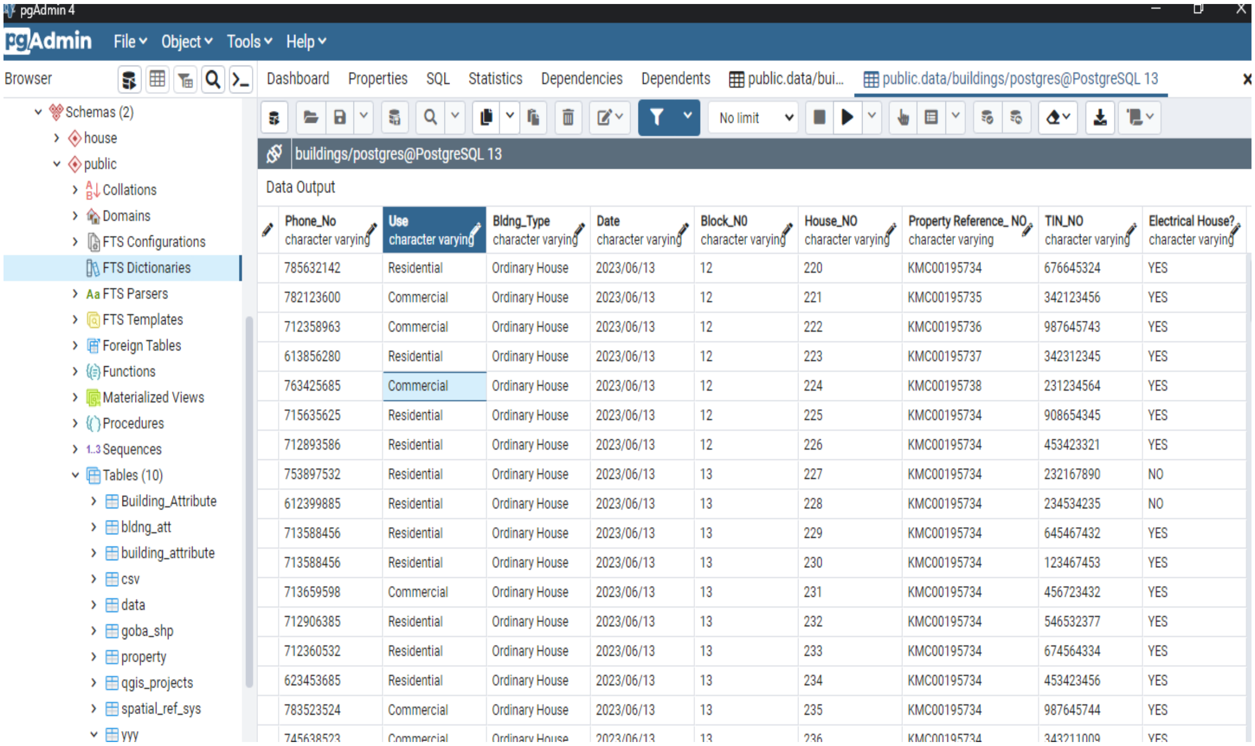


Figure 4.1; Web structure

The system structure designed had three main parts which are data, web GIS back-end and web GIS front end. The end user who is an admin can send request to the server and server receives requests and interprets it. If the request was property tax data then by using Python programming language building information from the PostgreSQL database could be sent back to the end user (admin) but also other function like adding the new customers, searching for location and updating status to the PostgreSQL database could done using the same interface. Python language connects the client side and apache server so that to enable sending and receiving csv and Json data from the database. If the request from the admin could be spatial data, then Geoserver which has published data will receive request and send back the published layers with their attributes that will pop up when selected in the admin side interface. Web map services and feature services are being received and sent back to the admin using Geoserver.

4.3 Geodatabase

Geodatabase that has spatial data and building attribute data was developed. Spatial data was stored in the database as tables where you can only see the attribute table of published layers. Other buildings data like owner, building type, plot number, buildings uses and date of data collection can be viewed directly from the Geodatabase as you can view in figure 4.2



Phone_No character varying	Use character varying	Bldng_Type character varying	Date character varying	Block_NO character varying	House_NO character varying	Property Reference_ NO character varying	TIN_NO character varying	Electrical House? character varying
785632142	Residential	Ordinary House	2023/06/13	12	220	KMC00195734	676645324	YES
782123600	Commercial	Ordinary House	2023/06/13	12	221	KMC00195735	342123456	YES
712358963	Commercial	Ordinary House	2023/06/13	12	222	KMC00195736	987645743	YES
613856280	Residential	Ordinary House	2023/06/13	12	223	KMC00195737	342312345	YES
763425685	Commercial	Ordinary House	2023/06/13	12	224	KMC00195738	231234564	YES
715635625	Residential	Ordinary House	2023/06/13	12	225	KMC00195734	908654345	YES
712893586	Residential	Ordinary House	2023/06/13	12	226	KMC00195734	453423321	YES
753897532	Residential	Ordinary House	2023/06/13	13	227	KMC00195734	232167890	NO
612399885	Residential	Ordinary House	2023/06/13	13	228	KMC00195734	234534235	NO
713588456	Residential	Ordinary House	2023/06/13	13	229	KMC00195734	645467432	YES
713588456	Residential	Ordinary House	2023/06/13	13	230	KMC00195734	123467453	YES
713659598	Commercial	Ordinary House	2023/06/13	13	231	KMC00195734	456723432	YES
712906385	Residential	Ordinary House	2023/06/13	13	232	KMC00195734	546532377	YES
712360532	Residential	Ordinary House	2023/06/13	13	233	KMC00195734	674564334	YES
623453685	Residential	Ordinary House	2023/06/13	13	234	KMC00195734	453423456	YES
783523524	Commercial	Ordinary House	2023/06/13	13	235	KMC00195734	987645744	YES
745638523	Commercial	Ordinary House	2023/06/13	13	236	KMC00195734	343211009	YES

Figure 4. 2: View of both building attribute data and spatial data in geodatabase

4.4 Web map and its prototype validation

Web map that contributes in viewing building data and spatial data was successfully made. The user interface had the following prototype functionalities;

4.4.1 Zoom in and out/panning the layers

The user will be able to zoom in, zoom out, and pan the map the way he or she may need to view. Figure 4.3 show zooming in and zooming out of the layer and panning functionalities on the web map.

Figure 4. 3: Zooming in and zooming out of the web map layer

4.4.2 Measurements of distance, area and location coordinates

The web map created enables the user to measure distance of the line like road from one house to another house, measure the coordinates of the specific location of building and calculate the area of different polygon like plot on which the building is found. The land valuer who needs to change the ownership of building on the specific plot can use the web map to measure the size of the plot. Figure 4.4 describe the functionalities.

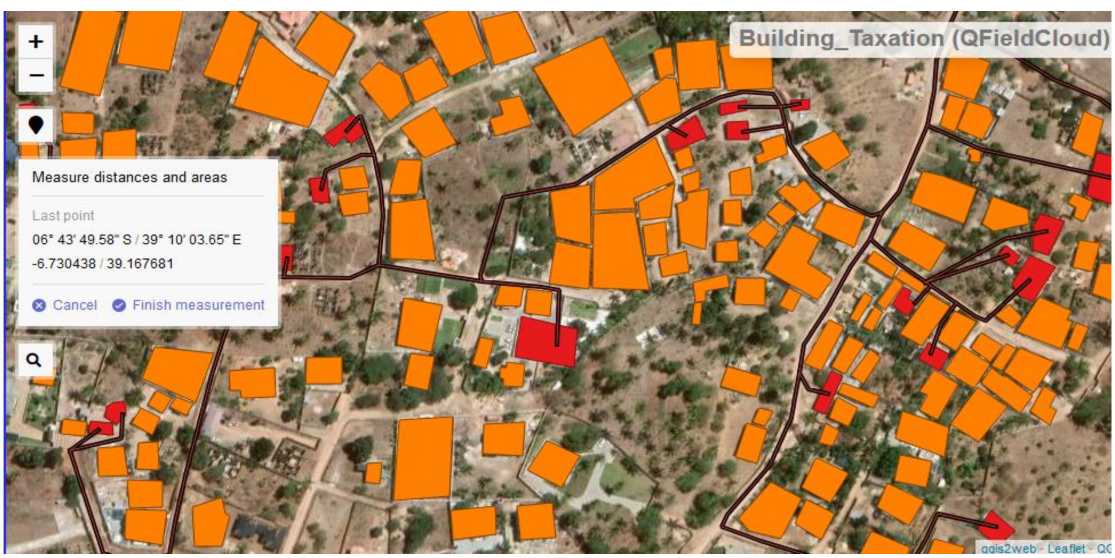


Figure 4.4: Point, line and area measurement functionalities in the web map

4.4.3 Pop ups of attribute data in spatial feature

User will be able to pop up the attribute data of all spatial features found in the web map like building attributes and layer attributes. This will help TRA employees to see the characteristics of each feature just while located at any place. This will help to manage building taxation remotely without depending on the houses to houses data collection. Figure 4.5 illustrates these functionalities.

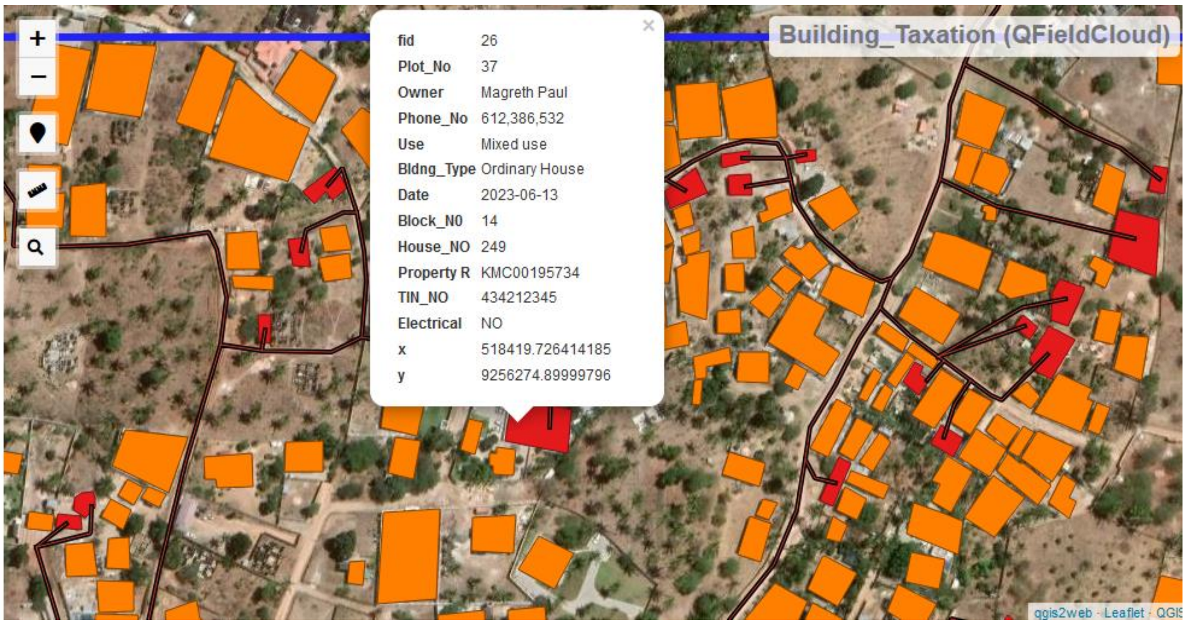


Figure 4. 5: Building attribute pop ups functionalities in the web map

4.4.4 Finding the location of the user and search tool

The web map enables the user to find his/her location at the specific time but also can search for the area if he/she is unaware. Buildings assessor who perform site visiting can use this web map to find their locations and search unknown area. Figure 4.6 illustrates these functionalities

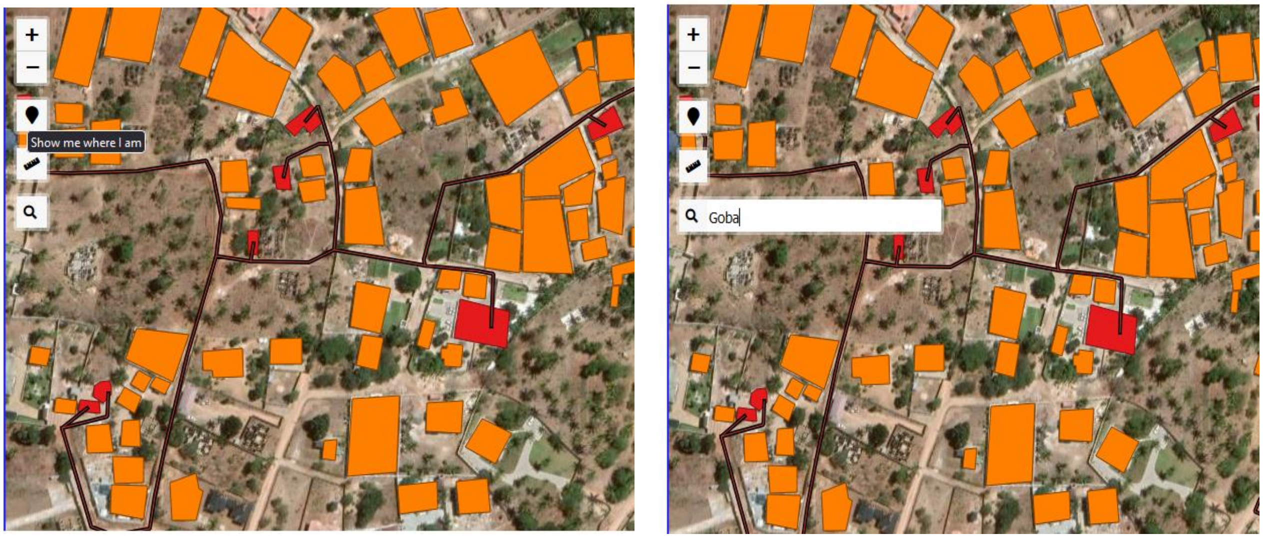


Figure 4.6: Place search and user location identification functionalities

4.4.5 Searching customer information using name of the owner

This search tool created using python framework known as Django. This framework help on retrieving information from the created database so that can be visible in the created system. In this context if the information within the database is updated also the system can achieve the updated information. From this list an admin can search for the customer having electricity by YES keyword and NO keyword for customer having no electricity. This can be shown in table 4.2

Table 4. 2 : Searching customer information by owner name

Search

FID	Owner	Plot Number	Building Type	Use	Date	Block Number	House Number	Property reference number	TIN number	Electricity
1	John Ilomo	10	Ordinary House	Residential	June 13, 2023	12	220	KMC00195734	676645324.0	YES
2	Juma Kulunge	11	Ordinary House	Commercial	June 13, 2023	12	221	KMC00195735	342123456.0	YES
3	Raulian Ferdinand	12	Ordinary House	Commercial	June 13, 2023	12	222	KMC00195736	987645743.0	YES
4	Samwel Daniel	13	Ordinary House	Residential	June 13, 2023	12	223	KMC00195737	342312345.0	YES
5	Paschal Apolinary	14	Ordinary House	Commercial	June 13, 2023	12	224	KMC00195738	231234564.0	YES
6	Adilia Christopher	15	Ordinary House	Residential	June 13, 2023	12	225	KMC00195734	908654345.0	YES
7	Anord Rugemalila	16	Ordinary House	Residential	June 13, 2023	12	226	KMC00195734	453423321.0	YES

4.6 Logging in to the system

A developed web-based GIS system have authentication process before starting to use the system. A system allow user (admin) have to verify his/her password and user name to be verified that is the one who is responsible to login in the system. This is shown in figure 4.8

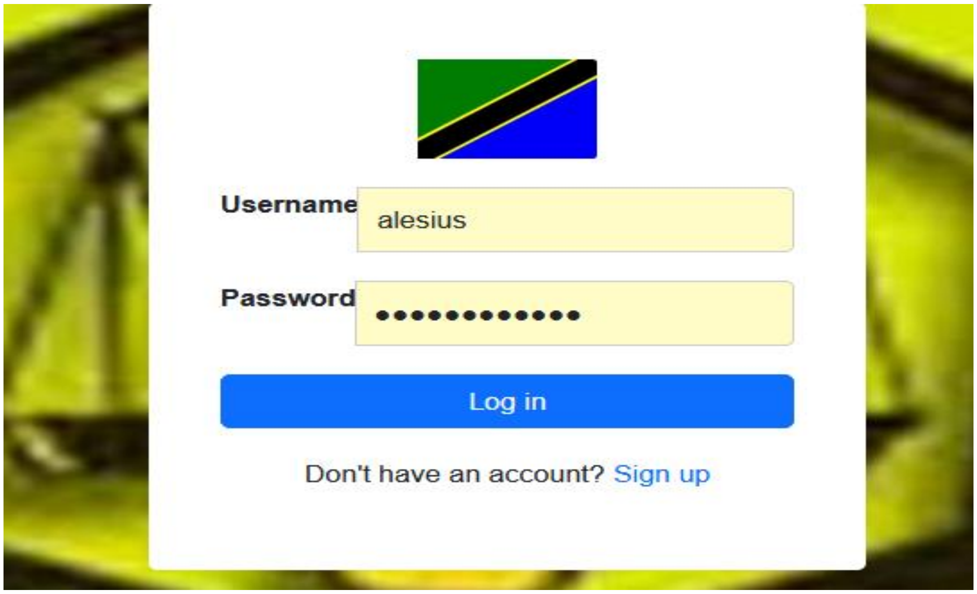
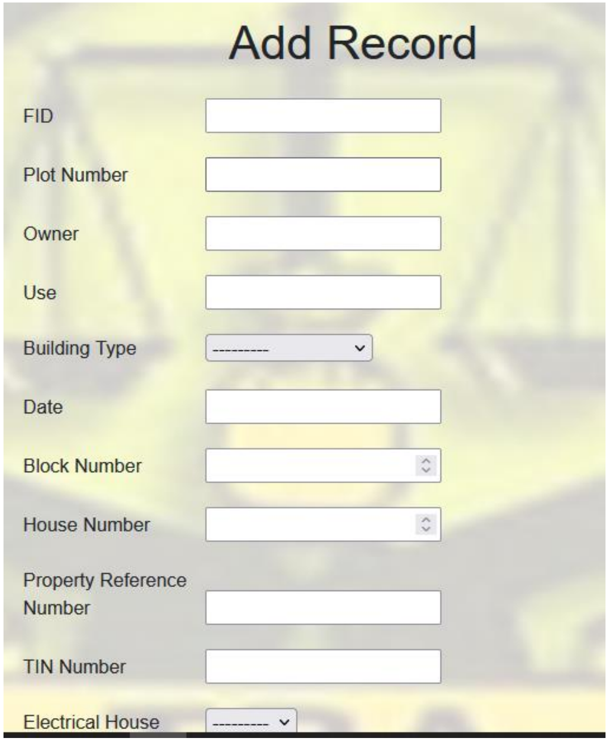


Figure 4.7: Admin authentication

4.7 How to add a new customer

In this system there is an interface where by a new customer information can be added manually. The added customer information are similar to the requirements that a user wants to implement within the system. Also in the system there is an option of adding a excel file containing more than one customer. This is shown in figure 4.8 below



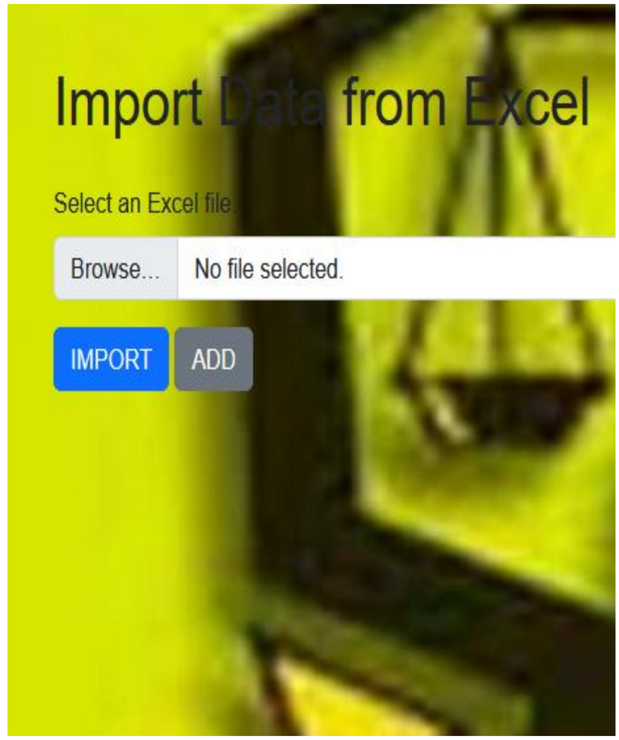
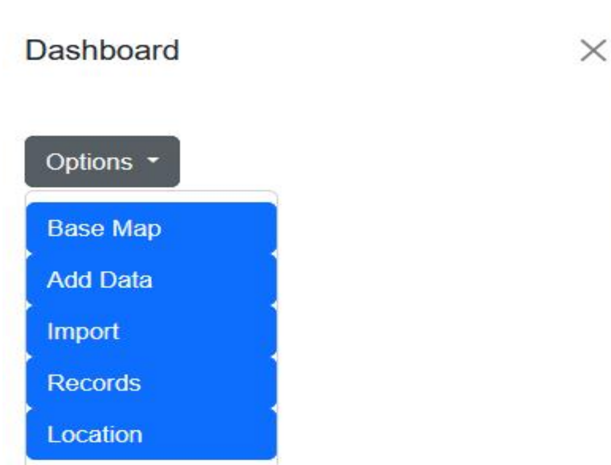


Figure 4.8: Adding single customer and importing file

4.8 Dashboard to show system options

A board show different options that a user want to select, the options are base map, add data, import data, showing customer records, searching for customer location and route tracing to reach ones location. This is shown in figure 4.9 below



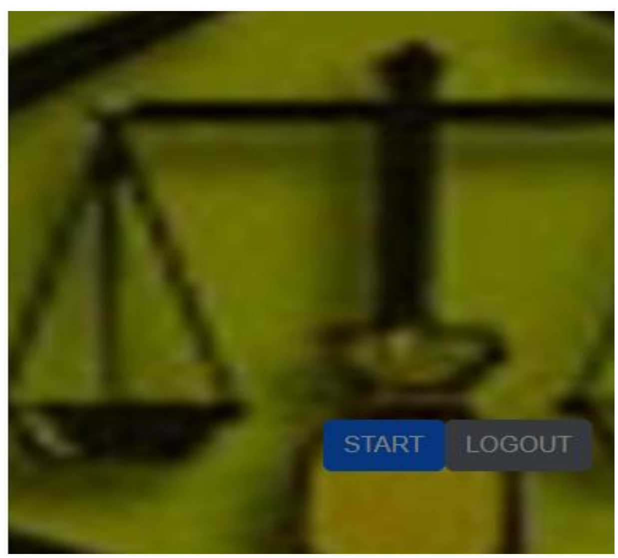


Figure 4. 9: Dashboard for different options

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This research delved into the development of web-based GIS system for property taxation tracking that determine the houses without electricity, also a system can trace route for the destination to the customers. A designed web-based system further amplifies the potential for streamlined property taxation process, offering accessibility, route tracing, adding location information and data recording. As technology continues to reshape administrative procedures, this research underscores the importance of user centric design and innovative solution in modernizing property taxation system.

5.2 Recommendation

This research is basically used for determination of houses that have not electricity, a researcher and wed developers are recommended as follow:

5.2.1 From a developed web-based GIS system

A developed web-based GIS system have a capability of accessing some one location, therefore TRA can use a developed system to access someone who have not paid.

5.2.2 For the coming researcher.

For the coming investigator or researcher should create a valuation tool within a system that can help in proper imposition of tax to a relevant property. This is because some of ordinary houses have different value but levied equal.

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APPENDICES

WEB-BASED GEOGRAPHIC INFORMATION SYSTEM FOR PROPERTY TAXATION TRACKING

APPENDIX A: PRIMARY DATA COLLECTED DIRECTLTY FROM THE FIELD

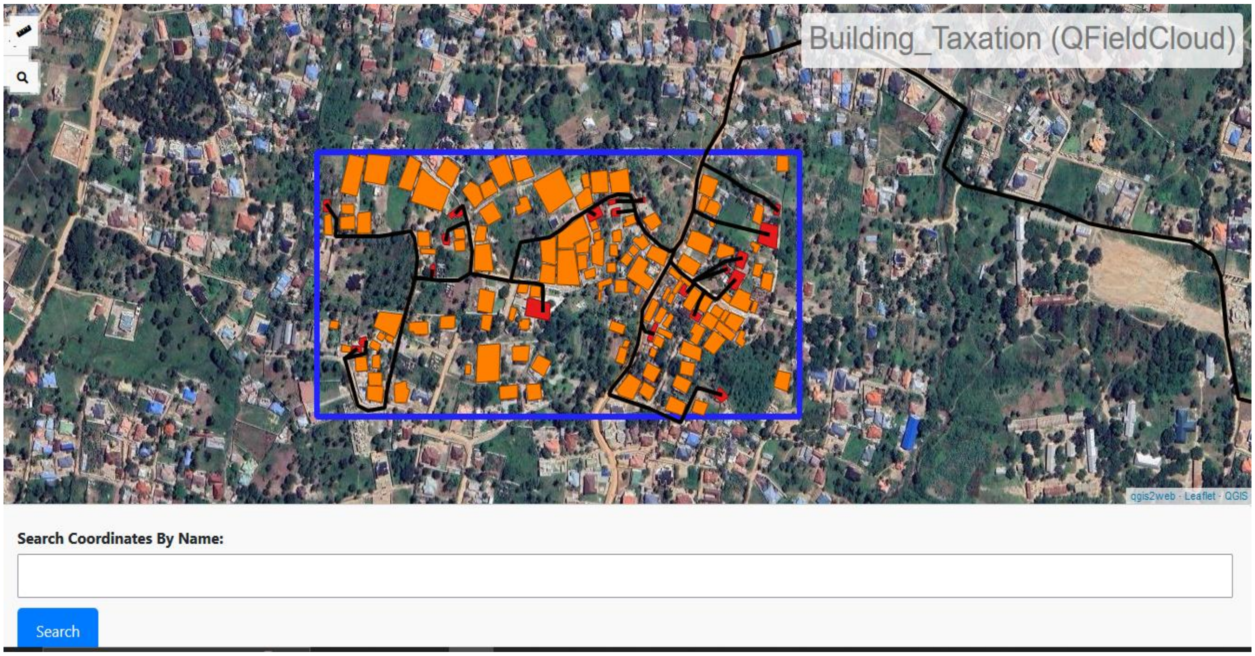
Table show the data that are collected directly from the field by the means of Qfield mobile application.

Plot_No	Owner	Phone_NO	Use	Building Type	Date	Block_NO	House_NO	Property Reference_ NO	TIN_NO	Electrical House?
17	Flolian Kikwete	753897532	Residential	Ordinary House	13/06/2023	13	227	KMC00195734	232167890	NO
18	Evans Kanondo	612399885	Residential	Ordinary House	13/06/2023	13	228	KMC00195734	234534235	NO
37	Magreth Paul	612386532	Mixed use	Ordinary House	13/06/2023	14	249	KMC00195734	434212345	NO
52	Hamis Mluma	716432862	Residential	Ordinary House	13/06/2023	15	264	KMC00195734	556633442	NO
63	Anitha Mendson	715389652	Residential	Ordinary House	13/06/2023	16	275	KMC00195734	564346784	NO
66	Revelian AgustÃn	623853484	Commercial	Ordinary House	13/06/2023	16	278	KMC00195734	876439874	NO
74	James Mkinga	623886687	Commercial	Ordinary House	13/06/2023	17	286	KMC00195734	456723432	NO
78	Queen Mzavaz	736879906	Residential	Ordinary House	13/06/2023	17	291	KMC00195734	765432412	NO
79	Lewis Hamilton	715768263	Residential	Ordinary House	13/06/2023	17	292	KMC00195734	456723432	NO
83	Claudia Simon	745398853	Residential	Ordinary House	13/06/2023	17	296	KMC00195734	453423456	NO

91	Kassim Lewis	623884436	Residential	Ordinary House	13/06/2023	17	304	KMC00195734	546532377	NO
94	Antony Julius	785358963	Residential	Ordinary House	13/06/2023	18	307	KMC00195734	546532377	NO
111	Elius Thomas	715700890	Residential	Ordinary House	14/06/2023	19	324	KMC00195734	343211009	NO
112	Maulid Brian	712356852	Commercial	Ordinary House	14/06/2023	19	325	KMC00195734	889000878	NO
113	Mjuni Mjuni	715369000	Commercial	Ordinary House	14/06/2023	19	326	KMC00195734	908654345	NO
118	Innocent Makila	762859785	Residential	Ordinary House	14/06/2023	19	331	KMC00195734	546532377	NO
139	Venancy Juma	716978635	Residential	Ordinary House	14/06/2023	21	352	KMC00195734	546532377	NO
142	Yolanda Kitama	712640523	Residential	Ordinary House	14/06/2023	21	355	KMC00195734	456723432	NO
143	Fatuma Geoffrey	716980532	Residential	Ordinary House	14/06/2023	21	356	KMC00195734	765432412	NO
153	Radius Sunday	713685234	Residential	Ordinary House	14/06/2023	22	365	KMC00195734	123456324	NO

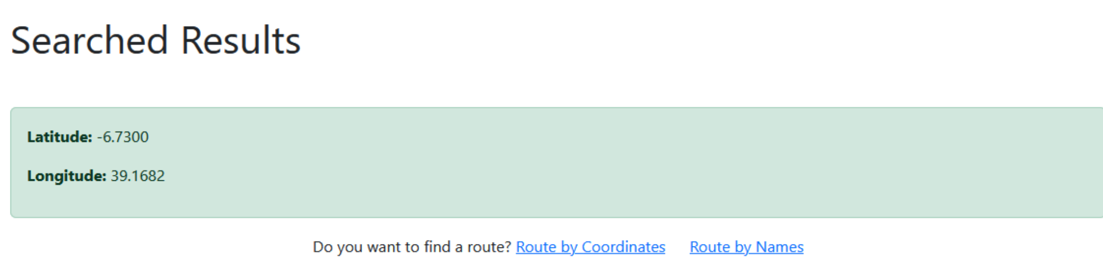
APPENDIX B: DIGITIZED HOUSES AND ROADS TO THE CUSTOMERS

A base map showing sample of houses with electricity and those without electricity.



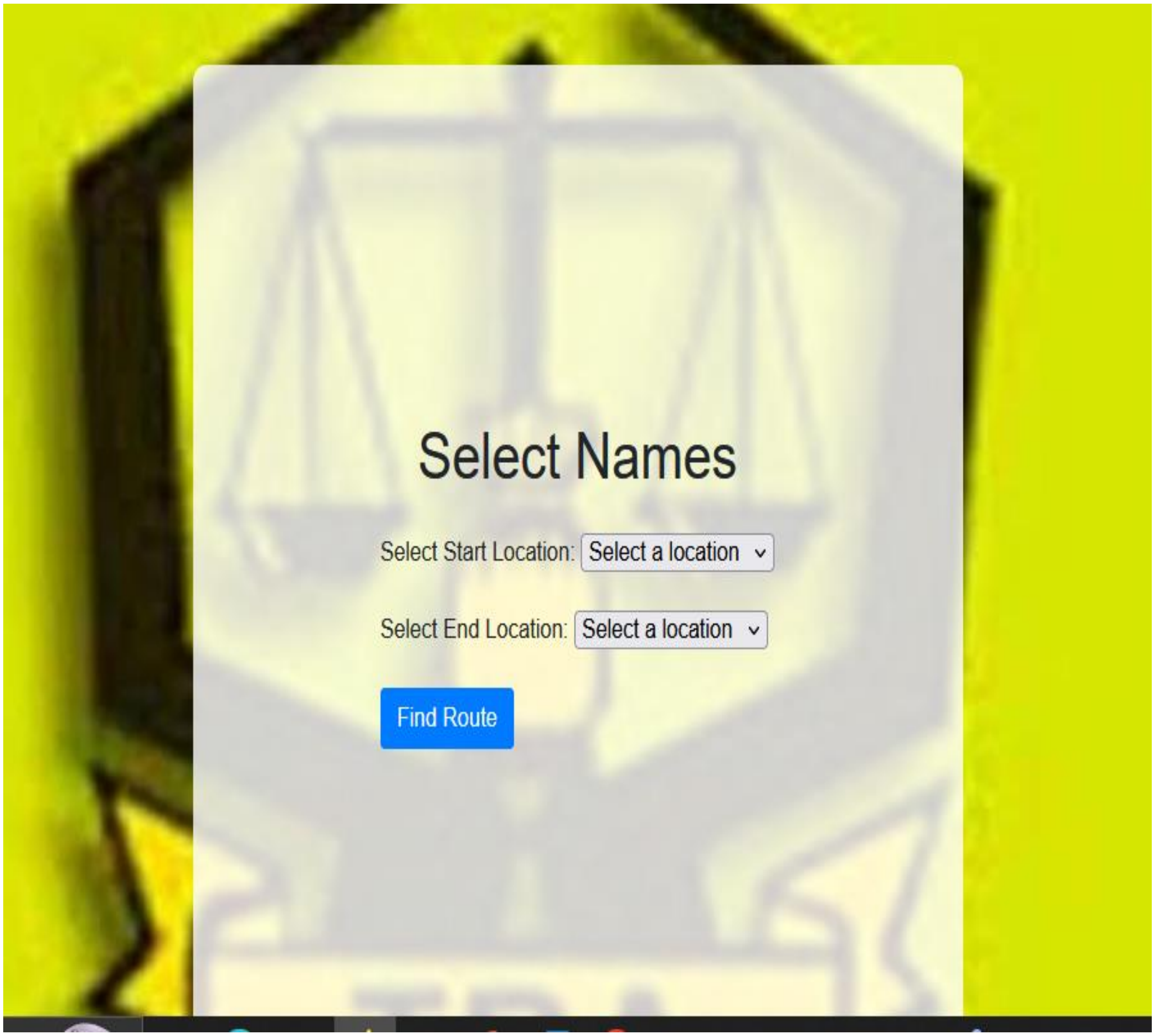
APPENDIX C: SEARCHED RESULTS USING CUSTOMER NAME

Result after searching the customers name that brings two options that are to trace route by coordinates or by name



APPENDIX D: START AND ENDING NAMES

When searching by name two options of selecting starting name and ending name are displayed. These two options helps to specify the location by tracing route from the starting name to the ending name.



APPENDIX E: ROUTE TRACED FROM STARTING NAME TO ENDING NAME

After specifying a starting name and ending name, a line is drawn to show the place where house is found from one node to another node.


Ruvu Forest
Kibaha Town
Kibaha
T26
Kinondoni Municipal
Mbudya and Bongoyo Marine Reserve
Coastal Zone
Ubungo Municipal
T1
Dar es-Salaam
Julius Nyerere International Airport
Temeke MC
Ilala Municipal
Pwani
T7