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**DEVELOPMENT OF A WEB-BASED GEOGRAPHIC INFORMATION SYSTEM FOR TAX COLLECTION AND MANAGEMENT**

**CASE STUDY OF UBUNGO MUNICIPALITY**

**BY**

**MINJA, SIA**

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# DEVELOPMENT OF A WEB-BASED GEOGRAPHIC INFORMATION SYSTEM FOR TAX COLLECTION AND MANAGEMENT

## CASE STUDY OF UBUNGO MUNICIPALITY

**By**

**MINJA, SIA**

A dissertation submitted to the department of Geospatial Sciences and Technology in partial fulfillment of the requirements for the award of Bachelor of Science degree in Geographic Information System and Remote Sensing (BSc. GIS & RS) at Ardhi University.

## CERTIFICATION

The undersigned certify that they have supervised and proof read the dissertation and hereby recommend for acceptance by Ardhi University as dissertation document entitled: **"Developing a web-based Geographic Information System for Tax collection and management; Case study of Ubungo Municipality"** in partial fulfilment of the requirements for the award of degree of Bachelor of Science in Geographic Information System and Remote Sensing at Ardhi University.

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| Date: ……………………. | Date: …………………. |

## DECLARATION AND COPYRIGHT

I, **Minja Sia,** declare that the contents of this dissertation are the results of my own findings, obtained through studies and investigations. To the best of my knowledge, it has not been presented to any other university as a thesis for an award of Diploma, Degree or similar professional award.

……………………………

Minja, Sia

Date……………………….

## ACKNOWLEDMENTS

I would like to thank God for his mercy, blessings and everything that he has done for me throughout my whole life journey. For he did what he said, “For I know the plans I have for you,” declares the Lord, “plans to prosper you and not to harm you, plans to give you hope and a future." (Jeremiah 29:11). Without him, I wouldn’t have reached where I am today.

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## DEDICATION

To my cherished mother and dear brother, this research is dedicated to them with immense love and gratitude. Their unwavering support, encouragement, and belief in me have been the driving force behind my accomplishments. Mom, your love and sacrifices have shaped me into the person I am today. Brother, your unwavering belief in my abilities has inspired me to reach for the stars. I am forever grateful for you've always being there, guiding me with your wisdom and showering me with unconditional love. Without you, this research would not have been possible. May this dedication serve as a small token of my love and appreciation for your immeasurable impact on my life and academic journey. May God bless you.

## ABSTRACT

The tax collection and management system in Tanzania currently faces significant challenges arising from manual processes, paper-based documentation, and fragmented data storage. These issues result in delays during tax processing, inaccuracies in tax assessment, limited data accessibility, and a lack of transparency. Furthermore, the absence of an effective spatial-based information system hinders the Tanzania Revenue Authority (TRA) from efficiently managing spatial data, identifying business locations, and conducting tax collection effectively.

Through a systematic examination of the existing challenges and deficiencies, this research outlines a strategic approach to design, develop, and implement a web-based Geographic Information System (GIS) tailored specifically for tax collection and management. By leveraging spatial data analytics, data visualization, and modern web technologies, the proposed system aims to transform the current tax collection landscape.

The research objectives encompass: Identifying user needs and specifications, defining system functional requirements, designing the architecture of the web-based GIS, developing the system's structure and architecture, establishing a spatial database for comprehensive data storage, creating an intuitive user interface, implementing the web-based GIS and thoroughly testing the GIS for robust functionality.

The research also highlights the importance of utilizing software tools like ArcGIS, Quantum GIS, PostgreSQL, PostGIS, GeoServer, Leaflet, Apache/Tomcat, and Visual Studio Code/GitHub for the development of robust and efficient GIS solutions for tax collection and management. It also employs a systematic methodology encompassing data processing, system design, and integration of interactive features. The results demonstrate the successful implementation of the web-based GIS system, providing tax officials with access to functionalities such as zooming, layer switching, measurement tools, attribute data pop-ups, location finding, and an interactive user interface.

This research contributes to the advancement of modern tax management systems, setting the stage for optimized revenue generation and sustainable economic progress in Tanzania.

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| HTML | Hyper Text Markup Language |
| CSS | Cascading Style Sheets |
| GIS | Geographical Information System |
| HTTP | Hypertext Transfer Protocol |
| URL | Uniform Resource Locator |
| TRA | Tanzania Revenue Authority |
| TIN | Taxpayer Identification Number |
| PHP | Hypertext Preprocessor |
| SQL | Structured Query Language |
| WWW | World Wide Web |
| CSV | Comma-Separated values |
| PT | Property Tax |
| PIT | Personal Income Tax |
| CIT | Corporate Income Tax |
| RT | Rental Tax |
| WMS | Web Map Service |
| WFS | Web Feature Service |
| VAT | Value Added Tax |
| IT | Information Technology |

# CHAPTER ONE

# 1 INTRODUCTION

## 1.1 Overview

This chapter introduces the overall details of the research. These include the background of the research problem, the Statement of the research problem, the objectives, research questions, significance of the research, scope and limitations, beneficiaries of the study and the description of the study area.

## 1.2 Background

Tax evolved and developed independently in the great ancient empires (Samson, 2002). The concepts that evolved were transported to other empires and cultures where tax ideas took root (Samson, 2002). This pattern continues through to today as nations are influenced by developments in tax from other countries (Samson, 2002). Taxation has a long history, it played a relatively minor role in the ancient world. Taxes on consumption were levied in Greece and Rome. Taxation is used primarily to raise revenue for government expenditures, though it can serve other purposes as well. In modern economies, taxes are the most important source of governmental revenue (McLure, 2023).

Taxation is the process by which governments collect funds from individuals, businesses, and other entities to finance public expenditures and provide essential services (iLibrary, 2010). Taxes are levied by governments at various levels, including national, regional, and local levels, and are used to fund infrastructure development, social welfare programs, public health, education, defense, and other government functions (McLure, 2023).

In Tanzania, taxation has a long history that can be traced back to pre-colonial times when local chiefs levied taxes on their subjects in the form of tribute. During the colonial period, which lasted from the late 19$^{th}$ century to the early 1960s (Levin, 2001). After gaining independence in 1961, Tanzania established its own tax system as part of its efforts to build a sovereign nation. The tax system has evolved over the years, with changes in tax laws, regulations, and administrative structures (Sikika, 2019).Currently, Government of Tanzania has various sources that are used to widen its tax base and increase revenue collection. These sources are grouped into direct taxes and indirect taxes (Mrema, 2018).

The direct taxes are the ones that are levied directly on people's income from employment, business or ownership of property and an investment. These include Corporate income tax, Personal income Tax (PIT), and withholding tax on business, capital and investment incomes (Mrema, 2018). The indirect taxes are the ones that are basing on the consumption. The indirect taxes comprise taxes on international trade transactions and on domestically produced goods and services. They include value added tax (VAT), excise and custom duties and import duties (Mrema, 2018). The direct taxes account for around 30% of total tax revenue, while the indirect taxes account for around 70% of total tax revenue (SANEC, 2020).

The Tanzania Revenue Authority (TRA) was established by Act of Parliament No. 11 of 1995, and started its operations on 1st July 1996. In carrying out its statutory functions, TRA is regulated by law, and is responsible for administering impartially various taxes of the Central Government. (TRA, 2023). TRA is mandated to collect revenue on behalf of the government of Tanzania through effective tax administration, taxpayer education, and enforcement of tax laws and regulations. TRA provides taxpayer services, including tax registration, filing of tax returns, issuance of tax clearance certificates, and taxpayer education and support. (TRA, 2023). TRA also provides online services, such as electronic filing and payment options to facilitate tax compliance (TRA, 2023).

TRA currently faces challenges on collecting and managing taxes. These challenges include; Tax evasion and avoidance, Limited enforcement resources, Informal economy, Taxpayer non-compliance, Technological challenges, lack of accurate property records, limited resources, lack of effective statutory rate, lack of means of transport, delay in payment and inconsistency in valuation process, lack of awareness of tax payers, corruption behavior of the officials, limited knowledge of tax laws and regulations, and lack of motivation of property tax collector (Ally, 2015). The challenges are enhanced by unavailability of a tax collection management system that accommodates spatial (locational) information like; web-based Geographic Information System (GIS). GIS is a powerful technology that integrates geographic data with tax-related information, allowing for efficient tax assessment, mapping, and management (HighPoint, 2020). Without a web-based GIS system, TRA may face difficulties in accurately identifying taxpayers, verifying property ownership, and assessing taxes based on location-specific data. Additionally, without real-time access to spatial data, TRA may face challenges in identifying tax evasion, enforcing tax compliance, and managing tax-related disputes.

This study intents to develop a web-based Geographic Information System. Tax collection management system for enhancement and efficiency of revenue collection and management to support sustainable development of our country.

### 1.3 Statement of the research problem

The current tax collection and management system in Tanzania suffers from manual processes, paper-based documentation, and fragmented data storage, leading to delays in tax processing, inaccuracies in tax assessment, difficulties in retrieving and analyzing tax-related data, and limited transparency (Dedu, 2015).

The existing system for tax collection in Tanzania also lacks an effective spatial-based information system that incorporates spatial data of taxpayers. Without a spatial-based information system, the TRA faces difficulties in managing spatial data, identifying business locations, and collecting relevant taxes efficiently. This lack of integration undermines the revenue generation potential and the overall economic growth and development. It also hampers real-time and accurate processes, making reliable tax collection a challenging task for the TRA.

Therefore, there is a need to develop and implement a comprehensive web-based information system that incorporates spatial data, enabling the TRA to efficiently manage tax collection processes, accurately identify business locations, and ensure timely and accurate tax collection.

### 1.4 Research Objectives

#### 1.4.1 Main Objective

The main objective of this study is to develop a web-based GIS for tax collection and management.

#### 1.4.2 Specific objectives

The following are the specific objectives of the study:

i. To identify the user needs and specifications.

ii. To identify the system functional requirements and specifications.
iii. To design the structure of the web-based GIS system.
iv. To develop the structure or architecture of the web-based GIS system.
v. To develop a spatial database for storage of both spatial and non-spatial information.
vi. To design and create a user interface.
vii. To develop a web-based Geographic Information System.
viii. To test the web-based Geographic Information System.

### 1.5 Research Questions

The following are the research questions of the study:

i. What are the user needs and specifications?
ii. What are the System functional requirements and specifications?
iii. How can the structure of the web-based GIS system be designed?
iv. How can the structure or architecture of the web-based GIS system be developed?
v. How can a spatial database be developed for the storage of both spatial and non-spatial information?
vi. How can a user interface be designed and created to manage both spatial and non-spatial information?
vii. How will the system be developed?
viii. How will the system be tested?

### 1.6 Scope and limitations of the study

This research will base on the data collection and management, mapping and visualization, User-friendly interface, data security, reporting and tax calculation and payment. And lastly, developing a web-based GIS which will contain all the information that are required and important for the TRA.

The limitations of this study may be lack of technical expertise among government officials and property owners in Tanzania, not all areas may have reliable internet access and not all people will have the access to the internet, and the budget to manage a web-based GIS system can be costly.

### 1.7 Significance of the study

This study will bring many significances. The following are the significance of this study: -

i. Improving efficiency and accessibility of data;

A web-based GIS would allow a well-organized data collection, storage, and analysis, making the property tax collection process more efficient and makes it more convenient and accessible to the users.

ii. Increasing transparency;

Making the property tax collection process more transparent through a web-based GIS, would increase trust and cooperation from citizens.

iii. Better decision-making;

A web-based GIS would provide local government officials with more accurate and up-to-date information about properties, enabling them to make more informed decisions about tax collection.

iv. Increasing revenue;

By making the property tax collection process more efficient and transparent, a web-based GIS could help to increase revenue for the government.

v. Better property tax data management;

Web-based GIS can facilitate the management of property tax data and improve data accuracy, integrity and access which will lead to better decision making.

Generally, in the context of tax collection and management, a web-based GIS system can be used to integrate geographic data, such as property ownership information, tax assessment values, and land use data, with spatial data, such as maps and satellite imagery. This can enable tax authorities to accurately identify taxpayers, assess taxes based on location-specific data, identify tax evasion patterns, and enforce tax compliance more effectively. Also, web-based GIS systems can provide tools for visualizing and reporting tax data, enabling tax authorities to monitor and analyze tax collection performance, identify areas with low tax compliance, and make informed decisions on tax policies and enforcement strategies.

## 1.8 Beneficiaries of the study

The beneficiaries of this study would include: the government, property owners, taxpayers and the TRA as described below;

i. The government;

Would benefit by having a more efficient and accurate way to collect property taxes, which are an important source of revenue.

ii. Property owners;

Would benefit by having a clear and transparent system for paying their taxes and understanding how their property is valued.

iii. Taxpayers;

Would benefit by having a more streamlined and easy-to-use system for paying their taxes.

iv. TRA

Firstly, it can enhance data collection by capturing accurate geospatial data on properties and businesses. Secondly, it can enable spatial analysis, allowing the TRA to visualize tax data on maps, identify patterns, and optimize enforcement efforts and resource allocation. Thirdly, it can improve revenue management by integrating tax data with other relevant datasets. Fourthly, it can enhance transparency and accountability by making tax data accessible to the public through interactive web map. Lastly, it can improve customer service through online self-service portals, enabling taxpayers to access information and make payments easily.

## 1.9 Description of the Study Area

Ubungo District (officially known as Ubungo Municipality) is one of five districts in Dar es Salaam region (Council, 2017). The other districts are: Temeke Municipal Council, Kinondoni Municipal Council, Ilala Municipal Council, and Kigamboni Municipal Council (Council, 2021). Ubungo District is subdivided administratively into 9 wards, which are: Kimara, Goba, Msigani, Saranga, Makuburi, Ubungo, Mabibo, Sinza, Manzese and Mburahati. Ubungo District covers an area of approximately 266 square kilometers (Council, 2017). It is located at coordinates latitude

-6.7826º or 6º 46' 57" south and longitude 39.2018º or 39 12' 7"east. Figure 1.1 illustrates the location of the study area.

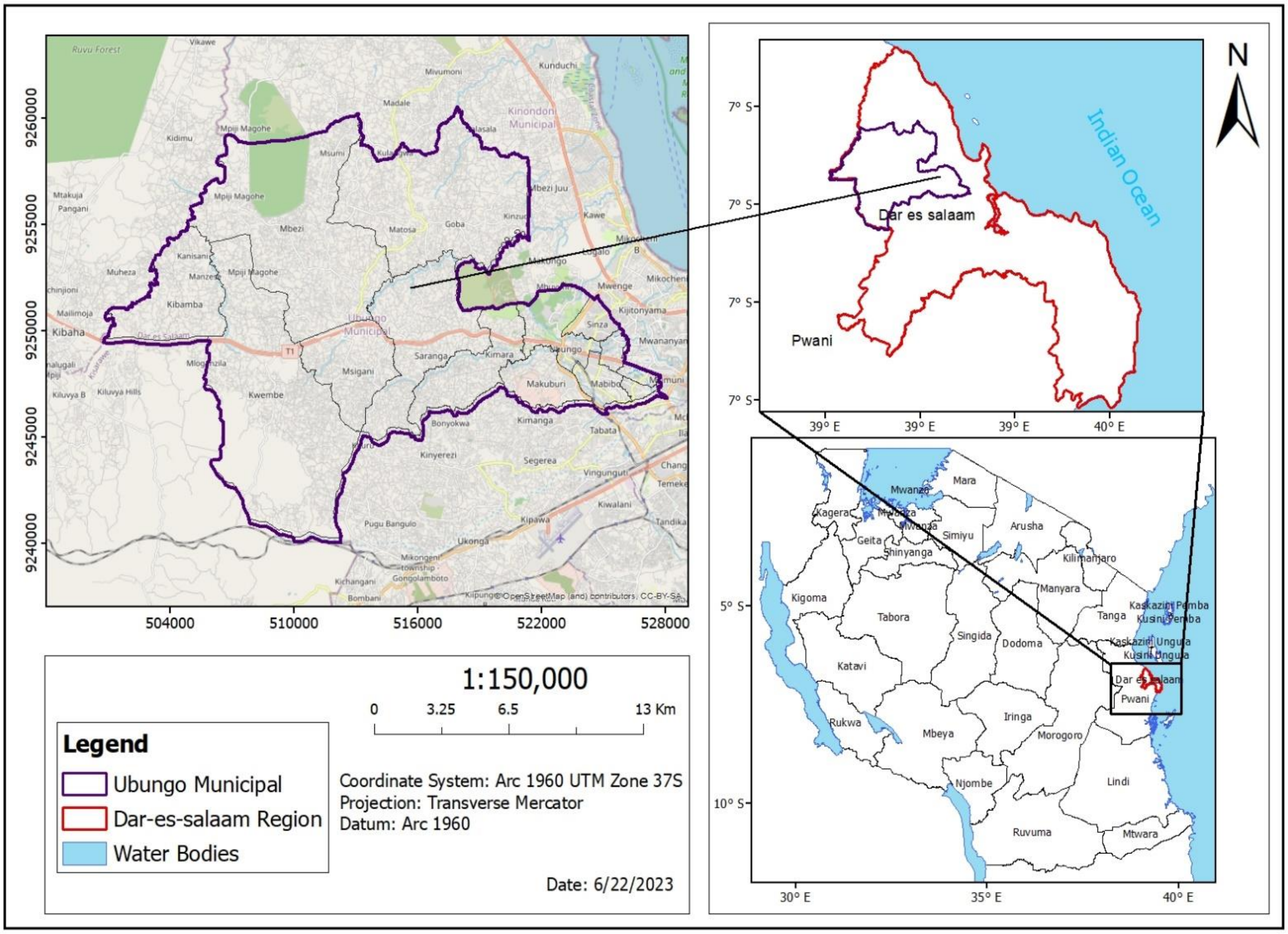


Figure 1.1 Location of the study area Ubungo Municipality

## 1.10 Dissertation organization

This dissertation consists of five chapters, explaining in details all the methods, principles, procedures and the results obtained in developing Web-based GIS system for tax collection and management in Ubungo Municipality.

Chapter 1 explains the background of the study, which gives more information of the problem. It also includes; 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 the developed web-based GIS system. It also shows how other countries uses a web-based GIS in collecting and managing tax. Chapter 3 covers all the methods and techniques involved or used while conducting 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 about the study.

# CHAPTER TWO

# 2 LITERATURE REVIEW

## 2.1 Overview

This chapter provides a comprehensive overview and analysis of existing literature and studies relevant to the topic. It explores the theoretical and practical foundations, key concepts, methodologies, and best practices related to web-based GIS systems and tax collection and management.

## 2.2 Tax

A tax is a compulsory financial charge or some other type of levy imposed on a taxpayer (an individual or legal entity) by a governmental organization in order to fund government spending and various public expenditures (regional, local, or national) (OECD, 2019). A failure to pay in a timely manner (non-compliance), along with evasion of or resistance to taxation, is punishable by law (TRA, 2023). Taxes are mandatory contributions levied on individuals or corporations by a government entity—whether local, regional, or national (Gorton, 2023). The levying of taxes aims to raise revenue to fund governing or to alter prices in order to affect demand. States and their functional equivalents throughout history have used the money provided by taxation to carry out many functions. Some of these include: expenditures on economic infrastructure (roads, public transportation, sanitation, legal systems, public security, public education, public health systems), military, scientific research & development, culture and the arts, public works, distribution, data collection and dissemination, public insurance, and the operation of government itself (TRA, 2023).

## 2.3 Tax evasion

Tax evasion refers to the illegal and deliberate act of evading or avoiding paying taxes owed to the government (gov, 2018). It involves intentionally misrepresenting or concealing income, assets, transactions, or other financial information in order to reduce the tax liability or avoid paying taxes altogether. Tax evasion is considered a criminal offense in most jurisdictions and is subject to penalties and legal consequences (Kagan, 2022). There are methods for tax evasion, some of the are: Underreporting Income, Overstating Deductions or Expenses, and False Invoicing or Double Invoicing (Gorton, 2023).

### 2.4 Tax Administration

Tax administration in Tanzania has a three-tier structure, namely Central Government tax administration, tax administration in Zanzibar and Local Governments tax administration. The Tanzania Revenue Authority (TRA) administers the Central Government taxes, is the government agency of Tanzania, charged with the responsibility of managing the assessment, collection and accounting of all central government revenue in Tanzania (TRA, 2023). Zanzibar Revenue Board administers domestic consumption taxes in Zanzibar. While, the Local Authorities administer the various local imposts. Central Government taxes are the major revenue earner for the Government, accounting for about 90% of domestic revenue (SANEC, 2020).

### 2.5 Types of Tax

There are two types of Tax in Tanzania, which are: Direct tax and Indirect tax. These can be explained as:

i. Direct Tax

A direct tax is a tax that a person or organization pays directly to the entity that imposed it (Kagan, 2022). Examples include: income tax, real property tax, personal property tax, Skills and Development Levy (SDL), Resident Individual Income Tax and taxes on assets, all of which are paid by an individual taxpayer directly to the government (Kagan, 2022).

ii. Indirect Tax

An indirect tax is collected by one entity in the supply chain, such as a manufacturer or retailer, and paid to the government; however, the tax is passed onto the consumer by the manufacturer or retailer as part of the purchase price of a good or service. The consumer is ultimately paying the tax by paying more for the product (Kagan, 2022). Indirect taxes can be defined as taxation on an individual or entity, which is ultimately paid for by another person. Examples of indirect taxes are: Excise duties, value-added tax (VAT), Stamp Duty, and Import Duty (Kagan, 2022).

There are several taxes used while carrying out this research. These taxes are as follows:

### 2.5.1 Property Tax

Property taxation in Tanzania is one among sources that the government can potentially and largely use to widen its tax base and increase revenue collection. Property tax refers to a form of tax imposed on the ownership or possession of certain types of properties. It is levied by the local government authorities, including municipalities, city councils, and district councils (Collin, 2021). Property tax is governed by the Local Government Finances Act of 1982, as well as other relevant regulations and by laws at the local level (Chegree, 2020). It is calculated by a local government where the property is located and paid by the owner of the property. This tax is usually based on the value of the owned property, including land (Kagan, 2022). Other factors that are considered when valuing properties for tax purposes includes the location of the property, the size and condition of the property, and the type of use of the property (for example: residential, commercial, industrial).

In Tanzania, the property tax rates for valued properties vary depending on the size, value and location of the property. Previously, for unvalued properties, property tax is charged at TZS 10,000 for a normal building and TZS 50,000 per storey for a storey building. Currently, for unvalued properties, property tax is charged at TZS 12,000 for a normal building and TZS 60,000 per storey for a storey building (Mseti, 2023).

### 2.5.2 Rental Tax

Rental tax refers to the tax imposed on rental income earned from the leasing or letting of properties. It is a form of income tax levied on individuals or entities who receive rental income from residential, commercial, or other types of properties. Rental tax in Tanzania is governed by the Income Tax Act, 2004, and its subsequent amendments (TRA, 2023). It is the type of withholding income tax that is deducted by a company or an individual doing business from a landlord rent. If a company is renting premises from a landlord or landlady it is required by law to withhold 10% of the gross payment as rental income tax payable to the government (Minde, 2017).

### 2.5.3 Personal Income Tax

Personal income tax is a tax imposed on the income of individuals or entities such as sole proprietorships, partnerships, and limited liability companies that are taxed as pass-through entities. Personal income tax is a tax levied on the wages, salaries, dividends, interest, and other income a person earns throughout the year (Institute, 2022). The tax is typically levied on a person's taxable income, which is calculated by subtracting allowable deductions and exemptions from their gross income. This tax is usually a tax that the state imposes. Because of exemptions, deductions, and credits, most individuals do not pay taxes on all of their income (KAGAN, 2023). Personal income tax is collected by national and state governments, and the rates of tax can vary depending on a person's income level and other factors such as marital status, dependents, and deductions. The top marginal rate of tax for resident individuals is 30%. Non-resident individuals are subject to tax at a flat rate of 15% on employment income, which is final tax in Tanzania (PWC, 2023).

### 2.5.4 Corporate Income Tax

Corporation Tax is a tax charged on the taxable incomes (Profits) of entities such as limited companies and other organizations including clubs, societies, associations and other unincorporated bodies (TRA, 2023). It is a tax levied on the profits or income earned by corporations and other legal entities. It is imposed at the national or federal level and is typically separate from personal income tax. The tax rates for corporate income tax can vary from country to country and may also depend on factors such as the size of the corporation or the industry it operates in. In Tanzania, corporate income tax is levied on the profits earned by corporations and is regulated by the Income Tax Act of 2004, which was subsequently amended in subsequent years (TRA, 2023). The standard corporate tax rate in Tanzania is 30% for resident companies and 30% for non-resident companies (TRA, 2020).

## 2.6 Information System

An information system is a combination of people, processes, data, and technology that work together to collect, store, process, analyze, and disseminate information within an organization. It is designed to support the effective management and operation of an organization by facilitating the flow of information and enabling decision-making (Reynolds, 2016). According to (EMERITUS, 2022), describes an information system as a combination of software, hardware, and telecommunication networks to collect useful data, especially in an organization. Many businesses use information technology to complete and manage their operations, interact with their consumers, and stay ahead of their competition. Information systems are crucial for organizations to effectively and efficiently manage their operations, make informed decisions, and achieve their goals. They can vary in complexity, ranging from simple systems that handle basic tasks to sophisticated enterprise-wide systems that integrate multiple functions and departments (Kalloniatis, 2012).

### 2.7 Types of Information System

There are several types of information systems, each serving specific purposes and addressing different aspects of organizational activities. Here are some common types of information systems:

i. Transaction Processing Systems (TPS)
ii. Management Information Systems (MIS)
iii. Decision Support Systems (DSS)
iv. Executive Information Systems (EIS)
v. Enterprise Resource Planning (ERP) Systems
vi. Knowledge Management Systems (KMS)
vii. Business Intelligence (BI) Systems
viii. Geographic Information Systems (GIS)

### 2.8 Components of Information System

The components of an information system can be broadly categorized into five main elements: people, hardware, software, data, and procedures. These components work together to collect, process, store, and disseminate information within an organization. (Reynolds, 2016). These can be explained as:

i. **People:** People are the individuals who interact with the information system. They include users, stakeholders, managers, IT professionals, and system administrators. People play various roles such as data entry, data analysis, decision-making, system development, system maintenance, and system governance.
ii. **Hardware:** Hardware refers to the physical components of an information system. This includes computers, servers, network devices (routers, switches), storage devices (hard drives, solid-state drives), peripherals (printers, scanners), and other devices that facilitate data processing, storage, and communication.

iii. **Software:** Software encompasses the programs, applications, and operating systems that enable the information system to function. It includes both system software and application software. Software provides the instructions for the hardware to perform specific tasks and processes.

iv. **Data:** Data is the raw information that is collected, stored, processed, and transmitted by the information system. It can be in various forms such as text, numbers, images, audio, and video. Data can be categorized as structured (organized in a predefined format) or unstructured (not organized in a predefined format). Data is the foundation for generating meaningful information and knowledge within the system.

v. **Procedures:** Procedures refers to the rules, guidelines, and instructions that govern how the information system is used and managed. These include data entry procedures, data validation rules, backup and recovery procedures, system maintenance procedures, and other operational guidelines. Procedures ensure the proper functioning, security, and reliability of the system while guiding users on how to interact with the system effectively.

### 2.9 Geographic Information System (GIS)

Geographic Information System has been defined and explained in many different ways, some are:

According to (Demers, 2009), Geographic Information Systems are systems designed to input, store, edit, retrieve, analyze, and output geographic data and information. The primary task of a GIS is to analyze spatially referenced data and information. To perform meaningful analysis requires that the software be able to perform many other tasks, such as input, editing, retrieval, and output.

Environmental Systems Research Institute (1994) explains that, a Geographic Information System (GIS) is a specialized type of information system that captures, stores, manages, analyzes, and visualizes spatial or geographic data. It integrates geographic data (such as maps, satellite imagery, and aerial photographs) with attribute data (such as demographics, infrastructure, and environmental information) to provide insights and support decision-making related to specific locations or geographic areas.

A Geographic Information System (GIS) is a broad term that refers to a computer-based tool that combines maps and data to help us understand and analyze information about specific locations on Earth. GIS finds applications in various fields, including urban planning, environmental management, natural resource management, transportation, logistics, agriculture, emergency management, real estate, and public health. It helps organizations and governments make informed decisions, solve spatial problems, and understand the spatial relationships between different phenomena (Nielson, 2014).

### 2.10 GIS techniques and technology

GIS techniques and technology involve the collection, integration, analysis, and visualization of spatial data. These methods encompass data collection through techniques like GPS, remote sensing, and digitization, as well as data integration by combining spatial and attribute data from various sources. GIS provides analytical tools for spatial querying, analysis, and modeling, enabling users to derive insights, predict outcomes, and solve spatial problems. Visualization tools help represent data through maps, charts, and graphs, facilitating effective communication of spatial information. Web-based GIS and mobile GIS extend accessibility and collaboration, while spatial database management systems ensure efficient storage and retrieval of spatial data. GIS techniques and technology are integral in numerous fields, supporting decision-making, planning, and problem-solving in a spatial context (Nielson, 2014).

### 2.11 Advances in GIS

Advances in GIS technology have expanded GIS applications, improved data management and analysis, and opened up new possibilities for solving complex spatial problems, supporting decision-making, and understanding our world in a more comprehensive and interactive way. GIS has been advancing from Desktop GIS, Server GIS, Web GIS and Distributed GIS. According to Choi (2020) explains these as:

a) **Desktop GIS**:
   Desktop GIS refers to GIS software that is installed and run on individual computers. Users can create, edit, analyze, and visualize geospatial data using desktop GIS software. It provides a comprehensive set of tools and functionalities for data management, spatial analysis, and map creation. Examples of popular desktop GIS software include ArcGIS Desktop, QGIS, and GRASS GIS.

b) **Server GIS**:

Server GIS involves the use of GIS software and technologies to publish, manage, and distribute geospatial data and services over a network. It allows users to access and utilize GIS data and functionalities through web-based applications or another client software. Server GIS provides capabilities for data storage, geospatial processing, and sharing of maps and services. Examples of server GIS software include ArcGIS Server, GeoServer, and Map Server.

c) **Web GIS**:

Web GIS refers to the deployment of GIS applications and services over the internet. It allows users to access and interact with geospatial data, maps, and analysis tools through web browsers. Web GIS applications provide a user-friendly interface for querying, visualizing, and analyzing geospatial data, making it accessible to a broader audience. Web mapping platforms like ArcGIS Online, Google Maps, and Open Layers facilitate the creation and sharing of web GIS applications.

d) **Distributed GIS**:

Distributed GIS involves the distribution and coordination of geospatial data and processing across multiple systems or locations. It leverages distributed computing technologies to divide geospatial tasks and data across a network of computers for improved scalability, performance, and collaboration. Distributed GIS enables collaborative data management, analysis, and decision-making in scenarios where data and computing resources are distributed across different organizations or regions.

## 2.12 Web GIS

A web GIS (Geographic Information System) refers to the deployment of GIS applications, data, and services over the internet. It allows users to access and interact with geospatial data, maps, and analysis tools through web browsers on various devices, such as computers, tablets, and smartphones. Web GIS leverages the power of the internet to make geospatial information widely accessible and easily shareable. (Fu, 2022). A web-based Geographic Information System (GIS) is a technology that uses web-based platforms and tools to integrate, analyze, and display geographic data. GIS allows for the capture, storage, manipulation, analysis, and visualization of spatial data, such as maps, satellite imagery, and geospatial databases, in a digital format. Web

GIS employs the World Wide Web to facilitate the storage, visualization, analysis, and distribution of spatial information over the Internet (Nielson, 2014). Web GIS allows users to access and interact with geographic data from anywhere with an internet connection, using a standard web browser.

### 2.13 Web based GIS for tax collection and management

According to Nieminen (2002) explains, the worldwide development of web-based Geographic Information Systems (GIS) for tax collection and management has revolutionized tax administration by enhancing efficiency, accuracy, and transparency. These systems automate processes, improve property assessment, enable spatial analysis for compliance, provide user-friendly interfaces for taxpayers, facilitate data visualization and reporting, promote collaboration among government agencies, enhance revenue forecasting, and increase transparency. Overall, web-based GIS has transformed tax systems by leveraging technology to streamline operations, improve taxpayer experiences, and optimize revenue generation.

According to AMDA (2014) explains, In India, web-based GIS technology has been embraced for tax collection and management, revolutionizing the way taxpayers interact with the system. Municipalities and local government bodies have implemented web-based GIS systems that allow property owners to conveniently access and manage their tax-related information online. Through interactive maps and user-friendly interfaces, property owners can view property details, calculate tax liabilities, and make online payments. The integration of property data with tax administration databases enables accurate record-keeping and enhances tax compliance monitoring. Additionally, web-based GIS facilitates spatial data analysis, helping authorities visualize tax patterns, identify high-value properties, and make informed decisions. The seamless coordination and data sharing among different departments involved in tax administration further enhance the efficiency and transparency of the tax collection process in India.

## CHAPTER THREE

# 3 METHODOLOGY

## 3.1 Overview

In this chapter, methods implemented, techniques applied and data inputs used throughout this study are explained. This chapter describes overall methods ranging from user requirement analysis, data collection, System design, development, testing, and finally getting the expected Web-GIS system. The whole process from identifying the user requirements, designing and developing the system is summarized in the figure 3.1;

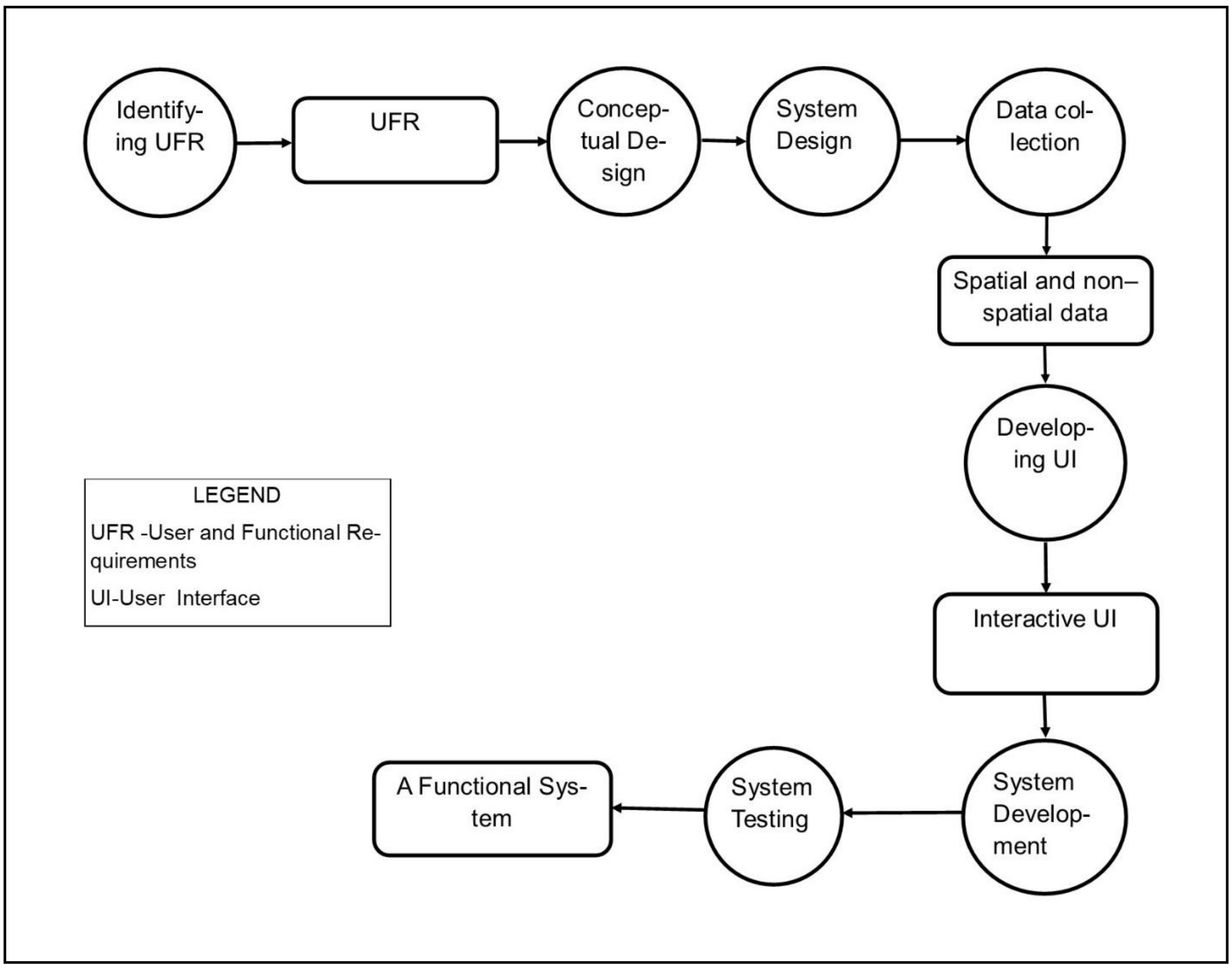


Figure 3.1 Workflow of the utilized methodology

### 3.2 Identification of user and function requirements

User and function requirements were identified through a combination of participants consultations, surveys, interviews, and data analysis. Rapid Application Development (RAD) was an effective approach used in identifying these requirements. It emphasizes close collaboration between developers, end-users, and stakeholders. Through initial discussions with participants provided insights into their needs and expectations. Observation, and discussions with taxpayers helped gather their perspectives and specific requirements. Data analysis techniques were employed to identify common themes and patterns from the collected data. The identified requirements such as measure tool, adding information, security, editing features and interactive user interface were refined through iterative feedback sessions, ensuring the development of a web-based GIS system aligned with the needs of tax officials and taxpayers. This iterative process allowed for incorporating additional insights and ensuring that the requirements aligned with the objectives of the research and the needs of the users.

### 3.3 Conceptual Design

It involved creating a system architecture that outlines the components and their interactions. It includes designing a database structure to store residential address and tax-related data, designing a user interface for easy navigation and interaction, and incorporating mapping and visualization capabilities. The design also focused on functionalities such as adding data, attribute data popups, zoom in/out, finding location, measure tool and sign in/out. The design also addressed security measures and access control to protect sensitive data. Overall, the conceptual design provides a framework for the development of a tailored web-based GIS system that meets the specific requirements of tax collection and management in Ubungo Municipal Council. The Figure 3.3 illustrates the conceptual design structure.

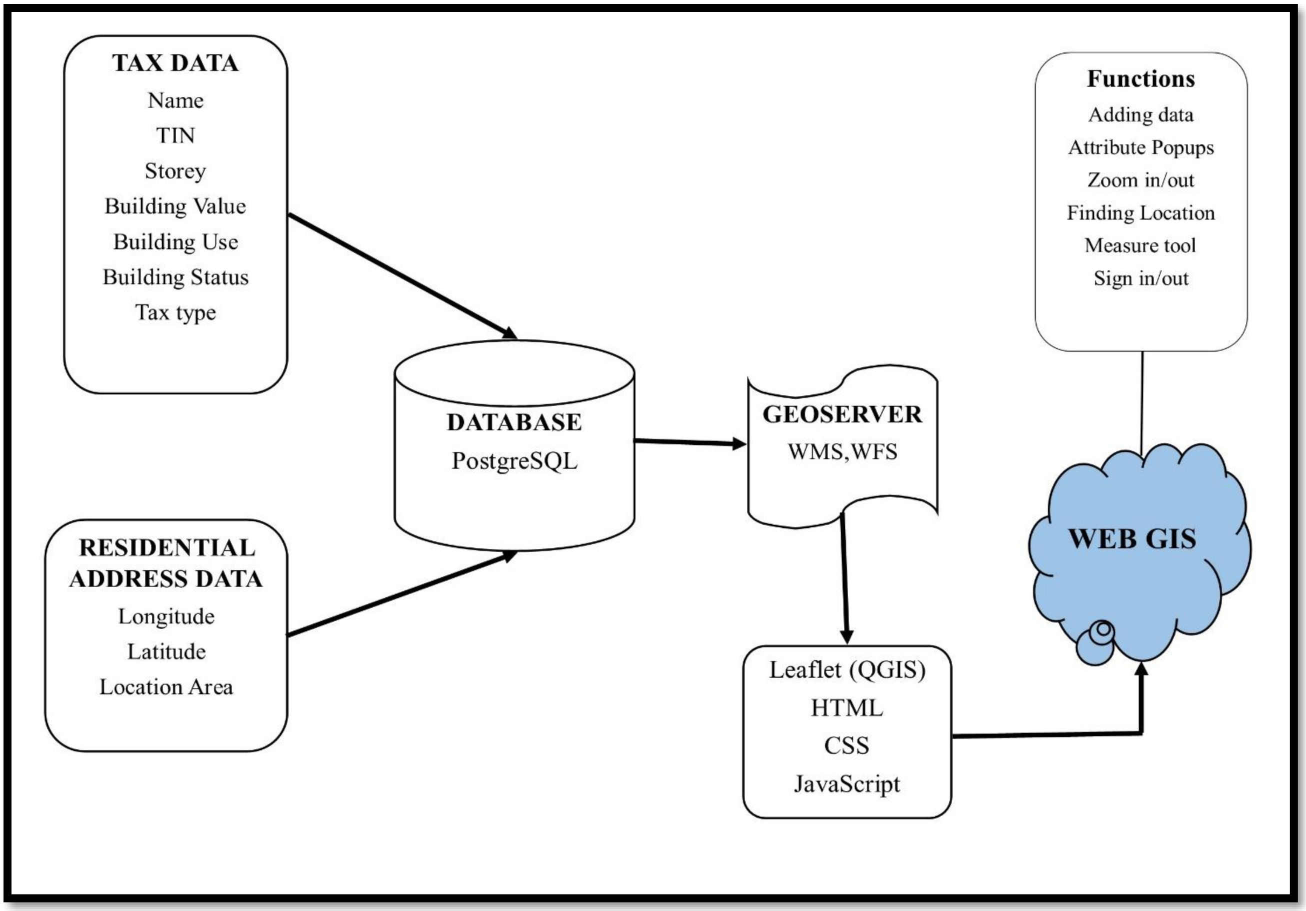


Figure 3.2 Conceptual design Structure

### 3.4 System Design

Involves the detailed planning and specification of the system architecture, components, and functionalities. It serves as a roadmap for the actual implementation of the GIS system. It includes:

A spatial database is specifically designed to store and manage spatial data, which includes geographic or location-based information. It serves as the backbone of the GIS system, enabling efficient storage, retrieval, and analysis of spatial data related to tax collection. The client side consists of HTML, CSS, and JavaScript code that is executed in the user's web browser. This code is responsible for rendering the web pages, handling user interactions, making requests to the server-side components, and updating the user interface dynamically. So, the client side is responsible for presenting the user interface, interacting with the user, and rendering the application's content.

The server side of a web-based GIS system refers to the backend components that handle data storage, processing, and communication with the client side. The server-side code handles tasks like validating submitted data and requests, using databases to store and retrieve data and sending the correct data to the client as required. The Figure 3.3 illustrates how the three main parts performs their work and how they were designed:

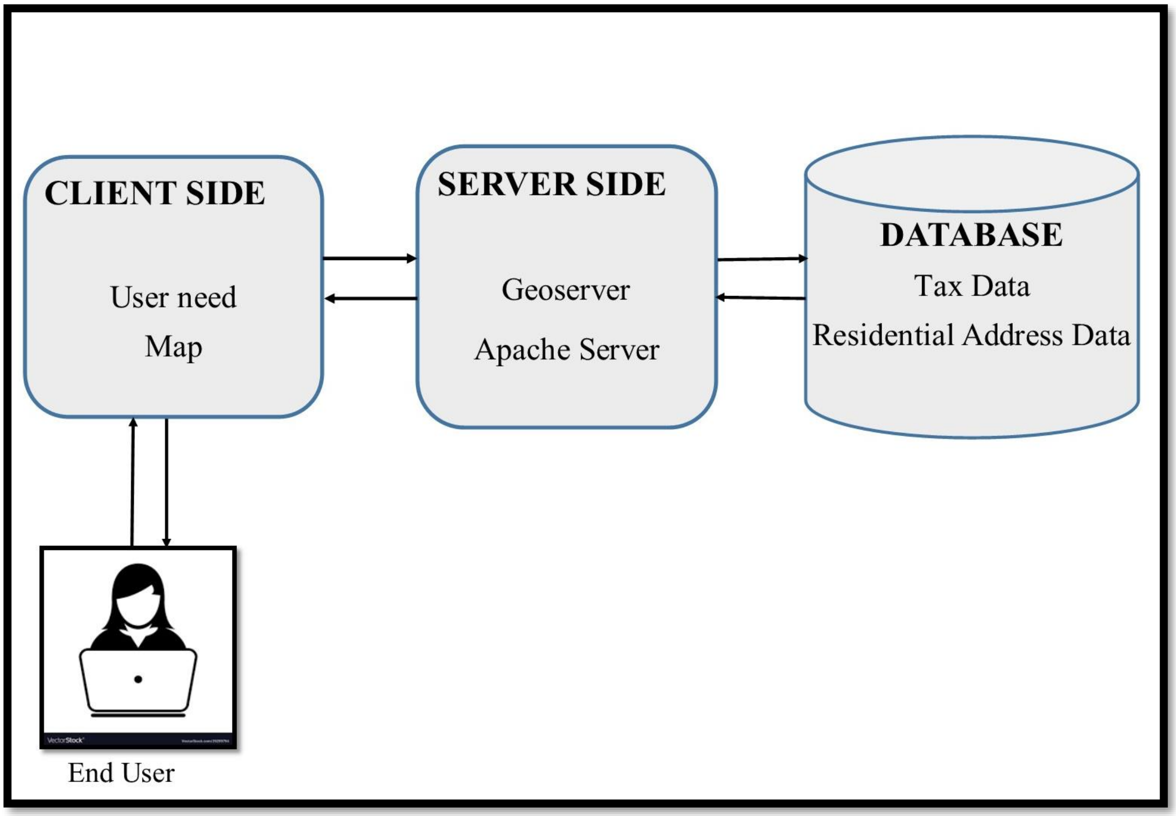


Figure 3.3 System design structure

### 3.5 Tools and Software used

#### 3.5.1 Software

When choosing a specific software for developing a web-based Geographic Information System, several factors were considered. These factors include: costs and licensing, ease of use, functionalities, data management and integration capabilities. Table 3.1 shows the software package needed for Web GIS system development.

Table 3.1 Software package

| S/N | SOFTWARE | FUNCTION |
|---|---|---|
| 1 | ArcGIS | Joining spatial and non-spatial data |
| 2 | Quantum GIS | Spatial data creation |
| 3 | PostgreSQL | Geo-database creation |
| 4 | PostGIS | Data conversation |
| 5 | GeoServer | visualizing geospatial data |
| 6 | Leaflet | For building interactive web map and developing geographical user interface |
| 7 | Apache /Tomcat | Web Application manager |
| 8 | Visual Studio Code/GitHub | Code editor and management |

### 3.5.2 Hardware

A personal computer having the following specifications:

- 2.10 GHz processing speed and above
- 8GB RAM or higher
- 64-bit Operating system
- 1 GB Hard Disk or more

## 3.6 Data Collection

Data which were collected in order to meet the objectives of this study were of two types, which are; spatial data and non-spatial data. The spatial data are the ones which shows the properties and their locations of the earth. The non-spatial data are the data having the information on the taxpayers. Table 3.2 shows the summary of the data collected;

Table 3.2 Data collected

| DATA | FORMAT | SOURCE | USE |
|---|---|---|---|
| Tax payer's data | Excel Workbook (.xlsx) | Tanzania Revenue Authority | For showing tax payer's information |
| Residential Addresses data | Excel Workbook (.xlsx) | Ministry of Lands, Housing, and Human Settlements Development | For mapping component in the system |
| Ubungo administrative boundary | Shapefile | Ubungo Municipal Council | For mapping component |

### 3.7 Data Processing

It involved acquiring spatial and attribute data from various sources, integrating and converting the data into a compatible format, preparing and organizing the dataset, loading it into the GIS system's spatial database, validating the data for accuracy and consistency, and establishing mechanisms for data updates and maintenance. This ensures that the GIS system has access to reliable and up-to-date tax-related information, enabling efficient data management and supporting effective tax collection and management processes.

#### 3.7.1 Data Preparation

Spatial data and non-spatial data were prepared for geospatial fusion. This process involved cleaning and formatting the data and ensuring that they are in compatible formats and have appropriate data structures. The residential addresses data and the tax payer's data was cleaned and rearranged the columns in the order that will be easily recognized in the ArcGIS software. After all that process, the data in Excel Workbook (.xlsx) format was saved in the CSV format for further processing.

#### 3.7.2 Identifying Common Identifiers

This step involved carefully examining the datasets or layers involved in the analysis and determining the appropriate attribute or field that serves as a common identifier for joining the data. This was achieved by reviewing the data structure, identifying fields with similar content or unique identifiers, and understanding the relationships between the datasets.

### 3.7.3 Joining the spatial and non-spatial data

Using the common identifiers, the spatial and non-spatial datasets were joined together. The residential Addresses data were first processed and being converted to the shapefile format. Then, the residential Addresses data shapefile and the tax payer's data in CSV format were joined together by attribute join. Figure 3.4 shows process of spatial data join;

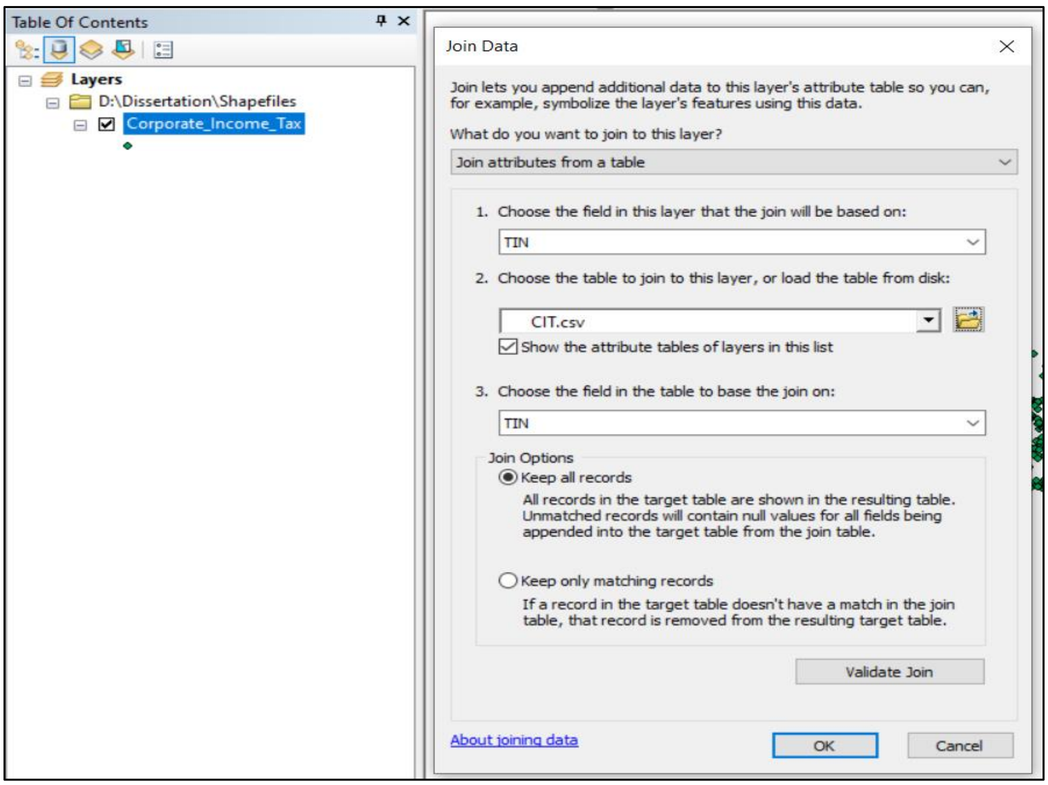


Figure 3.4 Spatial data join

## 3.8 Geodatabase development

Geodatabase was developed by following the steps below;

### 3.8.1 PostgreSQL and PostGIS installation

PostgreSQL software (postgresql-10.3-windows-x64) was downloaded from URL:https://www.postgresql.org/download/, and there after it was installed successfully by following carefully all the procedures. The PostGIS extension of 3.3.2 version was also downloaded separately from URL:https://postgis.net/source/ and installed. Thereafter, it was connected successfully to the PostgreSQL software through the "application stack builder" found in its package.

The rationale for downloading, installing, and connecting PostgreSQL and the PostGIS extension lies in their capabilities to provide a robust and feature-rich environment for handling spatial data within the web-based GIS system. The chosen versions ensure compatibility, stability, and access to the functionalities, supporting efficient tax collection and management in Ubungo Municipality.

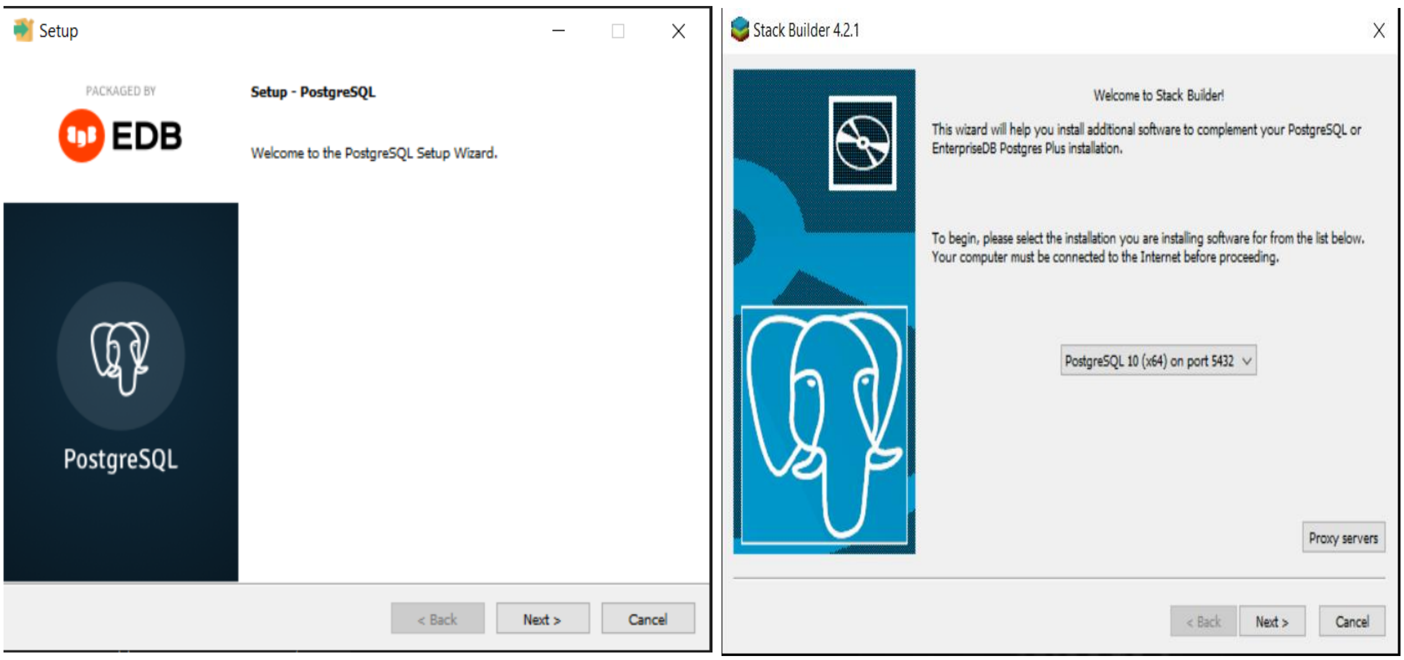


Figure 3.5 PostgreSQL installation and connection of PostGIS extension in stack builder

### 3.8.2 Loading Shapefiles into the PostgreSQL Database

The shapefile that combined both residential addresses data and the tax data was loaded to the PostgreSQL Database using the PgAdmin 4 v7. The decision to use PgAdmin 4 v7 was based on its reputation as a reliable and widely used administration and development platform for PostgreSQL databases.

This was done by firstly login in the software, then login in the PostgreSQL 10 server. Then after, the database was created which was named as "UbungoMunicipal". After the database being created, its extension was also created by right clicking the database created and select create "extension". PostGIS extension was the one that was used. The creation of the PostGIS extension for the "UbungoMunicipal" database is essential as it adds support for spatial data types and functions within the PostgreSQL environment.

PostGIS Shapefile Import/Export Manager was used to establish a connection by clicking on view connection details and connection parameters like Host, Port, Username, Password, Database and Server were filled. The connection was successfully made and then the shapefile was added by clicking the Add File button and selecting the shapefile. Then, the shapefile was imported by using the import button found in this manager. PostGIS Shapefile Import/Export Manager provides a user-friendly interface for establishing a connection between the database and the shapefile. By filling in the necessary connection parameters and successfully establishing the connection, it ensures seamless data transfer between the shapefile and the PostgreSQL database.

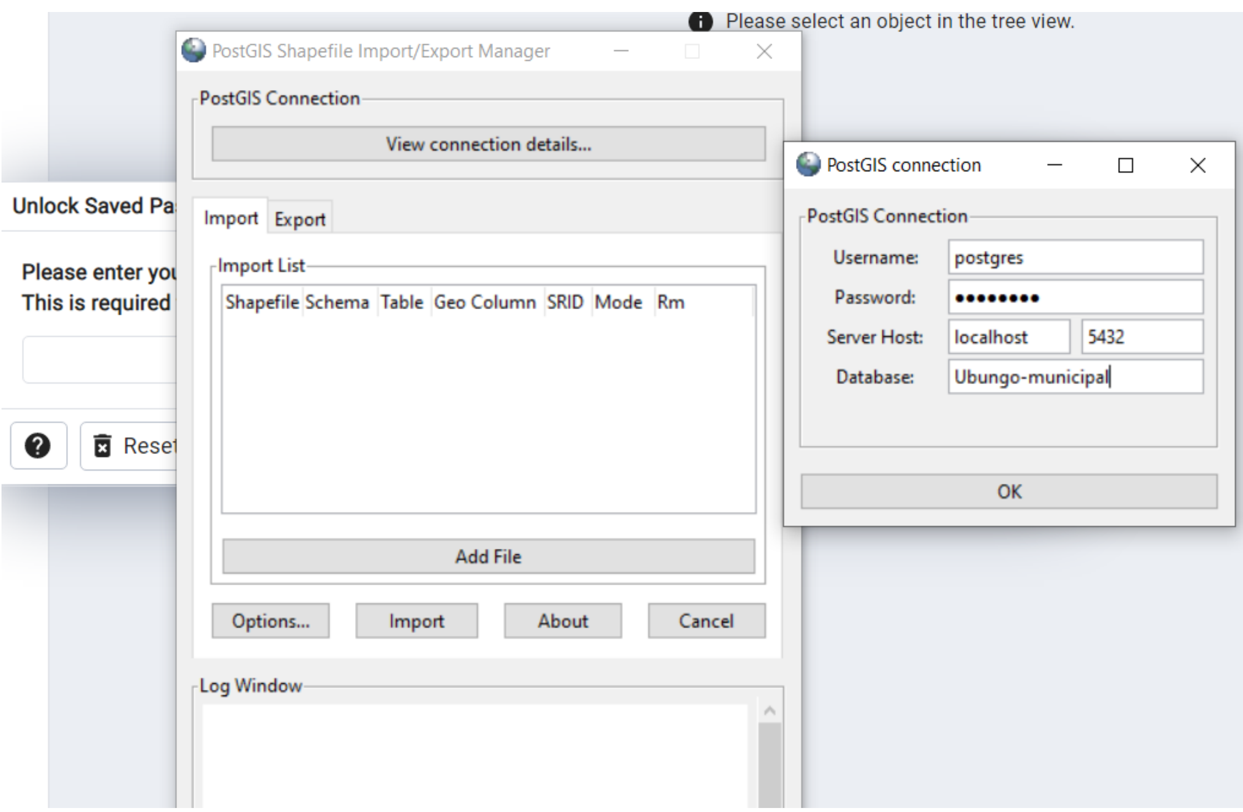


Figure 3.6 Importing Shapefiles in PostgreSQL by PostGIS shapefile Import/Export Manager

### 3.9 Web development

The development of the web server side was done by following the procedures below;

#### 3.9.1 Downloading and installing tools

The GeoServer and Java Development Kit (JDK) was installed successfully. GeoServer (geoserver-2.23.1-bin) was downloaded from URL:https://geoserver.org/, which was then installed by following all the necessary procedures. Java Development Kit (JDK) was downloaded by following the version explained in the user manual of the downloaded GeoServer. JDK (jdk-17_windows-x64_bin) was downloaded from https://www.oracle.com, which was then installed successfully.

The rationale for the successful installation of GeoServer and the Java Development Kit lies in their critical roles within the web-based GIS project. GeoServer serves as a robust platform for geospatial data sharing, while the JDK provides the required Java runtime environment for GeoServer smooth operation. By following the necessary procedures and obtaining these components from official sources, the project ensures a reliable and compatible environment for the development and deployment of the web-based GIS system for tax collection and management.

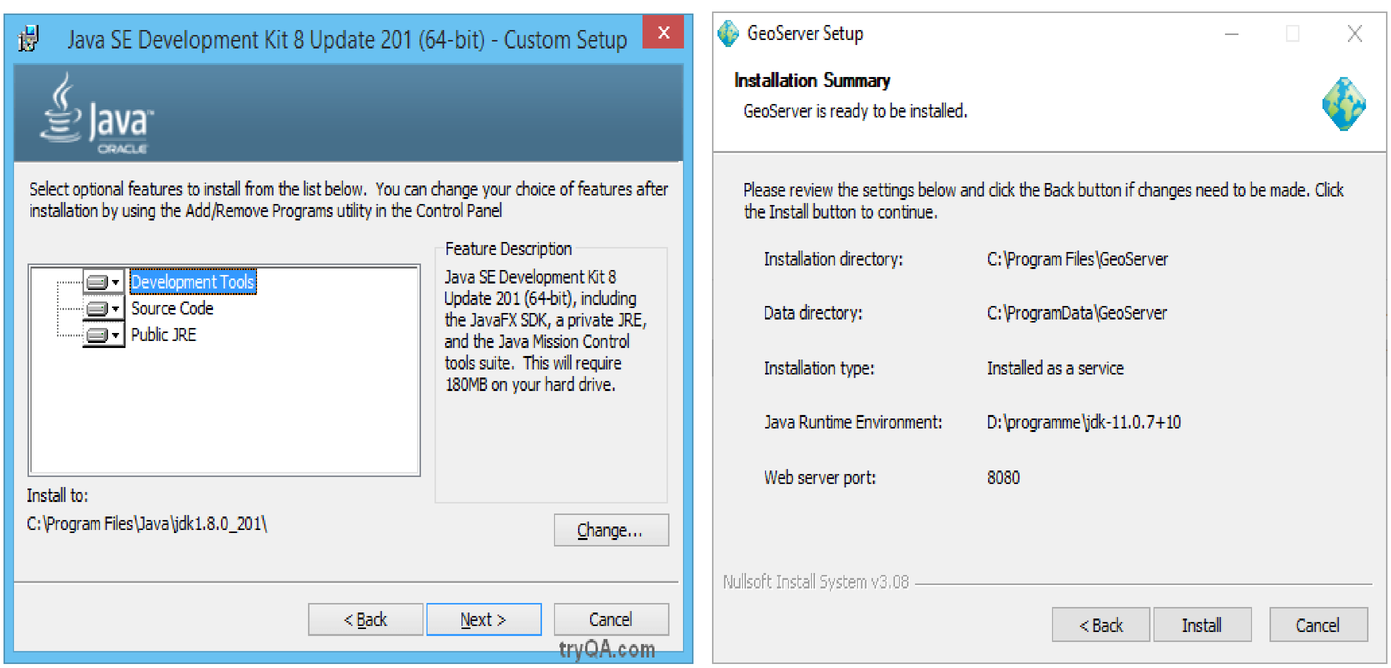


Figure 3.7 Installation of geoserver and Java Development Kit (JDK)

After having downloaded the GeoServer and JDK, the system environment variables were edited for the purpose that, these downloaded tools environment can be created. This was done by creating a new Variable name and writing the directory path in the Variable value. This can be illustrated in the figure 3.8 below;

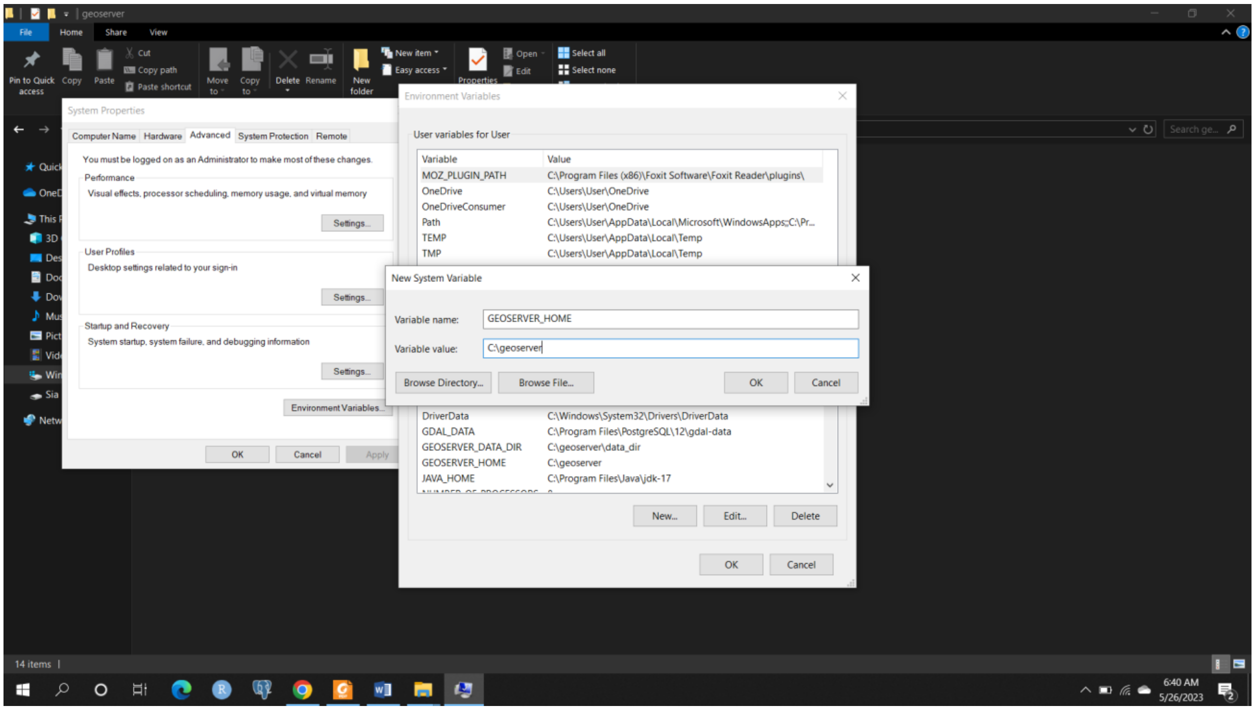


Figure 3.8 Creation of New Environment

### 3.9.2 Logging in the GeoServer

After creating the new environment for both Java and the GeoServer, the geoserver was started by clicking the “startup.bat” found in the bin folder inside the geoserver folder. Having the geoserver started, logging in geoserver was done via the link URL: [http://localhost:8080/geoserver](http://localhost:8080/geoserver). The user interface appeared and login process was done by using the default username “admin” and password “geoserver”.

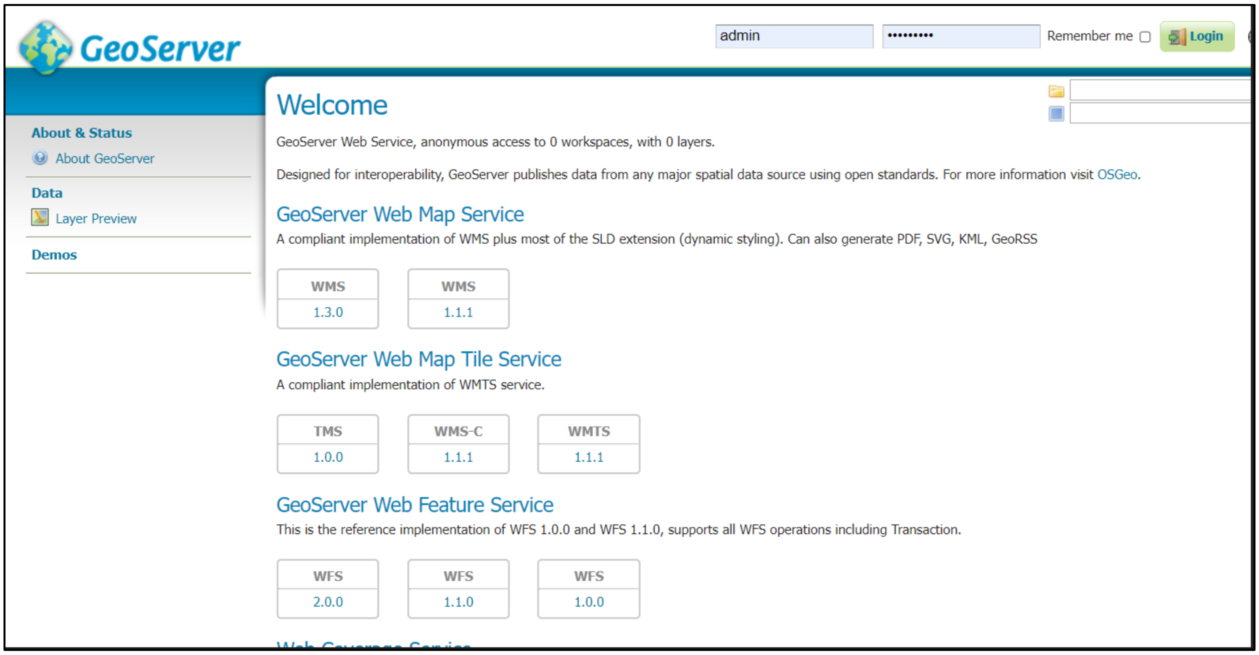


Figure 3.9 Logging in Geoserver

### 3.9.3 Interactive map creation

Interactive map was created by using the QGIS software. This was done by firstly downloading the qgis2web plugin in QGIS. Then, the created shapefile was added in the software, changing the symbols and other features in such a way that the users can easily understand map. After that, the qgis2web was used for creating an interactive map. This was done by choosing what layers to be shown on the web map, choosing what features to be shown i.e. zoom in/out, measurement tool, my location tool, legend and location finding tool. Then, the map was exported by using the "leaflet extension". Figure 3.6 illustrates the procedures as explained;

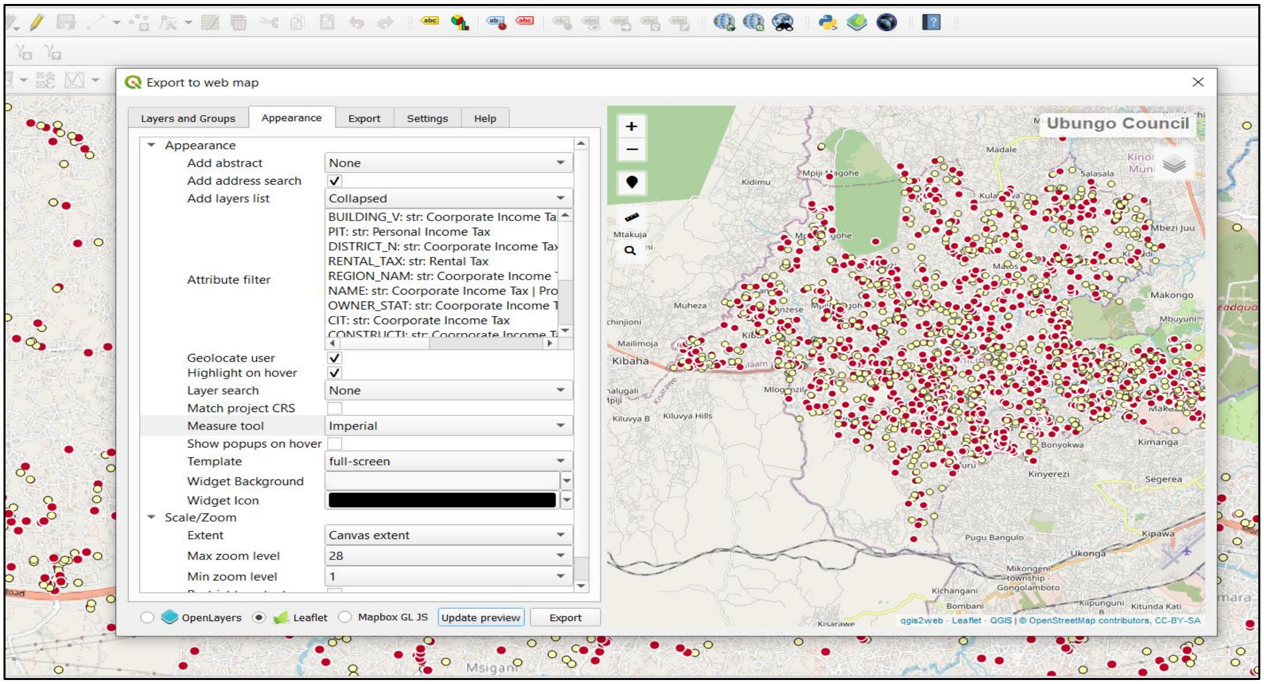

Figure 3.10 Interactive map creation

### 3. 10 Development of the geographical user interface

The development of the geographical user interface (GUI) is a crucial aspect of the methodology chapter in the research on developing a web-based GIS for tax collection system. The GUI serves as the primary means of interaction between users and the GIS system, facilitating the visualization and manipulation of spatial data related to tax collection.

The development process involved several key steps. Firstly, a thorough analysis of user requirements was conducted to understand the specific needs and expectations of users in terms of data visualization, analysis, and functionality. This helps in determining the scope and design of the GUI. Next, appropriate web technologies and frameworks were selected to create the interface. This involved the usage of HTML, CSS, and JavaScript to develop a responsive and user-friendly interface that is accessible across different devices and platforms. Mapping libraries such as Leaflet was also utilized to incorporate interactive mapping functionalities.

The GUI design focuses on providing an intuitive and visually appealing interface. This includes organizing and presenting spatial data layers in a clear and understandable manner, using appropriate symbology and color schemes. User controls, such as zooming, panning, and toggling layers, were implemented to enhance user navigation and exploration of the tax-related spatial data. To ensure the GUI meets user expectations, iterative testing and feedback collection were carried out. This allows for refinement and improvement of the interface based on the user input.

```html
<!DOCTYPE html>
<html>
<head>
    <title>Tax Collection GIS</title>
    <link rel="stylesheet" href="styles.css">
</head>
<body>
    <div id="map"></div>
    <div id="sidebar">
        <h2>Tax Collection GIS</h2>
        <input type="text" id="searchInput" placeholder="Search address">
        <button id="searchButton">Search</button>
        <div id="layers">
```

Figure 3.11 Example of html codes

### 3.11 System testing

System testing was done to ensure its functionality and performance. Execution of various tests such as functional testing, usability testing, performance testing, security testing, integration testing, regression testing, and user acceptance testing were done. Through these tests, the verification of the system meeting the specified requirements, working smoothly, and delivering a user-friendly experience was also done. The following is the link of the system made https://tax-collection-app.onrender.com/

## CHAPTER FOUR

## 4 RESULTS

### 4.1 Overview

In this chapter, the results obtained through the implemented research methodology and discussion are presented according to the intended main and specific objectives of developing a Web-based GIS system for tax collection and management.

### 4.2 User requirements

Are the specific needs, expectations, and objectives of users or stakeholders of a system. User requirements typically describe the functionalities, features, performance criteria, and constraints that users desire or require from a product or system. The following table 4.1 are the user requirements identified for the implementation of the system;

Table 4.1 User Requirements

| S/N | DESIRED FUNCTION |
|---|---|
| 1 | Mapping and Geospatial Data |
| 2 | User-Friendly Interface and Accessibility |
| 3 | Tax assessment and calculation |
| 4 | Location of properties and customers |
| 5 | Measuring distance and areas |
| 6 | Adding and updating taxpayer’s information |
| 7 | Adding and updating payments recordings |

### 4.3 Design and structure of the system

The system was designed in the way that it meets the user requirements and that it can become the blueprint towards achieving the objectives of this study. This system had three main parts which are client side, server side and the spatial database (Geodatabase). Figure 4.1 illustrates the structure of the web-based GIS system.

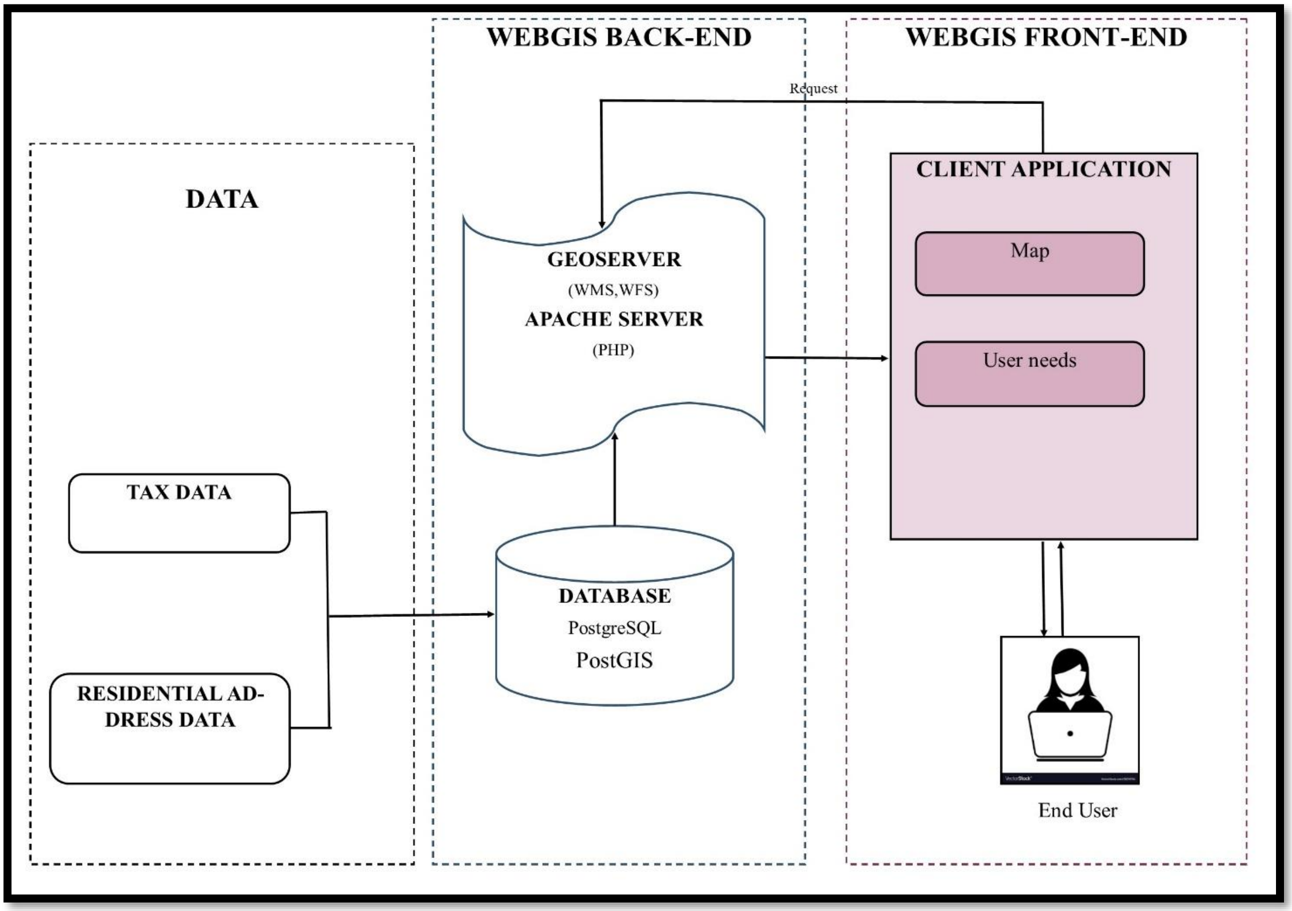


Figure 4.1 Web based GIS system structure

The client-side refers to the user interface or application running on the user's device, such as a web browser or a dedicated GIS software. It interacts directly with the user, allowing them to interact with the GIS system, visualize maps, and perform various operations. The client-side typically requests data and services from the server-side and displays the results to the user. It was implemented by using HTML, CSS, and JavaScript code in designing the user interface, language and different styles. The server-side consists of the backend components that handle data processing, storage, and communication between the client-side and the geodatabase. It receives requests from the client-side and performs the necessary operations, such as data retrieval, analysis, and geoprocessing. It interacts with the spatial database to retrieve or update geospatial data as needed. The spatial database (Geodatabase) is a specialized database designed for storing and managing geospatial data. It stores spatial datasets such as maps, layers, features, and their associated attribute data. The geodatabase was implemented using PostgreSQL with PostGIS extension. The spatial database provides efficient storage and indexing mechanisms to handle spatial queries, spatial relationships, and spatial analysis.

### 4.4 Geodatabase

The geodatabase was created by using PostgreSQL with PostGIS extension. The geodatabase which was created consisted of both spatial data (residential addresses data) and non-spatial data (taxpayers' data). Which was then published to the geoserver so as to get the format which is allowed for the development of web mapping.

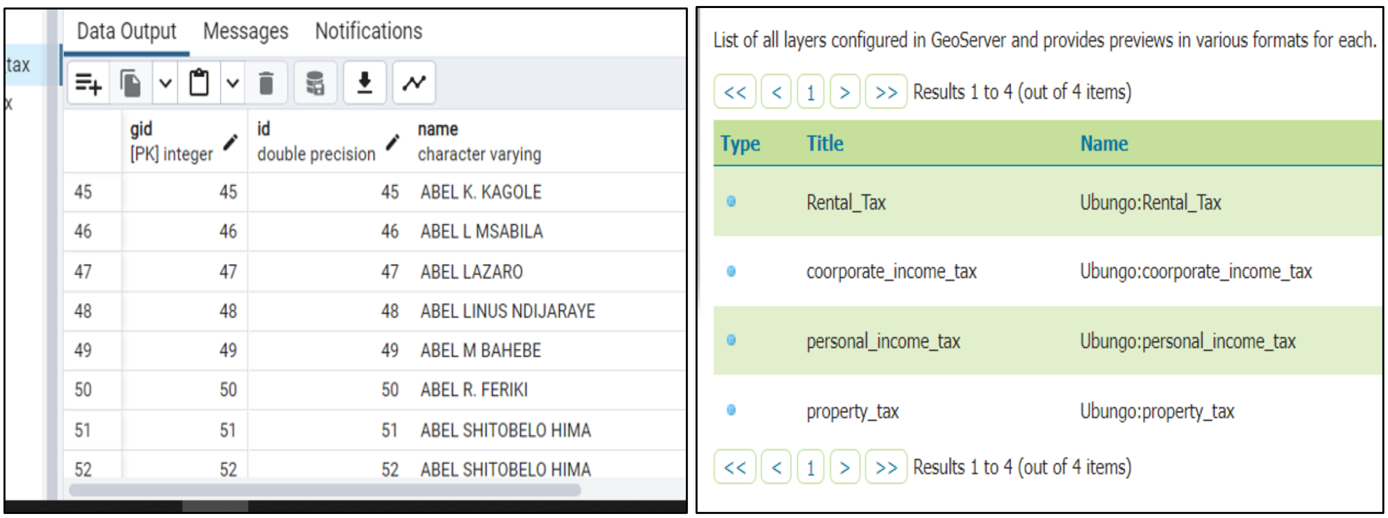


Figure 4.2 Database in PostgreSQL and published in geoserver

### 4.5 Web GIS system and prototype validation

Web GIS system combining non-spatial data and spatial data was successfully made. The user interface had the following functionalities;

#### 4.5.1 Zoom in and out/ switching on and off layers

The zoom-in function allows users to increase the level of detail by magnifying a specific area on the map. Users can typically perform a zoom in operation by clicking a "Zoom In" button or using a mouse scroll wheel. When users zoom in, the map display is adjusted to show a smaller geographic extent but with greater detail. The zoom-out function allows users to decrease the level of detail and view a larger area on the map. Users can typically perform a zoom out operation by clicking a “Zoom Out” button or using mouse scroll wheel. When users zoom out, the map display is adjusted to show a larger geographic extent, resulting in less detail but a broader view. Switching on and off layers provides users with control over the visibility of different layers of spatial data on the map. Figure 4.2 shows the Zoom in/out and switching on/off layers functionalities;

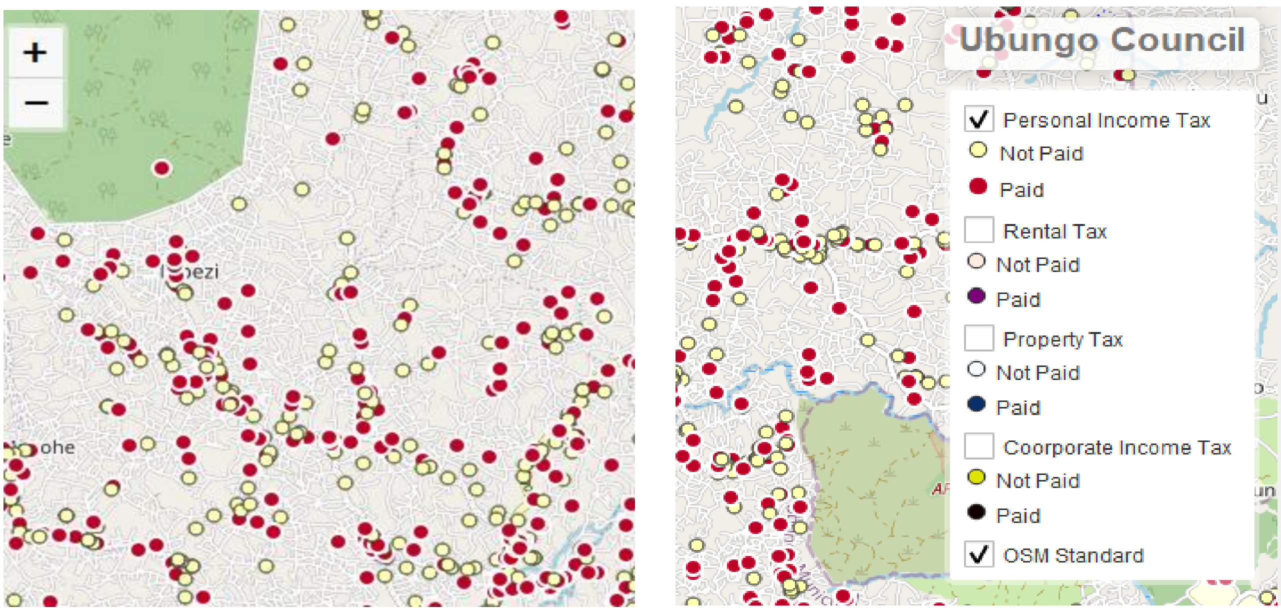


Figure 4.3 Zoom in/out and switching on/off layers functionalities

### 4.5.2 Measure tool

The measure tool in a web-based GIS (Geographic Information System) allows users to measure distances, areas, and other spatial properties on the map. It provides a way to quantify and analyze spatial relationships between features. The measure tool calculates and displays the cumulative distance and areas between the points, providing users with an accurate measurement. Depending on the specific implementation, the measure tool may offer additional measurement capabilities, such as measuring angles, perimeters, or coordinates. Figure 4.3 illustrate the functionalities of the measure tool in the system.

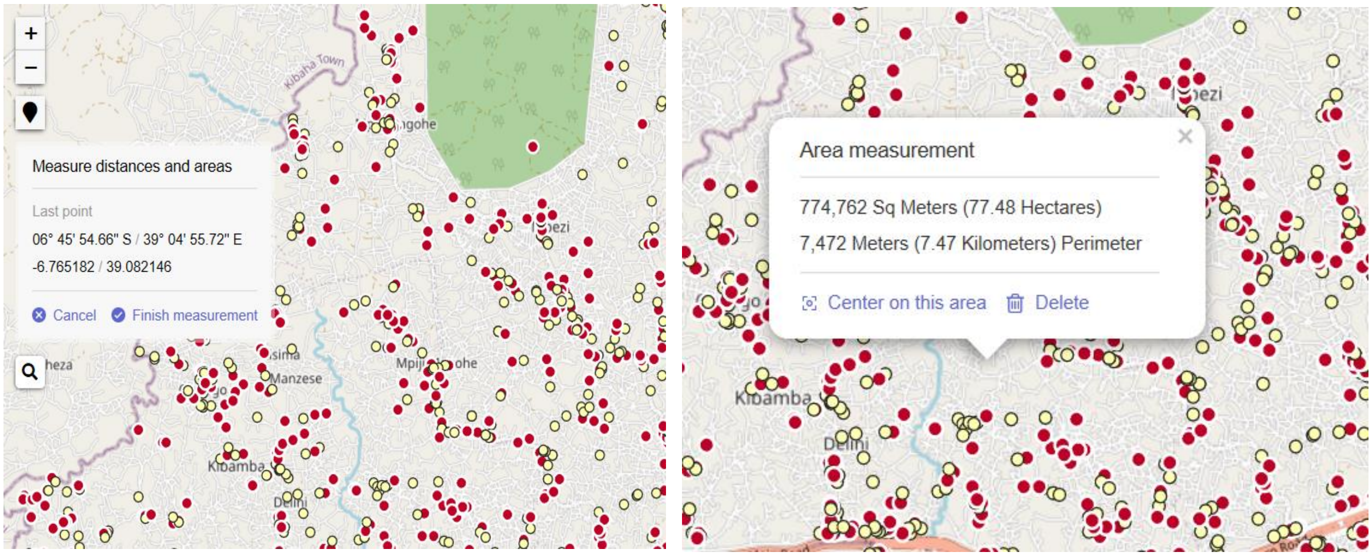


Figure 4.4 Measure tool functionalities

### 4.5.3 Pop ups of attribute data of spatial features

Pop-ups of attribute data in a web-based GIS (Geographic Information System) provide users with detailed information about the spatial data displayed on the map. When a user interacts with a feature on the map, such as clicking on it, a pop-up window or dialog box appears, presenting relevant attribute data (taxpayer's information) associated with that feature. Figure 4.4 illustrates the pop ups functionalities.

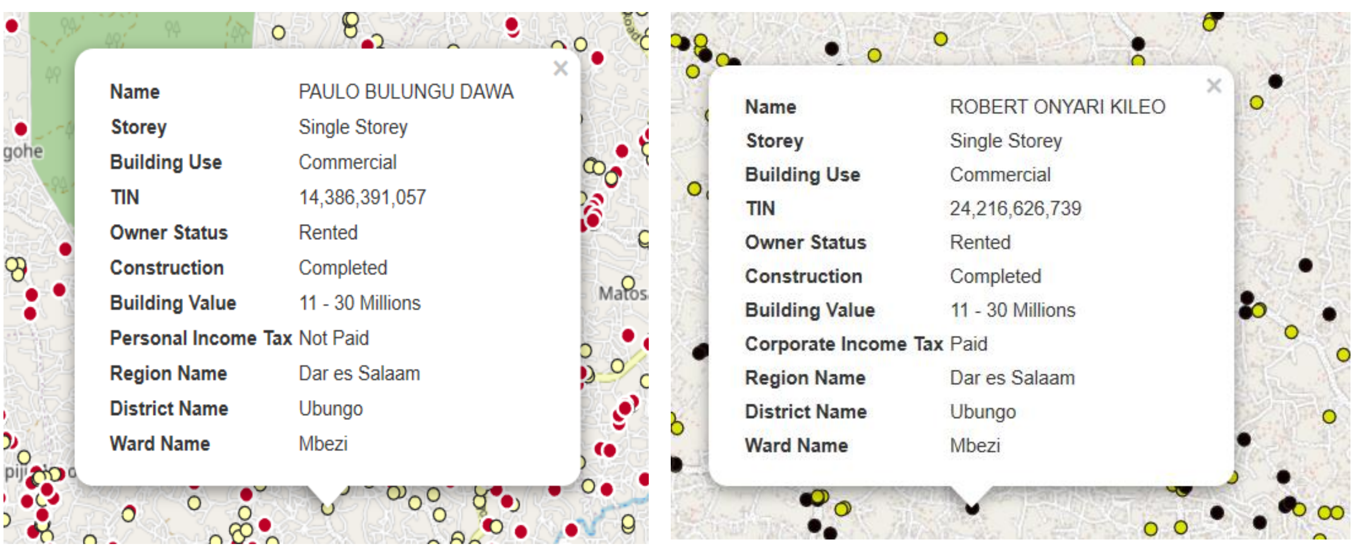


Figure 4.5 Pop ups functionalities

### 4.5.4 Finding the location of the user and search area

Location of the user allows users to quickly orient themselves on the map and view nearby features or relevant spatial data. The search area tool enables users to search for specific areas, addresses, landmarks, or places of interest. Figure 4.5 illustrates the location of the user and search area tool functionalities.

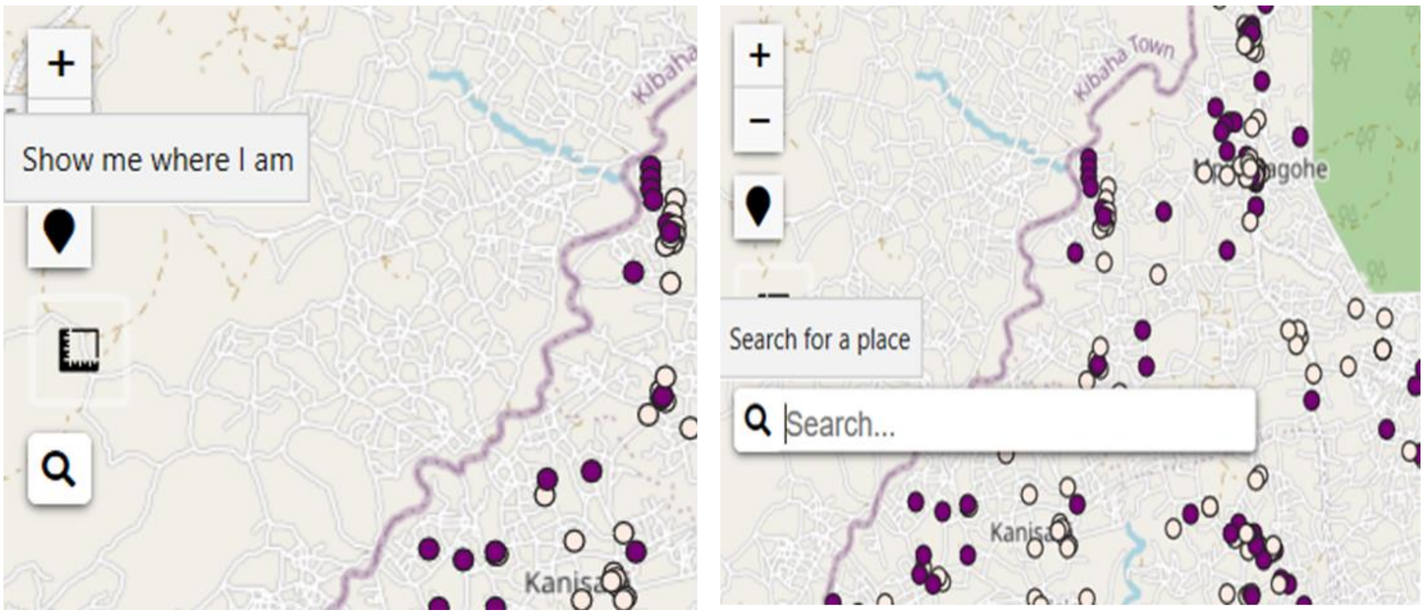


Figure 4.6 Location of the user and search area tool functionalities

### 4.5.5 Sign in and log in page

The signing in and login page is a critical component of the system that allows users to authenticate and gain access to the web-based GIS for tax collection. It serves as a gateway for users to enter their credentials, typically a username and password, to verify their identity. The page performs validation checks on the provided credentials, ensuring their accuracy and authenticity. The signing in and login page plays a crucial role in maintaining the security and integrity of the system by controlling access and ensuring that only authorized individuals can interact with the GIS platform. Figure 4.7 shows the sign and log in page;

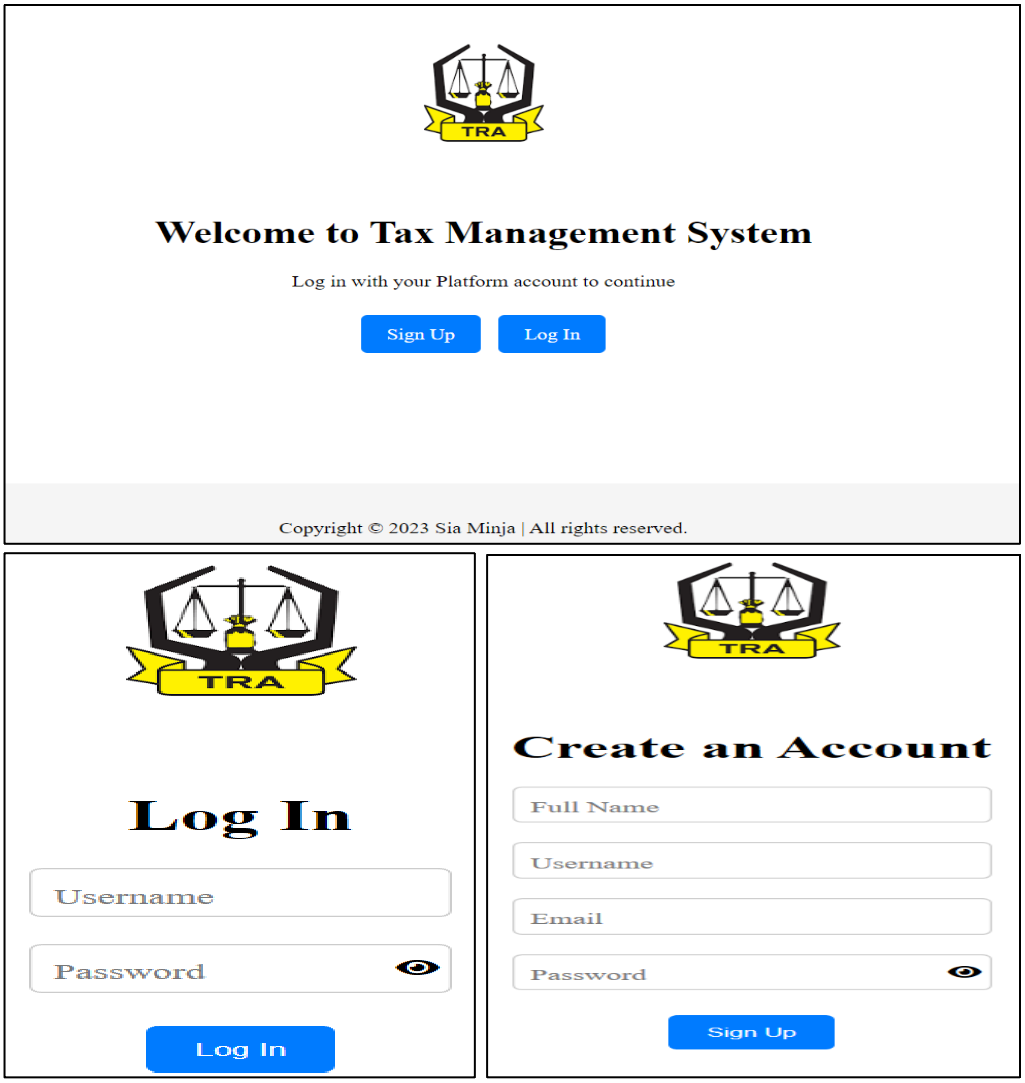


Figure 4.7 Sign in and log in page

### 4.5.6 User Interface

The user interface (UI) of the web-based GIS for tax collection was designed to offer a user-friendly and visually appealing experience. It includes features like a dashboard with important information, easy-to-use navigation menus, interactive maps for data visualization, intuitive data entry forms, search and query functionality, user management capabilities, and helpful documentation. The User Interface prioritizes simplicity, ease of use, and responsiveness across devices to enhance user satisfaction. Figure 4.8 shows the user Interface;

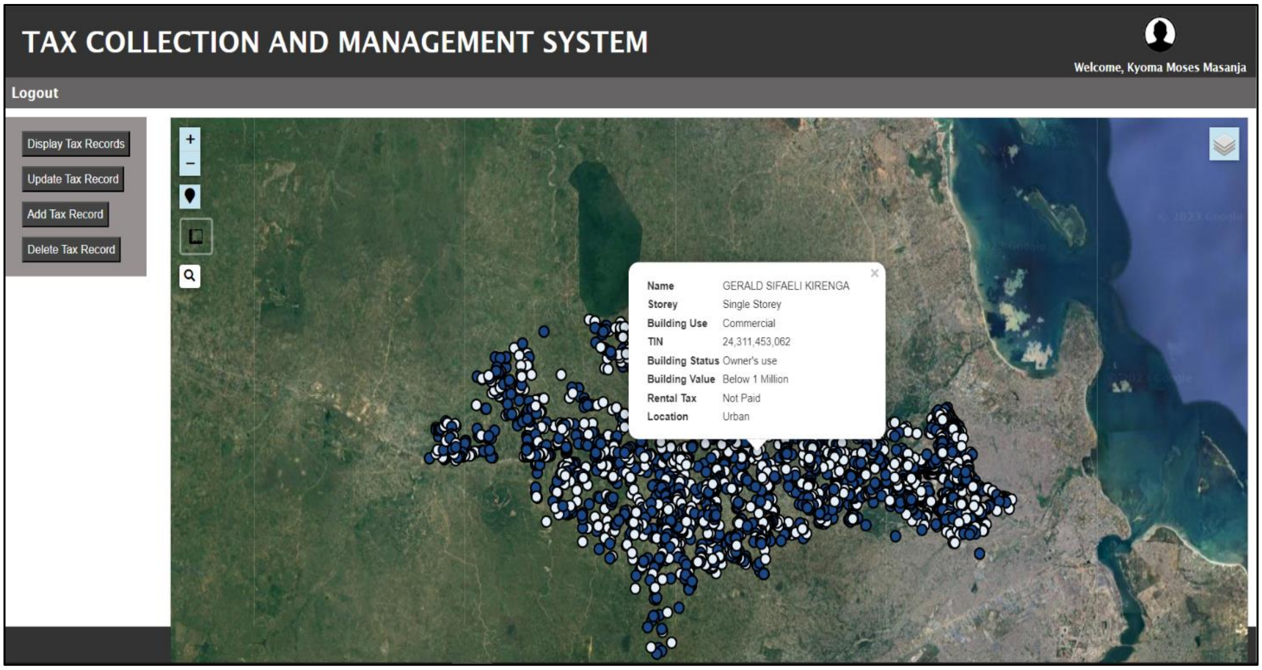


Figure 4.8 User Interface

### 4.5.7 Display Tax records

Display Tax records icon allows users to effortlessly access and view detailed tax information directly on the GIS map interface. By clicking the tool or icon, users can instantly overlay essential tax data onto the map, such as property boundaries, assessed values, tax rates, ownership details, and historical payment records. Lastly, it offers the ability of the users to download the displayed data records. So, the user can download the tax payers' details in the form of excel and use it in other activities.

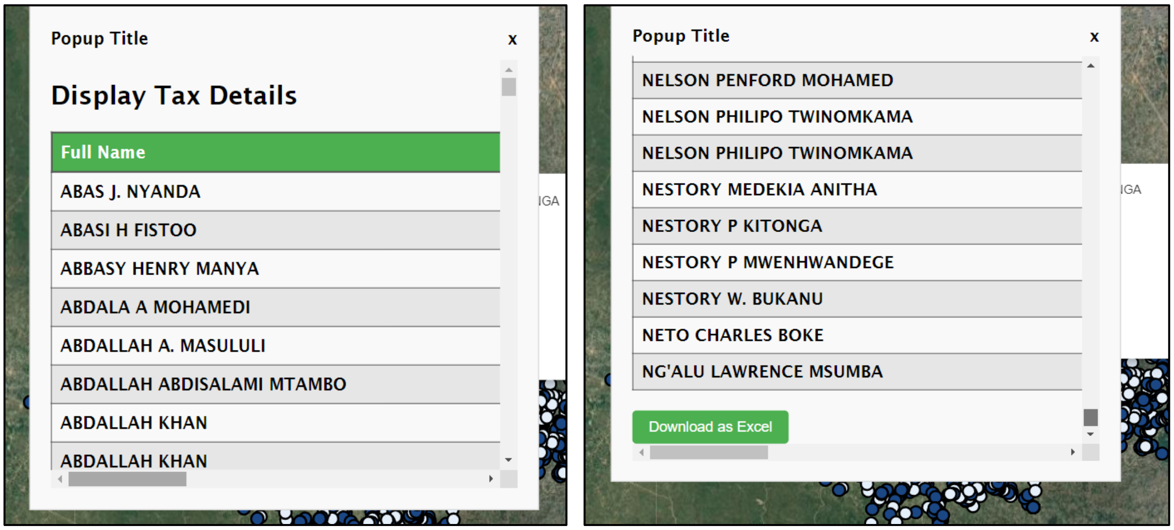


Figure 4.9 Display Tax record

### 4.5.8 Update tax records

It empowers authorized users to make real-time modifications to tax-related information directly on the GIS map interface. By clicking the tool or icon, users can seamlessly edit data such as tax payers name, storey, building use, payment records, and relevant notes. This capability streamlines administrative tasks, ensuring accurate and current tax records, and contributing to effective tax assessment, collection, and management processes.


Figure 4.10 Update tax record

### 4.5.9 Add tax records

It enables authorized users to effortlessly input new tax-related information directly onto the GIS map interface. By clicking the tool or icon, users can conveniently enter data like property details, ownership information, valuation updates, and payment records. This functionality expedites data entry, ensuring comprehensive and up-to-date tax records, and contributing to efficient tax assessment, collection, and management procedures.

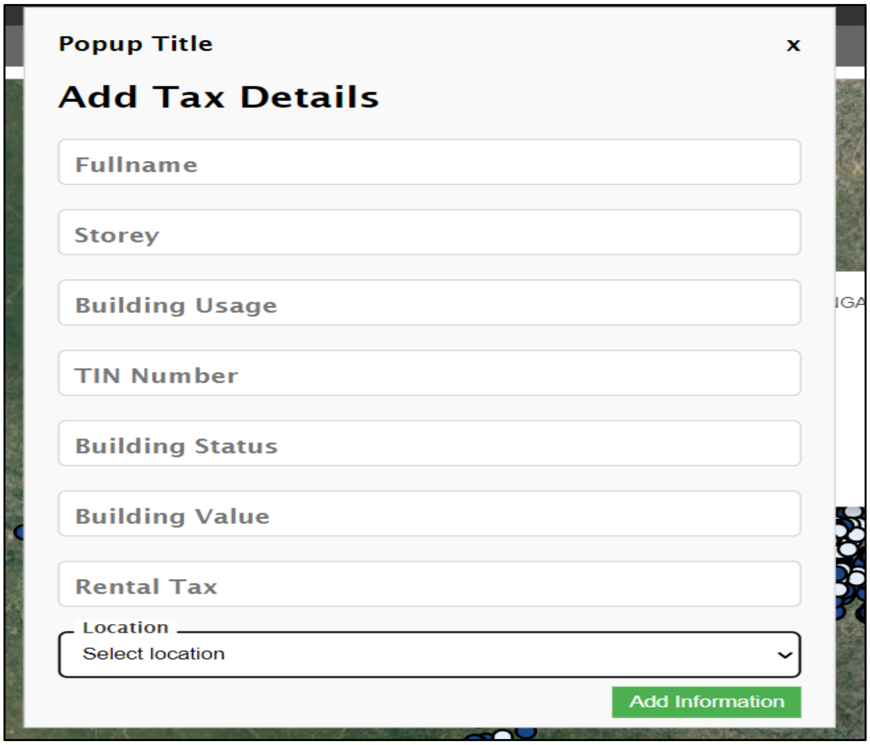


Figure 4.11 Add tax record

### 4.5.10 Delete tax records

It grants authorized users the ability to seamlessly remove specific tax-related information directly from the GIS map interface. By clicking the tool or icon, users can efficiently delete data such as outdated property records, ownership details, or inaccurate payment information. This functionality streamlines data maintenance, ensuring the integrity of tax records, and contributing to effective tax assessment, collection, and management processes.

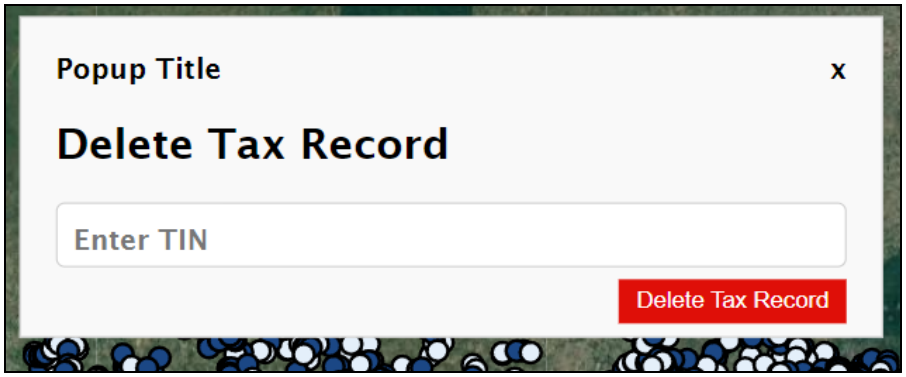


Figure 4.12 Delete tax record

# CHAPTER FIVE

# 5 DISCUSSION

## 5.1 Overview

This chapter provides a comprehensive analysis and interpretation of the study's results. It delves into the findings related to user requirements, system design and structure, geodatabase, interactive features, and user interface.

## 5.2 Discussion

The objective of this study was to develop a web-based Geographic Information System (GIS) for tax collection and management in Ubungo Municipal Council. The results obtained from the research encompassed various aspects including user requirements, design and structure of the system, geodatabase, interactive features, and user interface.

One of the key findings of the study was the identification of user requirements. By engaging with stakeholders, such as tax officials and administrators, their specific needs and expectations were captured. This ensured that the developed GIS system would be tailored to address the unique requirements of tax collection and management in Ubungo Municipality. The incorporation of user requirements in the system design is crucial for its successful implementation.

The design and structure of the developed system will play a significant role in facilitating tax collection and management processes. The system architecture was designed to enable efficient storage, retrieval, and analysis of tax-related spatial data. The utilization of a well-organized geodatabase allowed for the integration of different layers and datasets, enabling seamless access to relevant information (Ally, 2015). This structured design ensures that tax officials can easily navigate and manipulate spatial data, contributing to improved decision-making processes.

The inclusion of interactive features within the web-based GIS system proved to be crucial for enhancing user experience and functionality (AMDA, 2014). The ability to zoom in and out, as well as switch on and off different layers, provides tax officials with the flexibility to explore spatial data at various scales and focus on specific features of interest. Additionally, the measure tool facilitates accurate measurements and calculations, aiding in the assessment and analysis of tax-related attributes.

Another important outcome of the study was the implementation of pop-up functionality, which allows tax officials to access attribute data of spatial features. This feature enables users to retrieve detailed information associated with specific locations, such as property details, tax assessments, and payment histories (AMDA, 2014). By providing access to attribute data within the GIS system, tax officials can make informed decisions and streamline tax collection processes.

The integration of location-based services, which enables the system to identify the location of the user and search areas of interest (Demers, 2009). Proved to be a valuable feature for tax collection and management. This functionality allows tax officials to easily locate properties, identify tax defaulters, and efficiently plan tax collection routes. By incorporating location-based services, the developed GIS system enhances the overall effectiveness and efficiency of tax administration.

Finally, the interactive user interface of the web-based GIS system contributes to its user-friendliness and accessibility (Fu, 2022). The interface was designed with simplicity and intuitiveness in mind, ensuring that tax officials can easily navigate through the system and perform tasks efficiently. A user-friendly interface encourages system adoption and minimizes the learning curve for tax officials, thereby enhancing the overall effectiveness of tax collection and management.

In conclusion, the results of this study demonstrate the successful development of a web-based GIS system for tax collection and management in Ubungo Municipality. The incorporation of user requirements, a well-designed system architecture, a comprehensive geodatabase, interactive features, and an intuitive user interface contribute to the system’s effectiveness and user-friendliness. The findings highlight the potential of GIS technology to streamline tax administration processes and improve overall tax collection and management efficiency in local government settings.

# CHAPTER SIX

# 6 CONCLUSION AND RECOMMENDATION

## 6.1 Conclusion

In conclusion, this research successfully developed a web-based GIS system for tax collection and management in Ubungo Municipality. The study identified user requirements, designed an efficient system architecture, established a comprehensive geodatabase, and incorporated interactive features and an intuitive user interface. The findings highlight the potential of GIS technology to streamline tax administration processes and improve overall efficiency and accuracy in local government settings. It can improve data management, enable real-time data updates, reducing instances of tax evasion or under-assessment, and provide better visualization of tax-related information. As a result, the tax collection system would become more efficient, reducing administrative burdens and saving time for both taxpayers and tax authorities.

## 6.2 Recommendation

Based on the developed web-based GIS, the developer recommends;

a) Given the requirements of tax collection and management in Ubungo Municipal Council, there is a clear need to develop a mobile application. This application will provide tax officials with a convenient and accessible platform to leverage the capabilities of the GIS system on-the-go. The mobile application should be user-friendly, equipped with offline capabilities, location-based services, real-time data synchronization, and integration with mobile payment solutions. This will enable tax officials to enhance their efficiency and effectiveness in carrying out tax-related tasks, ultimately improving the overall tax collection and management processes.

b) Giving education on how the system works and its functions to the users.
Provide comprehensive educational resources and training to users, including tax officials, administrators, and property owners, explaining how to effectively use the web-based GIS system. This training ensures that users understand the system's features, functions, and workflows, enabling them to navigate the interface, access tax data, perform tasks, and make informed decisions with confidence.

c) The Web GIS system developed has been limited to employees who manage water supply, there may be developed a Web GIS system that allows customers to access some parts of the system like viewing their account information status.

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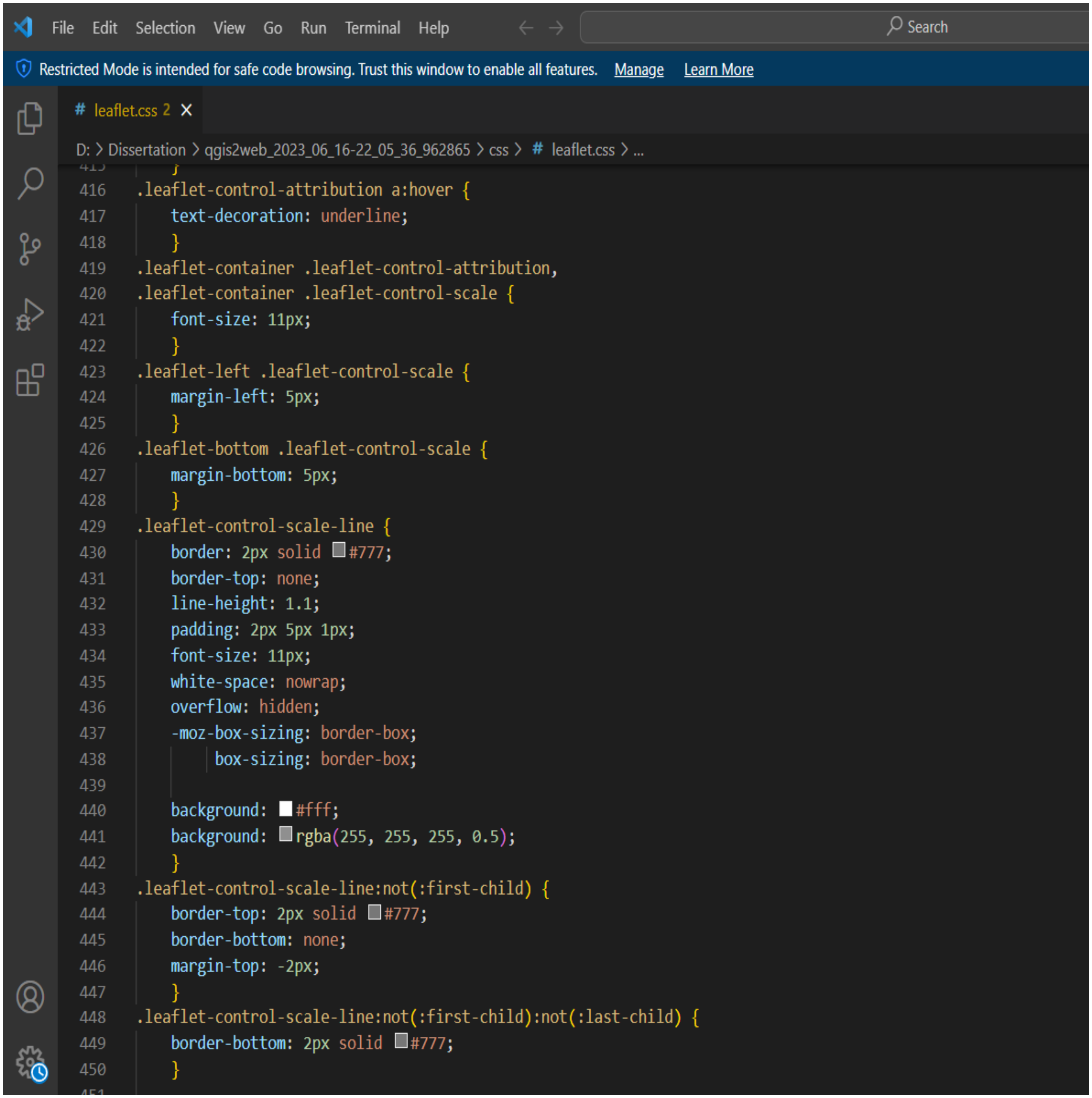
# APPENDICES

## TAX COLLECTION AND MANAGEMENT WEB BASED GEOGRAPHIC INFORMATION SYSTEM SAMPLE CODES

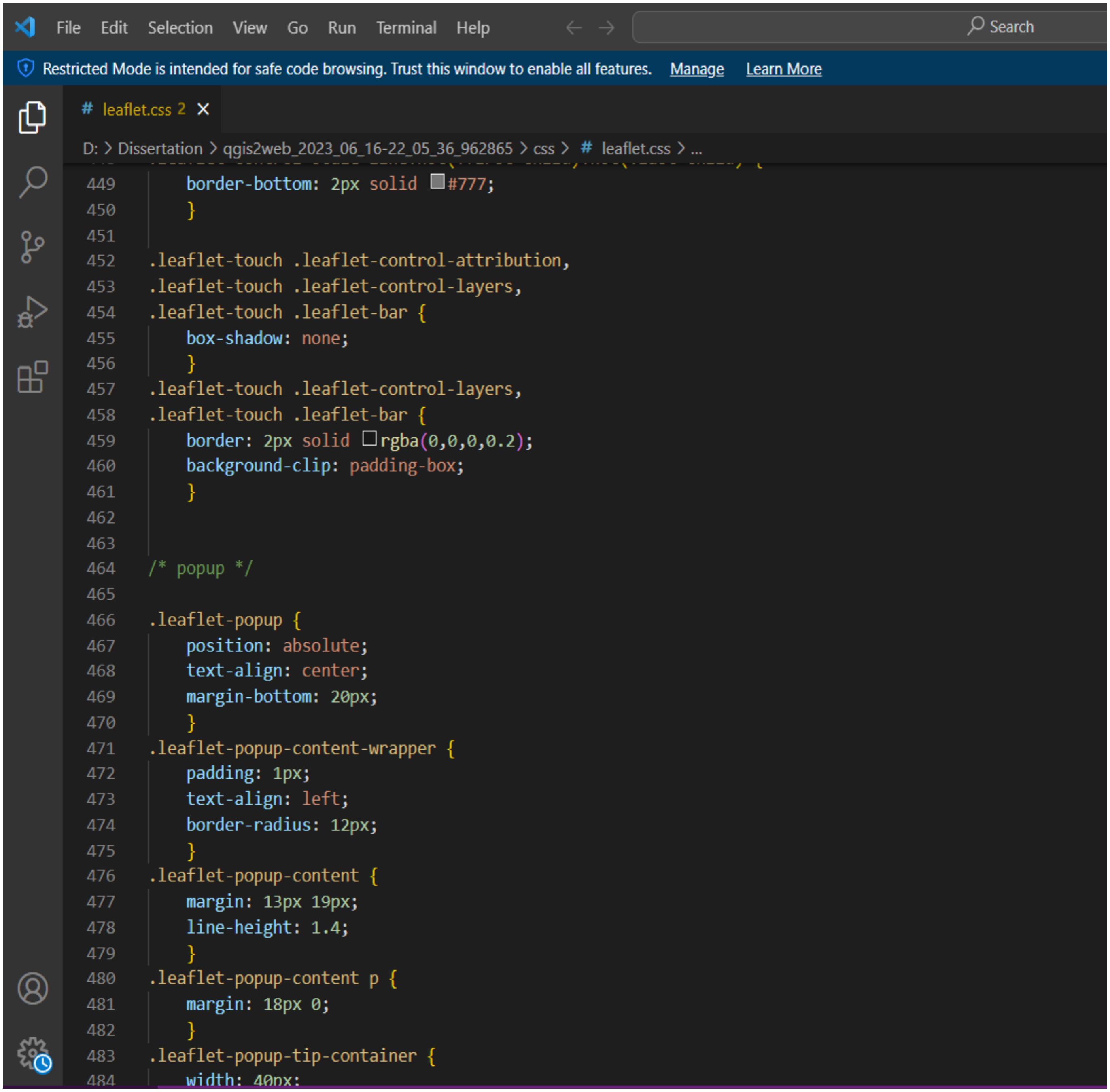
## APPENDIX A: FRONTEND SAMPLE CODES FOR THE IMPLEMENTED SYSTEM

This shows the sample codes for the frontend part or the client side of the implemented system.




```css
.leaflet-control-attribution a:hover {
    text-decoration: underline;
    }
.leaflet-container .leaflet-control-attribution,
.leaflet-container .leaflet-control-scale {
    font-size: 11px;
    }
.leaflet-left .leaflet-control-scale {
    margin-left: 5px;
    }
.leaflet-bottom .leaflet-control-scale {
    margin-bottom: 5px;
    }
.leaflet-control-scale-line {
    border: 2px solid #777;
    border-top: none;
    line-height: 1.1;
    padding: 2px 5px 1px;
    font-size: 11px;
    white-space: nowrap;
    overflow: hidden;
    -moz-box-sizing: border-box;
         box-sizing: border-box;

    background: #fff;
    background: rgba(255, 255, 255, 0.5);
    }
.leaflet-control-scale-line:not(:first-child) {
    border-top: 2px solid #777;
    border-bottom: none;
    margin-top: -2px;
    }
.leaflet-control-scale-line:not(:first-child):not(:last-child) {
    border-bottom: 2px solid #777;
    }
```




```css
	border-bottom: 2px solid #777;
	}

.leaflet-touch .leaflet-control-attribution,
.leaflet-touch .leaflet-control-layers,
.leaflet-touch .leaflet-bar {
	box-shadow: none;
	}
.leaflet-touch .leaflet-control-layers,
.leaflet-touch .leaflet-bar {
	border: 2px solid rgba(0,0,0,0.2);
	background-clip: padding-box;
	}


/* popup */

.leaflet-popup {
	position: absolute;
	text-align: center;
	margin-bottom: 20px;
	}
.leaflet-popup-content-wrapper {
	padding: 1px;
	text-align: left;
	border-radius: 12px;
	}
.leaflet-popup-content {
	margin: 13px 19px;
	line-height: 1.4;
	}
.leaflet-popup-content p {
	margin: 18px 0;
	}
.leaflet-popup-tip-container {
```

## APPENDIX B: BACKEND SAMPLE CODES FOR THE IMPLEMENTED SYSTEM

This shows the sample codes for the backend part or the server side of the implemented system.

```python
async def shutdown():
    app.state.database.close()
    await app.state.database.wait_closed()

# Token functions
def create_access_token(data: dict, expires_delta: Optional[timedelta] = None):
    to_encode = data.copy()
    if expires_delta:
        expire = datetime.utcnow() + expires_delta
    else:
        expire = datetime.utcnow() + timedelta(minutes=15)
    to_encode.update({"exp": expire})
    encoded_jwt = jwt.encode(to_encode, SECRET_KEY, algorithm=ALGORITHM)
    return encoded_jwt

def verify_password(plain_password, hashed_password):
    return pwd_context.verify(plain_password, hashed_password)

def get_password_hash(password):
    return pwd_context.hash(password)

# User functions
async def get_user(username: str):
    query = "SELECT * FROM users WHERE username = :username"
    values = {"username": username}
    result = await app.state.database.fetchone(query=query, values=values)
    if result:
        return User(**result)

async def authenticate_user(username: str, password: str):
    user = await get_user(username)
    if not user:
        return False
    if not verify_password(password, user.hashed_password):
        return False
    return user
```

## APPENDIX C: DATABASE SAMPLE CODES FOR THE IMPLEMENTED SYSTEM

This shows the sample codes for the database of the implemented system.

```python
from sqlalchemy import Column, Integer, String
from app.database.database import Base, SessionLocal, engine

class User(Base):
    __tablename__ = "users"

    id = Column(Integer, primary_key=True, index=True)
    username = Column(String, unique=True, index=True)
    email = Column(String, unique=True, index=True)
    password = Column(String)

# Create the database tables
Base.metadata.create_all(bind=engine)

def create_user(username: str, email: str, password: str):
    # Create a new user
    new_user = User(username=username, email=email, password=password)

    # Add the user to the database
    db = SessionLocal()
    db.add(new_user)
    db.commit()
    db.refresh(new_user)
    db.close()


def get_user_by_username(username: str):
    db = SessionLocal()
    user = db.query(User).filter(User.username == username).first()
    db.close()
    return user
```