KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

COLLEGE OF ENGINEERING

DEPARTMENT OF GEOMATIC ENGINEERING

A GIS-BASED REAL ESTATE TAX INFORMATION SYSTEM

The Case Study of Sinkor District, Monrovia - Liberia

BY

TITUS S. ZONEH, BSc. CIVIL ENGINEERING

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THESIS SUBMITTED TO THE DEPARTMENT OF GEOMATIC ENGINEERING, KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN GEOMATIC ENGINEERING

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DECLARATION

All opinions, findings, conclusions and recommendations expressed in this document have been school-worked and presented in accordance with academic rules by the author and do not necessarily reflect the views of the Institution. As required by these academic rules and regulations, all materials and results that are not unique to this work have been fully cited and referenced.

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Student's Name and ID	Signature	Date

Certified By:

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Supervisor Name	Signature	Date

Approved By:

……..	……	……..…
Head of Dept.	Signature	Date

To:

My lovely wife Hannah, who assumed all the responsibilities during my absence from home, my daughter Luah, who taught me the meanings of patience and love and my caring mother Oretha Dolo, who has been praying and sacrificing every single thing she has had for me. Your love and care were essential to the success of my study.

Abstract

The Real Estate Tax Division is responsible to steer the affairs of the property tax within the City of Monrovia. Its statutory duties are to provide the most efficient and effective method to list, assess and collect taxes on all taxable properties (unimproved and improved land) situated within the City of Monrovia. Determination of taxes on real estates requires accurate information on individualized property structure, location, ownership, condition, size, and its use classification. Moreover, today's communities are undergoing rapid developments and so, is the need to regularly piece together those changes to keep the assessment records up-to-date. At the Division, the existing method of property mapping is not parcel based and thus is increasingly incapable of supporting unique parcel identification. Additionally, these property records are maintained in various types like filing cabinets, on paper maps of varying qualities and different sizes, and in computers using different software. This makes paramount the importance of bringing full information communication technology (ICT) into the Division's day-to-day workings, especially the need to capture, store, retrieve, update and manage large amounts of data within a unique system. Further, any system that can visualize data and analyze trends in spatial context can enhance the efficiency and effectiveness of the taxation procedures. Remote sensing and Geographic Information System (GIS) provide a whole new dimension to ICT as they bring the spatial elements to it (ICT).

The study aims at developing a GIS-based tax information system for Monrovia. System development techniques were used. The process involves structuring the geospatial database in its capabilities for both spatial and non-spatial data capture, management, and manipulation of the required data sets. The GIS-based tax information system is one such endeavor that makes tax assessment simpler by providing locational and thematic information on individualized properties including 2D footprints of structures on each improved parcel in rating areas. The system automatically calculates the tax due on each property just by inputting raw data. Additionally, the system has the potential to generate tax recovery information and locate each property when required, so as to keep a check on tax defaulters. Most importantly, the GIS-based tax information system provides opportunities to perform various analyses on spatial and attribute data, thus providing a base for decision-making, future planning and streamlining the workflow of the property tax assessment.

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Chapter 1
INTRODUCTION

1.1 Background

Land management is a multifaceted challenge which takes into account, a careful examination of the land administration infrastructure required to support modern property systems, giving attention to the survey, registration, valuation, and land use control functions (Dale and McLaughlin, 1999). Amongst these modern property systems, property valuation stands out as a challenging element (Christopoulou and Haklay, 2005) due to its potential in revenue generation, but the intricacies involved in its administration demand new approaches that will be proficient in handling all complexities. Despite these complexities, property valuation has been in existence since the earliest days of settlements and has been one of the oldest forms of revenue channel for government, which up to date continues to form an indispensable part of the tax base in most advanced economies (Barker, 2004).

Valuation, in its simplest form is the determination of an amount for which a property will transact on a given date. Purposes for which valuations are required span from purchase and sale, transfer, tax assessment, expropriation, inheritance or estate settlement, investment and financing (Pagourtzi et al, 2003). Property valuation, herein after termed as tax assessment, is a reliable and stable revenue source, relying on commodities (land and buildings) that have identifiable and unchangeable geographic locations (Barker, 2004). Property ownership is also broadly visible and somehow easily established, making it relatively straightforward to determine who should be paying the tax. However, tax assessment has many fundamental problems and is known for its long-standing unpopularity. Considering its revenue stability and importance, striving to attain proficiency and effectiveness rather than elimination is the best way in addressing these problems (Kenyon et al, 2010).

One of the main problems in property taxation, particularly in developing countries, is the manner in which the taxes are valuated. In these countries, most often, valuations are done manually. Manual tax assessment systems maintain property records in hardcopy archives like vellum maps, cards, forms, and lists placed in files and cabinets. Striving to attain efficiencies in such systems where traditional survey methods are used to collect and store property information is challenging. As today's communities are in constant state of change and growth, authorities need to continuously monitor new developments to keep the property

records up-to-date. Effectuating such change in manual system takes a great deal of time and requires creating new tax map to reflect all new improvements from scratch. Thus, making the updating process labor intensive, costly and time consuming. As a result of these drawbacks, it is often difficult for authorities to conduct regular updates, track tax defaulters and trace out unauthorized and under taxed properties. Correspondingly, resulting to poor coverage of properties under tax net, high accumulation of arrears and low revenue. A new system is desirable for these areas.

For example, taxes are Liberia's main source of government revenue. Evasions and withholdings of taxes present serious challenges to the government because administrative processes are manual and depend solely on the integrity of civil servants (Fallah, 2011). To persuade people to pay taxes, the Ministry of Finance has embarked on a vigorous tax awareness campaign. It has organized public programs for people from the business community, mounted giant-sized billboards on main streets, carrying messages like "taxes bring development" or "good taxpayers are nation-builders". Additionally, there are smaller signboards carrying warnings that property owners should declare their properties within seventy-two (72) hours, else will face prosecution. In the midst of all these campaigns, withholdings and evasions still pose major challenges for authorities. As is usually in the case of taxation, getting people to willing pay or tax themselves in the absence of a robust tracking mechanism is no easy way (Bird and Slack, 2002). However, the tax administration still demonstrates the spirit necessary to excel in its tax implementation by constantly instigating procedures to realize the country's tax objectives (efficiency). Identifying and capturing taxpayers into the tax net still remains a daunting challenge for the tax administration.

Capturing and storing processes in analogue form therefore dampen authorities potential to adequately maximize the tax collection. Furthermore, data accessibility, retrieval and manipulation are often difficult to achieve (Chanza, 2003). For example, using the analogue procedures to determine whether evaluations are equitable takes a terrific deal of time for data retrieval and manipulation. This process requires just by looking up building locations and ages. In such system, one looks from sets of cards, locates the buildings' parcel on a map and notes the age. If the tax zone contained 25,000 units, for example, this process takes a considerable time (URISA and IAAO, 1999), yet it only combines just two pieces of information, location and age. Adding another factor, such as building area, doubles the time

require just for compiling simple information, thus making the process mind-numbing. In addition to the potential for data retrieval and manipulation, there are high possibilities of tampering with property details entered manually in paper form. Calculations and clerical errors in taxation by bill collectors and revenue officers are imminent, hence resulting to high rate of corruption, fraud and tax appeals. Considering all these complexities in relation to the revenue stability of the property tax mandates equally, a complex and sophisticated set of tools to complement its administration (Dent, 2000).

The need for decision-makers to institute an effective and reliable property tax administration to ensure all taxable properties are brought to the tax net cannot be undervalued. It is strongly believed that, vast amount of potential resources can still be generated if structural and administrative changes are brought about with regard to this tax (Raghuram, 2011). These administrative changes demand a dedicated information technology system for both the assessment and the financial accounting systems for the billing, collection, and enforcement procedures. Hence, the importance of incorporating remote sensing and GIS (spatial techniques) into the property tax infrastructure is paramount, especially the need to capture, store, update, retrieve and display large amounts of data. Today, with the use of large storage servers and reliable database management systems, information communication technology (ICT) empowers the authorities to make informed decisions and much more so easily.

1.2 Research problem

It is evident from the research background that there exist lots of underlying problems within manual and partly computerized valuation systems. That is, no functionality for map visualization. Numerous GIS related property tax researches and projects have been done to address some of these problems.

Fosu and Ashiagbor (2012) examined how GIS technology can enhance revenue mobilization for local authorities in Ghana. The research shows that an integrated GIS-database technology tool is capable of providing a more efficient collection, tracking and management of Local Government revenue and other municipal fees.

Nisanci and Yomralioglu (2002) present how satellite images (IKONOS) can be used to produce fast, up-to-date and dynamic land valuation maps for property assessment purposes in Turkey. The study examines how a raster based value map can be obtained from nominal

values, based on pixel calculation using necessary analyses of GIS. The study also illustrates overlapping a vector based cadastral map on the raster based land valuation map to determine cadastral property values on a parcel basis.

Mantey and Tagoe (2012) highlight the ineffectiveness and fundamental problems of manual process of valuation and outline a possible application of an interactive and user-friendly geo-property tax information system (GPTIS) that enables spatial query, visualization, efficient updating and processing of assessment records for authorities in Tarkwa Nsuaem Municipality, Ghana. The system incorporates all the spatial and non-spatial details regarding built-up structures for effective maintenance, collection and update of the property tax information.

Olaniyi et al (2006) study aimed at effective management of Araromi Estate and resources via GIS for authorities in Oyo State, Nigeria. The study highlights land-surveying techniques using digital equipment like Global Positioning System (GPS) and total station in capturing spatial data for the database design, thus demonstrating primary data acquisition for GIS development.

It can be seen from the above researches that various techniques have been developed to assist in property tax administration globally. Despite all these efforts, property mapping and the tax assessment functions at the operational level of the tax administration in Liberia are still being deprived of these technological advances in this electronic age. As a result, the leading effort in capturing the tax base and maintaining an accurate and up-to-date assessment records in the property tax full implementation still remains a daunting challenge. As there is no easy way to get people to tax themselves (Bird and Slack, 2002), failure to capture the tax base may lead to lack of accuracy and uniformity in reporting property values, and increase taxpayers' willful acts of underestimation and evasion in self reporting (Almy, 2001), thus, limiting the revenue performance. In fulfilling such potential, a technological leap has to be taken through spatial techniques that enable geospatial identification of all properties (locations) and unique assessment procedures for fair property taxation. Accordingly, remote sensing and GIS have in recent years proven to be the spot-on scientific tools relevant for such performance, and as such an attempt has been made here to schoolwork the need for its application in real estate tax assessment function.

1.3 Research aim and objectives

The aim of the research is to develop a GIS-based real estate tax information system to enhance regular re-inspection of the tax base and improve the assessment office in Monrovia.

The following specific objectives are set to achieve the goal of the research.

- To investigate the current issues and problems regarding property mapping and regular updates for the tax assessment function in the study area.
- To develop a GIS-based property tax information system for Monrovia.
- To implement the developed prototype using data from the study area.

1.4 Research questions

The following questions are what the research seeks to address.

- What mechanisms do exist to map property locations and conduct regular updates for assessment and taxation purposes in Monrovia?
- Which GIS-based model is suitable for effective property tax information system in Liberia?
- What is needed to implement GIS-based tax information system in Liberia?

1.5 Research design and Methodology

Administering a reliable property tax system means adequate property mapping, fair assessment and taxation, and up-to-date information. Consequently, study involving securing an efficient tax administration cuts across several disciplines. Therefore, an interdisciplinary process-oriented and institution-focused approach was adopted for this research, which uses concepts from sociology, geomatic engineering, civil engineering and information communication technology (ICT). The versatile nature of the study means that it cannot be accomplished adequately from a single methodological perspective. Hence, in this study, a variety of research methods from different disciplines were used to address the research questions outlined above.

The study's research methodology is based on the use of an intrinsic case study – an undertaking to gain a deeper understanding of the case; to develop a strategy for designing and implementing the prototype GIS that could be adapted for institutional productivity of

tax administration. The research methodology is divided into two stages; first, an analysis of the literature, and second, the design of a GIS system, based on the case study. Stages of the research design are conceptualized in six steps, as discussed below and shown in Figure 1.

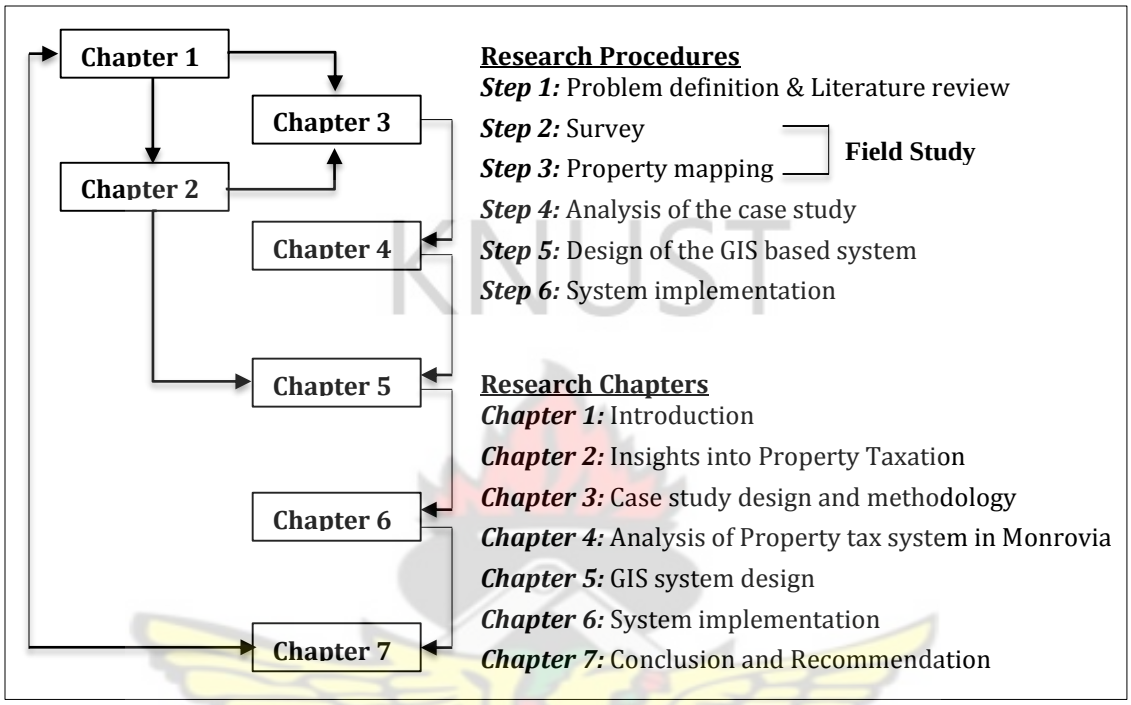

Figure 1: Research design and methodology

1.5.1. Problem definition and literature review

At the most basic level, the literature analysis is an important concern that facilitates the definition of the research problem, formulates the research question and sets the framework for the system design. The overall objective is to comprehend the relevant technical design considerations with which property tax administrations are globally concerned, prior to setting the framework used in the study.

1.5.2 Field study

This is the core instrument used to understand how the tax division functions. It is to find out from users, their potential GIS need so as to safeguard the requisite data collection and development of a GIS that would be in scope and in accordance with quality standards. The purpose of the field study is to gather as much information about the present system as possible and then endeavor to identify problems that need to be addressed. In the field study, two techniques would be used; survey and property mapping.

Survey

In the survey, interviews will be used to elicit information about the tax related problems and identify users' requirements and the needed datasets for the system design.

Property Mapping

Spatially mapping and registering all properties within the study area is critical to the development of the research's comprehensive and integrated property tax information system. The reason is to provide locations of parcel boundary and 2D building footprints, ownership and tax information on each parcel through unique identifiers. This uniqueness gives users the capabilities to exploit the attribute information intrinsic to tax assessment easily without any particular specialization being necessary. Furthermore, this enables the tax records to be up-to-date by allowing assessors to conduct regular re-inspection through spatial management easily without re-surveying the entire tax zone or municipality.

1.5.3 Analysis of the case study

At this level, the researcher conducts an analysis of the case study to understand how the current system works. The research endeavors to comb through the data gathered from the case study and to transform the meaningful data into a simplified format that can be understood and analyzed in a general context. Its purpose is to establish users' requirements, understand the requisite data types and identify potential users to ensure the project meets required needs. The analysis is expected to gather information required from the system as well as the input and output procedures.

1.5.4 Design of GIS-based real estate tax information system

Having analyzed the system requirements, the next step would be to design the information system. This task involves the design effort of structuring the geospatial database in its capabilities for both spatial and non-spatial data capture, management, and manipulation of the required data sets. It involves the undertaking of modelling the data, looking for the best tools and using technical expertise in combining them to get a working system. In the design realization, relationships between these varying data sets, their nature and usage, and how they are represented in the database are defined including system processes and outputs. Additionally, integrity and validation rules to ensure data sensibility is considered to minimize errors and flag properties with irregular characteristics. Implementing all of these is crucial to achieving the research's goal and ensuring workability and reliability of the system.

1.5.5 System implementation

This stage involves testing and reviewing the system for knowing its full functionalities and to determine whether the outputs match expected results. This process involves defining the hardware and software required to run the system using empirical data. The results drawn from the test allows the research to outline the extra enhancement the study brings to the tax assessment functions. It further justifies the need for a GIS-based tax information system in property tax implementation.

1.6 Structure of the Thesis

Chapter one: The chapter introduces readers to the study's background, which gave the researcher the zest to assume it (study). It also highlights the research problem based on prior works, reveals the research aim and objectives and as well the research questions. Furthermore, the chapter reviews the general methodology used to achieve the study's overall goal as well as the structure of the thesis.

Chapter two: The chapter discusses the general overview of the property tax system by examining the design principles, system framework, the tax administration and the different models of valuation considering their strengths and weaknesses. In addition, the chapter examines the computer-assisted mass appraiser (CAMA) in property assessment and finally reviews the essence of remote sensing and GIS in property tax administration.

Chapter three: The chapter describes the study area and further discusses the survey method used in conducting the field study that safeguarded the collection of the requisite input data for the system development. Additionally, the analysis and reporting method as well as the limitation of the field study are examined.

Chapter four: The chapter discusses the practical techniques used for property mapping and tax assessment procedures in the study area. Furthermore, the chapter highlights the problems and prospects regarding the current property tax implementation from which a consideration for technology is examined.

Chapter five: This section focuses on the design of the GIS-based real estate tax information system. The chapter discusses the data modelling (E-R diagram), hardware, software and the system architecture used to develop the system.

Chapter six: This chapter presents the implementation of the GIS-based tax information system using empirical data from Monrovia. The chapter further discusses the challenges for implementing the GIS-based tax information system.

Chapter seven. This chapter presents the conclusion drawn from the study and makes recommendation for further research.

Chapter 2
PROPERTY TAX SYSTEM AND GIS

2.1 Introduction

This chapter examines the property tax system by discussing the relevant technical design considerations and implementation issues with which, policy-makers are to be concerned with in developing or redesigning the property tax. It discusses the legislative role, political benefits and problems, organizational obstacles and designed tools to complement those obstacles, as well. To begin with, the chapter highlights the definitions and some terminologies used in property tax administration and design.

2.2 Overview of the property tax design principles

In securing a well-designed property tax system, a number of principles are considered which could also be used in evaluating existing systems. These principles fall into administrative, social justice, economic, and political categories. Some are complementary while others are mutually contradictory (Almy, 2001). Hence, knowing a general brief description of how these taxes are administered and levied is helpful in understanding how property tax systems work and the first step is to understand these terminologies and principles.

2.2.1 Useful terminology

Some useful terminologies used in property tax design include:

Appraisal is an estimate of the most probable selling price of a property.

A*ssessed value* is the value placed on property for tax purposes. Properties are often divided into different classes and assessed at a fraction of its market value.

Assessment is the valuation of the tax base for property tax purposes.

Assessment ratio is the proportion that the assessed value is to the market value of the property. Property classes may have different assessment ratios.

Effective tax rate is the rate that results from dividing the tax bill by the actual market value of the home or other property.

Market Value is the estimated amount for which an asset (property) should exchange on the date of appraisal between a willing buyer and a willing seller in an arm's length transaction (International Valuation Standards Committee).

Property mapping is a systematic process of capturing and documenting relevant information such as ownership, assessed value, municipal addresses, legal descriptions and assessment roll number (parcel ID) on each property in a municipality.

Property tax is an annual levy on properties, usually by government powers, for which property owners are obliged to pay.

Property tax rate is a specified percentage on the assessed value of a property.

Real estates/properties are all immovable units physically characterized with location, shape, size and reference point such as land, building, house, production plant etc.

Tax base is the pool of property or value from which a government draws assessments.

Tax map is a pictorial representation of the properties in a municipality, showing location, dimensions and other information about each property for tax purposes.

Taxable property is property that is subject to the property tax. It includes real property (land and buildings) and, to a lesser extent, personal property (automobiles, boats and other similar items).

Tax zone or rate block is a delineated area inside a municipality with identifiable and relatively stable physical boundaries (e.g., roads, river, etc.) established for assessment purposes.

2.2.2 Design principles

The following are the underlying principles in the design of the property tax systems.

Uniformity in property taxation measures equity or fairness in valuation. This policy ensures that assessed values of comparable properties within a given jurisdiction are the same (horizontal equity).

Openness and Transparency contributes to a sense of fairness. With an easy to understand system (simple), transparency is enhanced. Transparency moves parallel with openness. In an open system, taxpayers easily obtain information, ask questions, lodge appeals, and make payments. They both improve accountability and are characteristics of a democratic government.

Public Acceptance is the cumulative effect of many things, including amount of the tax, ease of tax payment, benefits received, openness, and perceived fairness.

Buoyancy in property taxation refers to a change in tax revenues, which is a function of two mechanisms, administrative actions such as frequent revaluations and adjustments to the property tax rate, or both.

Cost-effectiveness refers to a property tax system in which almost all taxable properties are discovered, valuation and other assessment errors are minimized, tax collections approach one hundred percent of the total amount due, and the costs of administration (including taxpayers' compliance costs) are minimized.

Neutrality in property taxation means the tax should not distort economic behavior, including decisions about where to live and work, and what improvements to make to one's property. A uniform, broad-base tax guarantees neutrality.

It is often difficult to achieve all of the these principles at the same time, so choices have to be made in order to gain the full relevance of the property tax in its implementation. These choices bring about simplicity, which is the hallmark of a well–designed tax system. A simple tax system provides the environment for taxpayers' understanding and thus makes the assessment process easy and inexpensive for governments to administer. However, a complex tax system may be confusing, time consuming and costly for taxpayers and thus, expensive for government to administer effectively.

2.3 Components and framework of property tax system

Property tax is not without problems because of a dynamic and politically complex environment in which it is administered (Almy, 2001). Consequently, political determination is essential, and if there are political doubts, authorities should not waste time and money in considering the introduction of this tax. The wide application of property tax and its long history show that, if there is sufficient political will, there are no impossible technical or administrative problems to the introduction of it (Keith, 2002). Because the commodities (land and buildings) have fixed positions, property tax becomes unavoidable with underlying complexities (Almy, 2001); these complexities can be described in different ways as follow.

Elements

Property tax system comprises of different elements, which are well thought out in achieving the overall success of its goal (maximize collection). These elements include people, policies, technologies, data, and process. Policies and processes required legitimacy through legislation or provided in legal code. The statutory process of the tax system sets out policy choices clearly, provide the enabling environment for their achievement, and assign responsibilities. Laws, regulations, and court decisions establish the legal framework. Matters requiring legal support include organizational responsibilities, power to tax, liability for tax,

defining the tax rate and tax base, taxpayer rights and responsibilities, and tax jurisdiction and extent (Almy, 2001).

Functions

There are three basic functions, which a property tax system tends to fulfill. These functions include identifying and establishing links between ratable properties and their owners (discovery), conducting assessment and addressing appeals, and collecting the taxes and addressing arrears. These principal functions are interdependent. Inefficiency or absence in one potentially causes complete failure. Thus, the successful implementation of the property tax requires the completion of these functions to ensure the success of the whole process.

Times

Implementing property tax requires time component. As the process framework implies, the time taken to implement the system depends on the scale of the task and the resources available. It takes at least two years to implement a new assessment list from scratch, and usually takes longer (Keith, 2002). The time can be reduced in subsequent years if the list has been well maintained and if the computer systems are well designed. Policy makers need to take time into account when developing or redesigning the property tax.

Linkages

A property tax system does not exist in isolation of other systems. Because an up-to-date information is required for the completeness of a secured system, linkages between agencies responsible for the property tax administration and those of title records, mapping, soil classification, building permit, business and population registers need to be established and maintained so that data needed in the property tax implementation flow regularly and efficiently. Similarly, property tax agencies need to establish similar linkages with their clients and stakeholders. However, there is considerable international variation in how functions related to property tax administration are organized. While it is administratively prudent to consolidate some functions (title-registration combined with surveying and mapping) to simplify institutional linkages, it is fiscally expedient to keep the legal cadastre distinct from the fiscal cadastre. Property buyers will soon tend to evade registration or cancel the true nature of the transaction, knowing that one of the costs of title registration is property taxation (Almy, 2001).

2.4 Property tax administration

Property tax administration deals with stakeholders such as taxpayers, tax recipients and policy makers in legislative bodies. It endeavors to provide the most efficient and effective system to list, appraise, assess, prepare and certify the annual assessment roll of all taxable properties in accordance with state laws and administrative procedures. However, failure to establish a creditable tax base erodes taxpayers' confidence, dampens compliance rates, and limits revenue potential. Lower revenues mean poorer services and poorer services stiffen the resistance to higher taxes (Bahl et al, 2008). Therefore, it is imperative upon policy-makers to ascertain a well-administered property tax system by considering those different features and procedures, which must be well defined in achieving the overall success of its goal. Below are those features and procedures:

2.4.1 Basic features of property tax policies

Policies required legitimacy through legislation or provided in legal code. The statutory process of the tax system sets out policy choices clearly by setting the tax rate, defining the assessment procedures, exemptions and setting the guideline for responding to assessment appeals as discussed below.

Tax rate

There are three possible approaches in establishing tax rate. In one approach, local government takes into account the budgeted needs of the authority and fixes the rate annually. The setting of the rate is a political act, which gives rise to local debate. In another approach, the law fixes the rate in primary legislation and the tax revenues vary according to changes in market values and periodic reassessments. In a third approach, the central government fixes the property tax rate annually taking into account the needs of local government and reflecting the extent of intergovernmental transfers from central to local government (Keith, 2002).

When the rates are based on budgetary needs (first approach), the first step is determining the amount of revenue desired from the property tax (property tax levy) based on government expenditure requirements. This levy is usually the difference between planned expenditures and expected revenues from other sources (Almy, 2001). This approach is depicted mathematically as:

$$R = \frac{E - NPR}{AV}$$

where R is the tax rate, E is the total approved budget, NPR is the total estimated taxes from other sources (non-property tax), and AV is the total assessed value. The rate R can still be subject to limits.

As stated by Keith (2002), it is also possible to have differential rates depending on the value and/or the amount of property held by any taxpayer. Consequently, it is possible to introduce a policy where the tax rate is proportional to the assessed value of the taxpayer's properties. In theory, it makes the tax more progressive, and it sounds appealing at first sight. There are, however, various technical reasons to avoid this and adopt a single tax rate. It leads to artificial splitting of properties to avoid the higher rates. The approach makes the total yield of the tax less predictable and therefore, complicates local government budgets. It also makes the tax a degree less transparent. The greater complexity decreases the level of accountability achievable from the administrative staff and can lead to corruption (Keith, 2002).

Tax rates are commonly referred to as mill levies; a mill is one-tenth of a cent. One (1)-mill levy means that the taxpayer owes $1 for every $1,000 in taxable property value.

Property tax exemptions

An exemption is a full or partial exclusion from the tax base and/or tax liability for certain types of properties. Tax exemptions are determined in many different ways around the world, but one unique thing they all have in common is they either reduce or entirely eliminate one's obligation to pay tax. Federal and state governments often exempt organization from taxes entirely when it serves the public with socially worthwhile services that government otherwise might have to provide, such as with charitable, religious and educational services. They are designed to help reduce property tax burdens or encourage publicly desired objective. However, exemptions tend to violate the principle of neutrality because they favor particular land uses and distort the distribution of the tax burden (Slack, 2000). As a result, exemptions and other targeted forms of property tax relief should be kept to a minimum by carefully employing effective measures in identifying such exempt properties. Otherwise, owners may soon tend to hold more properties than they can use productively for such services thereby leading to reduction in the tax base and subsequently reducing tax yields

(Almy, 2001). In general, it is the case that the lesser the exemptions, the easier and cheaper it is to administer the property tax.

Tax assessment

Tax assessments are conducted in order to determine the value of properties based on standards established by the state. It is performed to determine property value solely for taxation. They are usually implemented using a multiple regression analysis package (Gloudemans, 1999). This is a statistical technique used to analyze data in order to estimate the value of one variable (market value) from the known value of other variables such as building size, quality, location, lot size etc. There are three traditional appraisal techniques use in assessment for taxation purposes, namely, comparable sales, income, and cost approaches. The statutory process of the tax system sets out policy choices clearly that provide the enabling environment for assessment purposes.

Tax appeals

Assessment appeal, which distincts property taxes from other forms of taxes (income, consumption, sales, etc.), is an essential component in the assessment process. This approach provides property owners with an opportunity to meet with the assessor, to inquire about their assessments. It enables owners to learn about the procedures used and the various factors considered in the assessment of their properties if they so desire. If dissatisfaction arises, owners take an appeal through a tribunal, local court or the state (hierarchical steps), where an appeal panel will determine whether or not the assessment should apply. Dissatisfaction may arise from owner's property value too high while another owner of similar property value too low, incorrect classification, etc. This appeal board is usually an independent body from both the body responsible for tax assessment and tax collection. The dispute resolution procedure is extremely essential to the smooth administration of the tax and is also an important safety valve (Keith, 2002). So, this process is usually handled with caution to ensure transparency and openness. The law of course clearly specifies how and when appeals are made.

2.4.2 Procedures in property tax appraisal administration

There are a number of critical steps involved in the process of assessing real properties. They include the identification of the properties being assessed, valuation of the assessed property, and tax collection and enforcement.

2.4.2.1 Property identification

The assembling of an inventory on all taxable property units is the very first step in identifying and describing properties. The tax cannot be collected if those properties are not located. This task is achievable if the property registry has up-to-date information on these data. Information on property transfer and other data, are received from other sources. Permit issuing agency, title registry or surveying and mapping agency aid in providing needed information to improve the completeness and quality of this record. Authorities also issue public calls, publish in daily newspapers, print brochures and use other communication channels, like the Internet to gather information for the completeness of the property records. The aim of these actions is to target citizens as property owners to fulfill their legal obligation to declare their properties. However, relying on property owners to declare willing is a mirage and thus requires a system to trace and capture individual taxpayer from the tax base. In identifying these properties, a complete and quality assessment record must be produced and should include at least the following information (based on IAAO, 1990).

- parcel identification number
- address
- classification of property usage
- zoning code
- legal status
- size and shape of parcel
- improvement details
- building perimeter drawing
- owner's details

The descriptions of improvements and land are useful and sensible data for property assessment. The quality and quantity of the data used correlates with the accuracy of the resulting assessments, so collecting information on properties requires accuracy and uniqueness to ensure correctness. Data quality refers to the currency, completeness and accuracy of the data collected while data quantity simply refers to the amount of data available or that needs to be collected (Gloudemans, 1999). Once the property data has been sourced and sorted, it is used to determine market values.

2.4.2.2 Property appraisal and assessment

Assessment process is a step-by-step approach, which allows appraisers a framework or methodology to solve assessment assignments. This systematic approach leads the appraiser to a defensible and supportable value conclusion. To effectively achieve these value conclusions, assessing offices establish effective procedures for collecting and maintaining property data for assessment purposes. The data includes property ownership, location, size, use, physical characteristics, sales prices, rents, costs, and operating expenses. The appraiser responsibility is to ensure that the property data used for assessment are uniform and accurate, complete, and up-to-date because such data are also used for performance audits, defense of appeals, public relations, and management information (ODR, 2008).

Whittal (2008) stated that assessment efficiency of the entire assessment roll is measured by the ratio of the total assessed value (total value shown on assessment roll at base date) and the total actual market value at time of billing. This will highlight changes in overall property value as the time between base date and date of billing increases.

Mathematically;

Assessment efficiency = $\left(\frac{AV}{MV}\right)$; where AV is assessed value and MV is market value

The quotient of the assessment efficiency should be 1, but is usually less than 1 due the retrospective nature of property assessment and taxation. This means, assessment and taxation rely on judgment taking effect from a date in the past, but can be adequately compensated for in the property tax rate adjustments (Whittal, 2008).

2.4.2.3 Appraisal techniques

There are different methods available for real estate valuation, the choice of which depends on the purpose of the valuation and the nature of properties to be valued. Furthermore, choice is dependent upon the information available to the appraiser. Whenever appropriate, more than one method is employed to arrive at the appraiser's conclusion about the property value. Property appraisal usually involves three basic methods as categorized below.

Income (rental value based) approach

Income approach is used to value commercial (and residential) or investment property that is producing, or has the potential to produce, future cash flows through the letting of the property. This approach is considered the most applicable valuation technique for income-

producing properties especially where sufficient market data exists. It intends to directly reflect or model the expectations and behaviors of typical market participants. However, this approach requires reliable income and expense data from the taxpayers. Objective evidence of the relationship between income and the present value is required to reflect the expectation and behaviors of typical market participants (IAAO, 2002). Otherwise, it soon tends to be undesirable for valuation.

Sales comparison (market) approach

The comparable sales approach is a method of comparing similar properties that have been recently and officially transacted on the open market, under certain conditions. This technique in real estate appraisal is based primarily on the principle of substitution (ODR, 2008). In developing this approach, the appraiser attempts to interpret and measure the actions of parties (buyers, sellers, and investors) involved in the marketplace to enable him arrive at a value conclusion. Using this approach helps assessors avoid errors inherent in either the income or cost approach. This approach is applicable to all types of real property if and only if there are recent, adequate and reliable transactions on the market from which trend determinations are carried out in a statistically valid manner (IAAO, 2002). The approach is difficult to yield results in the case of special purpose properties where insufficient numbers of comparable sold properties exist, i.e., the impediment to the heavier use of this approach is in areas where sufficient property data are not available.

Cost Approach

The cost approach, formerly known as summation approach, is the determination of the estimated value of a property by summing the land value and the depreciated value of any improvements (engineering approach). The value of the improvements is often referred to by the abbreviation RCNLD (reproduction cost new less depreciation or replacement cost new less depreciation). Reproduction refers to reproducing a replica (ODR, 2008). Replacement cost refers to the cost of building a house or other improvement, which has the same utility, but using modern design, workmanship and materials. The cost approach is considered most reliable when used on newer structures, but the method tends to become less reliable for older properties. The cost approach has the advantage of being applicable to virtually all improved properties, regardless of the availability of market and income data (AMA, 2004). The cost approach is often the only reliable approach when dealing with special use properties - public assembly, marinas, etc.

Each of the approaches has a recognized format or procedure to be used to process the data applicable to that approach into an indication of value. In valuation, appraisers are often dealing with unpredictable quantities and qualities, which cannot be reduced to strict rules, regulations, formulas, and tables (ODR, 2008). Therefore, the assessor must have an understanding of the basics involved in each approach by having the ability to recognize pertinent data. The assessor must also be an expertise in determining the valuation approach applicable to a given property assessment in order to arrive at a logical and supportable estimate of value. Because of this complexity in property valuation process, providing property owners with an easily understood explanation of how their properties have been valued remains a continual challenge for assessor and therefore, demands well-qualified professionals for the execution of this task in the property tax implementation.

2.4.2.4 Computer assisted mass appraiser (CAMA)

Accomplishing assessment of several property units within a given period (say two years) is a mammoth task for revenue authorities. The large number of different real property units causes the tax administration to be more complicated. This demands the need for the use of mass appraiser techniques that allow appraisers to get the job done on time and with the available funds. Mass appraisal is the process of valuing large number of properties at the same time using common data, standardized procedures and statistical testing (IAAO, 1990). Mass appraisal requires complete and accurate data, effective valuation models, and proper management of resources. This method focuses on a variety of properties and calculates the averages (market values) on properties with similar characteristics.

A well-designed CAMA system is essential to mass appraisal because the system helps assessors provide accurate assessments. Computer assisted mass appraisal refers to the process of using a computer in conjunction with either a cost approach or market approach in producing assessment values. The computer system is used to store, manipulate, analyze, and generate output in support of the assessment process.

The achievement of the full potential of this computerized assessment process is evolved into stages. The first stage is the handling of the data in the assessment list as a database (collection of related data, designed to meet the varied information needs of an organization). The next major priority is the computerization of the collection process. Because computers do not assist directly with the capture of information in the field, a simple and easy to use

inspection checklist that act as automated input forms are usually designed for data capturing. This checklist provides clear and standard coding and enhances careful monitoring through quality control program that measures accuracy and crosschecks the collected field information.

With the full establishment of these applications (data handling and collection), attention now turns to the task of computerizing the assessment process. With the above, put into place, the guidelines are now computerized, and assessments are automatically generated (Keith, 2002).

2.4.3 Property tax collection and enforcement

Identifying and reaching the taxpayers with a clearly formulated tax statement maximizes the property tax collection. For example, the actual tax bill targets the person or legal entity that is obliged to pay, and it also clearly formulates the tax liability. In a good property tax collection system, tax bills reach the taxpayers two to three weeks before the payment deadline. Additionally, authorities offer several options (cash, transfer or credit cards) for paying the property tax so that taxpayers are able to use the most convenient ways to pay their taxes and there may even be an option for installments; quarterly or semi-annually (NALAS, 2009).

Despite all these payment opportunities given to property taxpayers, there are still delinquent taxpayers (defaulters) for which enforcement strategies are provided. In every property tax administration, the revenue statute provides powers of enforcement in cases of non-payment. Typical remedies include seizure of rents and profits, fines and interest on late payment exceeding the commercial rate, distraint on property (i.e., seizure of one's property in order to obtain payment of money owed), forfeiture of the property by auctioning to the public and sometimes imprisonment.

However, in a reputable tax administration, legislation clearly spells out detail about the rights of the taxpayer as the government proceeds to collect the tax or seize personal property or other assets for nonpayment. The scheduling of notices and demands to be sent to delinquent taxpayers is explicitly laid out in legislations. If there is to be a right of property recovery, the statute also outlines it with rigorous deadlines (Powers, 2006).

2.5 Remote sensing and GIS as tools for real estate taxation

Giving assessors' obligations to provide accurate and consistent real property assessments, authorities are required to update the property records constantly to reflect the real world. Consequently, regular re-inspection is key to the property tax implementation for tracking developmental activities.

Until recently, traditional ground surveying and mapping were used for creating analogue base maps for assessment purposes. These traditional techniques for tax assessment are less efficient. Changes require starting from scratch with the creation of new tax maps, making updating extremely expensive and often avoidable. A new approach that will enhance data collection can enhance property taxation.

Due to the proliferation and widespread availability of high-resolution imagery with affordable pricing from increasing number of vendors, remote sensing techniques are becoming extremely useful. Creating base map and conducting change detection analysis and selection of sites for specific facilities are all feasible via remote sensing techniques (Bocco et al, 2001; Verma et al, 2008). Over the past decades, since the introduction of the 30cm resolution satellite data, the use of remote sensing data for cadastral purposes, including land taxation has featured prominently in academic and scholarly articles.

Remote sensing is a technology used to gather information about features, objects, area or phenomenon on the earth's land surface without being in direct contact with it. This process involves making observations using sensors mounted on platforms, which are at a considerable height from the earth's surface and recording the observations on a suitable medium from which interpretations can be made and information obtained. Access to remotely sensed images in digital format allows rapid integration of the results of remote sensing analysis into a GIS (Eastman, 2001).

GIS is a computer-assisted system for capture, storage, retrieval, analysis and display of spatial and non-spatial attribute data. This tool helps convert property tax complexities and challenges into opportunities for property tax administrators and improve assessor's judgment (URISA and IAAO, 1999). It also enhances access and accuracy of data and brings about change, a change in the way humans work with records. However, while GIS is the fundamental analytical platform for spatial planning that provides an environment for better

decision-making, remote sensing, of all the various data sources used in GIS, plays a fundamental role (Leeuw et al, 2010).

Because a tax cadastre needs to record only such information about boundaries, ownership and improvements, and regularly update those records as well, the need for the integration of remote sensing techniques into such practice is extremely worthwhile. The integration is mainly useful for supplying baseline information for land-use and other forms of spatial planning in areas where maps are not available, such as in developing countries (Bocco et al, 2001). Moreover, it fills the gap in areas with old-fashioned mapping record by providing the data to update those maps (Leeuw et al, 2010). As a result of such technological evolvement, the traditional approaches and techniques used for creating base maps for rate blocks now prove to be costly, labor intensive, time consuming and inefficient. Because of such extreme importance of remote sensing as a data input to GIS, it has become incumbent upon GIS analysts; particularly those involved in property tax administration, to gain a strong familiarity with this technology to enable them enhance the tax assessment function with spatial data that is relevant to property assessment.

However, remote sensing does not provide all the information needed for a full-fledged assessment, other spatial and non-spatial attributes from various sources are needed for integration with remote sensing data for the completeness of the tax cadastre. Such integration and their combined analysis are performed through GIS technique. With GIS, regular re-inspection is simply achievable by overlaying or superimposing recent imagery for change detection analysis. Field measurements are made of only the new properties\additions, and entered into the system to produce up-to-date information. In addition to its potential for fast update, adopting GIS enables assessor respond quickly and appropriately to requests for information by elected officials, other agencies, the media and citizens. Hence, promoting transparency and openness of the tax administration and improving taxpayers' compliance.

Using GIS, identifying changes in the real world, which influence the value of property, is achievable. Such changes include an arm's length property conveyance, an alteration to a property, a fire hazard, a change in the neighborhood such as a newly constructed shopping center or building and building addition, a new landfill site, a report of contaminated groundwater or a zoning change. This tool does not only identify these changes that influence

values, but also identifies the specific properties that are affected. It provides the assessor with analysis capabilities that will help determine the extent of the value change and enable him (assessor) assign new values that are accurate in accordance with legally and professionally accepted rules (URISA and IAAO, 1999).

It is evident from the above functionalities that these spatial tools convert all property tax complexities into opportunities for revenue authorities. These tools further provide the capabilities to view, query, and analyze spatial data, which enhances the assessment functions. They improve work efficiency through spatial task management and enable assessors to provide a better picture and service to the communities they serve. Since property taxation mainly relies on commodities (land and buildings) that are geographically fixed within jurisdictional boundaries, bringing remote sensing and GIS that take account of location into the property tax infrastructure is paramount. This provides decision makers with the base for strategic planning and streamlining the workflow of the property tax infrastructure. Unlike any type of information handling tool, GIS can understand the concept of location with ease and as such enhances cost efficient decision-makings.

2.6 Concluding remarks

The chapter discussed the general overview of the property tax system and the technical design considerations and implementation issues with which, policy-makers are concerned with in developing or redesigning property tax. Additionally, discussion of how remote sensing and GIS can tremendously provide an optimal environment for exploiting the information inherent in the geographic data sets, which enhance the assessment processes, was revealed. The chapter concludes that the implementation of modern and transparent assessment methods for real estate requires the application of remote sensing and GIS integrated with computer-assisted mass appraisal (CAMA). This integration enables the tax assessment function to be concurrent with spatial data that is relevant to the tax valuation model for accurate assessment. With the literature analysis of this chapter achieved, the next chapter now discusses the case study area and the research methodology used in answering the research's strategic questions that would safeguard the GIS development.

Chapter 3
STUDY AREA AND RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the method used to collect and analyze the empirical data. To begin with, the chapter describes the study area and the reason behind its selection. Second, it discusses the data collection method by examining the survey method, the creation of the tax map, as well as the analysis and limitation of the survey.

3.2 Study area

Sinkor, one of the several districts of the city of Monrovia was chosen as a case study to provide empirical data for the investigation. The selection of the case study area was based on site visits and literature reviews that provided insights into current administrative issues of the property tax and the level of property development in the area. The district's property tax is administered by central government through the Real Estate Tax Division. Its rapid developments and economic activities thus give reasons for its selection for this research and most importantly due to easy access to data collection.

The district of Sinkor lies further east down the Cape Mesurado peninsula, and is part of the several districts of the city of Monrovia; the capital city of Liberia. Sinkor is geographically located within the northern hemisphere between latitudes 6° 18' 9" and 6° 17' 38" and on the west of the Greenwich meridian between longitudes 10° 46' 19" and 10° 47' 51" with a total population of 38,953 (2008 census) and an approximate area of 4 sq. km. Originally a suburban residential district, today Sinkor acts as Monrovia's bustling mid-town hosting lots of well-developed and improved residential and commercial buildings. Because of its strategic location with proximity to the Atlantic Ocean as shown in Figure 2, its streetscapes and other amenities, many diplomatic missions, commercial facilities such as the Royal Hotel, Exclusive supermarket, Stop and Shop supermarket and many other hotels and businesses, as well as several residential neighborhoods have all been homed in this district. The district's rapid development and economic activities produce a good tax base and thus give reasons for its selection for this research and most importantly due to easy access to data collection. The study area is also home to the city's secondary airport, Spriggs Payne, and the area immediately nearby, called Airfield, is a leading nightlife district for the whole city of

Monrovia.

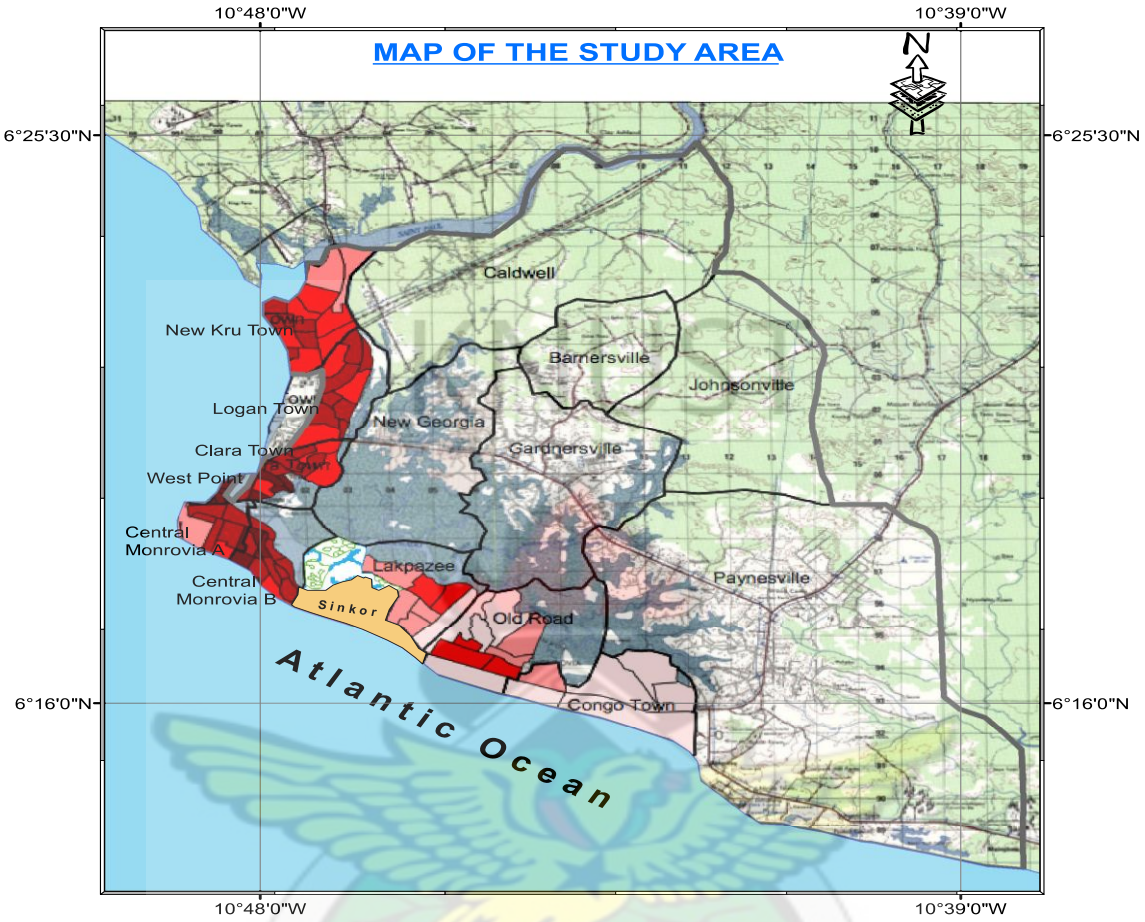

Figure 2: Map of the study area

3.3 Data collection method

The research project is a single case study, and hence the strength of it, as opposed to multiple cases requires some attention, not least of all in the ability to generalize the findings, and the analysis and research design which underpin this approach (Whittal, 2008). However, Yin (1984) identifies a number of real world scenarios in which single case studies are preferred to multiple case studies. These are when the case is vital in the testing of theoretical propositions, when the case is extreme or unique and for pilot studies. The case under consideration is unique; hence, the single case study design was adopted and used in providing firsthand information for understanding and describing users' needs in the property tax administration.

Case study tools are particularly useful as mechanisms for research design, data collection

and analysis of the case of fiscal cadastral reform (Whittal, 2008). This section discusses the case study methodology used and its unique application in the design and implementation of the data collection process. Much of this was accomplished by surveying potential users, determining what they do, and how GIS can help improve their operations. In its execution, a blend of social and technical skills was adopted for property mapping and collecting of attribute information from other sources for the system design. Because of the dual nature of the data collection, the process was split into two phases, user need assessment and collecting input data. To improve productivity and reduce incertitude in the data collection process, the first step was to find out from users, what they will need from a GIS-based tax information system. This study safeguarded the collection of the input data thus providing the framework for a successful GIS development.

3.3.1. Interview

Questionnaires and semi-structured interview, which consisted of some structured and followed up questions, were used for the survey. 'Structured' types consist of simple and comprehensible wording questions that are determined as the interviewer records the responses as they are given (Wikipedia, 2013). From the social standpoint, the researcher assumed the role of a fact finder and showed sincere respect for the knowledge of the people as the experts; making them relax and be as comfortable as they can, to provide the required and meaningful information. This technique provided more flexibility to the respondent to develop his answers and allowed both the interviewer and respondent asked for clarification (Shaughnessy et al, 2011). The method ensured that questions were properly understood leaving no room for inconclusive responses. It also provided the means for in-depth explanations to the face-to-face questionnaire; orally presented questions. To achieve the best response rate, the presented questions flowed logically from one to the next following the order, least sensitive to the most sensitive and more general to the most specific. The questionnaire used consisted of a set of highly 'structured' written questions that contained both open and closed-ended questions. The open-ended questions gave the respondent unlimited scope in providing the information that he feels was more appropriate while the closed-ended questions provided limited choice for answering with "yes" or "no" choices. The closed-ended questions were chosen for easy coding and easy analysis of respondents' feedback while the open-ended questions were considered to provide more in-depth information to the researcher. Unstructured interviews are time consuming and difficult to carry out, whereas structured interviews restrict the respondents' replies, thus adopting the

semi-structured interview to obtain the empirical data for the system design. The combined types provided more relevant information about the current system, though the process was labor intensive, snail-like and prolonged sitting in questioning and coding.

To investigate the property tax division requirements, an interview was held with the Director for valuation and accounts. The consideration for the choice was due to his experience and expertise to answer the questions truthfully. As a warm-up to help attract interest in the survey, the researcher demonstrated an early prototype to the respondent to introduce him to GIS-based property taxation and the intended objective of the research. Additionally, an assessor and enforcer from the Real Estate tax Division provided some practical information without formally being interviewed. The interview provided the most valuable internal information about the current system.

3.3.2. Property mapping

Preparation for property mapping

The first step of the mapping process involved acquiring an analogue cadastral map of the study area from the Department of Lands, Surveys and Cartography and further scanned (raster format). To enable editing and analysis of the scanned map, five ground control points were selected and surveyed to obtain their coordinates. Using the Leica GS10 as base, GS15 as rover and the Leica Geo Office processing software, the UTM coordinates of each point were obtained and then used to georeference and digitize the map using ESRI ArcGIS desktop (ArcMap 10.0 version). A 2012 Google imagery of the study area was overlaid and used as quick validation technique in producing the first phase validated map. Complementing this process with physical property inspection finally produced an updated digital tax map. The features created were parcels of individual property, 2D building footprints on improved parcels and street layouts. Each building was digitized for the sole purpose of change detection analysis - discovery of newly constructed shopping center, building or building addition or any development of such.

The Tax Division uses two data types - spatial and non-spatial data in the property tax implementation. The spatial datasets describe those objects that are linked to specific locations such as parcels, buildings, and streets. The non-spatial data contains the attribute information that describes those spatial data such as the property address, property ownership, occupant, taxpayer, land use and building type. All these datasets were captured

as part of the database design. The capturing process involved mapping and collecting current and relevant property information on all properties within the Sinkor district for the purpose of taxation.

3.4 Analysis and reporting of the case study

This research uses the case study approach as a strategy for conducting a qualitative study of the property tax system, with the aim of analyzing the processes, structures, contexts, responses, changes, unanticipated phenomena and the inter-relationship between these. This analysis is expected to inductively develop this framework. It is to provide a systems understanding of the fiscal cadastral process, with the main focus to understand users' requirements and develop a conceptual framework for the GIS development.

In the user needs assessment, the aim was to gain insight to the existing tax system and draws out patterns for the GIS development. The process helped in developing an understanding of what is needed to implement a GIS within the Tax Division. The user needs assessment provided two data; contemporary data - information on the current administrative procedures obtained from the interview, and complementary data - supportive information used to check against biases from the interview obtained from administrative documents. The goal of the dual data sources for the study was to increase credibility in the research's findings and provide accurate analysis of users' requirements, and as such needed to be analyzed separately and compared. These composite analyses can be understood as a form of comparing factual findings to expectations and developing an idea of what is happening and why. Thus, the pattern matching and explanation building analytical technique (PEMD, 1990; p. 73) was used to analyze and generate categories and explanations of the narrative data gathered from the study.

However, high quality analysis of qualitative data depends on the skill, vision, and integrity of the researcher (*BMJ,* 2000); and reliable qualitative analysis depends on understanding the data (Taylor-Powell and Renner, 2003) and thorough understanding means summarizing, ordering and placing the data within the frame of reference. This requires reading and re-reading the text to generate categories and explanations (Taylor-Powell and Renner, 2003). This entire process suggests a plausibility test, but of course computer does not do plausibility tests (Balbach, 1999). Though, software packages can help with interpretations, but should not be viewed as short cuts to rigorous and systematic analysis (*BMJ,* 2000). From

this backdrop, the researcher used the logic model (Yin, 2009), which uses a sequence of observed events with predicted outcomes to record the salient thoughts and observations about the data using Microsoft Word Processor, Microsoft Word. The level of analysis relied solely on inductive reasoning and thus, made the data interpretation easier by bringing together the themes and connections for explaining the findings. However, deductive reasoning was not excluded.

Case study reporting

This involves moving from a mass of words to a method of cutting and sorting - organizing and keeping track of the phenomenon of interest. The data was reduced and arranged chronologically and thus assisted in keeping notes of key ideas, concepts, procedures, terminologies and patterns. This process assisted in developing a logical chain of factors contributing to the better understanding of the tax assessment procedures and users' requirements. Putting all the pieces together helped create a beginning model with clear conceptualizations that set the path for the GIS development process.

The logical processes and design criteria adopted in the analysis of this research study provided detailed case report in the form of a narrative that are presented in Chapters 4, 5 and 6. Accordingly, the reports of the findings are presented in the form of a historical narrative. The aim of the narrative is to provide a blend of the data as simple as possible by personal interpretation, in order that, in line with principles of naturalistic generalization - generalizing the research findings to new contexts -other researchers may interpret the data for use within their own unique contexts. Giving this reason, the reports are structured sequentially as per the chain of independent steps and organized activities that needed to be accomplished in the GIS development life circle.

3.5 Field validation of the tax map

The process involved identifying all ratable, non-ratable and even vacant land and assigning each a provisional property reference number (PRN) since there was no house numbering system in place. The tax map was printed on paper along with a legend sheet for the contact field survey. All validations and corrections needed were done on the physical map and noted on the legend sheet. Additional attributes, such as approximate area of the plot, site dimension or sketch of the property demarcation, land use (commercial, residential, vacant, governmental, religious and educational usage); number of floors, and building type were

captured and recorded. Final validations were done on properties that needed to be corrected for accurate information on its site dimension, built up area, land use and classification whether owner occupied or under tenancy using the recorded information from the field. With validation completed, each parcel was numbered starting from the top left corner with 0001 on the map, moving through it (map) following an inverted "S" shape until all the parcels within the district were numbered. The tax map was now validated and used as a reference for all properties.

3.6 Limitations of the Field Study

Studies for investigating current issues and problems for capturing users' requirements in utilizing technological advances in property tax administration is simply not a single interview survey. Rather it is influenced by cross interviews of several respondents from various ranges of technical, administrative and organizational settings in order to understand individual requirements. The research could have crossed examined those settings to understand the technical, administrative, and institutional constraints under which the system will operate, but due to limited time for the thesis work, meeting and interviewing all participants in person is both expensive and time consuming (Shaughnessy et al, 2011). Hence, the field survey did not fulfill collective needs, especially those related to a wide range of system functions. Additionally, social desirability bias can be a significant problem with self-report measures (survey method) as respondents often in a way, answer to portray themselves in a good light by either exaggerating the conditions in order to make their situation seem worse, or under-reporting the severity or frequency of the conditions in order to minimize revealing private details (Wikipedia, 2013). Accordingly, these biases are likely to affect the results of the research. However, efforts were exerted to perfect the information for credibility and completeness via reviewing some tax related documents for the system design.

3.7 Concluding remarks

The chapter described the study area and as well discussed the survey method adopted and used to obtain the empirical data for the research. The methods used to collect and analyze the data required to answer the study questions were also highlighted. The adopted method aided the researcher in understanding users' needs, and provided the means for identifying the list of needed GIS functions and the required geographic data needed for the system

design.

The qualitative method used in the form of interviews based on the semi-structured questionnaire and comprehensive reviews of tax related documents, provided in-depth findings on the administrative structure and procedures used in the property tax implementation as discussed in the subsequent chapter.

Chapter 4
ANALYSIS OF PROPERTY TAX ADMINISTRATION IN MONROVIA

4.1 Introduction

The chapter examines the property tax administration and its implementation in Monrovia. The aim is to fully explore and understand the method of property mapping, assessment, and taxation and enforcement. The nature of the property tax administration and the consequences on its implementation form the core of the presented findings. To begin with, the chapter elaborates on the tax administration as well as the procedures used in mapping and assessment. In the latter, the research endeavors to evaluate the effectiveness of the property tax administration to determine whether there is need for a GIS based tax information system.

4.2 Property tax administration in Monrovia

4.2.1 Tax administration

The Real Estate Tax Division is the arm of the Department of Revenue, which consists of three sections, namely, valuation, accounts and enforcement sections (see Figure 3). Each section is charged with different statutory mandate in the implementation of the property tax as listed below.

- The valuation section is responsible for the collection of assessment data on properties and audit of appraisals or declarations of properties made by owners.
- The account section is responsible for the tracking of payment and compilation of reports related to the collection of taxes and payment of the tax bill.
- The enforcement section is responsible for the enforcement of delinquent and overdue taxes on land and building and works in collaboration with the court for prosecution of delinquency.

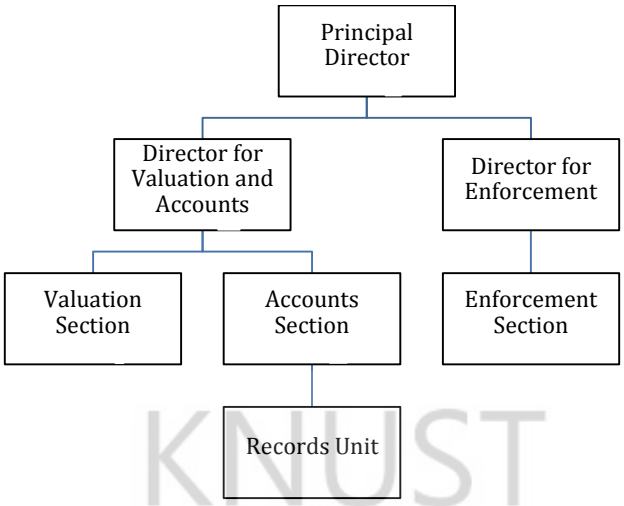

Figure 3: Administrative structure of the Real Estate Tax Division

The Division is responsible to steer the affairs of the property tax within the city of Monrovia. Its statutory duties are to provide the most efficient and effective system to list, assess and collect taxes on all taxable property (unimproved and improved land) situated within the city of Monrovia in accordance with state laws and administrative procedures.

Tax Rate

The tax rate is set by statute and provided in the Revenue Code of Liberia, Act of 2000. The rates vary widely from the used classification or property classes (commercial, industrial and residential) of a given locality. Different percentage rates are imposed annually on the assessed values of improved land not exempt from taxation, no matter where the property is situated. In the case of unimproved parcels not exempt from taxation, the tax rate depends on the property's description and geographic classification. Table 1 shows the rates imposed on improved and unimproved properties as per their categories.

Table 1: Annual tax rate on properties (Revenue Code of Liberia, Act of 2000)

Rates on Improved Land		**Rates on Unimproved Land**	
Commercial building	1.5%	***PARCELS WITHIN CITY OR TOWN LIMIT***	
Industrial building	1.5%	City or town lots	2.0%
Residential building	1/12%	Farm land	4.0%
Farm in urban areas	1/3%	Acre or above (vacant land)	3.0%
Improved Farm outside urban areas	¼%	***PARCELS OUTSIDE CITY OR TOWN LIMITS***	
BUILDING/IMPROVEMENT ON PUBLIC LAND		All land without building	L$5.00 per acre
Commercial building	1.0%		
Residential building	1/7%		

Property mapping and assessment in Monrovia

Properties are mapped according to zonal demarcation regulations followed by self-declaration for residential properties only and external assessment by certified architectural firm (independent valuation) for all other property types including the above-mentioned. Each method is subject to verification. The Division reserves the right to verify the declared information against existing realities. If certified, the declared value is used for the tax calculation. The subsections below discuss the procedures used for block mapping and assessment of properties in Monrovia.

Block Mapping

Based on the zonal demarcation, the technicians assigned to this section are required to conduct block mapping in order to record all information on ownership, area and location of all taxable and exempt parcels within each tax zone. The current practice of property mapping is traditional and not parcel based, thus becoming increasingly incapable of supporting unique parcel identification and regular re-inspections. However, the technicians take measurements of the entire block and streets and interpret the data collected into information on a map. With the general layout of a block, ownership and location information are collected on individual property.

Figure 4 shows the partial view of the block map for properties between 11th Street and the John F. Kennedy Medical Hospital in Sinkor.

Figure 4: Partial view of block map

Property assessment

In the case of self-assessment, private persons usually report the book value of their tangible asset (property) to the tax authorities. They provide basic information about their house and land, which are subject to taxation by simply completing the self-declaration form, attaching a photo of the property and providing legal documents authenticating ownership, which subsequently follows bill preparation if approved.

In the case of external valuation, either a certified member firm of the Liberian Chamber of Architect or an assessor from the Division of Real Estate Tax conducts the assessment. Here, assessors make a visual inspection of the property and note the size, layout, shape, age, finished quality, number of carports/garages, bedrooms, condition of the buildings and use classification. With the current excel system, the total square footage of the structure is computed from the field sketch, and a stipulated rate (US$5-US$35 per square foot) based on the component of the building and its state (old, newly constructed, under construction, average quality) is applied to determine the property's value. Ultimately, depreciation of two percent per annual up to a maximum of thirty percent (for ages ≥ 15 yrs.) is then subtracted to obtain the property's most probable selling price (market value). Usually, the cost and sales comparison approaches are used for determining said market value.

Mathematically;

Market value for improved property is:

$MV=LV+PV$

$MV=LV+(RCN-D)$

Where *MV* is the market value, *LV* is land value, *PV* is property value, *RCN* is replacement cost new, and *D* is depreciation.

Transactions within the period of at least five to seven years, for unimproved land are considered recent sales for land valuation. In such case, the amount in the deed is used for tax calculation, else the amount is based on the values enshrined in the Guide to Self-Declaration. However, if the amount stipulated in the deed is higher than the values in the Guide to Self-Declaration, the amount in the deed takes precedence for the tax calculation.

Land value considered for tax calculation:

LV = Amount stipulated in the deed

LV = Plot Area * Zone rate

where *LV* is land value, zone rate is enshrined in the Guide to Self-Declaration

4.2.3 Collection and enforcement

Real property tax covers the period from January 1 to and including December 31 of each year and becomes due on July 1 with a late payment period dating from July 2 to July 31 of the year in which the tax is levied. Taxpayers are given the opportunity to pay without the imposition of interest or penalty at any time prior there to from January 1. Interest is charged on the amount due or any underpayment thereof if the tax is not paid on or before the due date of the year in which it is levied. An administrative penalty of five (5) percent and interest of three point zero six (3.06) percent of the tax amount is calculated and added per month, or part of a month elapsing after July 31 that the tax remains unpaid, but not to exceed twenty five (25) percent and fifteen point zero three (15.03) percent in aggregate, respectively.

However, with penalty or interest on delinquent payments, there still exist non-payment for which enforcement measures are provided. Property owners are given seven days for notice of closure with an ultimatum of seventy-two hours to comply with delinquency. If there still exist noncompliance from delinquent property owner after several attempts, the delinquency is forwarded to the Ministry of Justice for prosecution through the tax court.

4.3 Effectiveness of the property tax in Monrovia

Property owners are requested to assess and register their property ownerships and values, and as well inventory and describe all their property holdings through self-declaration (residential property only) and external assessment in Monrovia. In such property tax administration where self-assessments are used to administer the property tax, considerable amount of data are collected within a very short period as compared to the tax administration conducting property-by-property field inspection (Almy, 2001). Furthermore, administrative capacity (assessment staff) is not required for its implementation hence, reducing administrative cost and increasing compliance cost (Almy, 2001). The assessment method creates no room for appeal processes. However, such a system requires competent administration to ensure that the system works, else it proves to be extremely inadequate for the property tax to gain its full potential.

In light of its potential, there is lack of accuracy and uniformity in reporting property values by taxpayers, which stem from lack of expertise and willful acts of underestimation and evasion (Almy, 2001). In practice, this property tax administration is not particularly effective because not all owners comply. Consequently, the number of potential taxpayers or taxable assets is generally unknown. Additionally, determination of the tax liabilities requires verification of the reported values submitted by the taxpayer. The lack of personnel to conduct field inspections of each property in Liberia means that verification is inadequate, and thus undervaluation is imminent. However, with their current system, limited assessment staff poses no threat to the tax implementation and thus appears to be relatively successful at a glance.

With undervaluation being possible, people with similar properties will not necessarily report the same book value and so will not pay comparable taxes, thus violating the principle of fairness on the basis of the ability to pay. To ensure accuracy and minimize the obvious problems of under-statement in the tax implementation, the administration has to identify the tax base and conduct expert assessments of individual properties in cases where it believes reported values are inaccurate. Else the system proves to be extremely inadequate for the property tax to attain its full potential. Expert assessments of course significantly increase the cost of collecting the tax (Bird and Slack, 2002).

For up-to-date record system, institutional linkages are required in property tax administration (Almy, 2001). In Liberia, however, linkages with other potential information producing agencies are currently at a minimum and thus, indicate the incompleteness of the tax records. Linkages between the Tax Division and those of title records, mapping agency, building permit agency, business and population registers, need to be established, strengthened and maintained so that data needed in the property tax administration flows regularly and efficiently. For instance, linkage with the permit agency ensures that when applying for a building permit, automatically a form for self-declaration is given; the agency then informs the Tax Division on new building permits; assessment officer informs automatically on surveys of new improvements, etc. With such system, the reliability, integrity and completeness of the tax information system is enhanced thus facilitating efficiency and effectiveness.

In addition to up-to-date record system, the Division currently maintains property records in various types like filing cabinets, paper maps of varying quality and different sizes, and in computers using different software. Such manual format of preserving property maps makes the task of spatial identification and expert assessments of taxable properties more difficult. This suggests the administrative efforts to constantly monitor new developments or new buildings and building additions to be hardly fruitful, thus, making it difficult to track tax defaulters and trace out unauthorized and under taxed properties. Consequently, resulting to high accumulation of arrears, poor coverage of properties under tax net and low revenue. However, contemporary geographic information systems and overlays and increasingly sophisticated computer assisted valuation techniques have, in fact, worked to assist with such function that enhances uniformity and consistency in property tax full operations around the world. Convincing top management having no knowledge of this new technology, which requires huge and major long-term investment is another daunting challenge; but owing to experiences from other successful property tax information system, its operation and maintenance can be fully supported through cost recovery once a proper GIS related property tax database is being implemented with provision for continuing validation.

4.4 The need for introducing information technology in the Division's Function

Although they are content with their current system, but the opinion is, the Real Estate Tax Division accepts that it needs something to enhance further, the tax implementation. Part of the process of defining what they need is with the help of the research. They now know why they need such enhancements and what other purposes they would fulfill if these requirements were met. The Division's wish is to identify and capture all taxable properties to the tax net. Though, is a herculean task and requires colossal amount of resources, but substantial benefits in data accessibility and revenue from the property tax will be enhanced if achieved.

The Division acknowledged that such requirement is achievable through the use of an interactive property tax information system. System that has capabilities to produce maps with associated attribute data that gives users the capabilities of converting those datasets into useful information easily without any particular specialization being necessary. They claimed such system would add another taste and functionality to the full potential of the property tax implementation. This shows the necessity of a property tax system that is

capable of capturing, storing and displaying property details and spatially locating each parcel and keeping track of owners' details. This necessitates a computerized system with current and accurate digital tax map of connected parcels and road networks. Such map would require property address, ownership and tax information on each parcel; thus serving as the core for the property tax database.

In an effort of taking the necessary steps to fulfill the outlined requirements, and considering also the results of other property tax researches, GIS technology can be used to create a successful property tax information system for the Division. Nevertheless, it was realized that discouragements could happen since top management has a vague idea about the importance of bringing GIS into property taxation and as such, do not see the significance of a GIS property tax system.

4.5 Concluding remarks

The chapter has highlighted the property tax administration by examining the administrative structure, methods of property mapping, assessment, tax collection and enforcement in the study area. Most importantly, discussions on the property tax performance measurement to establish its overall success proved right, the argument of the research. The current system needs a GIS based property tax system that will enhance the tax functions and further promote administrative proficiency and credibility. The comprehensive review of the case study and the level of analysis provided detailed understanding that helped immeasurably in the development of the prototype as discussed in the next chapter.

Chapter 5
DESIGN OF GIS-BASED REAL ESTATE TAX INFORMATION SYSTEM (GIS-BRETIS)

5.1 Introduction

The success or otherwise of any GIS development program requires set of activities to be organized into series of independent steps to ensure that the GIS is on time, in scope and in accordance with quality standards. Having analyzed the property tax administration in the study area, in chapter 4, this chapter focuses on the design of the real estate tax information system. The task here is to take the data developed during the field survey and place it in a structured format to arrive at a working and functional GIS system to meet users' needs. Consequently, this section focuses on the conceptual framework, tools and technology used for developing the GIS-base tax system that satisfies those requirements. Section 5.2 discusses the system design overview, section 5.3 discusses the conceptual modelling, section 5.4 discusses the logical modelling and section 5.5 discusses the physical modelling.

5.2 System Design

System designs are composed of composite activities that demand perfect implementation leaving no room for errors in order to meet users' requirements. Requirements for the Tax Division are enormous and require a robust system to meet those needs. By taking the necessary steps to fulfill the outlined requirements, this section discusses the construction of the successful property tax information system for the Division. It describes the basics of the GIS layer and database design. It also emphasizes the importance of the complete understanding of the potential users in order to determine the system's estimates of usage. Building this system worth developing enhanced tools and techniques for supporting the GIS database design activities. The design activities are categorized as conceptual, logical and physical models discussed in the ensuing paragraphs.

5.3 Conceptual modelling

A viable GIS-based tax system requires the conceptual model to be complete, i.e., contain all data needed to meet the system's objectives, and must be directly translatable into the logical and physical database schema (Calkins, 1996). Conceptual model is an unambiguous and rigorous description of the data at an abstract level for the system design. This is to ensure

that the data is understandable by the proposed users of the system. Such description is to also certify that the data is sufficiently structured for the programmer to develop the data files and implement data processing routines to operate on the data. Thus, by organizing the identified information gathered during the needs assessment, users were defined as well as the requisite data required to develop the functional system to meet users' need. Additionally, describing the relationships between these varying data, their nature and usage, and how they are represented in the database was key in developing the database. At the conceptual level, the data model is independent of the hardware and software constraints and thus acts as the bridge from real-world information to database storing relevant data content. Figure 5 shows the workflow depicting the set of organized processes for the system development.

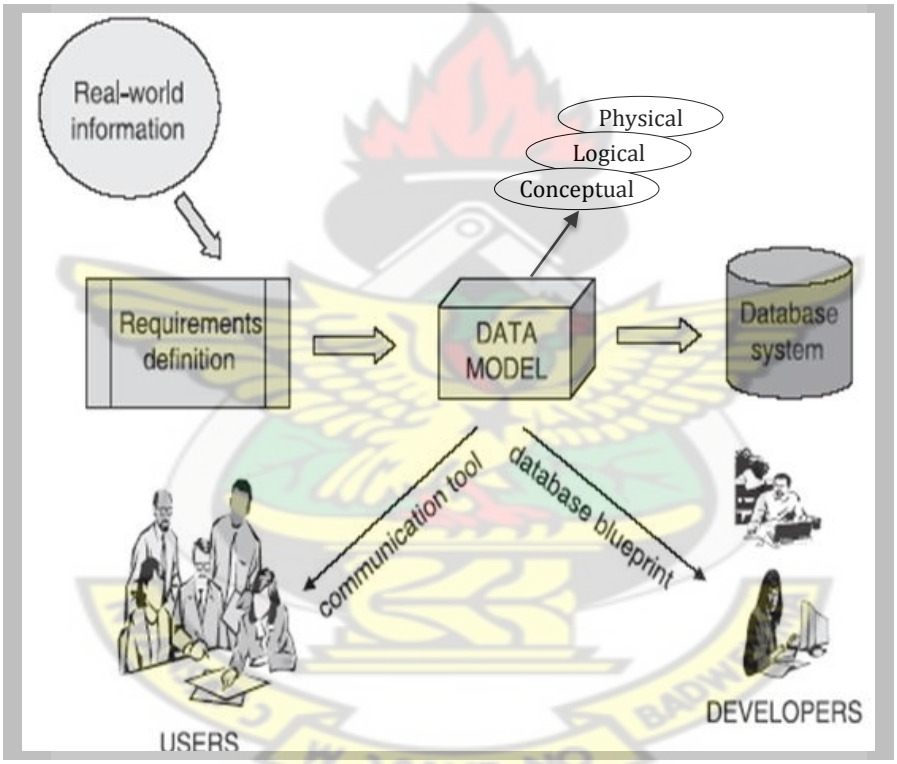

Figure 5: System design workflow
(Adapted from Aenagandula, 2012)

5.3.1. Potential GIS users and their requirements

The research intends to develop a GIS-based information system that satisfies various stakeholders. Needs of these users have to be rigorously described in addition to the tasks and its requirements in order to determine the system's estimates of usage. The users of the information system include decision-makers, taxpayers, Ministry of Justice, Building permit

agency, Title registry, Surveying and mapping agency and general public as shown in Figure 6. Users have different information need and also provide different input to the system as shown in Table 2.

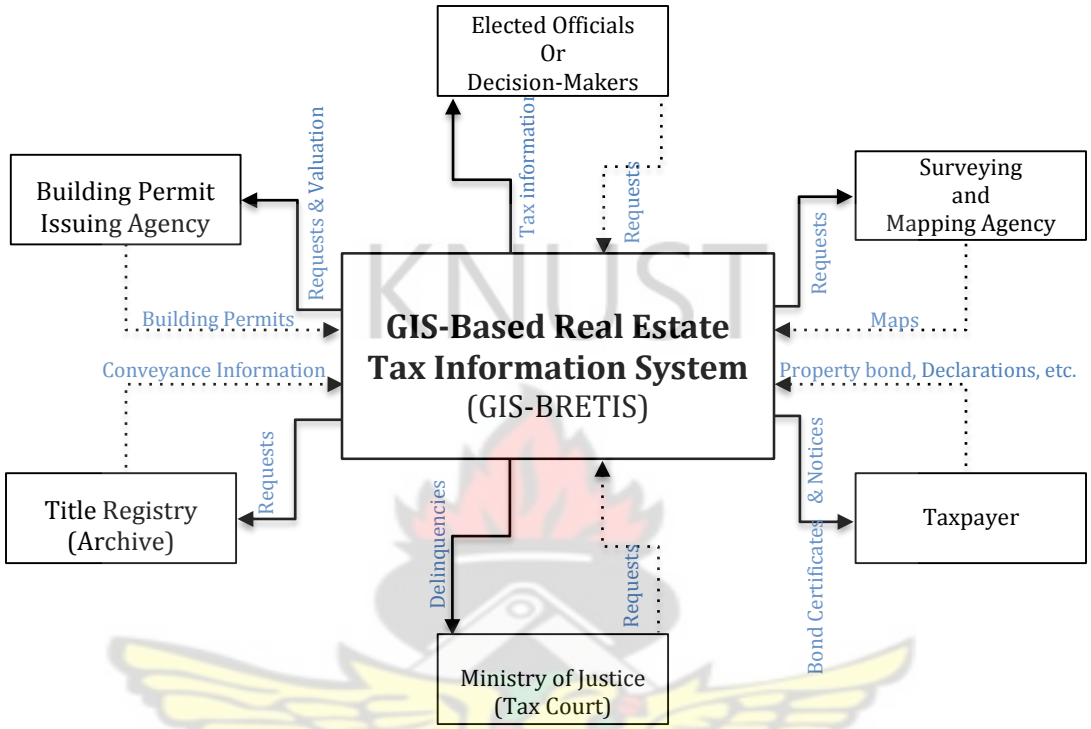

Figure 6: GIS-BRETIS potential users and their requirements

Table 2: GIS-BRETIS potential users and their requirements

GIS-BRETIS Conceptual Workflow with Potential Users		
Potential Users	***Input***	***Output***
Taxpayers	Property Bond, Declarations	Bond certificates, Notices, etc.
Surveying & Mapping Division	Provides maps	Request for maps
Title Registry (Archive)	Conveyance Information	Request for property transactions
Building permit issuing Agency (Ministry of Public Works)	Building permits	Request for new permits and conduct valuation upon demolition
Ministry of Justice (Tax Court)	Handle delinquencies	Request for action
Decision-markers	Request for information	Provide Tax information

5.3.2 Data Modelling

Objects (entities) in geodatabase are defined as either discrete objects (e.g., a building, a bridge, a household, etc.) or as an abstract object defined in terms of the space it occupies (e.g., a land parcel, a wetland, a soil type, a contour, etc.). In either case, developers are dealing with entities in the sense of things, which have thematic characteristics and also have

spatial relationships (topology) between themselves. Hence, these geospatial relationships have to be modelled between those objects to enable more advanced GIS analysis. To satisfy the data requirement, the identified data types (spatial and non-spatial) were sufficiently structured into formats that could be stored, handled and displayed in a computer, thus serving as the formal specification for the system development. Two data modelling processes are described; spatial and non-spatial. These spatial data sets provide to the user the place (location) where something is happening. The non-spatial data contains the attribute information, which describe the features (buildings, parcels and streets) and tells the user what is happening in that place described by these spatial entities. The geo-relational data model was used for interacting between the two data types. The spatial entities were stored as vector data structures. Vector data structures are used to store map or drawing information as a series of points and lines (URISA and IAAO, 1999). The non-spatial data contains the attribute information stored in tables. Linking both datasets through feature Ids allows the processing of various data stored in separate tables into information.

Data identification and description includes defining the entities, the relationships between the objects and the attributes of the objects (or relationships) that will be represented in the database. The needed data is properly described by developing an entity relationship (E-R) diagram that is suitable for translation into the logical schema of the proposed GIS-based tax information system. The E-R diagram is shown in Figure 7. The attribute data is shown in appendix A.2.

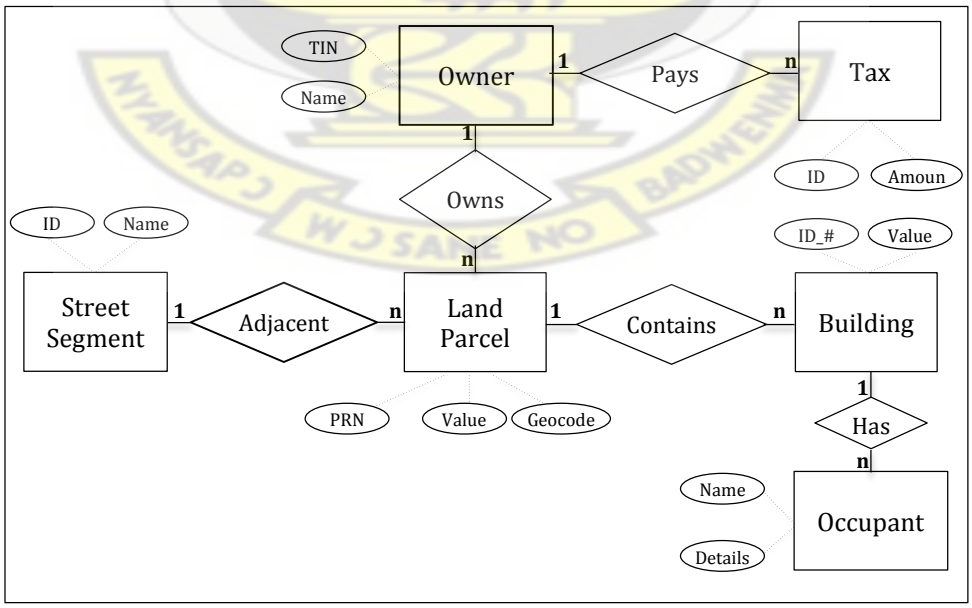

Figure 7: Entity-relationship diagram

5.4 Logical Modelling

As data has been identified and described at an abstract level, translation of the conceptual database model into the data model of a software system is now achievable. The logical design of the system is made of two separate components, the GIS software for the map graphics and the database driven software for the tax application, which during the physical design phase were linked to get the GIS tax system. The database software was used for the application development while the GIS software provides the functionality for the spatial analysis. The application offers better table functionality in handling attribute data and thus serves as the databank or centralized data repository for the entire system.

Considering the conceptual design, the software components considered were Microsoft Visual Basic (VB.Net) 2008 for the application development with MapWindow 6.0 being the GIS software. The language of choice for the application development is compatible with COM (*computer output on microfilm or microfiche*) and ActiveX controls and provides unlimited capabilities and features for menu design and Custom Application Development. The developer being conversant with this language coupled with all these functionalities placed it at the apex of all programming languages for its selection. Using the GIS and the database software, the described data (spatial and non-spatial) was then transformed into the model of the software using the development environment shown in Figure 8.

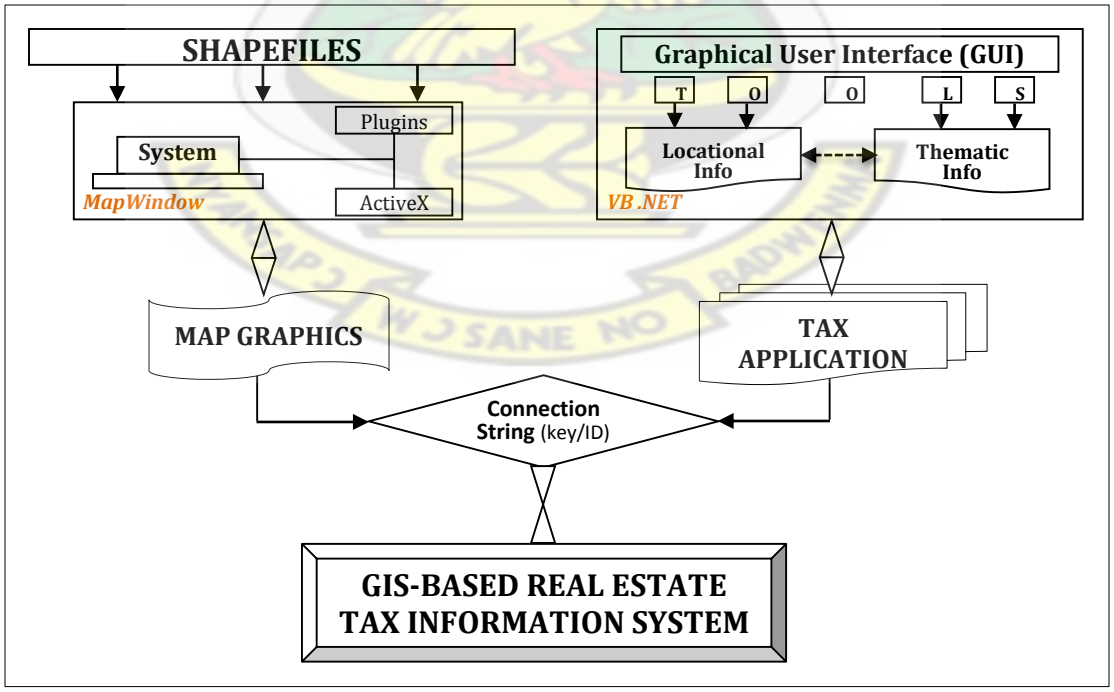

Figure 8: Logical system architecture

5.5 Physical Modelling

The direct representation of the logical data model in the schema of the software was the most crucial phase of the system development and thus, was implemented with much care to ensure a workable system. The representation was about organizing the data to create a blueprint of how the database will be constructed - dividing the logical data model into database tables. Each entity in the data list table was represented into table thus forming the database schema, which specifies the facts that can enter the database, or those of interest to the possible end-users. At this level, the schema now described how real world entities were modelled in the database as shown in Figure 9.

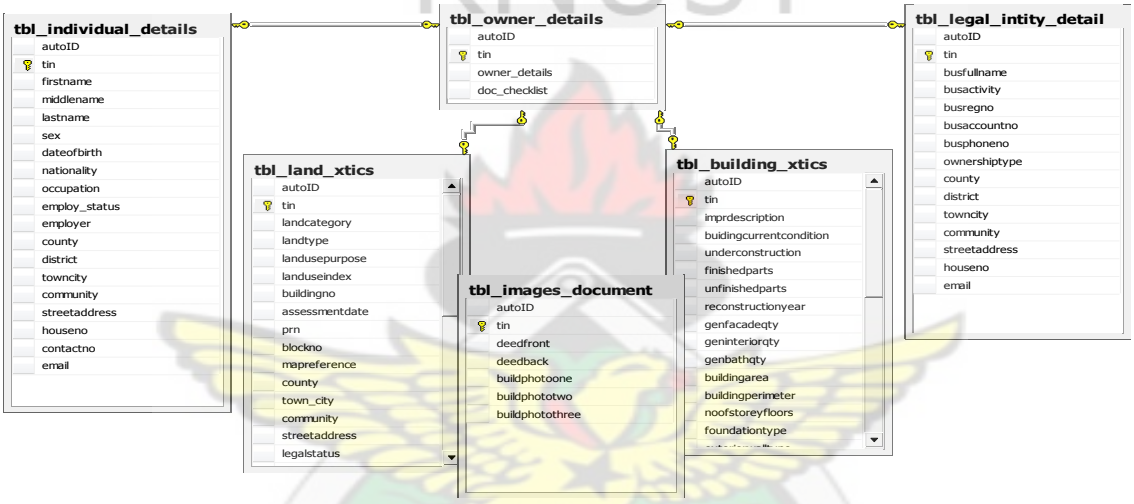

Figure 9: The database schema

The size of the schema obscures visibility, and as such, it is placed in the below table for readability.

Table 3: The database tables and tuples

Tables/Entity	Tuple/Field
Owner_Details	TIN*, owner_details, doc_checklist, ...
individual_details	autoID*, TIN, tax_id, firstname, middlename, lastname, .
legal_entity_detail	autoID*, TIN, tax_id, busfullname, busactivity, ...
land_xtics (characteristics)	PRN*, TIN, st_Id, landtype, landcategory, . . .
building_xtics	blg_id#*, TIN, PRN, buildingarea, nooffloors, ...
Images_document	autoID*, TIN, deedfront, deedback, buildphotoone, . . .

5.5.1 Programming (codification)

This involved coding the design into computer understandable language or converting the

program specifications into computer instructions. During its implementation, editing procedures and integrity rules were defined to enable the system coordinate data movements and control the entire ongoing process. To meet the integrity rules set for the data, editing workflow was designed to provide the ability to edit data as it is entered and also eliminate data transcription errors. At the frontend, built-in validation rules were well defined to minimize errors and flag properties with irregular characteristics, making sure data inputted is sensible (property values are never alphanumeric). To control user interaction at the frontend, different validation checks were defined for fields depending on the types of data entered. Those checks included:

- Type check to ensure the data is the correct type (string fields should never accept numeric data and verse versa);
- Range check to ensure the data value is within a set of range;
- Presence checks to ensure all fields are filled with data;
- Selection check to ensure one item is selected at a time for optional data (land category is either improved or unimproved type);

To get the most flexibility out of the system, map display properties were set to always enable map visualization and accurate overlaying of data obtained from different sources. Using the plugins of the GIS software, the map display window was set to open with all map graphics including the legend window displaying all other active and inactive map features. The main menu and toolbar contain functions to manage projects and manipulate and query the map and the attribute data.

As the program was being developed, test run was conducted for removing bugs (logical and syntax errors) using a prepared test data. However, during the test run, it was found that some outputs were not matching the expected results. In such cases, the errors in the given lines of codes were identified and debugged (error corrections) and further tested for the expected output. With some level of certainty that the application was running error-free as per the requirements, the GIS software was now connected through a connection string (primary Ids), and the system was developed and compiled for implementation.

5.6 Concluding Remarks

The chapter has outlined the various steps needed to design a GIS-based tax information system. The users' need requirements were discussed. The conceptual, logical and physical models were described. It is evident that developing a GIS application is more than just simply identifying and acquiring the appropriate GIS data, hardware and software. The most challenging part of the entire process was building the database to store the data in an appropriately structured way to avoid redundancy and ensure data integrity. To develop an efficient, effective and compatible system based on user requirements, attention was given the flexibility, data security, and user friendliness of the system. In the next chapter, the designed GIS-based information system will be implemented using empirical data from Sinkor District in Monrovia.

Chapter 6
IMPLEMENTATION OF GIS-BASED REAL ESTATE TAX INFORMATION SYSTEM (GIS-BRETIS)

6.1 Introduction

This chapter presents the prototype implementation of a GIS-based tax information system using data from Sinkor District in Monrovia. The chapter draws together, discussions on the important issues to consider for the new system implementation. It begins with the hardware and software requirements needed to implement the GIS-base tax information system. Next, detailed discussion of the prototype to demonstrate its capabilities is presented. Finally, the chapter examines the extra enhancement the new system brings to the tax assessment functions as well as the challenges of implementing a GIS-based tax system.

6.2 Minimum hardware and software requirements

The hardware and software specifications are to satisfy the system functional requirements to support the GIS full capabilities and performance in meeting users' needs. The purpose of this specification is to clearly and accurately portray the requirements of the newly developed system, which then serve as a reference in its implementation and maintenance. The goal here is to find the fastest, cheapest hardware and software to meet functional requirements. Hence, in defining the specification, computing performance, conformance to standards, network compatibility and interoperability and future growth plans were considered.

Table 4 presents the minimum list of hardware and software required for implementing the GIS-based real estate tax system.

Table 4: Minimum list of hardware and software

Item name	Description
Hardware:	
Processor	1.6 GHz, 32/64-bit
Memory	2GB random access memory (RAM)
Graphics Memory	512 MB
Storage capacity	10 GB free space
Display unit (monitor)	14 inch LCD Monitor
Screen resolution	1024 x 768 SVGA display
Software:	
Operating system (OS)	Licensed MS Windows operating system, 32/64- bits

Server	WampServer 2.0 (local host)
Browser	Firefox/Chrome
Application framework	dotNet Framework 3.0 - 4.5
Report Type	Crystal Report version 1.0
Application Installer	Windows Installer 3.1
Other Software	2007 Microsoft Office Professional (32/64-bit)

6.3 The prototype

The section presents detailed description of the system's external controls and its principle modules.

6.3.1 User Interface

GIS-based real estate tax information system is an application software that contains customized buttons created for opening and manipulating the data display and entry forms. The tools and menus in the general window have links to the various modules of the system for property assessment and taxation.

At startup, the server connectivity control pops up to allow users specify the server type (local host or network). Upon connection, the main application window as shown in Figure 10 displays and prompts users for access authentication.

Figure 10: Main interface of GIS-BRETIS

The system verifies the information entered with the database and determines the corresponding access (administrator, tax agent or guest) to the system. Administrative users have full privilege (100%) to the system. The system administrator inherits all the functionality of the tax agent and guest users with additional privileges to input, modify, view, and delete anyone's data. The tax agent and guest users have limited functionalities. Tax agent user can add, modify, and delete his /her data only, and the guest user can access data as read only.

The toolbar of the application's user interface contains a strip of tools and menu used to perform various functions as shown in Figure 11.

Figure 11: Tool and menu

Tax Admin

When user logs in as an administrator, the *'Tax Admin'* function is accessible for viewing tax transaction records and all other information in the system. Administrator can gain access to any data from the database through a search for either total number of taxpayers, total revenue generated, names of defaulters, etc.

Load Map

The *'Load Map'* button allows users to interact with the map window. The map window contains several functions that can be used when working with the map.

Data Entry

The *'Data Entry'* button displays a sub-toolbar with standard controls that allow user register new properties. Using this toolbar, user can enter all attributes for a given property as shown in Figure 12.

Figure 12: Data entry toolbar

When user clicks the *'Records Details'* button, a corresponding form opens with an automatically generated tax code. The user is obliged to specify the ownership as either individual owner or legal entity/business and tracks other documentation details. Upon successful validation, a message box displays, requesting whether user would like to proceed to the next stage. By clicking 'yes', the personal data form for the selected ownership category appears for validation. This registration process is executed in sequence until user completes the data entry task with image documentation.

Tax Defaulters

The *'Tax Defaulters'* button displays the list of taxpayers for which there are balances of the property tax to be paid. This function is used to keep track of defaulters, providing the environment for administrators to carefully monitor the collection process.

Property Schedule

The *'Property Schedule'* button allows the user to search for property owner and register all his declared property holdings.

Reports

The *'Report'* button displays a form as sown in Figure 13, from which one selects the desired record. User then uses whatever attribute fields from such record to generate a crystal report.

Figure 13: Report

The *'Tax Bill'* button displays a form as shown in Figure 19, for preparing and printing tax bill for payment. The *'Property Schedule'* button displays a form that allows user to search for desired property owner either by name or tax code to update his property schedule with newly declared property (ies). The *'Property Ledger'* button displays a form with all past billing and payment records of selected taxpayer, and is printable on user command. The

'Defaulter Notice' button displays a form with a pre-defined template for defaulters - taxpayers that have balance property taxes to be paid after due date. This document is printable upon user command and includes details such as tax code, tax zone, property description, location, name of the taxpayer and the content citing taxpayer to comply with delinquency.

Payment Details

The *'Payment Details'* button allows the user to search for taxpayer either by using name or tax code and upon getting desired payee, details for payment including payment date, amount paid, receipt number, payee's name are captured and saved to the taxpayer's ledger.

Search Engine

The *'Search Engine'* button allows user to build a query to access specific data, which can then be updated, edited or deleted from the system. Else, the system displays a message indicating that no results found.

Settings

The *'Settings'* button displays a window form, as shown in Figure 14 that contains the system network manager, system user manager, developer's information and system help.

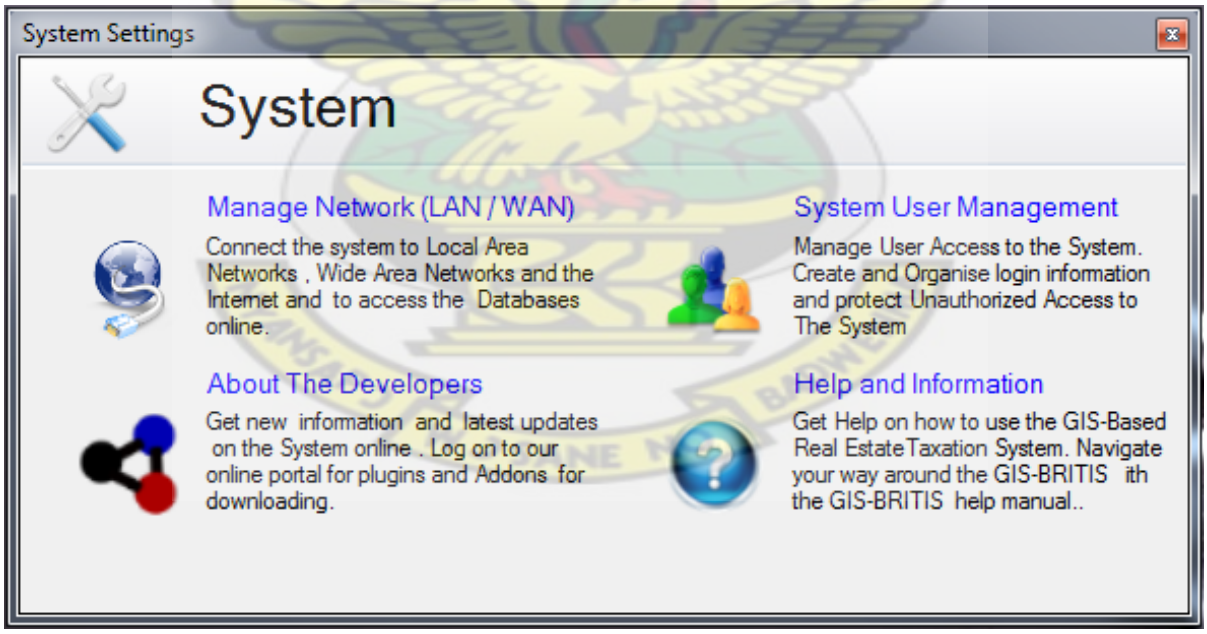

Figure 14: System settings

The system *network manager* controls the setting of the database server to a local or a network server, which is then used to allow user to connect to the server where the database

resides. The system *user manager* manages user access to the system and organizes login information. By using the *Developers information*, user gets latest updates about the system on the Internet where new plugins or add-ons are downloadable. Additionally, user can send error messages or feedbacks about the system using this tool. As the name depicts, the system *help center* provides generic help information on how to use the system with an index of topics specific to the system.

Variables

The *'variables'* button manages the account setting of tax officials (Principle and Valuation Directors) that are required to sign outgoing bills and notices. This capability allows users to change accounts as new tax officials assume the role.

The user-interface of GIS-BRETIS consists of the following principal parts:

- Spatial information module
- Property information module
- Improvement information module
- Tax information module

6.3.2 Spatial information module

The heart of GIS-BRETIS is the spatial information module, which includes a complete map interface with all functional map tools for geographically locating and tracking individual taxpayer. The map contains 2D building footprints on each parcel that facilitates change detection analysis. This functionality enhances the assessment process by making assessment patterns easier to detect inside and among different geographic regions in a community, thus, improving assessor's judgment and work efficiency through spatial task management. By default, the module includes a map area, a legend pane, and various tools for working with the map. These built-in tools allow users to print and interact with the map, and calculate the distances and areas of parcels. The module also contains a search engine, x and y screen display and an info button for viewing details of selected property. By using the search engine, users are able to view all attributes including the market value, improvement photograph and tax information of the selected property as shown in Figure 15.

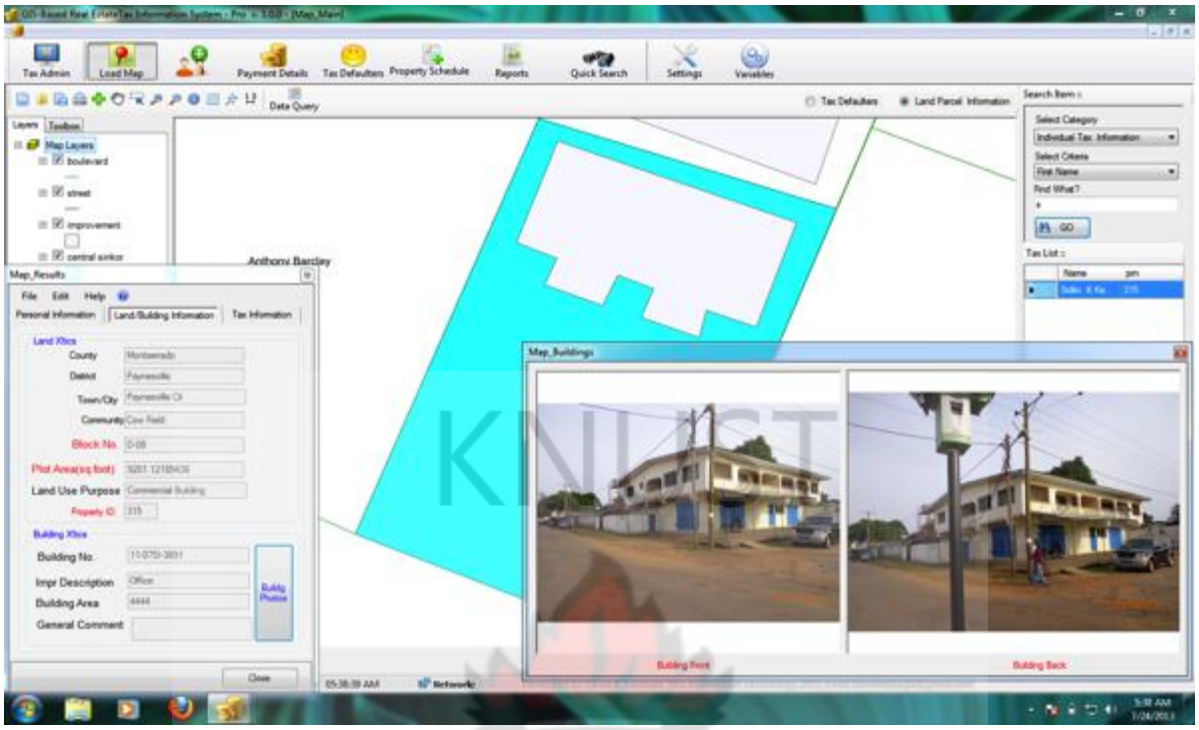

Figure 15: Spatial information module

This module is linked to the tax information module for identifying defaulters for enforcement operations. It has the functionality to filter and capture all delinquent taxpayers in the system and locate them on the map as shown in Figure 9, via the search engine.

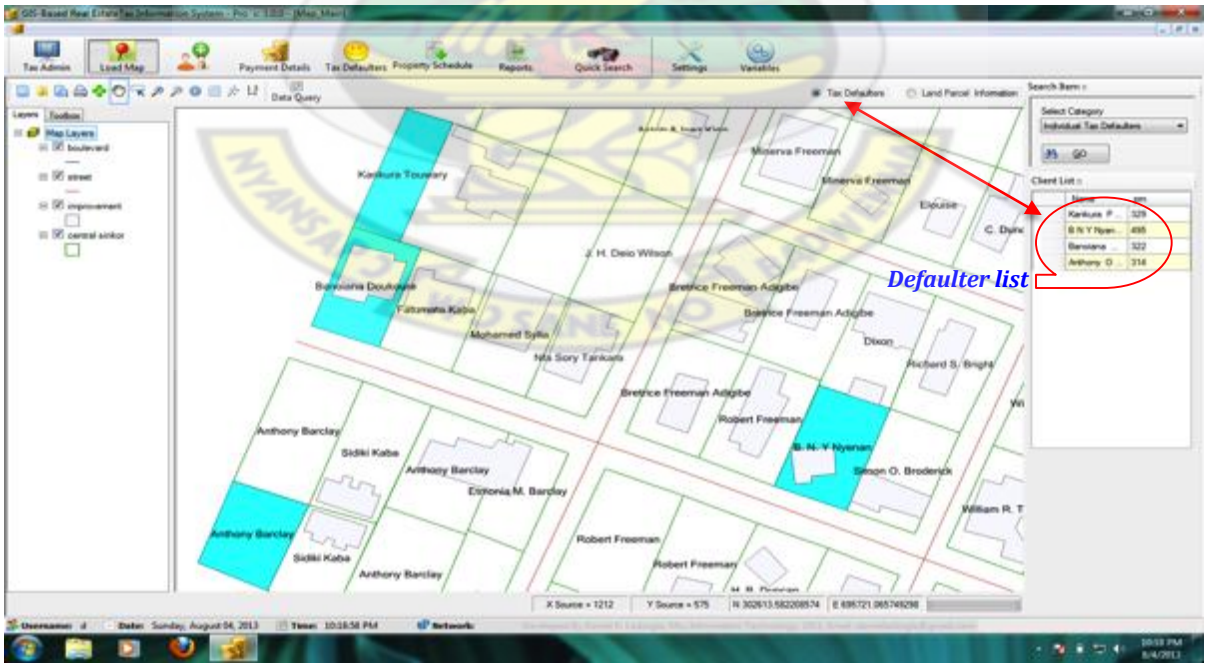

Figure 16: Map displaying tax defaulters

6.3.3 Property information module

The property information module forms the core of the system's attribute database for the parcel information. The module captures all relevant information pertaining to the land parcel such as property reference number (PRN), block number, tax period, land category (unimproved or improved), property use classification, building number, assessment date, utility information and types of construction materials for fence perimeter if applicable. The property information module is linked to the spatial information module (map) for automatically capturing block number and calculating parcel's square area for assessment purposes as shown in Figure 17.

Figure 17: Property information module

Additionally, this module has functionalities for calculating the landed value of the property and automatically computing the tax as per the category defined by the user. However, provisions are made for users, to calculate the value of the parcel using the land value guide. Most importantly, it has capabilities to capture the taxpayer full details including the photograph for future identification as shown in Figure 17.

6.3.4 Improvement information module

As the integrity of the assessment correlates directly to the improvement data, this module

forms the core of the assessment functions. The module is effective in capturing relevant information of improvement that is used to estimate its value. It provides flexibility to users through check boxes and pop-up menus for capturing optional improvement records. The module captures and store information such as building number, improvement type, building current condition, construction year, finished quality, material quality type and improvement characteristics such as number of carports, bedrooms, bath and windows (Figure 18).

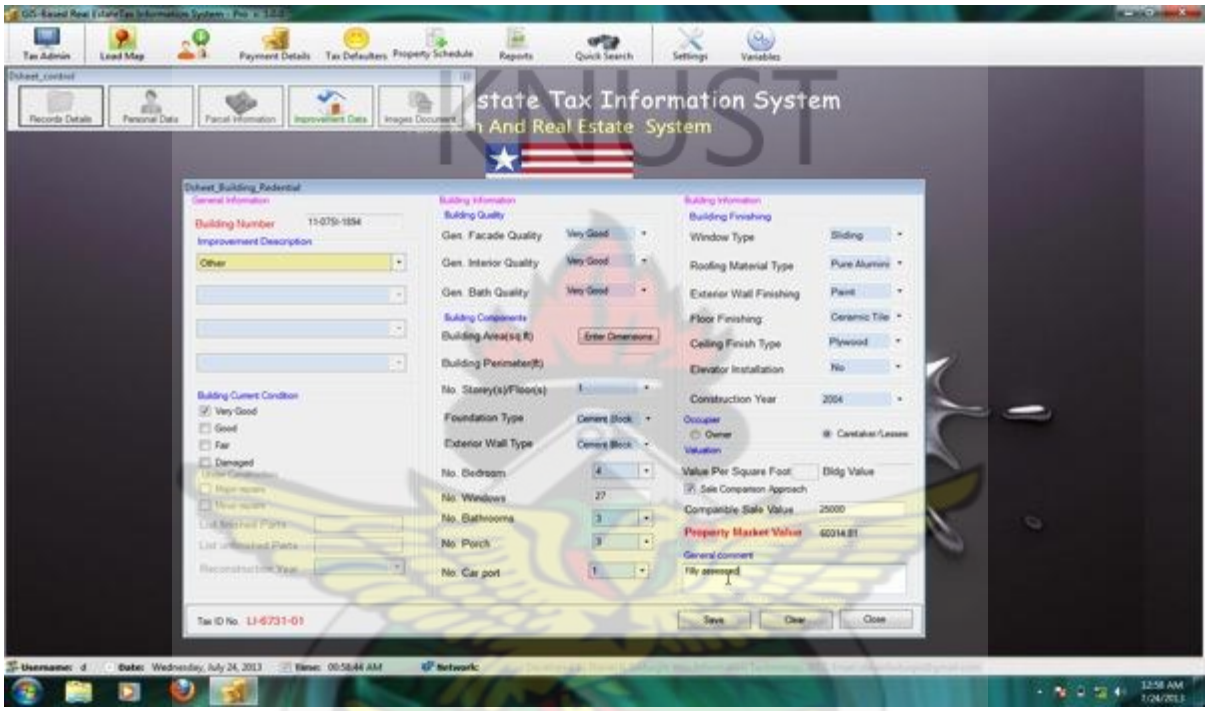

Figure 18: Improvement information module

Another function integrated into the module is the calculation of improvement areas and perimeters from field sketches. It has capabilities to capture information on unfinished improvements by listing the finished and unfinished parts to help assessors guesstimate the finish time for reevaluation. Most importantly, the module is built with functionalities, to compute the improvement value, calculate the tax and sum it with the landed tax from the property information module for final billing (as shown in Section 6.3.5).

6.3.5 Tax information module

The tax information module is the nucleus of GIS-BRETIS thus forming the most sensitive part of the entire system. This module provides all relevant records relating to tax information such as billing, taxpayer ledger, taxpayer details and payment records. It is a twin module that has billing function as shown in Figure 19.

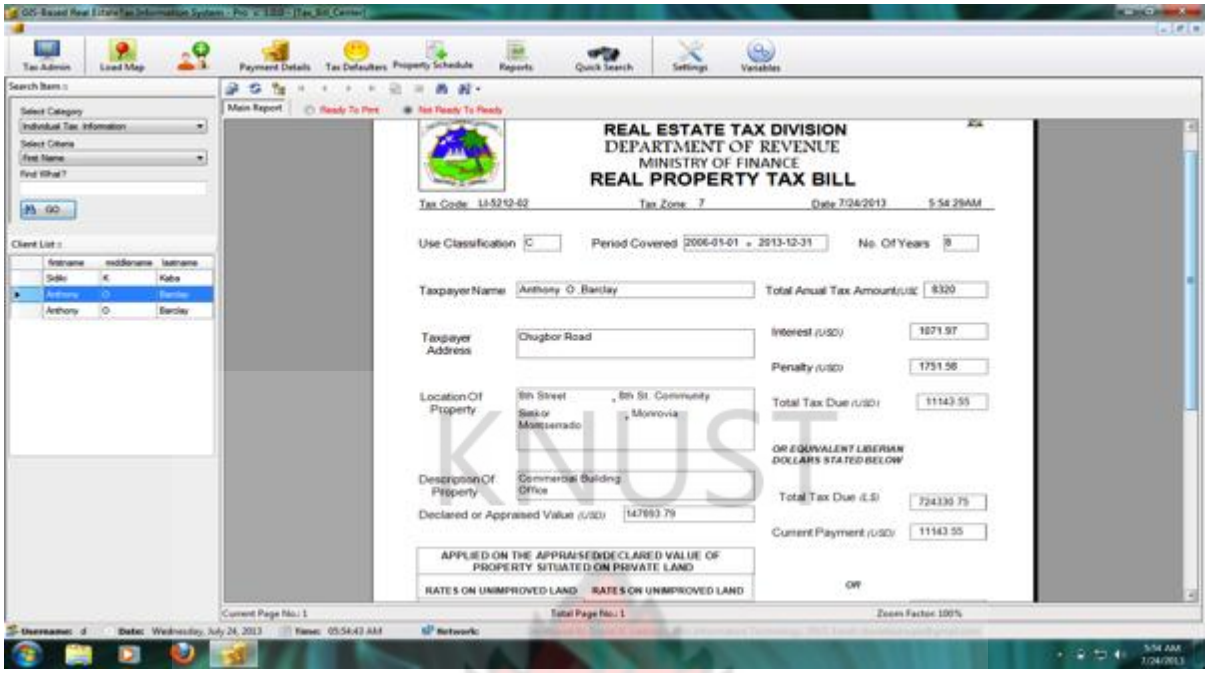

Figure 19: Tax information module

The menu allows for bill preparations and tracking function for capturing every detail of payment including amount paid, payment date, receipt number and balance due as shown in Figure 20.

Figure 20: Tax information module

The tax information module enables users to view all current and past tax information (tax

year, property location and value, applied tax rate, tax amount, arrears, payee details etc.) of any given property in the system. The tax information module is linked to the spatial information module for enforcement purposes. It contains a set of functions that merge all tax defaulters and display on the map from which enforcers can view and track for payments (as shown in Section 6.3.2). The module also allows printing of simple report of any query made, printing of information about a giving property based on user needs. The tax information module automatically populates the tax bill form and as well allows bill printing on user commands and specifications as shown in Figure 19. By printing bills, the module updates the property ledger of the taxpayer for which the bill has been printed in order to keep history of billing data. Upon return from bill payment, billing records form as shown in Figure 20 is used to track the payment records and update the ledger. The billing function has capabilities to link bills to all properties, so the actual revenue potential of the tax zone is known. Additionally, it facilitates the processing of various reports based on user needs.

6.4 Impact of GIS-BRETIS on taxation

In the existing property tax administration with paper maps, some significant problems such as map data not in a common system, extremely slow process for regular updates, storage and retrieval of property records are affecting the Tax Division efficiencies. However, GIS-BRETIS (prototype) has been designed to fill the gaps for all those inefficiencies. GIS-BRETIS consists of functionalities, to capture information about property ownership, building, land use and other socio-economic aspects of the real world. It was developed as a tool, to describe the location, the shape and the contents of each object thus, enhancing the tax assessment function with spatial data that is relevant to property taxation. Users can easily and quickly zoom in and out, present data according to their attributes, overlay spatial data and analyze spatial information effortlessly; without any specialization being necessary.

GIS-BRETIS is a taxation module with functionalities to check, with digital orthophotos or satellite imagery to detect change so that the tax assessment records remain accurate and up-to-date. That is, it has potential for regular re-inspection of properties and thus improves the efficiency with which the tax map and database are updated. All physical changes on a given parcel are easily identified, located and subsequently assessed after checking with imagery, thus keeping the tax records current. Additionally, the system is parcel based such that the location of each property is accurately known thus making taxation inescapable. Most importantly, GIS-BRETIS has capabilities to filter all delinquent taxpayers from the system

and display with possibilities of different zooming scales for visibilities on the map. The new system guides users through the work and thus minimizes the possibility of any malpractice, missed calculations and clerical errors. Search for information with the new system is exceptionally fast and efficient from the database thus promoting administrative proficiency and credibility. GIS-BRETIS has potential capabilities to produce printouts, maps, forms and reports easily, accurately and fast, thus enabling prompt response to request from top management.

6.5 Challenges in the implementation of the GIS-based taxation information system

The adoption and use of technical innovations, such as GIS usually comes with huge paybacks that enhance economic and administrative effectiveness. However, from the experiences of users in various organizational circumstances, we learn that securing the potential benefits of computer-based technologies, including GIS, can be problematic (Eason, 1998; McRae, 1993; and Moore, 1993). That is, executing and utilizing technological advances in property tax administration is simply not a technical matter, rather is influenced by a variety of cultural, institutional, and organizational settings and thus is essential to understand their requirements. It is necessary to understand the technical, administrative, and institutional constraints under which the system will operate in order to ensure users' support.

According to Solomon (2004), an inevitable consequence of computerizing a system is the consideration of the need for reorganization. The proficient use of a new technology, such as GIS, demands that work routines and chains of command be transformed in an organization. In turn, the overall organization is influenced. In reality, the achievement of this organizational change may be difficult, both because some factors of its structure are indescribable and so difficult to categorize. This is due to the existence of both formal and informal positions in all chains of command (Solomon, 2004). Changing the organization of course, changes staff authorities and relationships (Campbell, 1999).

The organizational problems are often more complex and essential to success than are the technical problems. Changing and replacing staff is more complex than changing computers and may cause unexpected difficulties. Thus, organizational matters require more consistent management concern than do technical problems (Bernhardsen, 1999). As a result, in applying GIS technology to property taxation and administration, addressing management

issues paramount. Resources need to be allocated to the training and motivation of middle managers because they often hold the key to the implementation of reforms. Experience has shown that the most influential organizational problems are the poor quality of managerial structures for implementing GIS, followed by the shortage of skilled staff and the lack of encouragement from senior staff. In several cases, staff resistance also presents a significant problem (Campbell and Masser, 1995). However, by successfully overcoming the various challenges, tax administrations can be economically efficient and successful once a proper GIS related property tax database is being implemented with provision for continuing validation.

6.6 Concluding Remarks

This chapter highlighted details of the system hardware and software specifications, and had detailed discussions on the prototype. Consciously securing the potential benefits of computer-based systems, including GIS, can be problematic, but by successfully overcoming the various challenges, work outputs are doubled and possibility of any wrongdoing is minimized. GIS-BRETIS offers an optimal environment for exploiting the tax assessment functions and helps improve assessor's judgment. It enhances the access and accuracy of data and brings about change, a change in the way the Real Estate Tax Division would work with records. Hence improving both efficiency and effectiveness of the assessment office.

Chapter 7
CONCLUSION AND RECOMMENDATION

7.1 Introduction

This chapter provides the conclusions drawn from the study and makes recommendations for further works.

7.2 Conclusion

The research aimed at integrating spatial technologies into the taxation process to help improve assessor's judgment and work efficiency so as to assist with uniformity and consistency in the property tax full operations. Implementing the technological integration necessitated a careful and organized approach to ensure success. The following are conclusions drawn based on the research objectives.

What mechanisms do exist to map property locations and conduct regular updates for assessment and taxation purposes in Monrovia?

Properties are mapped according to zonal demarcation regulations followed by self-declaration for residential properties only and external assessment by certified architectural firm for all other property types including the above-mentioned. Based on the zonal demarcation, the technicians assigned to this section are required to conduct block mapping in order to record all information on ownership, area and location of all taxable and exempt parcels within each tax zone. The current practice of property mapping is traditional and not parcel based, thus becoming increasingly incapable of supporting unique parcel identification and regular re-inspections. However, the technicians take measurements of the entire block and streets and interpret the data collected into information on a map. With the general layout of a block, ownership and location information are collected on individual property.

Which GIS-based model is suitable for effective property tax information system in Liberia?

The Division currently performs its tasks using customized Microsoft Excel and Assess databases without provision for map viewing capability and spatial updating facilities. In an effort to address the current deficiencies, spatial recognition of tax defaulters and regular re-inspection of properties for up-to-date information of the tax assessment records were highly

considered for efficiency. Thus, by taking the necessary steps to fulfill the outlined requirements, and considering the results of other researches, an interactive GIS-based tax information system with current and accurate digital tax map of connected parcels is suitable for effective property tax information system in Liberia. Such system enhances regular re-inspection of the tax base and gives users the capabilities to convert all datasets that are relevant to the property tax assessment, into useful information easily without any particular specialization being necessary.

What is needed to implement GIS-based tax information system in Liberia?

GIS-BRETIS is a GIS-based application software developed to solve problems in real estate taxation in Monrovia. The application was developed based on the existing system and users' requirements. The system has functionalities that enable the integration and analysis of a wide range of information based on their spatial locations. It also supports a full range of external and internal processes ranging from change detection analysis, registering property location and property assessment, tax calculation, tax billing, tracking payment records, locating tax defaulter etc. The key strength of the system lies in its single interface for all properties and tax information. Its GIS capabilities and flexible architecture allow different modules to be implemented independently based on the user restrictions and login. The new system guides users through the work and thus minimizes the possibility of any malpractice, missed calculations and clerical errors. Search for information with the new system is exceptionally fast and efficient from the database thus promoting administrative competence and credibility. GIS-BRETIS has potential capabilities to produce printouts, maps, forms and reports easily, accurately and fast, hence enabling prompt response to request from top management.

The system was dynamically developed such that, in spite of its potential in effectuating property taxation, it could be expanded to incorporate the implementation of utility services as information on property water and electricity connections was collected as part of the database. In the wake of time constraints, sufficient information on the valuation method, to facilitate automatic system calculation of property values was unattainable, thus allowing users to input a value per square foot or sale price to enable calculation. This led to suggestions for further improvement of the prototype as recommended in the next subsection.

Historically, much of the disappointments with GIS projects originate, not from a failure of the technical components of the GIS, but rather managerial structure for implementation, followed by the shortage of skilled staffs. Better knowledge and information are likely to bring about a better understanding of a system and thus create the prospect for better management. In addition, better management can bring considerable cost savings. Therefore, better management skills, better management education, and better management information are the essential components of management issues (Solomon 2004).

Furthermore, organizations have their own policies with respect to manpower employment and the extent to which systems must be capital rather than labor intensive. However, since property tax information system has been linked to high technology like GIS, maintaining and keeping the GIS application consistent with the data it supports is required. Because the system was developed to support an ongoing program, it must be kept up-to-date to fulfill its purpose since data will be changing in time (update). Thus, clear strategies for maintaining and coping with the impact of such developments need to be worked out.

Implementing any GIS-based property tax administration is worth to become successful, if the above outlined issues are rigorously taken into consideration. Hence, the administrative staff must develop a strategic plan and conduct a detailed study in addressing all these concerns to safeguard the successful implementation of the GIS technology for property tax administration in Liberia.

7.3 Recommendation

As discussed in Chapter 2, computer assisted-mass appraisal (CAMA) aids in valuing large number of properties at the same time using common data, standardized procedures and statistical testing (IAAO 1990). This method focuses on a group of properties and calculates the averages (market values) on properties with similar characteristics. As mentioned in the conclusion, standardized procedures on valuation methods were not gathered during the user needs assessment. Thus, this system has limitation in calculating the averages on properties. It is recommended that, further improvement on the CAMA component of the prototype be implemented to enhance the standardized calculation of the averages on properties.

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Appendix A Definition

A.1 Glossary

Business or commercial use refers to an improvement wherein the property is used to generate income. It is used either as an office space or shop or is a residential property rented or leased to tenants.

Industrial property is a property wherein its use is for the purpose of profit or gain as a factory workshop, brewery or canning factory, or which are engaged in the production and processing of goods for sale.

Residential property refers to an improvement wherein the property is occupied by the owner or relatives and is not used for the purpose of generating income.

Farmland means a tract of land of a lot, not less than five acres in an area which is used primarily for agriculture, horticulture or other farming purposes.

Improvements mean those physical additions and alterations to land, buildings and all works carried out for the benefit of land that have the effect of increasing its value.

Improved land refers to land upon which improvements have been effected.

Unimproved land refers to land on which no improvement has been effected and includes under-improved land.

Parcel of land means a subdivision of land, which is individually owned, the area limits of which are contained within an unbroken continuous boundary.

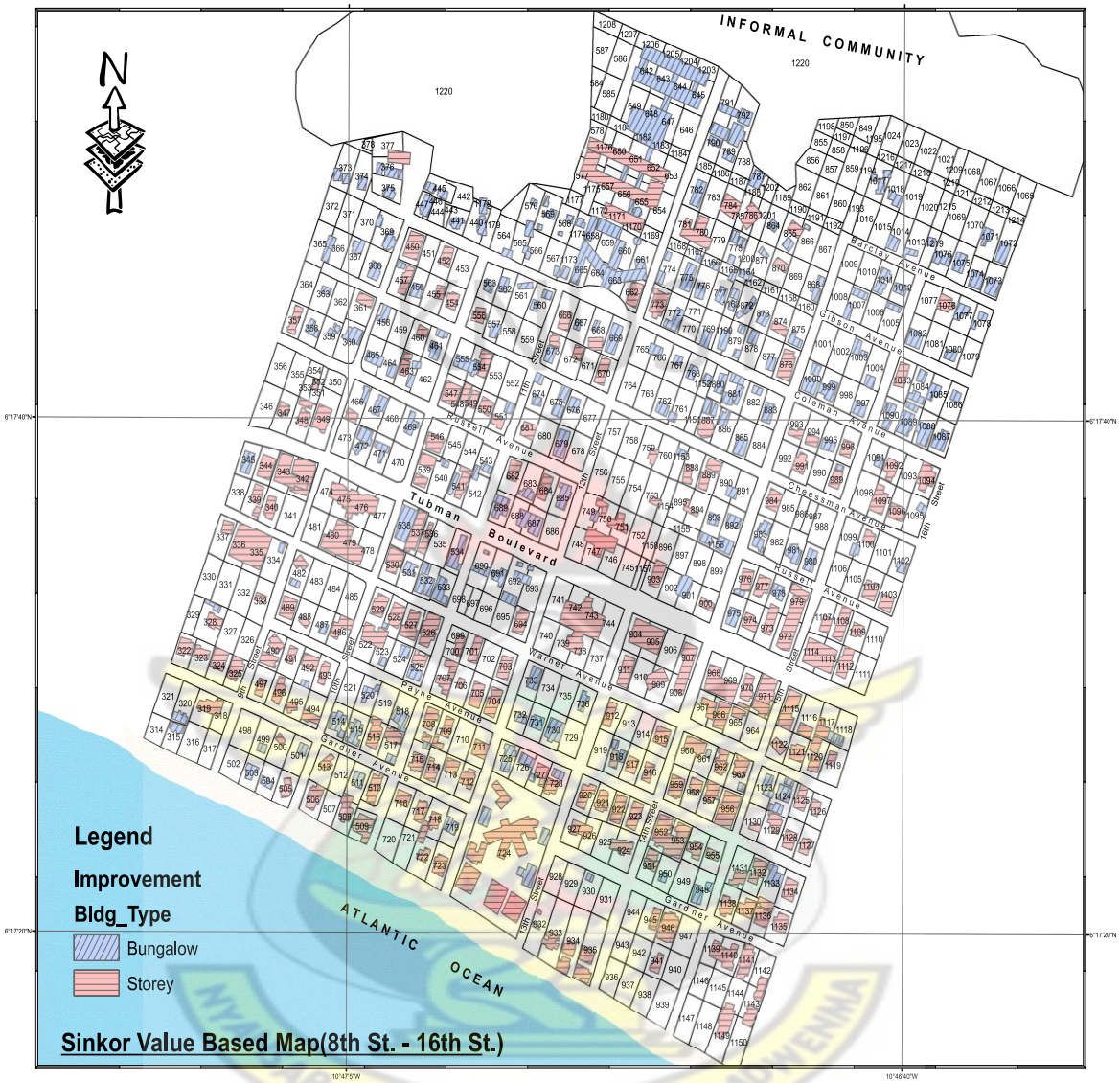
A.2 Data description

Entity	**Attributes**	**Data Type**
Street segment	Street_names	Line
Land parcel	PRN, block #, area, assessed_value, geocode	Polygon
Building (bldg.)	building #, yr_built, bldg._material, bldg._value	Footprint
Occupancy	occupant_name, contact_details	None
Owner	TIN, owner_name, owner_ address, contact_details	None
Tax	taxpayer_name, tax_amount, payment_date, arrear	None

Appendix B Parcel-based tax map

B.1 Value Based without Improvements

B.2 Value Based with Improvement Footprints



Appendix C Case study assessment

C.1 Letter sent to the Real Estate Tax Division for fixing interview

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
(KNUST)
College Of Engineering
Department Of Geomatic Engineering
Kumasi, Ghana

March 8, 2013

Dear Sir or Madam:

I'm a Liberian student of the institution captioned above pursuing Master of Science degree in Geomatic Engineering. On the most basic level, geomaticians maintain and develop spatial data, provide map production and analysis services, complete special projects, and provide technical support to the GIS environment.

I'm currently undertaking my research in "The Application of Spatial Techniques In Real Estate Taxation" of which the main theme is to develop a GIS based application (prototype) for property information system, with case study-area being Liberia. In view of the above, understanding the current property tax system is the crucial first step in determining whether, how, and in what form this research might contribute to a strengthened property revenue system for Liberia. Hence, full knowledge of the methods and techniques used in property taxation is required to safeguard the research in meeting the needs of the revenue department.

To achieve the above-mentioned, part of the process is defining what existing mechanisms are used to collect, store and retrieve property/parcel information (locational or geographic information), what volumes and formats are handled and what other constraints are encountered in the existing system?

As a means of data collection, kindly grant me an audience for interview, which would provide understanding (crucial first step) and answers to the research questionnaires set below. The viewing of tax related documents like annual reports, manuals and revenue statute is required to supplement this process. Your cooperation and answers will help ascertain the reliability of this research. I promise to send you the results as feedback for your information.

I hope my requisition would reach your highest consideration.

Kind regards,

Titus S. Zoneh
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e-mail: t.gballeah@yahoo.com

Cc.: Dr. Anthony Arko-Adjei, Thesis Supervisor, Department of Geomatic Engineering
Cell no. +233-244-232-446
E-mail: arkoadjei@hotmail.com

The information provided is confidential and straightly for research purpose.

C.1 Questionnaire

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
(KNUST)
College Of Engineering
Department Of Geomatic Engineering
Kumasi, Ghana

Questionnaires for some basic understanding of the property tax system

1. How is the property tax structured for implementation and what specific factors are considered?
2. What are the requirements of the valuation method(s) employed?
3. What are the procedures used in property assessment?
4. What data on parcel characteristics are collected and maintained?
5. What data on improvement characteristics are collected and maintained?
6. What data on property owners are collected and maintained?
7. Who has responsibilities for data collection and keeping and how are the collections carried out?
8. Who has responsibilities for valuation function and what are the procedures?
9. How is the property tax collected?
10. At what level is the tax collected, local/central government?
11. How can property taxes decrease or increase?
12. What mechanism is used to notify taxpayers of their tax value?
13. Is there an existing GIS system, building-based database or map?
14. What do you require to improve the valuation of property information?
15. Do you have any experience with GIS property valuation?
16. Are you interested in participating in an interactive GIS based property valuation?

The information provided is confidential and straightly for research purpose.