KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY KUMASI, GHANA

Building a Cadastral Information Systems for Land Records Management Using Hierarchical Approach and Geographic Information Systems: The Case of Ashanti Region, Ghana.

By

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Declaration

I hereby declare that this submission is my own work towards the award of Master of Science and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the university, except where due acknowledgement has been made in the text.

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Abstract

Humankind has since the times of human settlements, segmented and delineated the geographic environment in various ways to support their administrative, political and economic activities. The increasingly conflicting use-demands of land making it increasingly susceptible to pressure, has emphasized its importance as an important resource and made land issues a concern both locally and globally. Cadastral database which may be described as a component of Land Information system stores spatially defined cadastral plans and its related information. The Cadastral survey system provides land- related information to support the certainty of ownership and right to land, facilitate the process of conveyance and give legal protection to land tenure. As a result, cadastral system is primarily dependent on accurate individual cadastral survey and plans built from original survey observations. The Ashanti Regional Survey and Mapping Division has over the years continue using traditional analogue method of data keeping and management despite availability of technology to support modern trends of management and maintenance of cadastral records. Cadastral Information System (CadIS), custom desktop GIS application was developed to support the capture, maintenance, and the management of cadastral survey records for the Ashanti Regional Survey and Mapping Division. To achieve this objective, the challenges necessary for change in the Department were identified to include the absence of a common system that integrates all forms of geographic data, the difficulty in retrieving and managing archived cadastral records and the inability to share data among other land sector agencies among others. The developed system was tested with data obtained from the Ashanti Regional Survey and Mapping Division. The functionalities of the developed system were demonstrated and integrated with other geographic data sets held by the division in a well suited structure within a GIS environment. The result showed a developed practical system which achieved the objective of maintaining and managing cadastral records.

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List of Abbreviations

CAD	Computer Assisted Design
DBMS	Database Management System
DCDB	Digital Cadastral Database
FGDC	Federal Geographic Data Committee
FIG	International Federation of Surveyors
Geo-ICT	Geo-Information Communication System
GIS	Geographic Information System
GSDI	Geospatial Data Infrastructure
HSR	Hierarchical Spatial Reasoning
ICT	Information Communication Technology
ISO	International Organization for Standardization
LAP	Land Administration Project
LC	Lands Commission
LINZ	Land Information New Zealand
LIS	Land Information System
LRD	Land Registration Division
LVD	Land Valuation Division
MLNR	Ministry of Land and Natural Resources
PVLMD	Public and Vested Land Management Division
SMD	Survey and Mapping Division
TCPD	Town and Country Planning Department

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Chapter 1: BACKGROUND INFORMATION AND INTRODUCTION

1.1 Introduction

Humankind has, since the times of human settlements, segmented and delineated the geographic environment in various ways to support their administrative, political and economic activities. The increasingly conflicting use-demands of land making it increasingly susceptible to pressure, has emphasized its importance as an important resource and made land issues a concern both locally and globally. Rapid urbanization, population growth and its resulting problems like pollution, haphazard development, congestion, poor basic services and inadequacy of social amenities. These concerns are evidenced by the several local and international conferences, seminars and treaties such as the Agenda 21 (Cruz, 2004). Land issues are inevitably tied to combating poverty, promoting food security, protecting the environment, advancing social equity, ensuring peace and order, and to spurring economic growth. Various international and regional treatises and conferences have harped on the role of land administration in advancing sustainable development and good governance.

The term "land administration" (UN-ECE, 1996) is the processes of recording and disseminating information about the ownership, value and use of land and its associated resources.

Land Administration processes include the determination (sometimes known as the "adjudication") of rights and other attributes of the land, the survey and description of these, their detailed documentation and the provision of relevant information in support of land markets (Dale & McLaughlin, 1999).

The land parcel unit called the cadastral plan has been accepted as the legal unit for purposes such as land registration and taxation and for the development of cadastres. Aggregation of such Land parcel maps together with spatial analysis could be used for zoning of land use, and delineating different land administrative boundaries.

However, according to Eagleson et al.,1999, majority of these spatial boundaries have been constructed in an uncoordinated manner and has often generated fragmented boundary units.

The cadastre as defined by the International Federation of Surveyors (FIG) is "A parcel based and up-to-date land information system containing a record of interests in land (for example rights, restrictions and responsibilities). It usually includes a geometric description of land parcels linked to other records describing the nature of the interests, the ownership or control of these interests, and often the value of the parcel and its improvements ((FIG,1995)

The cadastre is an information system consisting of two parts: a series of maps or plans showing the size and location of all land parcels together with text records that describe the attributes of the land. The purpose of a cadastre is not solely for land registration which deals exclusively with ownership but also as the basic building block in a land administration system. Storage of cadastral plans or maps inevitably would play an important role in land administration and land management and therefore the development and maintenance of cadastral records and management information infrastructure is an important function in land administration.

Spatial Data Infrastructure (SDI) is an initiative intended to create an environment for the easy and secure access of complete and consistent data sets (Rajabifard et al. 2000). One fundamental problem restricting the objectives of SDI is the fragmentation of data between non-coterminous boundary systems and also fragmentation of data in various Agencies/Departments.

The focus of this research is to investigate a method of organizing spatial and attribute land data by applying the principles of Hierarchical increments of data as the framework for developing an overall land information system. Information regarding the inventory of approved cadastral plans consisting of its ownership, purpose, locality, district, area, shape and its geographic extent are obtained, stored, maintained and analyzed to enhance efficient and effective land administration. The problem of boundary overlaps encountered during data integration and the composing of such data into town sheets and layouts as well as fitting the data into district boundary maps will be investigated by using the current district administrative boundaries and the data attached to them.

In many developing countries like Ghana, land administration is handled by government agencies and the process of keeping records are mostly manual beset with conflicting and unreliable data, dubious manipulations of existing data by some recalcitrant staff and tedious retrieval of available information (Karikari, 2006). This suggests the need to establish or develop computer-based systems and networks to allow safe and improved storage, efficient manipulation and retrieval and analysis of stored data.

The use of technology to automate and streamline the process and provide timely and less expensive service delivery to stakeholders is essential for the improvement and development of land administration and national development as a whole.

In this prototype design, the Survey and Mapping Division of the Lands Commission in the Ashanti Region is used for data integration due to the fact that, this institution is already dealing with preparation of cadastral plans manually and it is envisaged its processes could be automated to incorporate other geospatial data for analyses. The research would develop a digital recording system for all beacons (controls pillars) and cadastral data (parcel information) using geographic information system (GIS) and database management system (DBMS) and also develop spatial analyses and management tools to allow users to obtain other integrated information from the system.

1.2 Problem Statement

In spite of advanced technology in Computer Aided Drafting (CAD) and Automated Mapping Systems cadastral, records are still being kept in analogue form. As a result, manual searches become slow and cumbersome. The existing manual systems frequently limit the opportunities for implementing optimal solutions. Even though the detailed description of parcel boundaries are needed to enable the extent of each parcel to be recorded for fiscal and legal purposes as well as re-establishing its boundaries in the event of dispute over the land (Dale, 1976) the manual recording system does not include all these information in databases that will allow efficient retrieval. Increasingly data referenced to administrative polygons such as Towns, Districts, and Constituencies are also required in a diverse range of applications. These units must be aggregated in a hierarchical fashion from cadastral parcel data to cover required administrative units. Data aggregation should be possible but would

require methods that will facilitate cross analysis (Eagleson et al. 1999). Many authors such as Bracken and Martin (1989), Huxhold (1991), Martin (1991), Fischer and Nijkamp (1993), Openshaw et al. (1998) and Williamson and Ting (1999) have highlighted the relevance of investigating the problem of data integration between boundary systems.

This research therefore aims at putting in place a system that would efficiently support the capture, integration, management, analysis and retrieval of the existing cadastral and Survey records held by the Survey and Mapping Division of the Lands Commission. This will demonstrate further the objective for the development of a National Land Information System.

1.3 Research Objectives

1.3.1 Main Objectives

The main objective of the study is to analyze the underlying problems of the existing systems for the cataloguing, storage and management of survey and cadastral records and then design a new system(s) that would facilitate the computerization and integration of cadastral and survey records to improve access to cadastral, geodetic and topographic information in order to speed up the land delivery and land information process.

1.3.2 Specific Objectives.

The specific objectives are to:

- Analyze the existing processes for data management by reviewing available literature related to the computerization of cadastral records.
- Determine the requirements or needs of the user and ensure that the data is structured and available to other institutions and organizations for multi-purpose usage.
- Transform all cadastral survey works and information into a multi – purpose land information system.
- Apply the design through prototyping and demonstrate the system functionalities for data capture, update, and retrieval.

- Provide an accurate, cadastral database to manage data at the Survey and Mapping Division and ultimately reliable land information required for land – related activities and decision making.

1.3.3 Research Questions

Based on the objectives stated above, the following research questions can be asked

i. What lessons can be learnt from developments in theory and practice?
ii. What are the issues affecting the Survey and Mapping Division in terms of data management?
iii. What improvements can be proposed to the existing processes for data management?
iv. Based on the analysis, what general specifications can be outlined for designing the system?
v. What are the requirements of the user/department that the system should be able to provide?

1.4 Significance of the Study

This research hopes to propose a viable mechanism to help the Survey and Mapping Division of the Lands Commission in the Ashanti Region deal with issues concerning all reference monuments as well as keeping inventory of all plans approved by the division to enhance efficient and effective retrieval and analysis. It proposes a design solution to an updatable cadastral information system which reflects current situations for decision making and for all activities about and related to cadastral data. The system would keep and maintain the data in computer medium in an updated form, and provide a more efficient, more expeditious activation of services provided by the Survey and mapping section in relation to the Cadastre, and enable other organizations and institutions to use the data supplied in a better and broader manner.

1.5 Scope and Limitations.

This study is about developing a system to support the storage and the management of cadastral survey records at the Ashanti Regional Survey and Mapping Division. It is however concerned with understanding processes of data management and the context of data at the Survey and Mapping Division and how that data can be structured and

stored as a first stage in the overall and eventual evolvement into a cadastral information system. In this vein, it should not be viewed as an absolute system. Mainly it requires contact with users through interviews, documentation and observation of activities and procedures in order to determine challenges and propose solutions to mitigate those challenges.

It is also worth mentioning that developing a complete system may entail changes in Institutional arrangements and Organization processes. This study is however limited only to the design of the proposed prototype system. It is more of building a working model to show system features and functionalities and also anticipate problems in the light of realities at the Survey and Mapping Division. This designed prototype is on a small scale and is dependent on data available to the investigator.

1.6 Thesis Structure

The thesis is structured into five chapters. In the first of these, the nature of the problem is laid out in an introduction that also includes justification or relevance of the research, the main objectives and envisioned solutions for the problem.

This chapter gives the parameters of the research. A brief background introduces the topic and raise preliminary issues into a practical research topic. This is then translated into specific research questions and objectives creating a path for the content for the chapters that follow. The significance of the Study also brings to bear the contribution of the work in producing policy-relevant information and hopefully in building knowledge. The Scope and Limitation further defines the research concern and identifies the constraint encountered in undertaking the study.

Chapter 2 reviews the legal and land administrative framework in Ghana. It also gives information relating to what available literature has said about Land Information System and analyzes the existing cadastral business process, the impact of the proposed system in its operation and the institutions involved in the land administration and cadastre.

Chapter 3 describes how the research is conducted. Firstly it gives the profile of the study area and specifically states the reason for the choice of the area, some geographic facts, its location, and other land sector agencies. It also discusses the

business processes involved in its operation and propose a new system that remedies the analyzed challenges in the existing system.

Chapter 4 presents the results of the development. It demonstrates the functionalities of the system by showing how it works.

Chapter 5 concludes the study and also recommend list of topics for further research.

Chapter 2: LITERATURE REVIEW

This chapter gives a review of the current trends in land administration in Ghana especially in the maintenance and management of Land Information. It examines the current bottlenecks in the cadastral survey system and the storage and/or treatment of cadastral data. The section discusses the modern technology available as well as approaches used in the maintenance and management of LIS in the light of key drivers for change and the current technology for maintenance and management of cadastral records. The last section also discusses the functions of the institutions involved in the land administration and cadastre in Ghana.

2.1. Legal Land Administration Framework in Ghana

2.1.1 Overview of Land Tenure System in Ghana

Land law in Ghana is a complex mix of constitutional, legislative and customary law. Land is owned predominantly by customary authorities (stools, skins, clans and families). Together they own about 78% of all lands, the State owns 20%, and the remaining 2% is owned by the State and customary authorities in a form of partnership (split ownership) also known as vested lands (Steudler et al, 2010). From the perspective of tenure, two broad arrangements exist, namely customary and public land tenure.

2.1.2 Customary Land Tenure Systems in Ghana

The term customary land is used to represent all the different categories of rights and interests held within traditional systems in Ghana including stool lands, skin lands, clan lands, and family lands. They occur where the right to use or to dispose of use-rights over land rest neither on the exercise of brute force, nor on the evidence of rights guaranteed by government statute/law, but on the fact that they are recognized as legitimate by the community, the rules governing the acquisition and transmission of these rights being usually explicitly and generally known, but not normally recorded in writing (Bower, 1993). Such ownership may occur through any one or a combination of the following ways:

- discovery and long uninterrupted settlement;
- conquest through war and subsequent settlement;

- ❖ gift from another land owning group or traditional overlord; or
- ❖ purchase from another land owning group

Four categories of interests were adopted in the Land Title Registration Law, 1986, namely the Allodial title, the Freehold title, the Leasehold and Lesser Interests in land (Hall et al, 2009).

These categories are briefly summarized:

The Allodial title

The Allodial title is the highest interest known to customary law (Kasanga & Kotey, 2001). It is absolute and permanent and occasionally known as 'radical' or 'ultimate' interest. This is because the holder of this interest has absolute freedom in dealing with the land (Ollenu, 1962). Allodial titles are vested in communities, which are represented by stools, substools, skins, clans and families. An allodial title is vested in a continual flow of people, and remains in them for generations (Woodman, 1966). Although allodial titles belong to the whole community, the right to deal with the lands is vested in the chief or family head, or other traditional leaders, as the case may be. The holder of the allodial title acts as a trustee, holding the land for use by the community or family. The holder 'executes judicial, governance, and management functions' (Kasanga & Kotey, 2001), but cannot dispose of the land without the consent of the members of the community.

Freehold title

Freehold title is categorized into two forms: customary law freehold and common law freehold. *Customary law freehold* also referred to as usufructuary title. Such rights are normally owned by the subjects of stools, skins or families. These subjects may exercise their inherent right to develop any vacant virgin communal land (Ollenu, 1962; Da Rocha & Lodoh, 1995). Customary law freehold may be held either on a corporate status by the sub-stool, lineage, family or by individuals. Customary law freehold is perpetual; it subsists as long as the owning group or subject or his/her successors continue to acknowledge the superior title of the stool. The interest is also inheritable and devolves on the holder's family upon the death intestate of an individual holder. The holder of the usufruct has the right to alienate his/her interest either by sale, lease, mortgage, pledge, or to grant agricultural tenancies such as

"abunu" or "abusa", but such alienation carries with it the obligation upon the transferee to recognize the superior title of the stool and the performance of customary services due from the subject grantor to the stool/skin. *Common law freehold* is an interest in land which arises out of a grant in the nature of freehold made by the allodial owner either by sale or gift. Apart from this, the holder of a customary law freehold can create a common law freehold by grant to another person out of his/her interest. The effect of such a grant is that the parties have either explicitly or implicitly agreed that their obligations under such a grant should be regulated by common law. The grantee's rights under such a grant are defined by common law and it is common law rules that govern any dispute which may arise over the land.

Leaseholds

Leaseholds are rights granted to any person to occupy specified land for a specified term. They are derived not from customary law but from common law. A lease may be granted either by the holder of the allodial title or a customary freeholder provided he or she has not granted a conflicting interest in the same piece or parcel of land. A lease may be granted for any period of time. The 1992 Constitution, however, imposes a 50 year limit for leases granted to non-citizens.

Various **Lesser Interests** in land can be created by owners of the allodial title or customary freehold. The two best known are "abunu" and "abusa" which are usually share-cropping arrangements by which the tenant farms the land and, at harvest, gives a specified portion of the produce to the landlord. In general, under "abusa" tenancy, the tenant farmer is entitled to a third of the produce from the land; while under the "abunu" system he is entitled to half of the produce. Variations of this practice exist in various forms or arrangements in the farming communities. There are instances where the land rather than the crops are shared.

Alienation

Alienation holdings include land acquired outright by a non-member of the land owning community usually for agricultural purposes.

Other customary tenancy arrangements.

Community's common property rights – rights to secondary forest produce, rights to water, rights to common grazing grounds, etc.

There are, however, a number of traditional groups in Ghana which do not recognize a stool or skin as symbolizing communal land ownership. In such places, the allodial title may be vested in a clan or family. This form of land ownership is common in the Volta Region and in some areas in the Eastern, Greater Accra, Central, Northern, Upper East and Upper West regions. In these areas, the owning clan, family or individual which holds the allodial title has complete and absolute freedom to dispose of it. They can legally sue and be sued in any dispute involving such lands.

2.1.3 Legal Framework

The overall legal regime for land administration in Ghana consists of constitutional provisions, policy instruments, statutory enactments, judicial decisions, common law principles and customary laws and practices which have been enacted and developed over the years to regulate land rights generally (Dowuona-Hammond, 2003) . Courts have also ruled on customary law issues resulting in a body of legal precedents for some land related customs. Currently there are over one hundred statutes on land ownership, tenure, planning and use, added to the different customary laws as they pertain to specific localities (Larbi, 2006)

Under the currently operating Land Administration Project (LAP), the laws relating to land are to be consolidated into two pieces of legislation, namely the Lands Act to provide for Land Tenure, Land Administration and Land Management and Surveying and Mapping, and the Land Use Planning Act.

(The key pieces of legislation within the Ghanaian legal framework are summarized in Appendix I)

2.1.4 Constraints in Land Administration

The land tenure systems and land administration in Ghana are beset with a number of constraints. These are aptly captured in the National Land Policy of Ghana (Ministry of Lands and Forestry, 1999) and can be summarized as follows:

- General indiscipline in the land market - characterized by the current spate of land encroachments, multiple sales of parcels, developments on land using unapproved schemes, informal settlements leading to development of shantytowns, etc. These issues individually and cumulatively lead to environmental problems, disputes, conflicts and endless litigation.
- Indeterminate boundaries of stool/skin lands - resulting directly from the lack of boundary maps/plans, and the use old or inaccurate maps, leading to land conflicts and litigation between stools/skins and other land owning groups.
- Compulsory acquisition by government of large tracts of land which has not been utilized and for which payment of compensation has been delayed. By this policy, land owners have been left almost landless, denied their source of livelihood and have, in effect, become tenants on their own lands, giving rise to poverty and disputes between the State and the stools, as well as within the private land sector.
- Inadequate security of land tenure due to conflicts of interests between and within land owning groups and the State, land racketeering, slow disposal of land cases by the courts and a weak land administration system.
- Difficult accessibility to land for agricultural, industrial, commercial and residential development purposes due to conflicting claims to ownership and varied outmoded land disposal procedures.
- A weak land administration system characterized by the lack of a comprehensive land policy framework, reliance on inadequate and out-dated legislation, lack of adequate functional and co-ordinated geographic information system (GIS)-based tools as well as of transparent guidelines; poor capacity and capability to initiate and co-ordinate policy actions let alone resolve contradictory policies; and inappropriate policy actions among various land delivery agencies.
- Lack of consultation with land owners and chiefs in decision-making for land allocation, acquisition, management, utilization and development which has generated intractable disputes between the State and the private land owning groups and within communities.
- Lack of consultation, co-ordination and co-operation among land development agencies.

The net effect of these constraints is a distorted and dysfunctional land market that is not investor and development oriented and which cannot guarantee security of tenure, resulting in high transaction costs and high incidence of poverty.

2.2 Challenges of Cadastral Survey System to Support Land Information in Ghana

Many activities such as taxation, land conveyance and legal protection for land tenure are all dependent on cadastral information thus the management and maintenance of cadastral records in cadastral organizations plays an importance role in land administration. The advent of Geoinformation technology (Geo-ICT) has improved the traditional way of maintaining and managing cadastral records. Geo-ICT has provided a means of converting analogue cadastral records to digital formats which has helped in the development and the supply of products and services as well as maintaining and managing the cadastral records in an effective and efficient manner.

2.2.1 Modern Trends of Maintenance and Management of Land Information System

Effective and efficient management and maintenance of land related records inevitably involves the use of modern Geo-information technology .Traditional means of managing and maintaining these records may no longer be plausible as the volume and the demand for data increases. Modern trends of land information systems through the use of Information and Communication Technology (ICT) and Geographic Information Systems (GIS) is a major driving force in spatial information management and maintenance as these improve data storage, retrieval, integration with other data as well as its distribution. There is therefore no doubt that modern comprehensive and complete cadastral systems require the use of Information and Communication Technology (ICT).

2.2.2 GIS as a core component for interoperability among different organizations.

In order to ensure that all land-related data can be treated as a corporate resource and shared between organizations, flexible and clearly defined data exchange standards will need to be introduced (ECE-HBP, 96). Interoperability is the ability to integrate or exchange information between different components of a geospatial solution, even

though different Organizations or Departments on different GIS platforms may have developed the components (Raghavendran, 2002). True GIS interoperability would mean the right tools and technologies to exchange or transform geospatial data into the structure wherein the end user can take full advantage of specific GIS software capabilities. The Establishment of an enterprise GIS is to implement business process solutions using GIS as a core component for interoperability among different organizations. Applications that have GIS built into its core enable a wide-range of users and expand to the greatest portion of organizations (Young-Ho, 2005). In the case of New Zealand for example, the land Information New Zealand (LINZ) has developed an e-cadastre system to automate the nation's survey and titling system. The aims of the automation were to integrate all survey and title processes, to reduce the costs of both provision and compliance, to utilize technological development, and to meet the growing community demand for improved quality and delivery (Bevin, 1999).

GIS provides a support for integrated work flow for creating and updating cadastral information that can be shared easily both within and between organizations. The real essence of GIS usage can be fully realized through applying the systems across the land record work flow in spite of the fact that it has been used in the management of individual land records for decades.

2.2.3. Renewal of existing system and environment

Given the present rapid rate of change in technology, investment in hardware and software will have to be renewed from time to time with the aim at satisfying the changing customer demands and also adapting to the change in environmental requirements (**ECE-HBP, 96)**.

The major investment, however, is in data which also though must be kept up to date, should not need to be renewed along with the hardware and software. FIG, 2003 identified the step by step and the big-bang approaches as strategies for the renewal process of the IT environment in cadastre and land registration.

Step by step approach is used in building an entirely new system in parts in a new environment while the old system is synchronized until it phases out completely. This approach ensures that the continuity and availability of the ICT systems at the initial level is guaranteed.

Big-bang approach means designing and building up an entirely new system as a whole. This approach may be faster and less costly. However this step has the risks which can be found in a short after the implementation of the new system. It is therefore highly recommended to develop a careful planning and preparation of this big-bang event.

2.3 Challenges and Key drivers for change

A common trait of every Land Administration organization is its devotion to the determination, registration and dissemination of information pertaining to the ownership, value and the land use (van der Molen, 2003).

Cadastral organizations are presently increasingly confronted with rapid development in technology, internet, database, modeling standards, open systems, GIS, as well as a rising customer demand for new services, enhanced user requirements, E-conveyancing, integration of public data and systems (FIG, 2003). Van der Molen (2003), states that the need for fundamental and far-reaching changes become manifest once customers seriously come to expect they will be assisted in a manner by their land administration organizations. Mapping agencies which therefore do not develop a strategic view to meet these rapid developments will face hard times and may possibly not survive.

2.3.1. Data standards for integration and sharing

The development of geo-information has become very important and such development requires data from different agencies at different times. Data from these different agencies exist in different formats depending on their immediate application requirements. Again these data may exist in unrelated and uncoordinated collections resulting in the duplication of data. However, a great deal of geospatial data from different sources is produced almost continuously. Therefore the issue of, how to acquire data rapidly from different sources, integrate the data for analysis, and realize interoperability of spatial data in a distributed environment, becomes very important (By et al, 2004)

The International Organization for Standardization (ISO) defines standards are documented agreements containing technical specifications or other precise criteria to

be used consistently as rules, guidelines, or definitions of characteristics, to ensure that materials, products, processes and services are fit for their purpose.

Standards may be distinguished as 'norms' against which we compare items for acceptability or as a formal technical or legal instruction which define more closely what is deemed acceptable for a particular purpose (Boadu, 2006). Standards therefore play a critical role in the design and development of an efficient and effective system.

The value of wisely chosen standards for geospatial information users as stated by Groot and McLaughlin (2000) is summarized under three basic themes:

- **Interoperability** and information access refers to the user's ability to connect and to retrieve information from multiple systems.
- **Maintainability** informs the user of the standards to promote long-term and efficient updating, upgrading and effective use of computer systems and databases
- **Portability** refers to the ability to use and move data, software as well as customized applications across multiple computer systems with different operating systems environments without reformatting. (Groot & McLaughlin, 2000)

2.3.2. Customer's requirement

Changing society and community expectations in relation to the availability of, and access to, information has forced many organizations to take up information technology with the aim to improve services, reduce cost and widen markets.

Increasing and on-going demands and new usages by consumers, greater spatial accuracies, continuous access to data and information, and the drive for public access demand to land are some examples of customer's requirement outlined in (Donnelly, 2008). Land registry data must be in a digital form, extremely up-to-date, conspicuously reliable, complete, rapidly available, susceptible to customization, well harmonized with other types of records and good value for money, and that it must fit in well with customers working procedures (van der Molen, 1999). Thus cadastral systems must change over time so as to meet the demands of the society in a sustainable manner. In relation to the requirement of customers, the development and maintenance of cadastral systems can profit a lot from Geo-ICT. It is also worth mentioning that digital land information should not be treated as an isolation problem

but regarded as part of an entire shift for the processing of land information (Falzon & Williamson, 2001).

2.3.3. Geo-ICT development

Cadastral systems usually include a database containing spatially referenced land data, a set of procedures and techniques for systematic collection, updating, processing and distribution in a uniform spatial reference system (van Oosterom & Lemmen, 2001). Cadastral survey systems have been widely involved in the production, storage and maintenance and retrieval of land related information for the many purposes. These have necessitated the involvement of Geo-ICT developments in recent cadastral survey systems. The impact of Geo-ICT has numerous benefits which include the provision of new range of products and services, easy accessibility of information as well as a decrease in the relative cost of data storage and maintenance. Recent developments in Geo-Information and Communication Technology (ICT) have a serious impact on the development of cadastral systems and Geo-Spatial Data Infrastructures (GSDI). The development of ICT in general and specifically the Geo-ICT can improve the quality, cost effectiveness, performance and maintainability of cadastral systems (van Oosterom & Lemmen, 2002).

2.3.4. Land Policy

Land policy is very crucial for sustainable development that can help to ensure peace and stability, economic growth, equitable social development and rational resource management. Land policy consists of a complex of socio-economic and legal prescriptions that dictate how the land and the benefits from the land are to be allocated. A balance must be struck between the exploitation, utilization and conservation of the land as a resource in order to obtain the necessary level of sustainable development for the survival of humankind (ECE/HBP/96, 1996). Land policy also influences the ways in which the development of land is regulated, the revenue derived from the land (through sale, lease, taxation, fees, etc.), and how conflicts concerning the ownership and use of the land can be resolved. It concerns both public and private land and impacts upon all aspects of land administration, including land title formalization, land survey and property description, land registration, land valuation, land-use control and management, and infrastructure and utilities management (ECE/HBP/140, 2005).

Unsuitable land policies can constitute a serious constraint on economic and social development: insecure land tenure, outdated regulations, and dysfunctional land institutions constrain private investment and undermine local government's ability to raise taxes in many countries (Deininger, 2003). Thus land policy formulation is aimed at creating political, legal, social and economical conditions for securing real properties through reforms and at the same time facilitating the conservation of other resources, continued use and increase in returns.

2.3.5. Budget Constraint

Land administration agencies all have to address a fundamental problem, which is how to ensure their sustainability in an age of computerized technology. The more an agency becomes capital-intensive, the more it needs to spend on the maintenance of equipment and its replacement, either using government funds or by generating the income through its own activities.

UNECE (2005) states that there are two cost elements: the building of the system and its maintenance. Building or rebuilding a national land administration system is an expensive process in which the costs for land surveying are much more difficult to recover than the costs of compiling the title registers.

Cadastre 2014 (Kaufmann & Steudler, 1998) however envisages and states that "*Cadastre 2014 will be cost recovering*" As governments themselves were often doing the cadastral and land registry work, they could cover the cost of building up and maintaining the system through land taxes which in most cases were considerably higher than the expenses incurred in the land recording system.

For a well understanding of the position of a cadastral system within the public administration, then, 'cost recovery' should be understood as the maintenance of the equity as specified in the balance sheet within a certain range, irrespective of any developments of relevance to the equity in the market as well as giving interesting background information (van der Molen, 2001) .

- **For cadastral systems in the government budgeting system**: the recovery of expenditure as an average over the last 5 years.
- **For cadastral systems in the cost benefit system**: the equity as the percentage of the (reduced) balance sheet total as an average over the last 5

years. But an option of this system is 'the result of the profit and loss account as an average over the last 5 years'. (van der Molen, 2001)

2.3.6. Market Trends

The demand to information is on the rise thus it is necessary to provide good products which are on demand to ensure that customers' satisfaction can be assured and the markets develops. Van Oosterom and Lemmen (2002) states that customers want to be served in a professional way, through user-friendly tools to information that is timely, up-to-date, reliable, complete, accurate, relevant, if necessary customized, well integrated with other relevant data sets for other suppliers, good value for money systems that are compatible with the customer's working procedures.

2.3.7. Internet and E-government

The internet and the world-wide web are the most recent new media to present and disseminate geospatial information. E-government is the utilization of the internet and the world-wide web for delivering government information and services to citizens (UN DPEPA, 2002). In a broad sense e-government can virtually include all information and present a straightforward benchmark for information technology (ICT) platforms and applications in use by the public sectors.

2.4. Cadastral Domain Model

A cadastre is a parcel based and an up-to-date land information system containing a record of interests in land. It usually includes a geometric description of land parcels linked to other records describing the nature of the interests, the ownership or control of those interests, and often the value of the parcel and its improvements (FIG, 2006). It may be established for fiscal purposes and legal purposes and where available, they assist in the management of land and land use and enables sustainable development and environmental protection.

2.4.1 The Concept of Cadastral Domain Model

The cadastral domain model can be described as an information model, which is an application independent description of information. The aim is to focus on the information itself and not the technical environment where it is stored. The model is dynamic and can be expanded with additional information according to changes in the legislation and cadastral ordinances. The model is a central tool for developing e.g.

geo-spatial applications, processing and analyzing real property information. (Paasch, 2004).

The cadastral domain is a description of a very complex legislation. It contains several objects and attributes. It has two main components namely; class diagrams and definition of object and attribute (Figure 2.1).

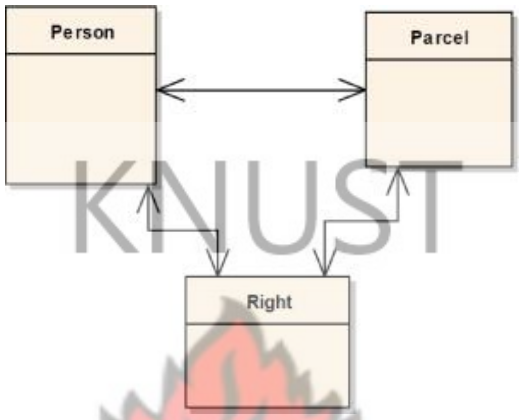


Figure 2.1: Basic Principles of Cadastral Domain Model (source: Aien et al., 2013)

2.4.2 Standardization of the Cadastral Domain

Standardization of the cadastral domain is relevant because computerized cadastral systems can support a customer and market-driven organizations with changing demands and requirements. The relevance of standards in cadastral domain model is to avoid re-inventing and re-implementation of the same functionality over and over again but instead to provide an extensible basis for efficient and effective cadastral system development and also to enable stakeholders, both within one country and between different countries to engage in meaningful communication based on the shared ontology implied by the model (Lemmen & Van Oosterom, 2003).

2.4.3 The Hierarchical Spatial Reasoning Theory as a method of organizing cadastral data.

The Hierarchical Spatial Reasoning is defined as part of the spatial information theory that utilizes the hierarchical structuring of space and reasoning (Car, 1997). Administrative boundaries are frequently used for the display and analysis of spatial information. A model based on HSR allows data to be captured easily and also stored in an efficient manner. Despite the improvement in Geo-ICT some forms of geographic data structures are still relatively expensive to produce, difficult to

manipulate and require large amounts of memory to store (Rajabifard & Williamson, 2001).Therefore, many organizations are utilizing established polygon-based administrative boundaries as a base for the collection and collation of spatial data.

HSR theory has predominantly focused on zero and one-dimensional structures to model urban systems (as points), road and drainage networks (as lines), and to a certain extent simple bi-dimensional objects such as square polygons in quadtrees (Rajibifard et al 2000). There are four global properties intrinsic to hierarchies making them adaptable to boundary design. These are:

i. Part-whole - *establishes a relationship as each element within the hierarchy forms a part of the elements on the layers above and also constitutes a whole of the elements below* (Palmer, 1977).

ii. Janus effect - *each level in this hierarchy possesses two faces, one facing the levels below and one facing the levels above. The outcome is such that, each administrative polygon has two faces, one looking to the smaller unit from which it is formed and a second looking towards the larger administrative units it supports such as from parcels to blocks and blocks to sections etc.*

iii. Near Decomposability- *This property is related to the nesting of systems, and based on the fact that interactions between various kinds of systems decrease.*

iv. Embededness- *This specifically applies to the development of a three dimensional spatial hierarchy such that each lower-dimensional structure is always algebraically and geometrically "embedded" in the next higher-dimensional structure*

The objects used in this research are organized in Figure 2.2 below.

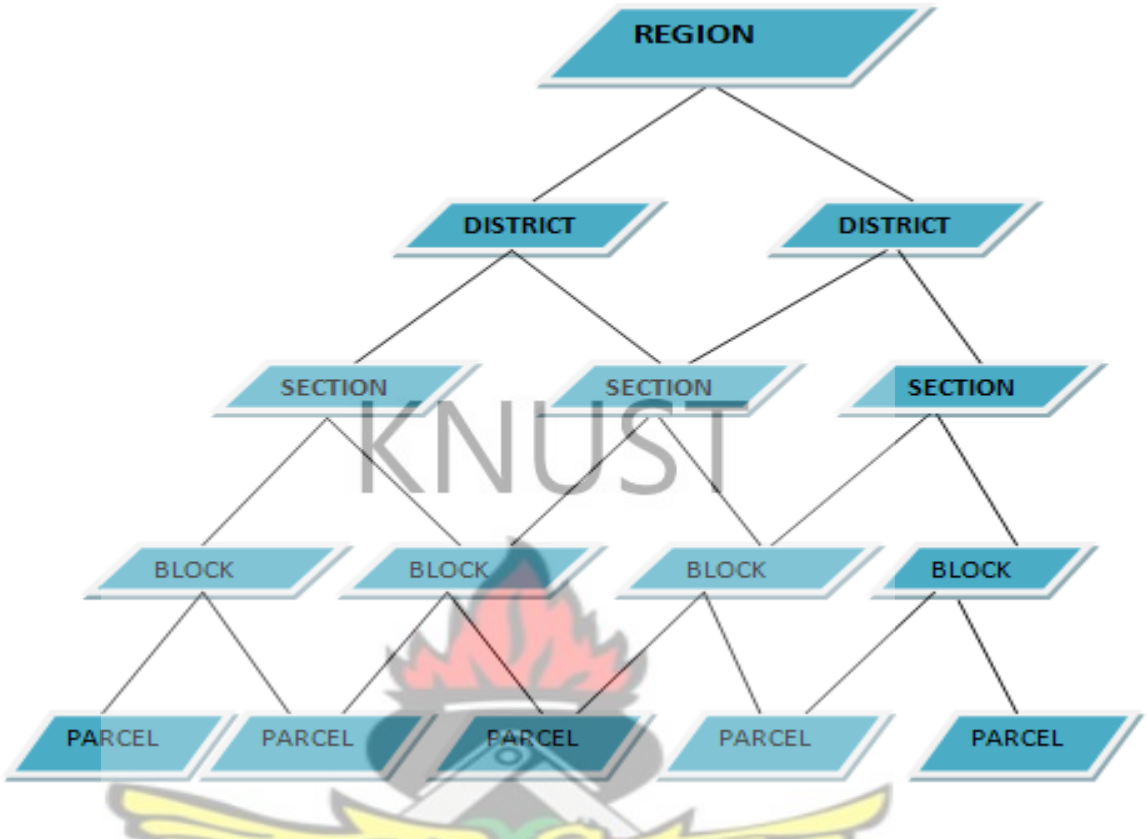


Figure 2.2: The hierarchical structure of data

2.5 The Current State of Digital Data At The Survey And Mapping Division

2.5.1 Land Ownership Data (Sectional Maps)

The most significant land ownership data available in digital format are the sectional maps held by the SMD. These maps show the delineation of land parcels for each Land Title Registration District. A district, comprising one or more sections, is part of a region or area, and is defined (declared) according to the Land Title Registration Law PNDCL 152 of 1986. The parcels within the sectional maps are identified by a unique concatenated fourteen character field (XXDDDSSSBBPPPP) that is comprised of a two character (XX) as a Region Code, three digit District Number (DDD), three digit Section Number (SSS), two digit Block Number(BB) and a four digit Parcel Number (PPPP). All sectional maps within the Greater Accra Region have been digitized by the SMD.

Currently, all land title parcel maps digitized by SMD are in two of the ten regions namely, the Greater Accra and Ashanti Regions. Each region is zoned into Land Title Districts, demarcated into sectional areas (surveyed by licensed surveyors). Each sectional area has an average of 1500 parcels with sectional areas sub-divided into blocks of 30 parcels /Block. To date 7,000 parcels have been surveyed and registered or are in the process of being registered at the LRD.

The following digital datasets are currently held by the SMD in ESRI coverage format or in Autodesk (AutoCAD) .dxf format:

- 1:2500 scale town sheets of urban areas and major towns
- Orthophotos and photomaps of some urban areas and major towns
- National coverage of 1:50000 scale topographic base maps covering the whole country and structured into 102 tiles.
- 1:250 000 digital datasets derived from the 1:50 000 series.

The LAP has contracted to a local company, CTK Network Aviation Ltd, to develop a metadata database of existing geographic, cadastral and other land related information covering the whole of Ghana. The metadata are documented using the international Federal Geographic Data Committee (FGDC) and International Organization for Standardization (ISO) TCI-211 Metadata Standard (ISO

2.5.2 Importance of Cadastral Information in Land Delivery Processes in the Lands Commission

Cadastral maps are an important component of land administration in most countries. In virtually all developed countries, the needs of computerized land and geographic information systems (LIS/GIS) has given urgent impetus to computerizing cadastral maps and creating digital cadastral data bases (DCDB). This process is creating many institutional, legal, technical and administrative problems. This desire to establish DCDBs is being given increased impetus due to a new range of enabling technologies such as satellite position fixing systems such as the Global Positioning System (GPS), improved spatial data collection techniques such as digital theodolites and "soft copy" photogrammetry, as well as a vast range of new information and communications technological tools, thus contributing to the advancement and keeping up with the great countries. The hitherto existing cadastre, consisting of paper maps and land

registers, is now becoming insufficient as its shortcomings force developments leading to its improvement into a Land Information System. A digital cadastral map is the main component of this system. A digital cadastral map can be the basis for additional thematic layers, successively converting it into a complex system for management of administrative units.

2.6 Land Administration and Cadastre in Ghana

Land administration in Ghana generally and cadastral systems in particular involves several divisions under the Lands Commission namely the Survey and Mapping Division (SMD), the Land Registration Division (LRD), the Land Valuation Division (LVD) and the Public and Vested Land Division (PVLD) as well as the Town and Country Planning Department. The focus of this research however is geared towards the operations of the Survey and Mapping Division whose function among others is to take custody of and preserve records that relate to the survey of any parcel of land.

Current registration regimes require the use cadastral plans for land title registration since the promulgation of the Land Title Registration law in 1986 (PNDC Law 152) which seeks to correct the weakness within the Land Registry Act 122 and the Survey Act 127 passed since 1962. Since its inception, large number of scientifically surveyed cadastral plan have been prepared by the Survey Department and other licensed surveyors. The records of such cadastral plans serve as the basis for land registration could well form the basis of a cadastral information system.

These records have however been kept in analogue forms in stores in spite of the development in information technology and its related benefits.

2.6.1 Land Registration in Ghana

The Registry Act 122 and the Survey Act 127 were passed in 1962 to regulate the administration and transaction of land in Ghana. The weakness in these laws did not allow it to yield the expected results. The registration of land with respect to the Registry Act 122 was done with the absence of maps of sufficient scientific accuracy to allow parcels of land to be identified and their boundaries to be ascertained. This resulted in multiple claims of land ownership and widespread litigations due to the fact that there were no documentary proofs by way of title to ownership of a particular well described parcel.

The Survey Act formed to serve the Registry Act also contributed in making the Registry Act ineffective. This was due to the fact that the Survey Act allowed two sets of cadastral records to be created; certified plans which purports to show boundaries of land with accuracy, and giving exact measurements by which the boundaries may be demarcated or of re-demarcated on the grounds with such plans or maps being certified by a licensed surveyor, and a cadastral plan purporting to show boundaries of land with accuracy and giving exact measurements by which the boundaries may be demarcated on the ground such maps or plans being made in conformity with the result of a survey carried out by an Official Surveyor or Licensed Surveyor to be certified by him and requiring whether made by an official surveyor or by a license surveyor to be approved by the Chief Survey Officer or any person appointed by him for that purpose. The effect of this was the fact that certified plans are at most times not accurate because they are done by merely tracing with protracted bearings and scaled distances from topographical maps, town sheets or unapproved layout schemes which are submitted by draughtsman and signed for a fee by some unscrupulous licensed surveyors (Fosu & Derby, 2006).

The promulgation of the Land Title Registration law in 1986 allow certified plans to be approved by the Director of Surveys alone and to be attached to instruments for registration. This was to achieve its main aim of providing proof of certainty of title to ownership. This means that cadastral plans are done with sufficient positional accuracies to prevent dispute of boundaries (Fosu & Derby, 2006).

2.6.2 Institutions Involved in Land Administration and Cadastre

Cadastre and Land administration in Ghana involves several land sector agencies. Institutions involved in land administration and cadastre is shown in Fig.3.2.

The Ministry of Lands and Natural Resources is the sector Ministry entrusted with the management of Ghana's land, forest, wildlife and mineral resources. The vision and mission of the ministry as far as land resources are concerned is to ensure sustainable management and utilization of Ghana's lands for socio-economic growth and development. This is achieved through efficient formulation, implementation, coordination, monitoring and evaluation of policies and programmes of sector agencies and through efficient and equitable land delivery (MLNR, 2013).

The minister responsible for Lands and Natural Resources in consultation with the Chief Registrar of the Land Registration Division and the Director of Survey and Mapping Division are mandated under the Land Title Registration law to declare districts known as Registration Districts to be demarcated and surveyed for the purpose of land title registration. Cadastral data collection is then initiated in these areas to produce sectional maps for land title registration.

These roles are carried out through the land sector agencies shown in Figure 2.3 and the roles of each sector are discussed in the preceding sub-sections.

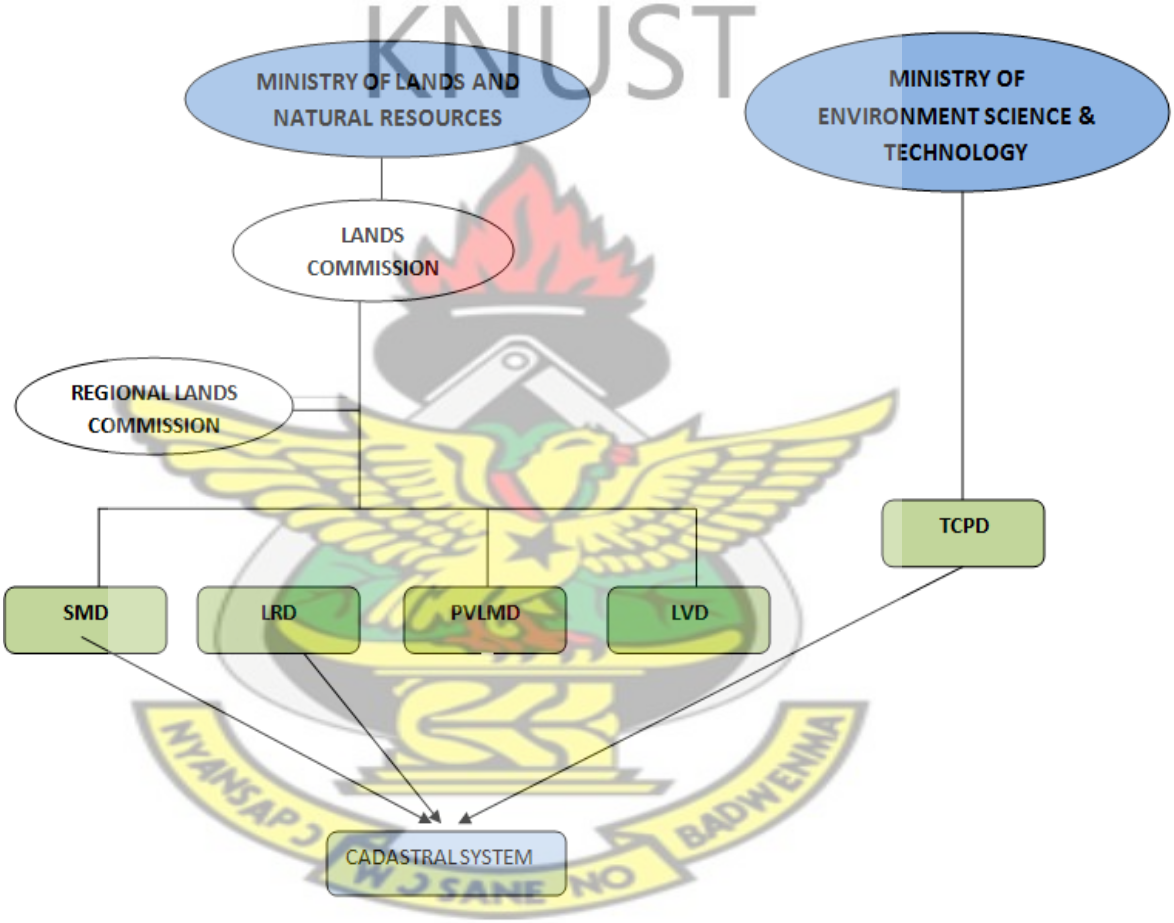


Fig.2.3 Institutions involved in Land Administration and Cadastre in Ghana

2.6.3 Town and Country Planning Department (TCPD)

The Town and Country Planning department is one of the major land sector agencies in Ghana. Although it is not under the Ministry of Land and Natural Resources, it plays a very important role as far as cadastre and land administration in Ghana is concerned. The department is charged with the duty of preparing land use layout schemes prepared on the large scale maps prepared by the national mapping agency or

by a licensed surveyor, for planning purpose. Setting out of the scheme on the ground is then carried out by cadastral surveyors (Fosu & Derby, 2006).

2.6.4 Land Registration Division (LRD)

The role of the Land Registration Division is to publicize notices of registration upon receipt of an application for registration, registration of title to land and other interests in land and the registration of deeds and other instruments affecting land in areas outside compulsory title registration districts. In registering a title to a parcel of land, a cadastral plan for the parcel of land should be produced to be used for the registration. Thus maintenance of cadastral records both in spatial and non-spatial extent could form the basis of land information for the purpose of land registration.

2.6.5 The Survey and Mapping Division (SMD)

The Survey and Mapping Division is the national mapping agencies tasked to supervise, regulate and control the survey and demarcation of land for the purposes of land use and land registration. It is also responsible for taking custody of and preservation of records that relate to the survey of any parcel of land. It is also charged with the responsibility of directing and supervising the conduct of surveys, coordinates the preparation of plans from the data derived from survey and any amendment of the plans. Again the division is responsible for mapping and maintaining the national territorial boundaries including maritime boundaries, supervises and regulate operations that relate to survey of any parcel of land, develop and maintain the national geodetic reference network for the country and supervise, regulate, control and certify the production of maps.

The Survey and Mapping Division has its headquarters in Accra and is headed by the Director of Survey and Mapping of the Commission .The Director of this division is also represented in all regional offices by regional surveyors who in turn are also represented in the districts by district surveyors across the entire country.

This research is focused on the operations of the Survey and Mapping Division of the Lands Commission in the light of managing records, thus the workflow or the business processes involved in their operations are discussed in the subsection that follows.

Chapter 3: RESEARCH MATERIALS AND METHODS

3.1 Study area

The study area for this research covers the Ashanti Region of Ghana (Figure 3.1). The region is centrally located in the middle belt of Ghana and lies approximately between latitudes 5° 50' and 7° 40' North and longitudes 0° 13' West and 2° 30' West. The total area of the land is 24,389 km². The region is administratively divided into 30 districts. Each district within the region has also been subdivided in sections in order to allow cadastral mapping to be done in a section-wise manner.

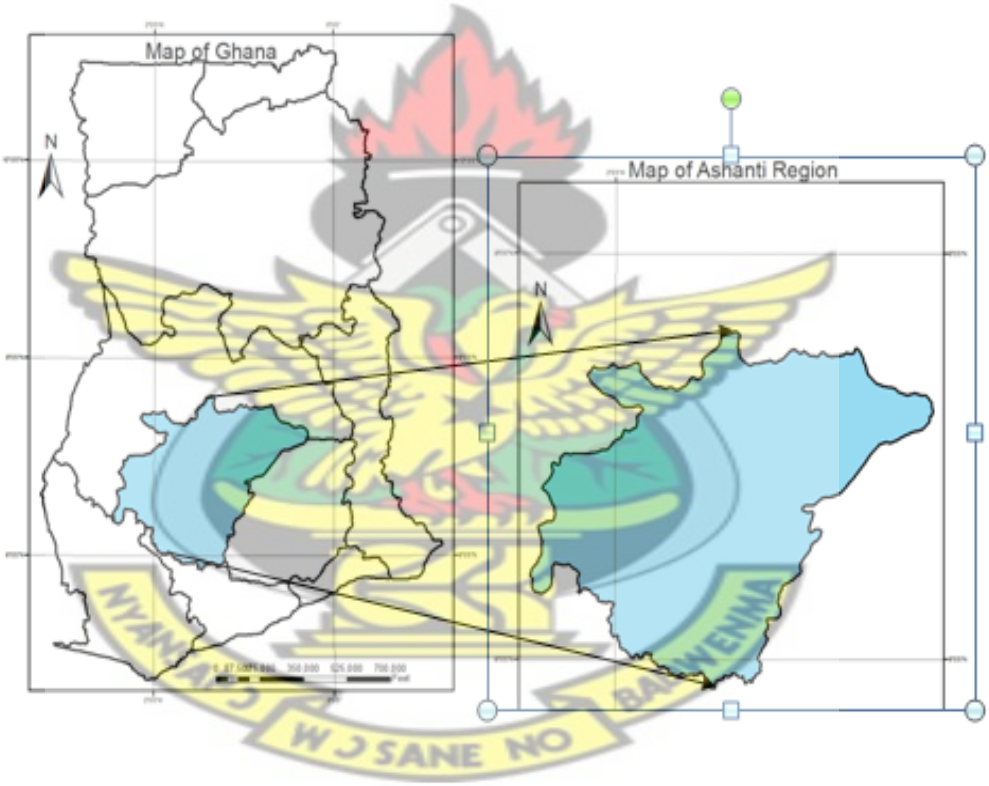


Fig. 3.1 Study Area

3.2 Materials used

The following materials were used

i. Topographic map of Ashanti Region (secondary data) obtained from aerial photograph in year 2000

ii. List of reference controls in the region obtained from the Regional Survey and Mapping

iii. Town sheet of Kumasi and its environs from the Regional Survey and Mapping Division.

iv. Samples of approved cadastral plans with spatial and thematic characteristics were obtained from the regional Survey and Mapping.

v. Data input form and samples of records captured in excel files.

3. 2.1 Software

i. Visual Studio for creating user interface that allows data capture, retrieval and analysis
ii. MS Excel and Microsoft Access
iii. ArcGIS for data preparation
iv. MySql database server

3.3 Research Methodology

The research methodology is categorized into four main stages namely, examination of the existing processes of data capture, storage, retrieval and analysis; Analyzing the deficiencies and challenges of the existing processes; Proposing a new system that will efficiently enhance existing processes in data capture, storage and retrieval and ; creating a prototype system for the proposed process.

3.3.1 Existing Processes at the Division

A business process is a collection of activities designed to produce a specific output for a particular customer or market. It implies a strong emphasis on how the work is done within an organization. A process is thus a specific ordering of work activities

across time and place, with a beginning, an end, and clearly defined inputs and outputs. The Ashanti regional survey and mapping division of the Lands Commission has a set of activities which it undertakes. Figure 3.2 gives a workflow of the business processes at the Ashanti regional survey and mapping division of the Lands Commission.

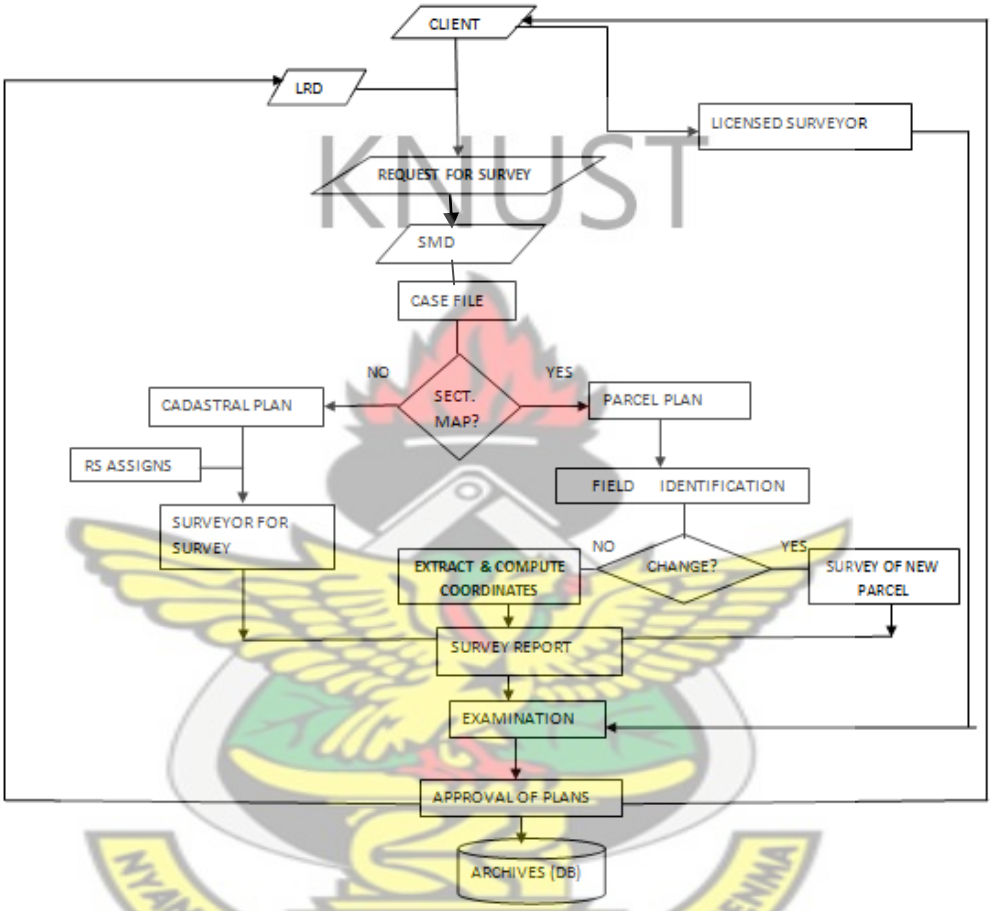


Fig.3.2 Workflow for Cadastral Processes at the Regional SMD

Client/Registry Section

A client applying for a cadastral plan for other purpose other than for land registration can apply through the division or through a licensed surveyor. Cadastral plans on the other hand which are intended for land title registration is initiated in the SMD by an application from the LRD. The application consists of an official application letter from the LRD and a site plan prepared by a licensed surveyor. This type of

application is brought into the SMD by the applicant. The application is received in the SMD's Registry Unit. Requests for cadastral plans for other purpose other than land registration are assigned to official surveyors for field survey by the Regional surveyor. Plans intended for land registration goes through a different process. Here the receiving officer checks the site plan against the land title sectional map to see whether there are already surveyed sectional maps covering the application area if not, then it might require a separate cadastral plan survey. In either case a case file is opened for the request. The receiving officer then looks for an official letter and LRD lodgment number and survey plan approved by the Director of SMD.

After the application has been received, the receiving officer opens a case file containing the information in Table 3.1. In most cases the application is about registration of new land or the transfer of already registered land.

Table 3.1: Case file

Columns	**Description**
Date	Date received
LRD lodgment No.	Number form LRD
Date	from LRD
Name and Address	of applicant
Amount paid	
Receipt No	
Telephone No.	of applicant
Regional Number	For the cadastral plan
Dist/Sect Map. No	For parcel/title plan

Applications emanating from sites located within a sectional map are treated as parcel or title plans and are sent to the examination section. Also those outside a sectional map are treated as cadastral plans and are sent to the regional surveyor to be assigned to an official surveyor for field survey.

Field Identification and Survey

An official surveyor is assigned to visit the site with the applicant and to survey the parcel. After the survey the surveyor provides the results with information showing the history of survey on the property, a report indicating if there is a shift in the boundaries of the parcel, a diagram of the survey, plan data of the parcel, bearings and distances calculated from the coordinates, the beacon or survey mark index and the results of a GPS survey if done.

Examination Section

The survey record is then submitted to the examination section of the Regional SMD for checking. The checks at examination section ensures that the quality of the survey output is acceptable and within the national mapping standards.

Cartographic and Digital Section

The role of the cartographic section is to draw maps and plans and also to ensure that plans or maps submitted to the department for approval conform to national and international cartographic rules and standards. The digital section is also responsible digital plotting and database creation for all geographic datasets. This involves the update of existing sectional maps (subdivision or surveyed parcels within the sectional map) and sporadically surveyed plans. This will in effect serve as a data source for reproducing plans or maps.

Approval of Plans

According to LI 1444 all plans attached to instruments for registration should be approved by the Director of SMD or his representative. The Director of Surveys or his representative thus appends his signature to the plan if he is satisfied that the plan is accurately produced as sign of approval. The signed plan is returned to the LRD for further action.

Licensed surveyors therefore submit records and plans of their completed surveys to the Regional Surveyor for checking and approval of the plans on behalf of the Director of SMD. These approval record copies are kept by the Regional Surveyor.

Other Tasks

Strata plans are prepared for apportionments when the property in question is a unit in a multi-storey building. The space occupied by the building is then surveyed to show the floor plan. Each floor or flat is labeled accordingly and indicated in the strata plan by a schematic diagram to show which floor or flat is being referred to. The survey is done by the surveyors in the field Section while the plotting is done manually at the Cartographic Section. The lithographic section prints the resulting manually plotted plan, and indeed all large scale plans for the SMD.

Disputed surveys are handled by the Disputes Surveys Unit under the Examination Section. Plans resulting from disputes surveys are known as composite plans. These are presented to the courts by officers of the Disputes Surveys Unit. Also requests for surveys received from government institutions are done here and plans or maps resulting from the surveys are submitted directly to the agencies concerned for further action.

3.3.2 Datasets held by the Division

The following data are held by the division

Records of cadastral surveys approved by the division. These records have been kept both in hard and soft copy formats. A Data input form (Figure 3.4) which is a hardcopy format is added to the file containing the copy of the plan, history of survey, a diagram of the survey, plan data of the parcel, bearings and distances calculated from the coordinates, the beacon or survey mark index and the results of a GPS survey. These files containing individual cadastral plans are stored in shelves inside a store room. The softcopy format is made up of the title, locality, district, beacon index (parcel coordinates) as well as the reference control coordinates saved in an excel file shown in Figure 3.3. Each cadastral plan by this recording system has an excel file saved in a district folder for which the parcel is situated. The regional number for each cadastral plan is used as a filename for its corresponding excel file. The current recording process for cadastral survey records in the region is inefficient and ineffective.

	A	B	C	D
1	TITLE: ELIAS KWAKU SEIDU & FLORENCE MANU (MISS)			
2	LOCALITY: BOKO			
3	DISTRICT: ATWIMA NWABIAGYA			
4				
5	STATION	X(NORTHEN)	Y(EASTERN)	REMARKS
6	SGA A001/2012/1	733661.320	673269.519	REFERENCE
7	SGA A001/2012/2	733661.126	673177.791	REFERENCE
8				REFERENCE
9				REFERENCE
10				
11				PARCEL CORNER
12	SGA B104/12/1	722895.760	642292.660	" "
13	SGA B104/12/2	722875.240	642271.450	" "
14	SGA B104/12/3	722863.850	642202.120	" "
15	SGA B104/12/4	722944.580	642202.380	" "
16	SGA B104/12/5	722956.470	642292.070	" "
17				

Figure 3.3: Cadastral record in excel file format (Source: Ashanti Regional SMD)

CO-ORDINATES INPUT FORM

TITLE:.....

LOCALITY:.....

DISTRICT:.....

ACREAGE:.....

DATE APPROVED:.....

SURVEYOR:.....

STATION	X(NORTHERN)	Y(EASTERN)	REMARKS
			REFERENCE
			"
			"
			"
			PARCEL CORNER
			"
			"
			"
			"
			"
			"

Figure 3.4: Data Input Form (Source: Ashanti Regional SMD)

The absence of a common digital dataset with the cadastral plans does not exist at this point in time;

i. Sectional Maps and Town Sheet available at the Ashanti regional SMD are held at the digital section in softcopies in AutoCAD drawing format (i.e. .dwg, .dgn and dxf file formats).
ii. Large scale topographic map of Ashanti region both in hard and soft copy formats. Again the softcopy is in AutoCAD drawing format (i.e. .dwg, .dgn and dxf file formats).
iii. administrative boundary maps in hardcopy format;
iv. List of all reference pillars within the region in both hardcopy and softcopy (excel file) formats.
v. These sets of geographic data are also unrelated

3.4 Analysis of the Weaknesses and Challenges of the Existing System

Many activities such taxation, land conveyance and legal protection for land tenure are all dependent on cadastral information thus the management and maintenance of cadastral records in cadastral organization plays an importance role in land delivery. The advent of Geoinformation technology has also improved the traditional way of maintaining and managing cadastral records. Geo-ICT has provided a means of converting analogue cadastral records to digital format which has helped in the development and the supply of product and services as well as maintaining and managing cadastral records in an effective and efficient manner.

The analysis of the existing business processes has detected several deficiencies and challenges in the areas of data storage and management at the Ashanti Regional SMD. These are outlined as the:

i. absence of a common system which integrates all forms of data held by the division
ii. difficulty in retrieving and managing archived cadastral records
iii. Inability to forecast or detect future conflicts resulting from overlap of sporadically surveyed plans since they are not coordinated.
iv. Inability to support analysis and decision making.

v. Inability to support data sharing or transfer among different land sector agencies.
vi. Inappropriate means of representing or recording geographic data sets
vii. Lack of support for development of customized application to enhance effective and efficient system
viii. Failure to provide a geographic database as a data source central to effective land administration.

3.5 The Proposed System

Users' requirement is very crucial in the development of any system. The lack of users' requirement could explain the suffering of cadastral organizations in the development of services and specifications of the cadastral organizations. Dale 2003 stated that cadastral systems that have been built from bottom up, from traditional tenures through to user driven access to local land registration system, almost always fail. Thus a careful analysis was conducted and inputs were made from cadastral administrators, users of cadastral data and customers with the purpose of identifying whether these stakeholders are satisfied with existing system, identify critical information required in developing the new system and also to identify the user needs.

The new system proposed is based on the analyses of the deficiencies of the existing system and the user requirements. It is mainly focused on four (4) functionalities namely data capture, storage, retrieval and analysis. The following components were then used in the design of the proposed system.

3.5.1 Creating the Prototype / System Design.

The system design was based on the flowchart presented in Figure 3.5. This involves the integration of foundation data namely; Large scale topographic map of 1:50000 scale, town sheet of 1:2500, parcel/sectional maps of 1:2500 as well as geodetic controls. These maps were brought to a common platform in terms of scale and data standard in order to allow them to be shared among different land sector agencies. Sporadically surveyed parcels containing both spatial and non-spatial information together with other additional document (scanned copy of cadastral plan) were prepared for its capture and subsequent overlay with the foundation data.

A custom application was then designed whose main functions were to;

i. Capture both the spatial and non-spatial data for the sporadically surveyed parcels (cadastral plans)
ii. Update existing parcel plans on sectional maps
iii. Create a data repository for all data sets
iv. Display the captured data within a map display environment
v. Allow effective retrieval of data stored through structured queries
vi. Provide support for analysis and effective decision making

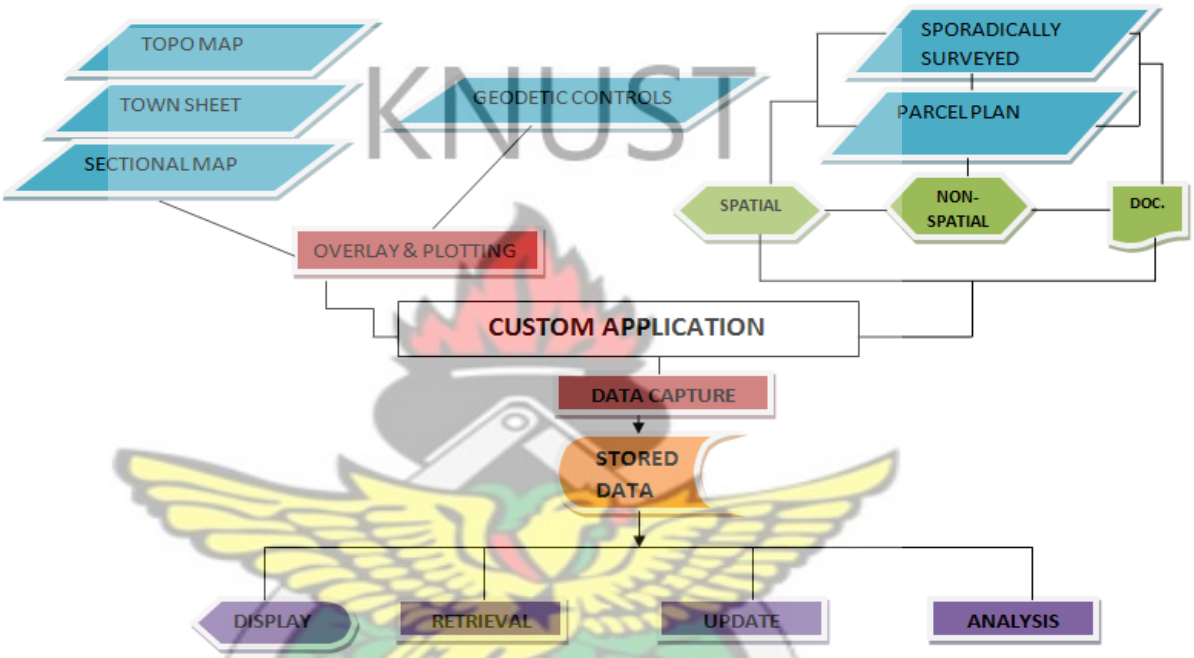


Figure 3.5: Conceptual Framework of the Proposed System (Source: Author's construct)

3.5.2 Organization of Cadastral Records into Administrative Boundaries

The organization of cadastral records is done with the cadastral plan being the basic spatial unit. Several of these spatial units (parcel) are aggregated to form a block. Several blocks are also aggregated to form a sectional area (map) and the later is subsequently aggregated to constitute a district. The HSR theory was employed in the organization of these geographic data sets. The hierarchical structure (Figure 3.6) gives a pictorial view of how the building blocks (cadastral data) are organized.

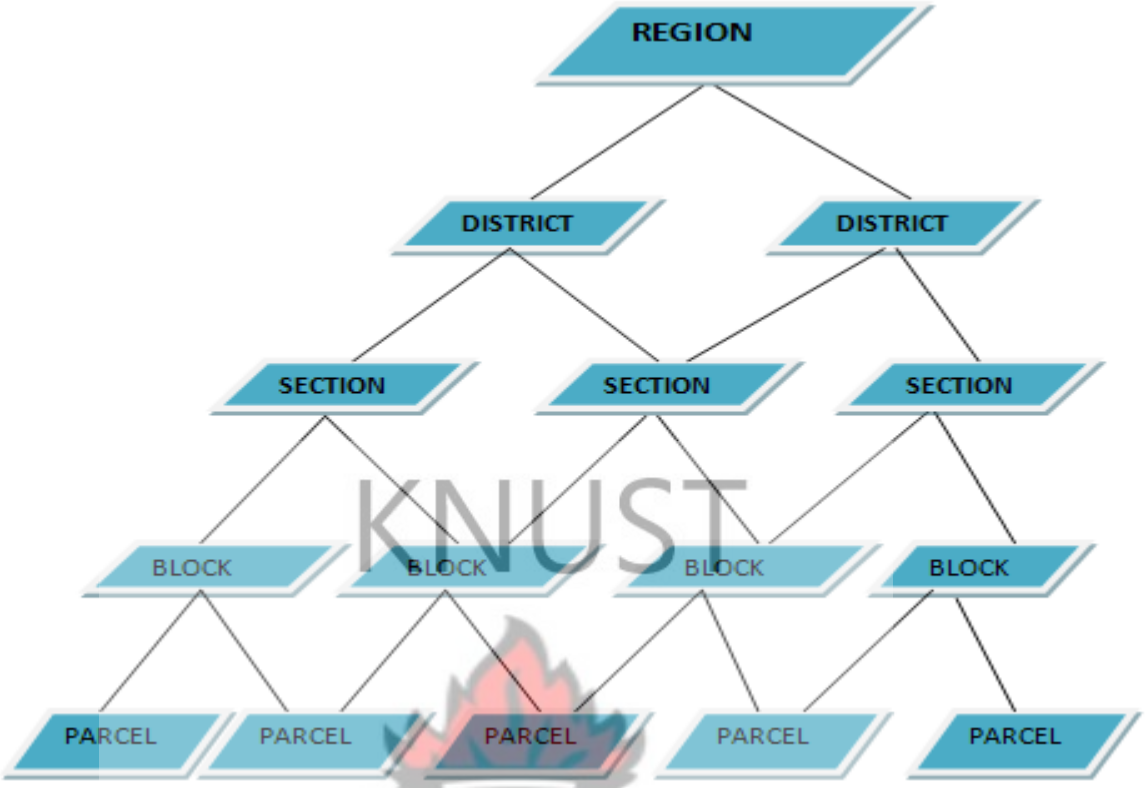


Figure 3.6: Hierarchical structure (Source: Author's construct)

The road, hydrographic and other important layers that form a topographic map were then overlaid. This operation was done at each stage or level within the hierarchy. The Union operation combines selected features into one new feature. Although the features may be from different layers, the layers must be of the same geometry type either line or polygon. Union maintains the original features and their attributes that is, the selected features are not deleted or edited during Union. The new feature is created in the current target layer with no attribute values.

3.5.3 System Development

The primary designed architecture, conceived was to develop an application similar to most desktop GIS applications. This includes the Main Menu, Toolbar, Legend Window, main Map Display and the Cadastral database page. The Map Display will always be opened, the Legend Window displaying all features, active and inactive, concerned with the map in the current project. The Main Menu and Toolbar contain functions to manage projects and manipulate and query the database. The main Software used was Microsoft Visual Studio 2008 and selected programming language was Visual Basic (VB.NET)

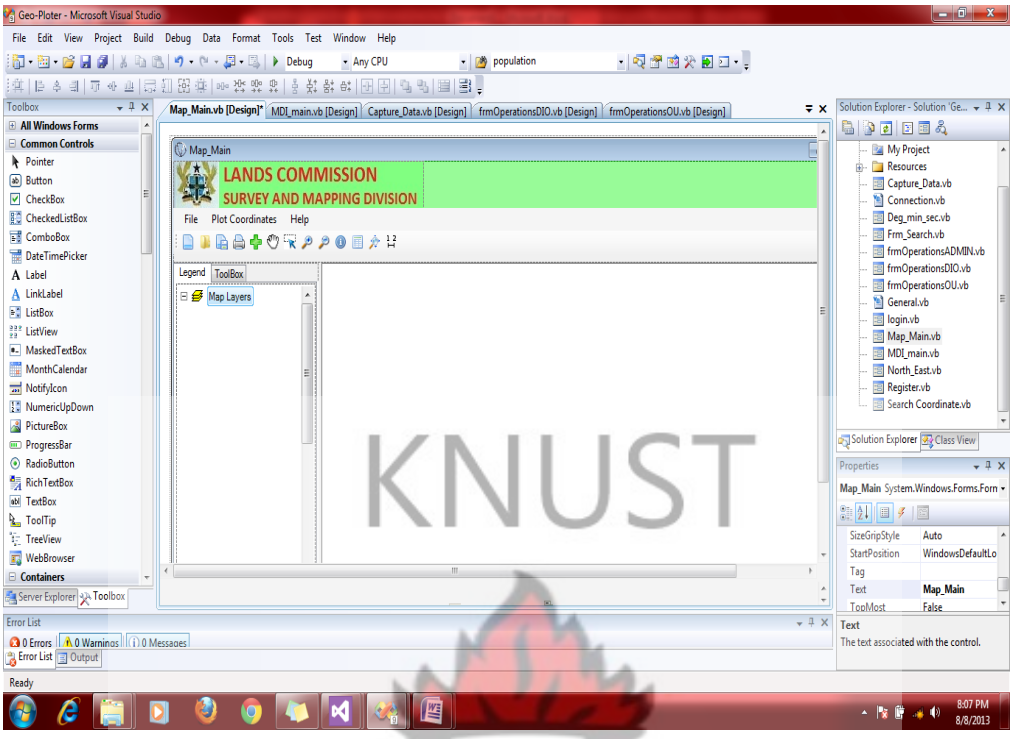


Figure 3.7: (Front end) Application design window (Source: Author's construct)

From the Figure 3.7, the control selected for displaying the map is known as MapWindow 6 ActiveX control. This is the newest version of a highly customizable open source GIS package, and it was chosen for the under listed reasons.

- ◊ It is an open-source alternative desktop GIS
- ◊ It allows distribution of data to others
- ◊ It allows development of functional custom spatial data analysis tools.

Features of MapWindow 6

- ◊ As an open-source tool, MapWindow is free to use and redistribute to the user clients and other end users. It may also be modified to fit the user needs, or embedded into proprietary software. MapWindow is an open source "Programmable Geographic Information System" that supports manipulation, analysis, and viewing of geospatial data and associated attribute data in several standard GIS data formats. MapWindow is a mapping tool, a GIS modeling system and a GIS application programming interface (API) all in one convenient redistributable open source solution.

- ◊ MapWindow is more than just a data viewer. It is an extensible geographic information system. This means that advanced users or developers can write plug-ins to add additional functionality (models, special viewers, hot-link handlers, data editors, etc) and pass these along to any number of the user's clients and end users.
- ◊ MapWindow includes standard GIS data visualization features as well as DBF attribute table editing, shapefile editing, and data converters. Dozens of standard GIS formats are supported, including Shapefiles, GeoTIFF, ESRI ArcInfo ASCII and binary grids.

Connection within the System

The separation of systems into front and back ends simplifies development and separates maintenance. A front end (Figure 3.7) also known as the client side simplifies the underlying component by providing a user-friendly interface whereas the back end (Figure 3.8) or the server-side is the code that supports the front end, like databases access and controls manipulations made by users. A connection is the created between these two components using a connection object.

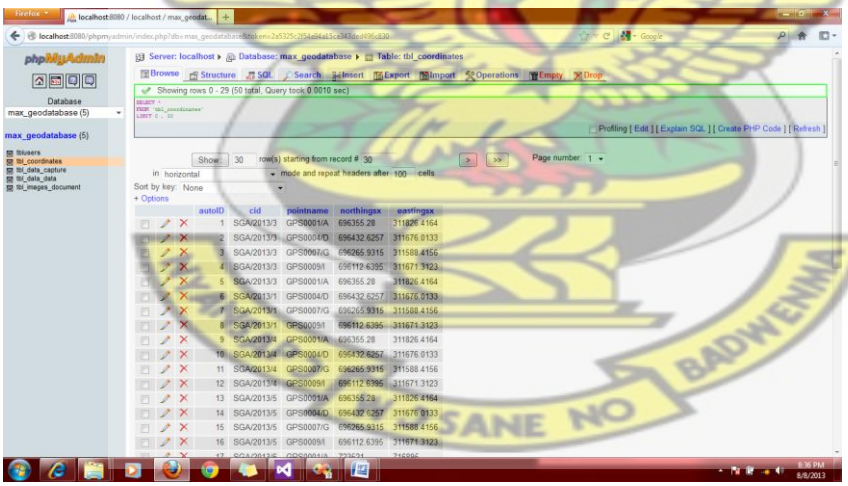


Figure 3.8: (Back-end) Cadastral Database page

Connection Object

The Connection Object is what is needed when connecting to a database. There are a number of different connection objects, and the type used depends largely on the type

of database being connected to. The `MySqlClient` was used as the connection object. This allows connection to data sources in general, and not just databases.

Setting a Connection String to cadastral database

There are Properties and Methods associated with the Connection Object, or with the Connection String property. The following procedures were conducted to link users to the cadastral database:

i. Create a new Object Connection.

ii. Pass technology used in building the database as well as the location of the database.


```
dbServer = "server=" + server + ";"
dbuser = "user id=" + user + ";
dbpassowrd = "password=" + password + ";
dbserverport = "port=" + port + ";
dbSource = "database=" + database + ";
con.ConnectionString = dbServer & dbuser & dbpassowrd & dbserverport & dbSource)
```

3.6 Packaging

It is necessary for an application created using Visual Studio.NET to be packaged and distributed as an installable (or deployed) program which a user can use on a different machine and/or platform. Installation of an application involves the creation of a folder structure on the end user's computer, and then some modifications to the registry are made by the application so that the application runs successfully. In Visual Studio.NET applications, the common language runtime (CLR) files are made available by the installation program for successful execution of an application.

Visual Studio.NET provides the following three types of installation programs:

1. Microsoft Windows Installer files
2. Merge modules
3. Cabinet files

Microsoft Windows Installer files, also known as MSI (Microsoft Installer) files, help install applications by using the Microsoft Installer service introduced with Microsoft Windows. This service was introduced by Microsoft to optimize project deployment, enabling a re-installment of application files that may have been accidentally deleted without adversely affecting the application. When compiling a deployment project for a Windows application, Visual Studio.NET creates an MSI file that includes the .NET runtime files required to execute the application.

Merge modules are created for packaging components that need to be shared across applications. An example is where a set of dynamic link library (DLL) files are required for use in three applications.

Cabinet files are used to package ActiveX controls that a user can download and install from a Web site. One can create a CAB file with the help of the basic support provided by Visual Studio.NET.

Among these three Microsoft installer (MSI) was chosen for deploying/compiling the project.

Chapter 4: SYSTEM VALIDATION AND TESTING

This chapter presents how the developed system operates. The validation and testing have been categorized into stages namely; application compilation, installation and system operation. The system's performance was tested and its impacts on improved cadastral business process in areas of data storage evaluated. Data selected from the current system were used as test data for testing and evaluation process.

4.1 System Installation

Compiling checks were done to make sure that the application has been packaged correctly. These checks include installation of the application on a test computer by performing the following steps:

- ◊ Double-clicking on the MSI file to start installation. Verifying that the Welcome screen
- ◊ Click on the Next button to continue. Verify that the License Agreement screen
- ◊ Select "I Agree" option to accept the license agreement and then click on the Next button. Note that the "Next" option is disabled when the "I Agree" option to accept the license agreement is not selected. Verify that the "Select Installation Folder" screen
- ◊ To install application in the Default folder by clicking on the Next button. Verify that the Confirm Installation.
- ◊ Click on the Next button to install the application. Verifying that the Progress screen appears.

4.2 System Operation

This application is intended to achieve the following functions; to provide a platform for capturing cadastral survey records and records of all geodetic controls, provide a means of integrating all geographic data sets held by the division, to provide a geographic representation of data captured in a map view and finally to manage stored records. These functions are carried out at the front-end of the application through a graphic user interface (GUI).

4.2.1 Log in Page

The log-In Window is the first window that pops out when the application starts operation. This is presented in Figure 4.6. This grants user access to the system based on a required credential and then assigns rights and privileges to each user-type. This application has three (3) users namely; the administrator, the data input officer and an ordinary user. The rights and privileges of each user is presented in table 4.1

Figure 4.1: The Log-In Window

Table 4.1 Users' rights and privileges

User	**Rights**
Administrator	Access to all operations
Data Input Officer	Data Capture, querying and view results for both cadastral and geodetic controls record
Ordinary	querying and view results for both cadastral and geodetic controls record

Access is granted when the user provides the system with correct credentials. The type of user is selected by clicking option button against the user type. Two textboxes

pops up on the log in form. Providing the appropriate username and password in their respective textboxes opens the application. The administrator credentials were used for the purpose of testing this system as shown in Figure 4.2. The users' rights and privileges are presented in Table 4.1.

Figure 4.2: Administrator's log in page

4.2.2 The Map View

The Map View (Figure 4.3) provides the display window where geographic features are visualized. Data set can be opened in the display by clicking on the "Add data button" . When the Add Map Layer window opens, navigate to the data directory where the datasets is, and then click on the dataset the user wants adds it as a new layer in the project.

To add multiple layers at once, hold down the control key and select each addition layer by clicking on it as shown in Figure 4.4.

Click the [OPEN] button. The new layer/s will be added to the project in the Map View.

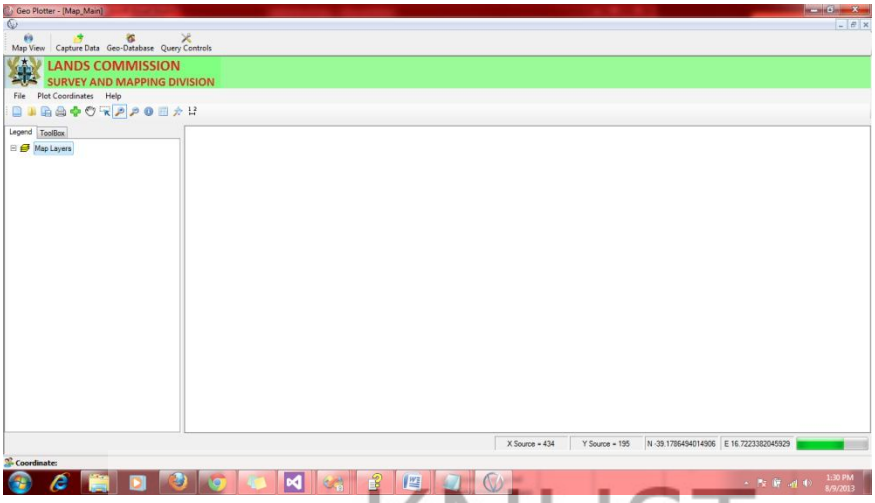


Figure 4.3: Map View Window

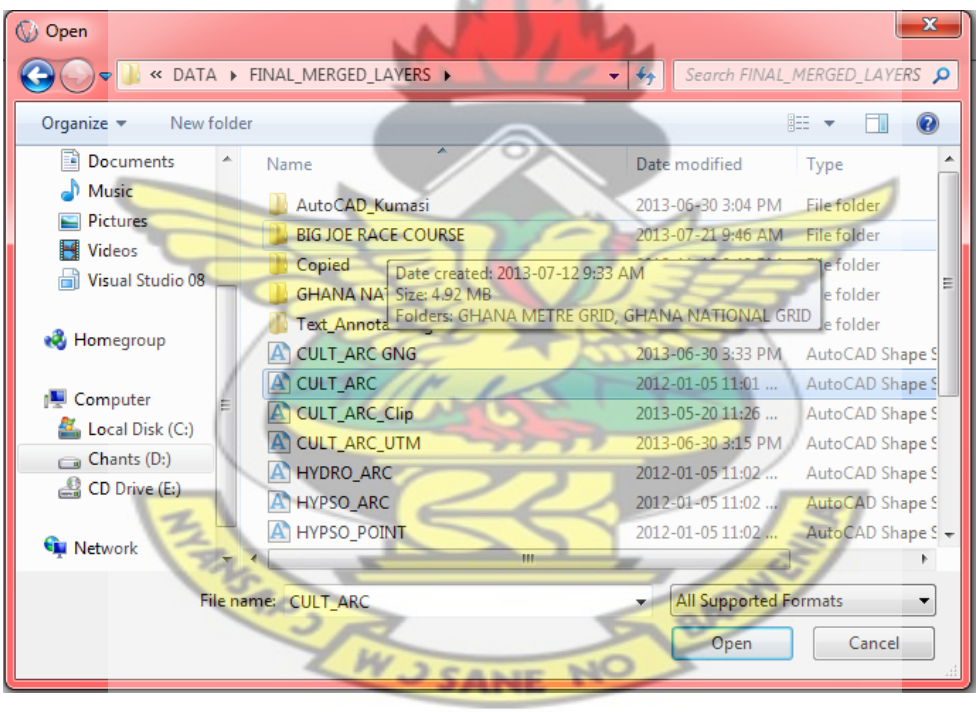


Figure 4.4: Opening a GIS data

The presence of visualization tools on the Map View enables user to have viewing controls over the datasets being visualized.

Panning allows the user to move the map display around to show areas outside of the current viewing area without changing the scale of the map. This is activated by clicking the button on the Tools toolbar (Pan), holding down the left mouse

button as it is moved to observe the map move with the mouse. The pan operation is completed by releasing the mouse button.

The Zoom in button  on the Tools toolbar, zooms in to a specific area. Click and hold the left and drag a rectangle to create the area the user wish to zoom to. The mouse button is released to complete the zoom.

The zoom out  button is used to effect a zooming out instead of zooming in.

Zooming to Full Extent  resets the map view so that every feature of very layer is contained within the visible extent.

The toolbar is presented in Figure 4.5.

Figure 4.5: Visualization Tools in the toolbar

Another useful tool in the Map View is the "Plot Coordinate" on the application's menu. This allows users to plot both geographic and projected coordinates in the Map View. Clicking on that menu provides the option to either plot geographic or projected coordinates (Figure 4.6).

Figure 4.6: Plot Coordinates' menu

Clicking on the “Add (N, E)” opens “Plotting Plane Coordinates” window in Figure 4.7. This allows the user to either load coordinates from .csv file or manually input coordinates to be plotted either as point or polygon shape in the Map View.

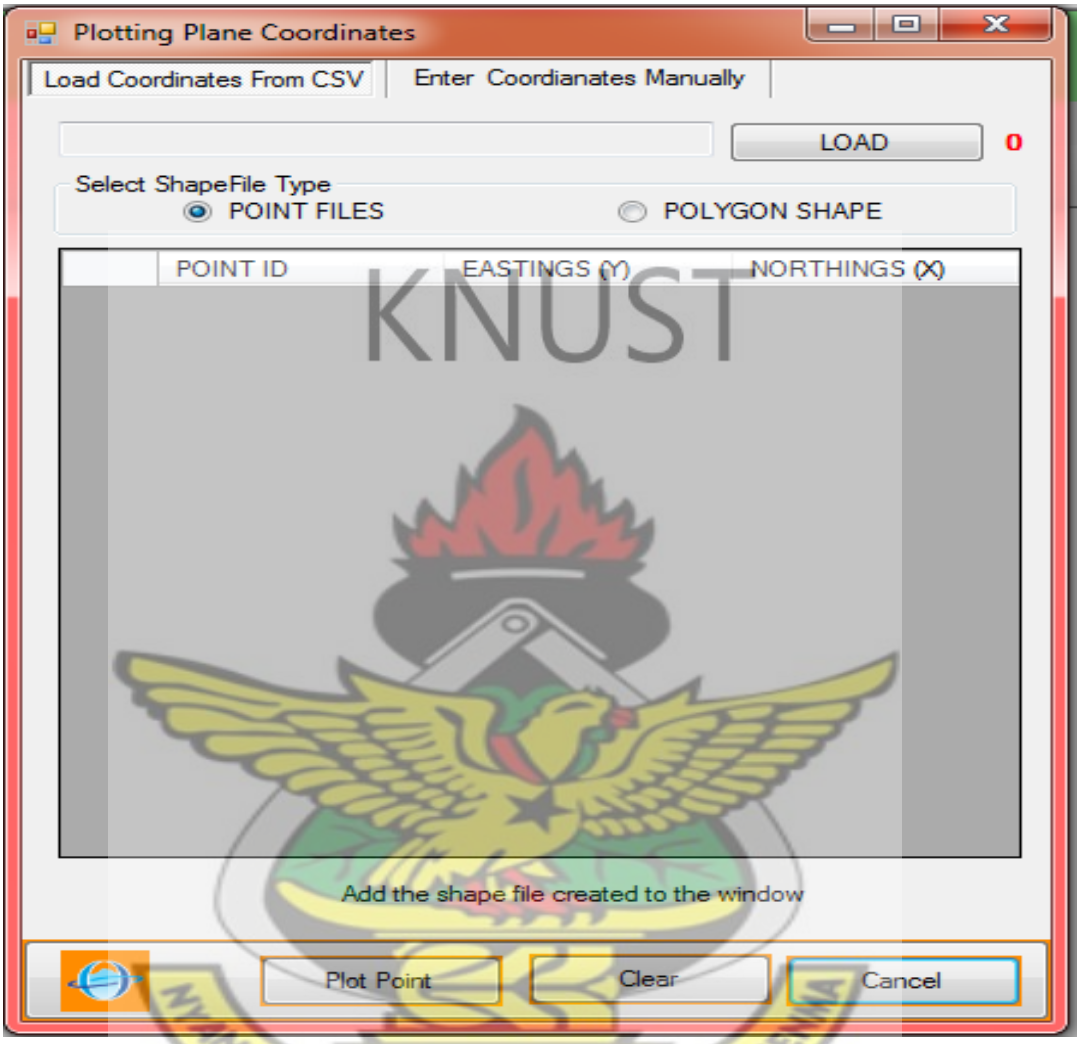


Figure 4.7: Plotting Plane Coordinates

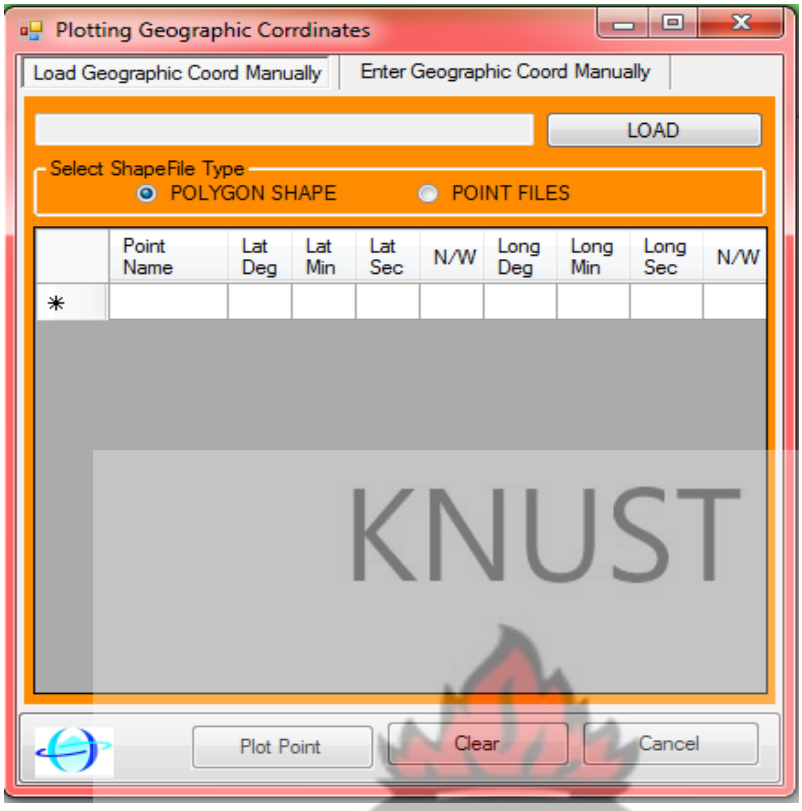


Figure 4.8: Plotting Geographic Coordinates

Clicking on the "Add Lat/Lon" opens the "Plotting Plane Coordinates" window in Figure 4.8. This also allows the user to either load coordinates from .csv file or manually input coordinates to be plotted either as point or polygon shape in the Map View.

4.2.3 The Capture Data Window

Four major operations are carried out at this interface. These include the following

i. Attribute data entry known in this application as Personal Information (Figure 4.9)

ii. Spatial data entry known in this application as coordinates details (Figure 4.10) platform for attaching document e.g. Cadastral plan (Figure 4.11).

iii. Geodetic controls database

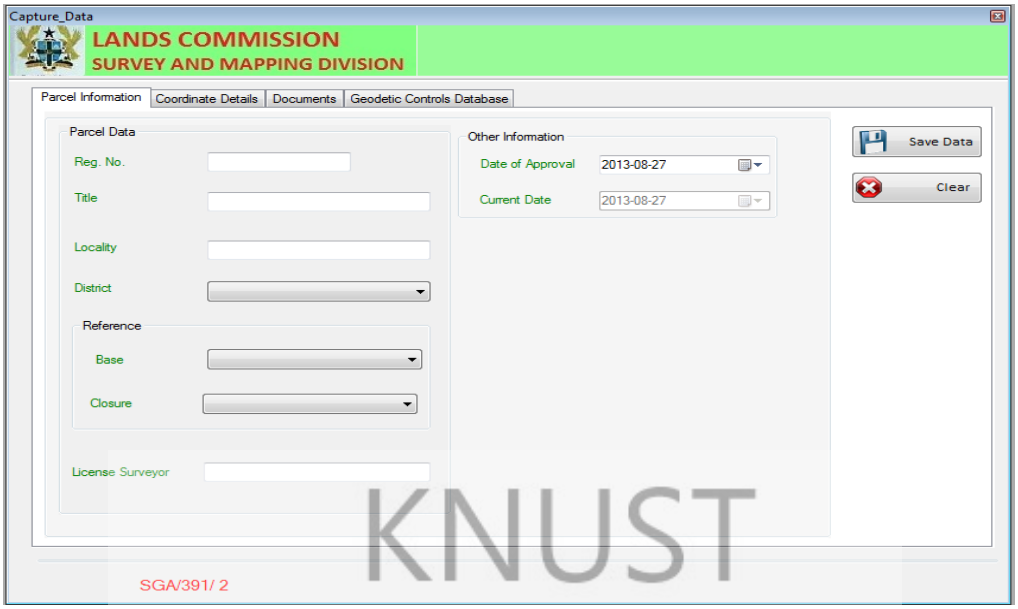


Figure 4.9: Attribute Data Entry

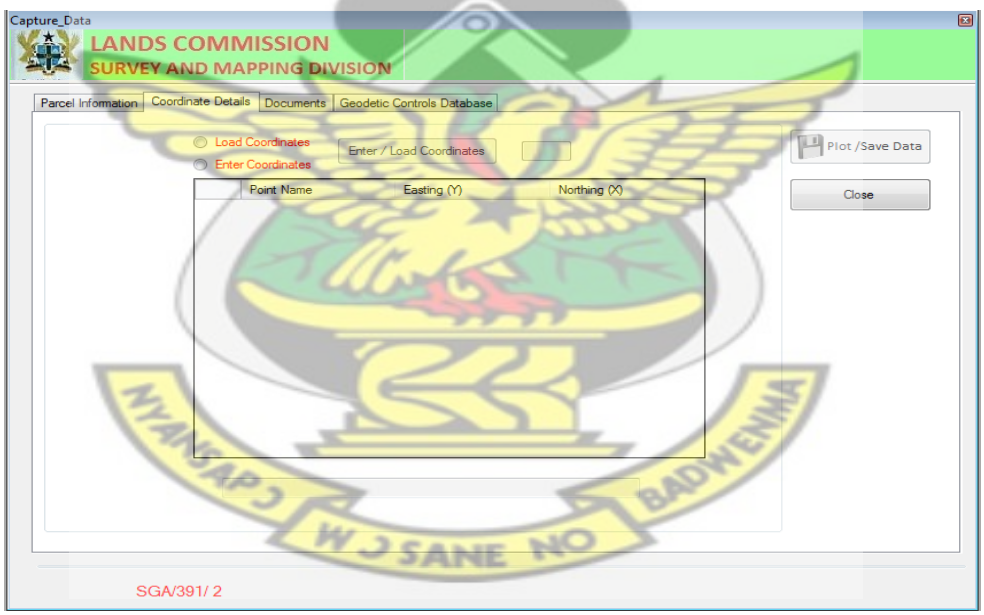


Figure 4.10: Spatial Data Entry

A sample of approved cadastral plan in Figure 4.11 was used as a test data for data entry. Spatial data entry involves the entry of beacon index that is parcel corner coordinates into the system. These coordinates are then used in geographically representing the parcel in the Map View window. Below is an illustration for the cadastral record capturing process in Figures 4.12 and 4.13.

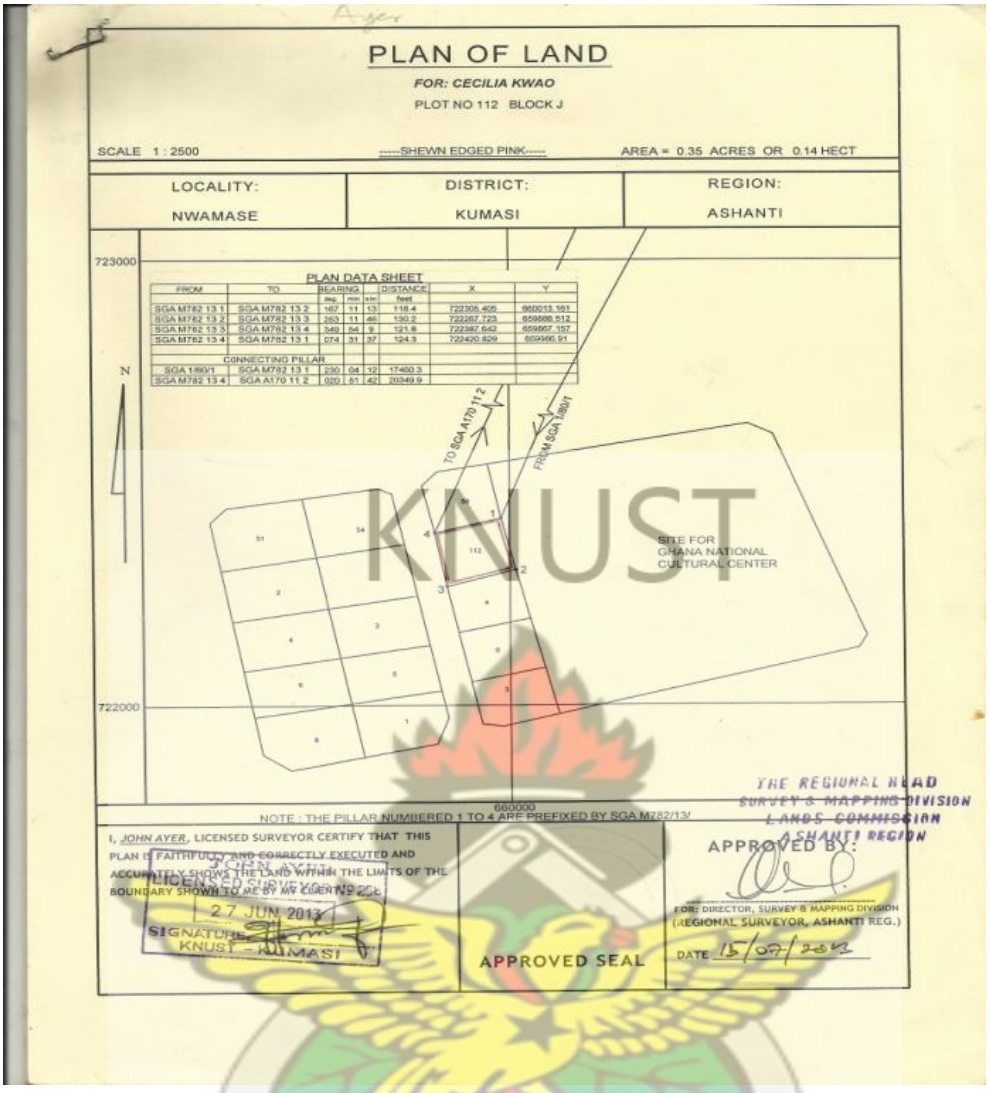


Figure 4.11: Sample of approved cadastral plan

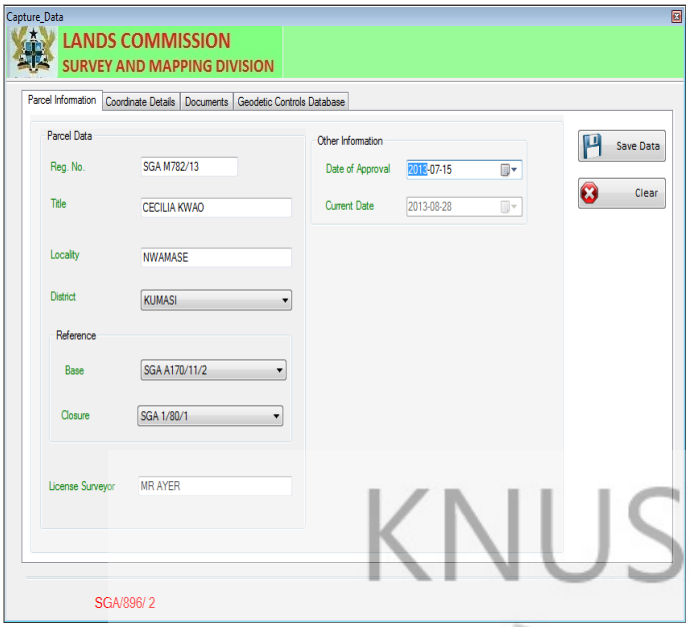


Figure 4.12: Sample of attribute data entry process

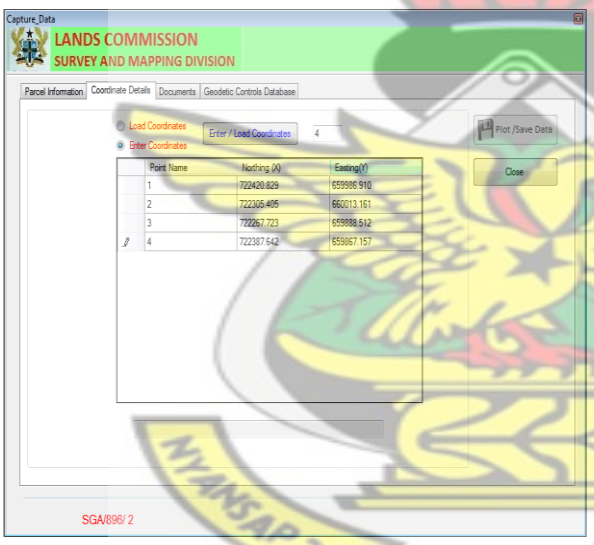


Figure 4.13: Sample of spatial data entry process

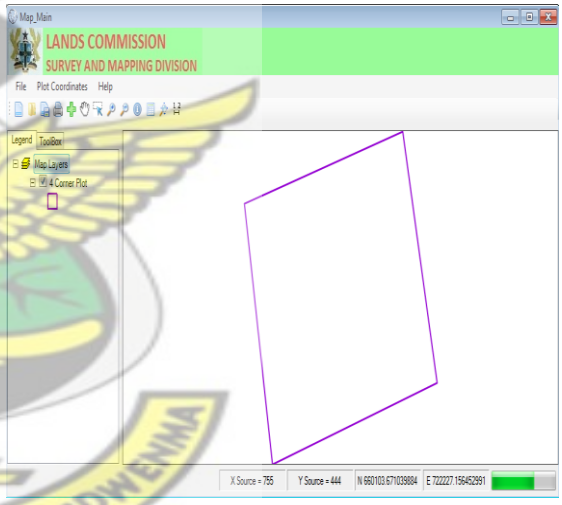


Figure 4.14: Geographic representation

On the Parcel Information tab, attribute data relating to the parcel under consideration are entered in their respective fields as shown in Figure 4.12. Save data by clicking on the "Save Data" button. Spatial data or beacon index relating to that same parcel are also entered on the Coordinate Detail tab. The entry of spatial data is done either by manual input or by loading from excel or comma delimited files as shown in Figure 4.13. Once the spatial data is saved, its geographic representation is visualized by

clicking on “Plot/Save Data”. The geographic representation of the spatial data is shown in Figure 4.14.

Other documents like a copy of the cadastral plan is scanned and attached to the spatial and attribute data. This is done on the document tab by clicking on “Upload the cadastral plan”. The uploaded plan (Figure 4.15) can be viewed and saved to its spatial and attribute data by clicking on the save button.

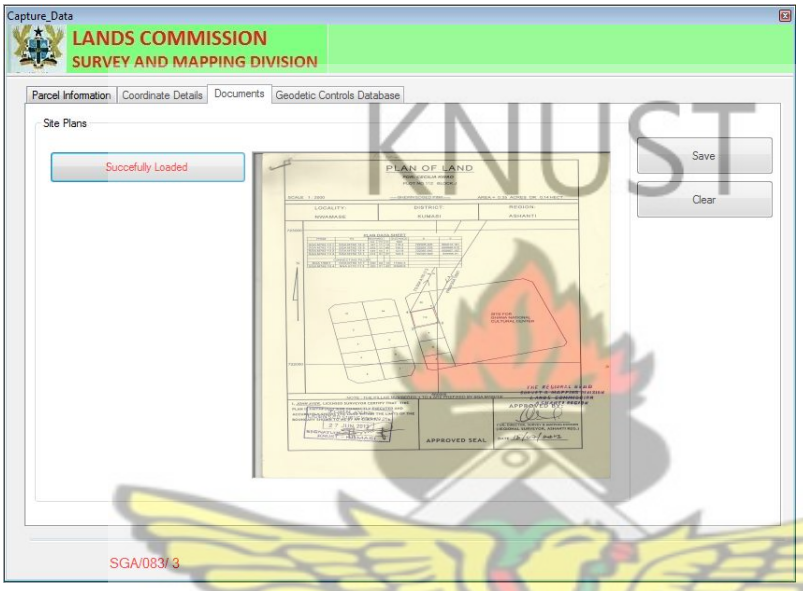
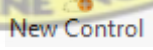


Figure 4.15: Uploaded cadastral plan at the Document page

4.2.4 Geodetic Control Database Window

The Geodetic Control Window (Figure 4.16) provides a platform for managing reference controls in the region. Its functions include adding new controls, editing existing ones, deleting and retrieving details of a control through predefined queries.

Click on the “New Control” button 

and enter the details (Description, Locality, Beacon, District, Easting and Northing) of the new controls in the fields provided for them.

Save the newly added control by clicking on the “Save Control” button 

. Existing controls can be edited by first selecting the field containing that control and double-clicking on it. Click again on the “Edit Control” 

button and edit

the specified detail in its appropriate field. Save changes by clicking on the "Save Control" button.

Existing controls can also be deleted from the database by selecting the field containing that control and double-clicking on it. Click again on the "Delete Control" 

button to delete that control from the database.

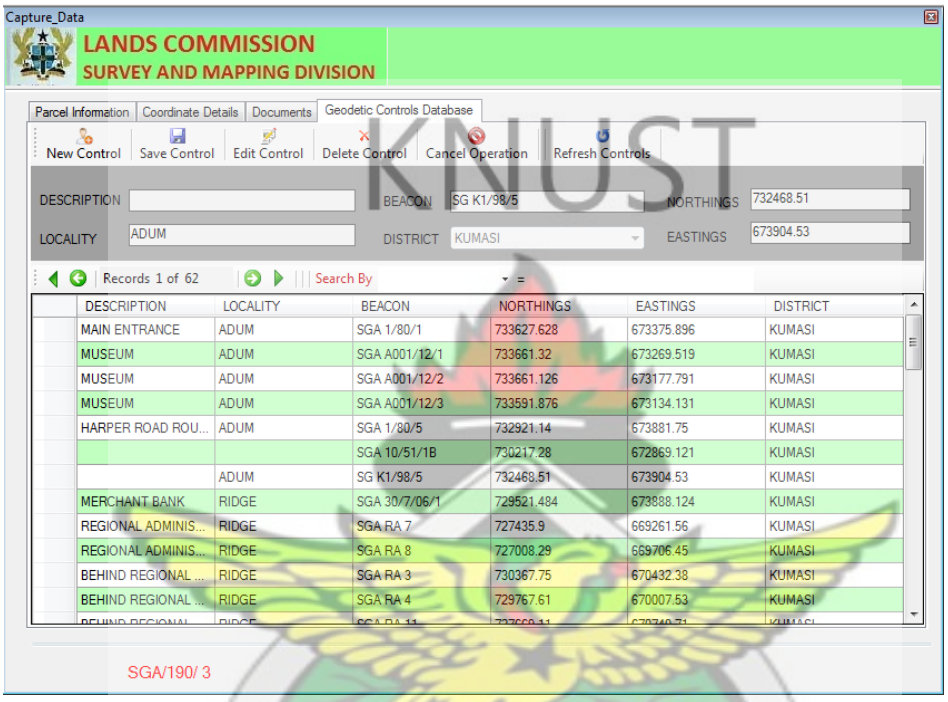


Figure 4.16: Geodetic Controls Database

You can also search for a control using a predefined category. Select the category from the combo box next to the Search by label on the page (Figure 4.17) and then the name next to the equal sign(=).

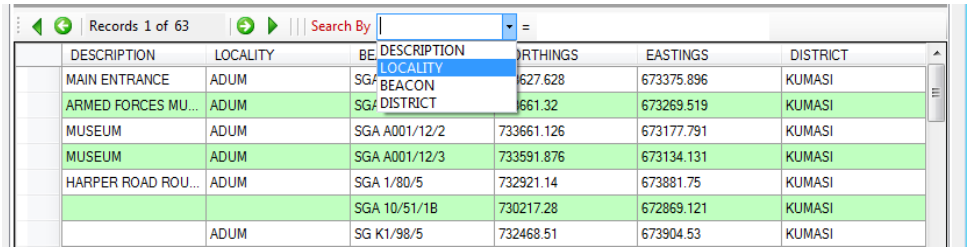
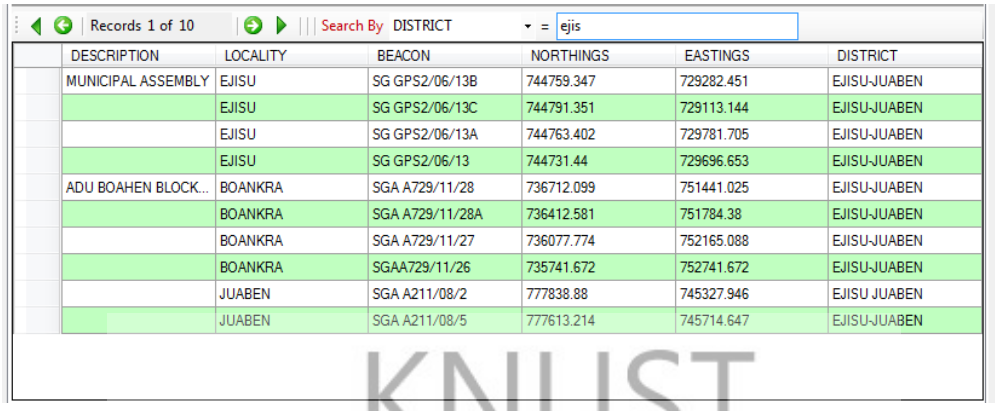


Figure 4.17: Search by category

The procedure for finding the details all controls in the Ejisu-Juaben District for instance is illustrated in Figure 4.18.



DESCRIPTION	LOCALITY	BEACON	NORTHINGS	EASTINGS	DISTRICT
MUNICIPAL ASSEMBLY	EJISU	SG GPS2/06/13B	744759.347	729282.451	EJISU-JUABEN
	EJISU	SG GPS2/06/13C	744791.351	729113.144	EJISU-JUABEN
	EJISU	SG GPS2/06/13A	744763.402	729781.705	EJISU-JUABEN
	EJISU	SG GPS2/06/13	744731.44	729696.653	EJISU-JUABEN
ADU BOAHEN BLOCK...	BOANKRA	SGA A729/11/28	736712.099	751441.025	EJISU-JUABEN
	BOANKRA	SGA A729/11/28A	736412.581	751784.38	EJISU-JUABEN
	BOANKRA	SGA A729/11/27	736077.774	752165.088	EJISU-JUABEN
	BOANKRA	SGAA729/11/26	735741.672	752741.672	EJISU-JUABEN
	JUABEN	SGA A211/08/2	777838.88	745327.946	EJISU JUABEN
	JUABEN	SGA A211/08/5	777613.214	745714.647	EJISU-JUABEN

Figure 4.18: Controls in Ejisu-Juaben District

4.2.5 Retrieval of Information at the Geo-Database Window

Data stored can always be accessed in such an efficient way in the Geo-Database Window (Figure 4.19).

Data stored can be edited, deleted, retrieved and represented geographically in this window. The functionalities at this very window include editing, deletion, retrieval and geographic representation of parcels. These functionalities are illustrated below.

Figure 4.19: Geo-Database Window

4.2.6. How to retrieve data from the system using predefined queries.

Stored data can be retrieved from the system through a search. The search can be initiated using any field in the "Personal Information" or the attribute information (Regional Number, Title, Locality, and District). The result of the query (Figure 4.20) gives all the details relating to that search.

To search for a client's (Addo Kufuor) records in the Geo-Database Window.

- Select "Personal Information" from the table field. 

- And then select owner name from the "Select Criteria" field. 

- Type the owner name(s) in the "Find What" field. 

- Double-click the row in the client list to pop-out all details (spatial and attribute information) relating to that search criterion.

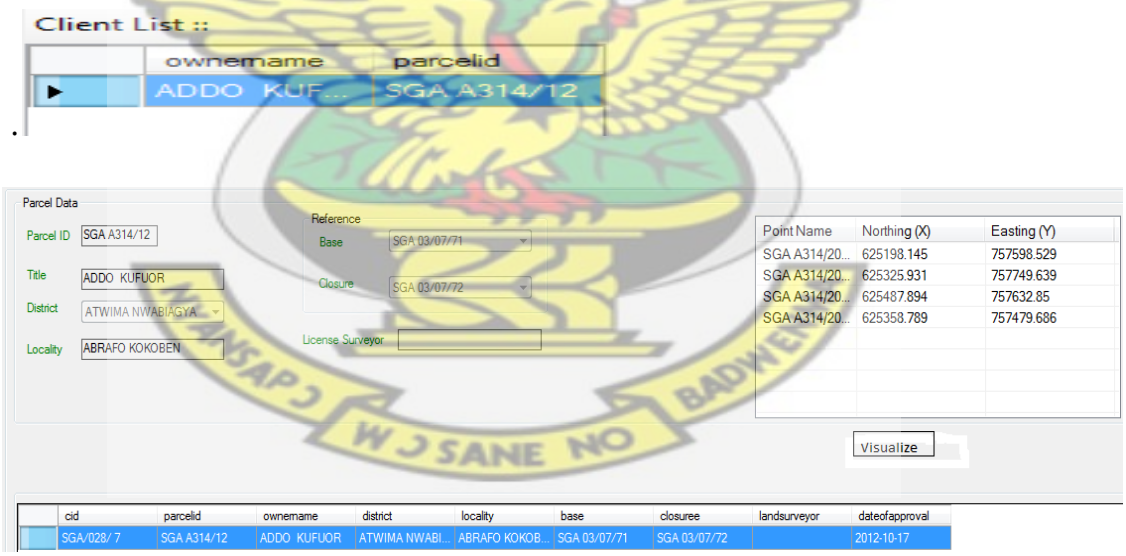


Figure 4.20: Results of a search

4.2.7 How to geographically represent a query in the Map View

The result can be visualized in the Map View by clicking on the "Visualize" button. This displays how the client's parcel is geographical represented (Figure 4.21).

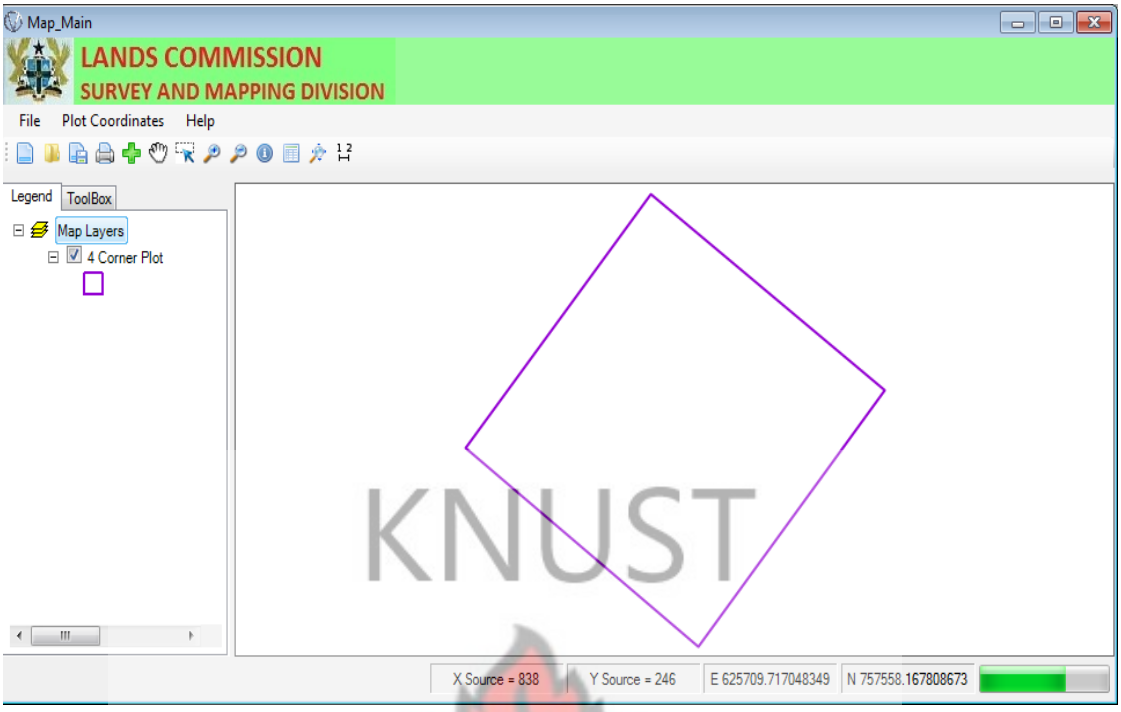
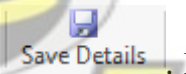


Figure 4.21: Geographic representation of the search results

4.2.8 How to edit a stored data and save changes

Stored cadastral records can also be edited and then save the changes made. To edit a particular record, the user must first search for the particular record to be edited. For instance to edit the details from the results in Figure 4.20, click on 

and edit the relevant detail. Save changes by clicking on 

. Figure 4.22 shows an edited detail.

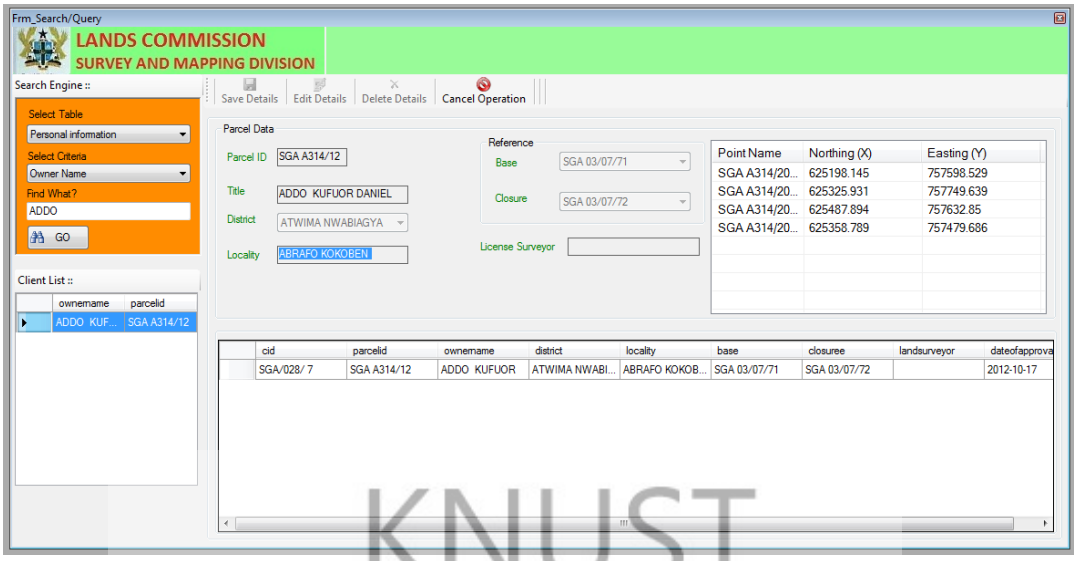
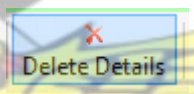


Figure 4.22: Querying for a particular record

4.2.9 How to delete a stored data and save changes

Stored cadastral records can also be deleted. To delete a particular record, the user must first search for the particular record to be deleted. For instance to delete the details from the results in Figure 4.20, click on 

and delete the relevant record.

4.2.10 Overlay of Other Geographic Data within the Administrative Boundaries

After plotting the parcel coordinates in the MapView, the administrative boundary can be superimposed in the view. Additional layers used for the development includes the district administrative boundaries, buildings layer, hydrographic layer and a road. Areas which have town sheet covering them are also displayed.

How to overlay the other geographic data sets with cadastral parcel.

i. From the Content, click on the Toolbar tab to show the available geographic datasets as shown in Figure 4.23.

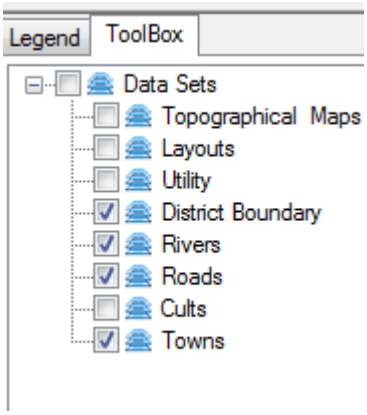


Figure 4.23: The Content Page in the Map View

ii. Check the layers you want to overlay. This displays all parcels captured, integrated with the checked geographic data set shown in Figure 4.24

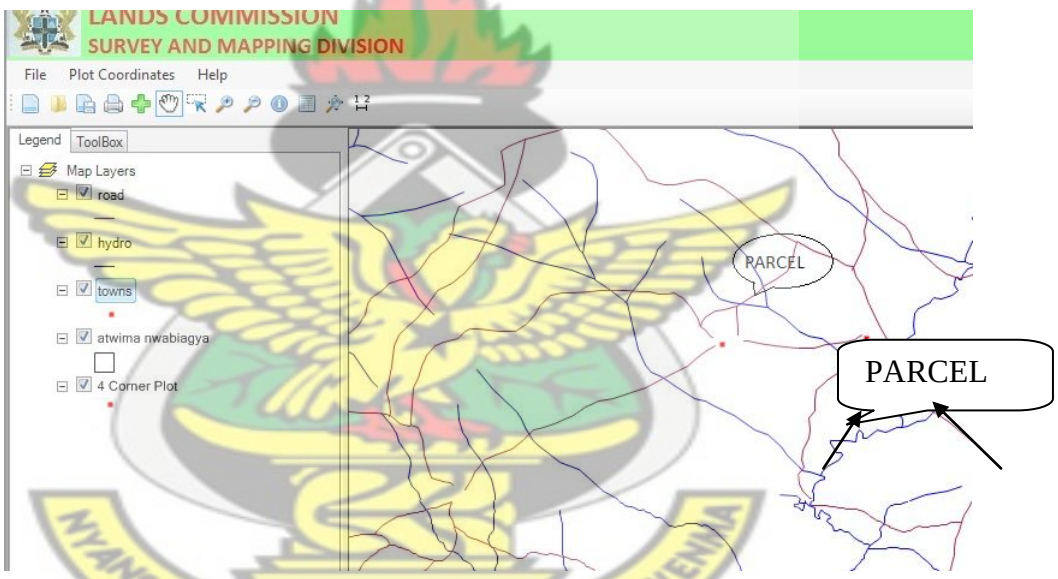


Figure 4.24: Captured Parcels superimposed with other geographic data sets

4.3 Analysis of Results

The analysis of the existing processes regarding data management at the Division was conducted. Its challenges or weakness were then determined. This together with the requirement of the user was used in the development of the system.

It has been demonstrated that the system developed fulfils its objectives of data capture and update and the retrieval of stored data. The spatial and attribute information required from approved cadastral plans are extracted and captured on the

Data Capture. The captured data is the visualized geographically in the map view. Information can also be retrieved from the system through specialized queries on the Query page. Stored cadastral records can also be edited and saved. Eventually a cadastral database is created that supports management of cadastral data in an efficient and effective manner.

The system is made of a data repository for the storage of all geographic data sets covering the whole region. A clip operation is done to select an administrative district whenever an update operation is performed within that district. It also allows users to overlay or superimpose these geographic dataset on all captured parcels. In effect a multi – purpose land information system is created which contains cadastral as well as other land related information.

The system also has incorporated geo-database for geodetic reference controls that allows the capture, update and retrieval of all controls points within the region.

Chapter 5: CONCLUSION AND RECOMMENDATION

5.1 Conclusions

The main objectives of this research were to analyze the underlying problems of the existing systems for the management of cadastral records, and the cataloguing, storage and management of survey records and then develop a new system that would facilitate the computerization of cadastral and survey records to improve access to cadastral, geodetic and topographic information in order to speed up the land delivery and land information process.

In achieving these objectives, some methodologies have been conducted. First of all modern trends of maintaining and managing land information system, cadastral data model and the concept of Hierarchical Spatial Reasoning were investigated. Secondly, the maintenance and management aspects of the existing cadastral system in the Ashanti regional Survey and Mapping division and the impact of the proposed system were analyzed. The proposed system was then designed as a data repository which supports updating and retrieval processes for approved cadastral records and related attribute data as well as geodetic controls. The following conclusions have been drawn at the end this research.

It was evident that cadastral organizations are rapidly changing to make it competitive and more effective in many countries and obviously in Ghana too. The change is necessitated by their external environments. To apply modern LIS, the existing system need to change to a more flexible system making use of advanced technology such as Geo-ICT, Spatial DBMS, Internet coupled with external factors like market trends, customer requirement, land policy and data standards. The core Cadastral domain model also plays an important role in the design of a flexible system and provision of data exchange between different organizations. The Hierarchical Spatial Reasoning was employed to allow for effective integration and combination of data into different administrative hierarchies and effective storage and visualization of cadastral data. Efficient services based on the sharing and distribution of cadastral data in a Geo-ICT environment requires cadastral organizations to develop the core cadastral domain model to an adequate standard to meet these.

The existing workflow processes at the division was investigated and the impact of the proposed system was analyzed as a potential solution for the challenges and weaknesses outlined in the existing system. From the technical point of view, the division must carefully consider the re-engineering of processes involved in capturing, storage, maintenance, management and retrieval of all datasets it holds. In order to support a sustainable LIS, these datasets are proposed to be managed in a well suited structure in a GIS environment.

The user requirements used for the design of the proposed system were identified based on the existing or traditional formats of capturing records and also from interviews with the regional head and some official surveyors of the division. It came out that the existing system fails to keep all survey records in a way that allows easy retrieval of records and datasets on the client-side.

The primary designed architecture conceived and developed is an application similar to most desktop GIS applications. It includes the Main Menu, Toolbar, Legend Window, main Map Display and the Cadastral database pages. The Main Menu and Toolbar contain functions to manage projects and manipulate and query the database. The design is a custom application capable of capturing both the spatial and non-spatial data for the sporadically surveyed parcels (cadastral plans), updating existing parcel plans on sectional maps, creating a data repository for all data sets and displaying the captured data within a map display environment. It allows effective retrieval of data stored through structured queries and provides support for analysis and effective decision making. The functionalities of this application is imperative for survey records storage and management unlike the traditional systems where survey records have been managed and stored as paper types of survey results in the store rooms and in separate databases.

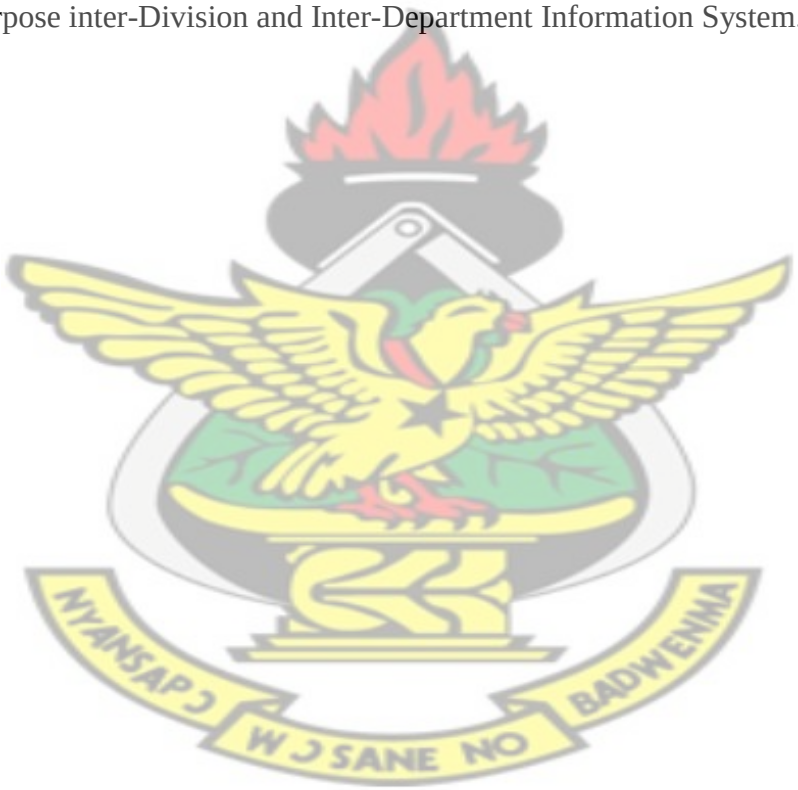
Based on this application, the division can manage and maintain survey records in a GIS environment as well as update new data. This application also integrates other geographic data set held by the division even though it was limited to only cadastral survey records. It also offers a good starting point to the current cadastral records management processes for effective cadastral survey system in the future.

5.2 Recommendations

Several issues are identified below as recommendations for further research and development in the context of Cadastral Information System.

The system developed in this research is a standalone one though with facilities for storing geographic dataset such as the cadastral records, control points and the topographic map of the whole region. These relevant data could however be shared among stakeholders within the cadastral organization via the internet. Thus a consideration must be given to a further research in creating this into a web-based system.

Yet another challenge as stated above is the scaling up of the system into a multipurpose inter-Division and Inter-Department Information System.



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Appendix I: Key Pieces of Land Legislation in Ghanaian Law

TITLE OF LAW	PURPOSE/SUMMARY OF CONTENT
Administration of Lands Act, 1962 (Act 123)	The Act empowers the Minister of Lands among other things to manage all stool lands in the country. The Act consolidates with amendments the enactments relating to the administration of stool and other lands. Its provisions deal with the administration of stool lands, grants of leases of Kumasi Town Lands, vesting of lands in the President in trust, occupation and use of land for public purposes and collection of revenue from stool land, among others. Section 10 of Act 123 empowers the State to acquire land in the interest of the public in return for the payment of annual rentals.
State Lands Act, 1962 (Act 125)	An Act to provide for the acquisition of land in the national interest and other purposes connected therewith. The Act deals mainly with compulsory acquisition of land and the powers to be exercised by the President (or Head of State) as well as the legal procedures to be followed for the compulsory acquisition of land. It also makes provision for claims to any interest in land so acquired to be submitted to the Minister, who is authorized under the Act to pay compensation in respect of the land having regard to the "market value of the replacement value of the land or the cost of disturbance or any other damage thereby". Upon completion of the procedures for compulsory acquisition, the only right that the previous owner of the land has is to apply for compensation. All applications for compensation are processed by the Land Valuation Board (Now Land Valuation Division of the Lands Commission).
Lands (Statutory Wayleaves) Act, 1963 (Act 186)	An Act to provide for entry on any land for the purpose of the construction, installation and maintenance of works of public utility and for the creation of rights of way and other similar rights in respect of such works and for purposes connected with such matters. The Act empowers the President to make executive instruments declaring any land to be the subject of a statutory wayleave for the purpose of construction, installation and maintenance of public utility works and provides for the payment of compensation to any person adversely affected by such declaration.
Land Registry Act, 1962 (Act 122)	The Act consolidates with amendments the law relating to the registration of instruments affecting land. The Act provides that any instrument other than a will or a judge's certificate shall be of no effect unless registered. The Act also establishes Registry offices to be supervised by a Chief Registrar (appointed by the President) and a registrar for each Registry

	Office. The Act further states that registration constitutes notice of the instrument and the fact of registration to all persons and for all purposes as from the date of registration and prescribes the mode for registration. The Act provides that a Registrar may refuse to register an instrument if it is inconsistent with a previously executed instrument, or if the grantor does not appear to be entitled to deal with the land in the way proposed, if the instrument is made in violation of any enactment or if it contains any unverified alterations, interlineations or erasures.

TITLE OF LAW PURPOSE/SUMMARY OF CONTENT Land Title Registration Law, 1986 (P.N.D.C.L. 152).	The Land Title Registration Law, 1986 (P.N.D.C. L 152) was enacted to provide a machinery for the registration of title to and interests in land. The Act provides for the registration of title to land and nearly all existing interests in land including Allodial title, customary law freehold, estate of freehold vested in possession leasehold interest, lesser interests in land, i.e. interests in land held by virtue of any right under contractual or share cropping or other customary tenancy arrangement including *abunu* and *abusa*. P.N.D.C. L152 also establishes the Land Title Registry which is tasked with the responsibility of registering titles and interests in land and the Land Title Adjudication Committee, which is mandated to determine any disputes relating to registering of titles and interests.
State Property and Contract Act, 1960 (CA 6)	Makes provision for the compulsory acquisition of land and other property and guarantees extensive compensation and established the procedure for such acquisition and payment of compensation. The Act provides for the declaration of areas as industrial areas and the allocation of land to industrial concerns via leases for industrial development.
Public Conveyancing Act, 1965 (Act 302)	It empowers the President by executive instrument, to declare any area of state or stool land to be a 'selected area' for certain restricted purposes and to grant titles to such lands to persons displaced by natural catastrophes, rendered landless by reason of compulsory acquisition of land, readjustment of boundaries under Town and Country planning laws etc.
Office of the Administrator of Stool Lands Act, 1994 (Act 481).	The Office of Administrator of Stool Lands Act, 1994 (Act 481), which implements Article 267(2) of the constitution, establishes the Office of the Administrator of Stool Lands and states its responsibilities to include the establishment of a stool land account for each stool into which shall be paid rents, dues, royalties, revenues or other payments, whether in the nature of income or capital from the stool lands, the collection of all such rents, dues, royalties, revenues or other payments and to account for them to the beneficiaries specified in the Act and the disbursement of such revenues as may be determined in accordance with the Act.

Survey Act, 1962 (Act 127)	Act 127 consolidates with amendments the law relating to geological, soil and land survey. The Act provides that the Director and Officers of the Geological Survey Department have power to go onto any piece of land and conduct geological survey works, that the Minister may appoint official surveyors and the Chief Survey officer may license private surveyors and only such persons may survey land and certify plans. Act 127 also provides for a system of survey work and empowers the Minister by Legislative Instrument to make Regulations governing survey work.
Stool Lands Boundaries Settlement (Repeal) Act, 2000 (Act 587)	Act 587 repeals the Stool Lands Boundaries Settlement Decree, 1973 (N.R.C.D. 172) and gives the High Court original jurisdiction to determine disputes relating to stool land boundaries. The Act transfers to the High Court all cases pending before the Commissioner before the coming into force of the Act, but allows the Commissioner to determine cases in which evidence has already been given.
Chieftaincy Act, 2008 (Act 759)	
Town and Country Planning (Gold Coast) (CAP. 84)	Cap 84 establishes the Town and Country Board, which is responsible for the orderly and progressive development of land, towns and other areas whether urban or rural, and the preservation and improvement of amenities in these areas. The Ordinance also provides for a set of planning and building regulations that creates the basis and standards for land use planning.

TITLE OF LAW	**PURPOSE/SUMMARY OF CONTENT**
Local Government Act, 1993 (Act 462).	Act 462 is an Act enacted to establish and regulate the local government system in accordance with the Constitution and to provide for other connected purposes. Act 462 makes provision for the planning functions of District Assemblies by establishing each District Assembly as the Planning Authority for its area of authority. For the purpose of executing its planning functions under the law, Act 462 establishes for each District Assembly a District Planning Coordinating Unit. With regard to land use planning, Act 462 stipulates that all development, particularly in urban centres, requires both planning permission and development permits from the District Assembly, and for urban areas, from the Metropolitan Assemblies

National Development Planning Commission Act, 1994 (Act 479)	Act 479 is an Act to establish the National Development Planning Commission under the constitution, provide for its composition and functions relating to development planning policy and strategy and for connected purposes. The Act establishes the National Development Planning Commission, its composition, membership and functions of the Commission. Section 2(1) b of Act 479 provides that the Commission shall make proposals for the protection of the natural and physical environment with a view to ensuring that development strategies and programmes are in conformity with sound environmental principles. The Act also provides that the Commission shall formulate comprehensive review national development planning strategies and ensure that the strategies, policies and programmes are effectively carried out.
National Development Planning (System) Act, 1994 (Act 480)	Act 480 is an Act to provide for a National Development Planning System, define and regulate planning procedure and provide for related matters. Act 480 provides that the decentralized national development planning system shall comprise District Planning Authorities at the District level, Regional Coordinating Councils at the Regional level and sector agencies, Ministries and the National Development Planning Commission at the national level. The Act spells out the functions of the District Planning Authorities, the District Planning Coordinating Unit, the Regional Coordinating Councils, the Regional Planning Coordinating Units, the Ministries and Sector Agencies and the National Development Planning Commission.
Conveyancing Act, 1973 (N.R.C.D. 175)	It regulates the modes of transfer of interests in land in Ghana. In general, the law requires transactions of three years duration or more to be in writing, save customary grants and other exceptions contained in the said section A transfer of an interest in land which is not in writing by the person making the transfer or by his agent duly authorised in writing confers no interest in the transferee, unless relieved against the need for such a writing by the provisions of Section 3. Schedule 1 of the Act prescribes the form or content of a customary grant. Once certified by a registrar as conformable to the requirements in the schedule, it is prima facie evidence of the matters stated therein. The requirement for writing together with certain implied covenants by the transferor and transferee under sections 22 and 23 of the Act make for certainty and predictability in land transactions.
State Property and Contract Act, 1960 (CAP6)	The State Property and Contract Act, 1960 (CA6) makes provision for the compulsory acquisition of land and other property and guarantees extensive compensation and established the procedure for such acquisition and payment of compensation. The Act provides for the declaration of areas as industrial areas and the allocation of land to industrial concerns via leases for industrial development.