



UNIVERSITY OF NAIROBI

SCHOOL OF COMPUTING AND INFORMATICS

**DEVELOPMENT OF INTEGRATED LAND
INFORMATION MANAGEMENT SYSTEM IN KENYA**

PRESENTED BY: GIDEON W. MWANGI

P56/71401/2007

SUPERVISOR: MR. STEPHEN MBURU

**A research project report submitted in partial fulfillment of the requirements of
Masters of Science in Information Systems (Msc.IS) of University of Nairobi**

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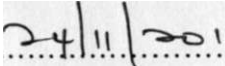
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DECLARATION

I, **Gideon Wathuo Mwangi**, do hereby declare that this research project is entirely my own work and where there's work or contributions of other individuals, it has been dully acknowledged. To the best of my knowledge, this research work has not been carried out before or previously presented to any other education institution in the world of similar purposes or forum.

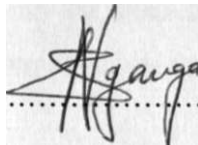
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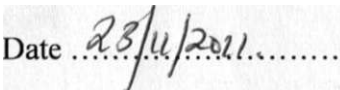
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Gideon Wathuo Mwangi

P56/71401/2007

I, **Stephen Ng'ang'a Mburu**, do hereby certify that this project has been presented for examination with my approval as the University of Nairobi Supervisor.

Signature 

Date 

Stephen Ng'ang'a Mburu

Lecturer, School of Computing and Informatics

University of Nairobi, Kenya

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Abstract

Land is a key asset of any country. It is one of the factors of production which includes labour and capital. It is critical for economic, social and political development of a country. There exists a correlation between proper utilization of land and the economic advancement of a country and its proper management can only be achieved if information on the said land is available. The current globalization trend in the world, demand for efficient and effective land services requires development of an integrated land information management system. Land information is both in spatial and attribute form. The basics of an integrated land information management system are the cadastral and land administration systems. These systems play a critical role in collection, management and dissemination of information about land ownership, use and value. Therefore an integrated land information management system should address the four key components which includes; land tenure; land value; land use and land development.

In developing an information system the process involves following a formalized approach to implement System Development Life Cycle. System Development Life Cycle is composed of four distinct phases which include planning, analysis, design and implementation. Depending on whether the emphasis is on business processes or the data that supports business there are various methodologies or approaches. These models includes; Waterfall Model, Prototype Model, Throwing away Prototyping Model, Spiral Model, Rapid Application Development Model, Scrum Model, Extreme Programming Model, Object Oriented Model, Dynamic Systems Development Model, Capability Maturity Model, View model and Unified Process Model. A model that will be used to develop an integrated land information management system is key in the management of land. This will ensure the country offers effective and efficient services to its citizens and the land information produced can be used by the country to make timely and efficient decisions.

In this research, we explored the above models and identified their weaknesses, strengths and gaps. This was done *visa a vis* the characteristics of the Integrated Land Information Management System. We adopted the **Unified Process Model** for developing the Integrated Land Information Management System. The main characteristics of this model which includes; Iterative and Incremental, Use Case Driven, Architecture Centric and Risk Focused were some of the major points that made us adopt the methodology. Further in selecting the methodology the following factors were considered: on whether the system has unclear user requirements; the developer is familiar with the technology to be used; the methodology is complex, reliable; the

schedule of developing and implementing the system i.e., the system is on time, budget and captures the user's needs.

To find out whether it was appropriate to develop the system and also to identify the user and system requirements the research methodology used in this research was mainly survey. We collected data from clients and staff in 10 districts where the land offices are located. The results of the study showed that both the clients and staffs would like us to develop a system. This system should be an integrated system and should integrate all the key Ministry services.

To find out whether the adopted model for developing the Integrated Land Information Management System was appropriate, a prototype of the system was developed and implemented. This prototype was for **Buruburu Block 78 and 79 or Phase IV and V** which is based in Nairobi County. The prototype is a web-based system.

Finally, we identified the various challenges of developing the Integrated Land Information Management System which includes: Political goodwill, Commitment of Heads of departments, Establishing a project management team, Change management, Voluminous land records data, Establishing a uniform modern Geodetic Control Network framework and resurveying all the parcels to ensure accuracy and update information, Legal and Institution changes which may affect the handling of data and information, Security of land information both physically and logically, Rapidly changing technology and High cost of developing the system.

The outcome of our research is a prototype that can be implemented in the whole country by the Ministry of Lands.

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ACRONYMES

Bhoomi	Land
CASE	Computer Aided Software Engineering
CMMI	Capability Maturity Model of Integration
DBMS	Data Base Management System
DSDM	Dynamic Systems Development Model
ERP	Enterprise Resource Planning
GDP	Gross Development Product
GIS	Geographical Information System
GUI	Graphical User Interface
ICT	Information Communication Technology
ILIMS	Integrated Land Information Management System
KIHBS	Kenya Integrated Household Survey
KLR	Karnataka Law Report
LAN	Local Area Network
LIMS	Land Information Management System
MS SQL	Microsoft Sequential Query Language
OO	Object Oriented
OS	Operating System
RAD	Rapid Application Development
RTC	Records of rights,
SAD	System Analysis and Design
Taluk	Sub-district
UN FIG	United Nations International Federation of Surveyors
UN ECE	United Nations Economic
UPS	Uninterrupted Power Supply
XP	Extreme Programming

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Land is considered as that part of the earth that is not covered by water and which is at the same time unique and a finite resource. It is among the three major factors of production which include labor and capital and it is critical to the economic, social and cultural development of any country. The wealth of any nation and its economic development is dependent on the state of the land and its usage.

The Kenyan people have special attachment with land and land issues are politically sensitive and culturally emotive. In particular the vital role played by land cannot be over-emphasized and as Mzee Jomo Kenyatta (1968), the First President of Kenya said, *"our greatest asset in Kenya is our land. This is the heritage we received from our forefathers. In land lies our salvation and survival"*, this shows how significant it is to the country.

The National Land Policy is a policy document that will guide the country in the management and administration of land. The policy emphasizes the importance of developing a land information management system to ensure land is managed in an effective and efficient manner. The basis of developing land information management system is on land administration and cadastral systems. Land administration and cadastral systems play a very significant role in collection, management and dissemination of information about land ownership, use and value. Cadastral systems are documenting land tenure rights and are thus providing crucial economic, social and environmental benefits. There are four key components in land administration and cadastral systems namely; land tenure; land value; land use and land development. Therefore the benefits of developing integrated land information management system will include; guarantee of ownership and security of tenure, support for land and property taxation, provide security for credit, develop and monitor land markets, protect land resources and support environmental monitoring, facilitate management of state owned land, reduce land disputes, improve urban planning and infrastructure development, produce statistical data and revenue from sales of products and services.

Land information is based on two forms; spatial information and attribute information. Spatial information includes, maps or photographs and attribute information includes land ownership records. Development of an integrated Land Information Management System will be used to input, store, retrieve and analyze geographically referenced land-related data in order to produce information for decision making. Establishment of a GIS based Land Information Management System will ensure efficient, accessible, affordable, transparent production of land information to support timely decision making and eventually contribute to economic growth.

System or software development involves solving some problems in an organization. System development is composed of four fundamental phases namely planning, analysis, design and implementation. The System Development Life Cycle is composed of these four phases. In implementing the System Development Life Cycle a formalized approach or methodology is followed. System development methodology is a framework that is used to structure, plan, and control the process of developing an information system. There are various system development models which can be used and includes Waterfall Model, Prototype Model (incremental model), Throwaway Prototyping Model, Spiral Model, Rapid Application Development Model, Scrum Model, Extreme Programming Model, Object Oriented Model, Dynamic Systems Development Model, Capability Maturity Model, View Model and Unified Process. These models have their weaknesses, strengths and gaps which need to be explored and identified. Further the following need to be considered when selecting a model: on whether the system has unclear user requirements, the developer is familiar or unfamiliar with technology, the model is complex, reliable; the schedule of developing the system i.e., to ensure the system is on time budget and captures the users requirements.

1.2 Problem Statement

As countries develop there exist a relationship between humankind and land. This relationship is affected by global drivers which include sustainable development, urbanization, globalization, economic reforms and environmental management. This relationship is further affected by the stage of development of a country.

This implies that there exist tension of sustainable development which is between the environment and the human activity and is dynamic. And as human race continue to increase and

the global population estimated to grow from the current 6.8 billion to 9 billion by 2040 (Enemark 2010), global challenges continue to confront the world. The challenges include climate change, shortages in food and fuel, environmental degradation and natural disasters. These challenges rotate around land and they are also compounded by the decreasing ratio of land to population. In order to confront these challenges, we require a system of recognizing, controlling and mediating rights and responsibilities over land and resources. It is thus important to develop a sustainable system that effectively incorporates economic, social, political, conservation and resource management factors in decision making for development.

This challenge of balancing these competing tensions in sophisticated decision making requires access to accurate and relevant information in a readily interactive form. In order to achieve this objective, information technology, spatial data infrastructure, multi-purpose cadastral systems and land information business systems will play a key role. This therefore calls countries worldwide to develop integrated land information management system.

In Kenya particularly, the management of land has remained one of the contentious issues. It has resulted to environmental, social, economic and political problems leading to tribal clashes, deterioration in land quality, squatting and landlessness, disinheritance of some groups and individuals, urban squalor, under-utilization and abandonment of agricultural land, tenure insecurity and conflict. Moreover, due to increase in land transactions which date back to over 100 years, the land records have increased to unmanageable levels. With this increase in land records, it is not tenable to manage them manually. The manual management of land records has resulted to inefficient, bureaucratic and time consuming land information systems which have complicated administration and management of land. The land problems in Kenya can be summarized by the late Professor Wangari Mathaai's words, who said in 1997, that, *"if the Attorney General cannot prosecute known land grabbers and the ordinary citizens lacks the locus standi to take such cases to court, who will save Kenya?"* The emphasis of land problems in Kenya were also echoed by Hon. Raila Odinga, the Prime Minister of the Republic of Kenya (October 2010) that *"Due to the past grabbing of public land, urban dwellers are caught in never-ending traffic jams, spaces meant for road expansion and by-passes were allocated to individuals"*.

1.3 Significance of the study

Since the wealth of a nation and its economic advancement are dependent on the state of the land and its usage, it's important for any country envisaging economic development to develop land information management system so as to ensure timely decision making. Countries in sub-Saharan Africa which have agrarian based economy need to develop their land information system since it is one of the basic resources that should be managed well.

This study would provide a model of developing Land Information Management System. This system will be based on the New Constitutional and the National Land Policy and; will provide some insights as the Kenya Government implements the New Constitution. With the system it will be possible to visualize how land will be managed at the national and county levels of governance.

The study will also give an insight on the products or services expected to enable managers in land administration organizations make informed decisions in a timely manner.

The study will provide a prototype for an integrated Land Information Management System and we will provide the challenges to be expected when implementing the system.

1.4 Research Objectives

The objective of the research will be:

- i. To find out existing models for developing integrated land information management system.
- ii. To determine the challenges of developing integrated Land Information Management System.
- iii. To propose appropriate model for developing integrated land information management system.
- iv. To develop a prototype for an integrated Land Information Management System based on the proposed model.

1.5 Research questions

The study will address the following questions:

- i. What are the existing models for developing integrated land information management system?
- ii. What are the challenges of developing integrated land information management system?
- iii. What is the appropriate model for developing an integrated Land Information Management System?
- iv. Can the appropriate model be used to develop a prototype of the Integrated Land Information Management System?

1.6 Project justification

Land is an important asset in society and affects all the citizens of a country in various ways including socially, economically and environmentally. The advancement of a country depends on how well they have been able to manage their land resource.

Despite Kenya being endowed with good weather, good soils, the management of land remains a challenge. Some of the effects of poor management of land include; food shortages, land related tribal clashes, land grabbing, irregular/illegal allocation of government land to individuals, destruction of infrastructures during construction of roads, destruction of forests especially the water towers, skyrocketing of values of land especially in urban areas, never-ending traffic jams in urban areas. These effects can be mitigated by developing sound land information management system which will ensure that land information is always available to make timely decisions.

CHAPTER TWO

LITERATURE REVIEW

2.1 Land

Without land, life on earth cannot be sustained and therefore it's the ultimate resource. Land is a critical resource for economic, social and cultural development of a country. According to SD Meena et al, 2003 land is the habitat of man and its use is very critical for a country to advance economically, socially and environmentally. Land is both a physical commodity and an abstract concept in that rights to own or use it are as much a part of the land as the objects rooted in its soil (UN ECE, 1996). In many countries it was the main reason for the struggle of independence and issues of land are culturally and politically sensitive. According to Deininger 2003, land is a key asset for the rural and urban poor. In developing countries where the poor people are the majority, land is the primary means of generating a livelihood and the main vehicle for investing, accumulating wealth and transferring it between generations. Therefore proper management of land, by securing rights to land goes a long way in increasing the net wealth of the poor. Secure tenure also encourages long term investments on land and creates incentives for sustainable development. Land parcel is the basic unit for access, control and making land use decisions.

Land provides the platform for food, shelter, economic production and a basis for social, cultural and religious practices. Access to land, shelter, natural resources and the associated tenure security have major repercussions to development. Secure access to land and other natural resources is crucial for hunger and poverty alleviation and the protection of environment (Stuedler et al, 2010). To cater for the present and future generations, proper management of land is of paramount importance. Further, with decreasing land to people ratio due to the fact that land is a fixed asset and the world population is growing, land has become a valuable asset in society and there is a growing demand for better security of land rights.

Economically land is something that individuals and communities have right of ownership and use, it can be sold or bought and be subjected to tax. With secure land rights there can be sustainable development since there will be willingness to make long-term investments. Its important to note that about 20 percent of gross domestic product (GDP) of every nation, comes from land, property and construction. Therefore there is need to determine the ownership and

value of land and property and to monitor their use in order to enhance the value of these assets (UN ECE, 1996). Since land forms the basis of any economic development its proper management can only be achieved if information on the land is available. This can happen if Land Information Management System is developed and utilized.

Land is subdivided for administrative and economic purposes and it is used and transformed in many ways. This subdivision creates land data records which form the basis for assignment and settlement of land titles. The land records consist of alphanumeric data i.e the records of rights details and cadastral map depicting the boundaries and the extent of the plots. These records are generated and managed by land administration and cadastral systems. Land administration and cadastral systems are the basis of developing land information management system.

2.2 Land Administration and Cadastral Systems

Land administration and cadastral systems play a very significant role in collection, management and dissemination of information about land ownership, use and value. They are the basis of building adequate land information systems. There are four key components in land administration and cadastral systems namely; land tenure; land value; land use and land development. The purpose of these components are; land tenure involves allocation and security of rights to land; land value involves assessment of the value of land and properties for taxation; land use involves control of land use through adoption of planning policies and land use regulations at national, regional and local levels and land development involves building of infrastructure, implementation of construction planning and the change of land use through planning permission and granting of permits. Though the four components land ownership, value use and development of land seem to be independent, in practice they are interdependent (as shown in Fig.2.2). Each attribute of land needs to be managed and to achieve this there must be good land records: to ensure security of tenure; of value to ensure fairness in land and property taxation and of the use of land to ensure efficient resource management. According to UN, FIG, 1996, land administration and cadastral systems are not an end to themselves but a means to the end. They support effective land markets, increased agricultural productivity, sustainable economic development, environmental management, political stability and social justice. This implies that a Land Information Management System should be developed to support both land administration and cadastral systems.

Land administration is the process of recording and disseminating information on land ownership value and use of land and other land resources. Land administration should include a form of land registration which is a process of recording or guaranteeing information about ownership of land. This ensures safe, acquisition, enjoyment and disposal of rights to land. "A land administration system should provide order and stability in society by creating security not only for land owners and their partners but also for national and international investors and money lenders, for traders and dealers, and for Governments", UN,ECE, 1996.

According to UN FIG, 1995 a "cadastre is a parcel based and up-to-date land information system containing a record of interests in land e.g rights, restrictions and responsibilities". Therefore a cadastre contains a set of records about land. It is based either on the proprietary land parcel which is the area defined by ownership or on taxable area of land or on areas defined by land use rather than land ownership. A cadastral system therefore includes a geometric description of land parcels linked to other records describing the nature of the interests, ownership or control of those interests, value and improvements of the parcel. A cadastre system consist of two parts namely; a series of maps or plans showing the size and location of all land parcels together with text records that describe the attributes of land. Therefore land registration and cadastre systems differ in the sense that the land registration system deals specifically with ownership while cadastre deals with ownership, value and use of land parcels. It is also important to note that cadastre can be designed in different ways depending on the history and cultural development of a country (UN FIG, 1995).

As we have seen a cadastre is a record that identifies the individual land parcels or properties. The purpose of this identification is either taxation or securing land rights. In the World today, most cadastral registers are linked to both land value or taxation area and the area of securing legal rights in land and therefore the reason why they are known as cadastral systems or cadastral infrastructure. The systems or infrastructures include the interaction between the identification of land parcels, the registration of land rights, the valuation and taxation of land and property and the control of present and future use of land (as shown in Fig. 2.1).

World Bank has recognized the importance of establishing appropriate land administration systems as a basis for generating economic development, social coherence and environmental sustainability. This is due to the fact that the world is facing serious challenges which include

climate change, food and fuel shortages, environmental degradation and natural disaster (Enemark et al, 2010). These challenges coupled with ever increasing population calls for proper management of land. Sustainable management of land should provide transparent and easy access to land for all thereby reducing poverty, secure investments in land and property development and thereby facilitate economic growth.

It is important to note that countries that have been able to manage their land properly have also excelled economically or they are emerging to be economic giants, e.g., Malaysia, Australia, India, Singapore and Sweden.

As UN, ECE, 1996 says benefits of a good land administration system includes; guarantee ownership and security of tenure, support land and property taxation, provide security for credit, develop and monitor land markets, protect state lands, reduce land disputes, facilitate land reform, improve urban planning and infrastructure development, support environmental management and produce statistical data. These characteristics can only be found under a solid foundation of a functional Land Information Management System. Therefore appropriate land administration systems provide the basis for sound land management towards economic, social and environmental sustainability.

2.2.1 Cadastre Systems

Since a cadastre is a parcel based and contains current land information system, the land parcels must have a geometric description and linked to other records describing the nature of the interests, ownership, control of those interests, value of the parcel and its improvements (as shown in Fig. 2.1).

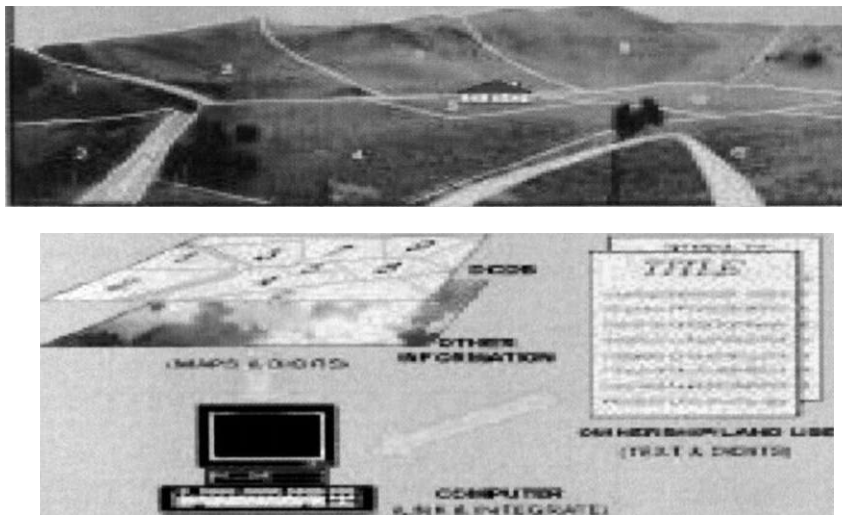
A cadastre may be established for fiscal purposes i.e valuation and taxation, legal purposes i.e conveyancing, to assist in management of land and land use control i.e planning and administration. This enables sustainable development and environmental improvement. Therefore a cadastre is a record that identifies the individual land parcels or properties. It is the basic component of any land information system.

According to the UN Bogor Declaration, 1996, the vision of cadastre is to develop modern cadastre infrastructures that facilitate efficient land and property markets, protect the land rights

and support long term sustainable development and land management. It is therefore important to note that, cadastre is seen as the basic infrastructure that supports land tenure system, land value system, land use control system and land development system.

Fig. 2.1: Cadastre concept

The Cadastral Concept



Source: Wikipedia, 2010

2.2.2 Land Administration

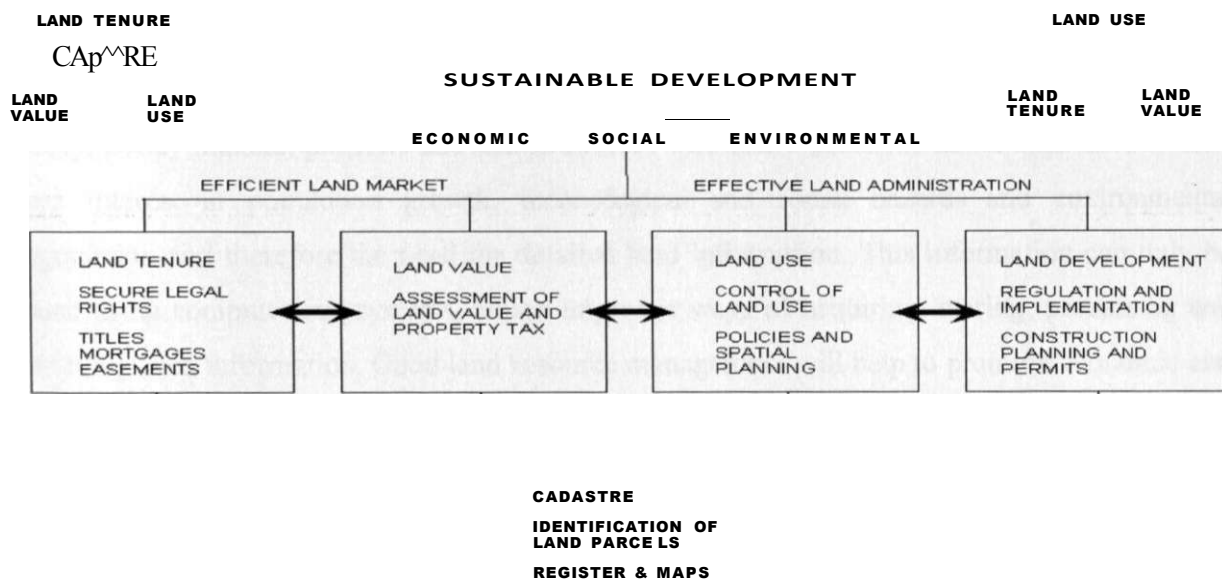
As indicated earlier land administration involves recording and disseminating information about the ownership, value and use of land and its associated resources. Land administration is therefore a central part of the infrastructure that supports good land management. The processes of land administration include the determination of property rights and other attributes of the land that relate to its value and use, the survey and general description of these, their detailed documentation, and the provision of relevant information in support of land markets.

Land administration is concerned with four principal and interdependent commodities - the tenure, value, use, and development of the land - within the overall context of land resource

management (as shown in Fig.2.2). Thus in modern land administration theory, the functions of land administration are land tenure, land value, land use and land development which are designed to deliver sustainable development (Enemark 2009). Land administration functions include the following areas:

- Land tenure (securing and transferring rights in land and natural resources);
- Land value (valuation and taxation of land and properties);
- Land use (planning and control of the use of land and natural resources); and
- Land development (implementing utilities, infrastructure, construction planning, and schemes for renewal and change of existing land use).

Fig. 2.2: Land administration infrastructure supporting sustainable development



Source: Enemark and Sevantal, 1999

Effectively functioning land administration systems, providing guarantees of land tenure, are of central importance to ongoing economic development. In many countries, however, land administration systems are not sufficiently robust to deliver effective land tenure, and this can limit or restrict economic development. Land information system is organized by combining cadastral and topographic data. Cadastre, land administration and land management are the basis for building adequate land information policies.

2.3 Land management

Land management is a process of managing the use and development of land resources in a sustainable way. Land resources are used for a variety of purposes which interact and may compete with one another and therefore a need to plan and manage all uses in an integrated way. The use of the land resources focuses on both environmental and economic perspective. Land management may involve the following; property conveyance, including decisions on mortgage and investment; property assessment and valuation; development and management of utilities and services; management of resources such as forests, soils and agriculture; formation and implementation of land-use policies; environmental impact assessment and monitoring of all activities on land that affect the best use of land UN, ECE, 1996.

In order to manage land in society, adequate information is required on the location, size and use of land to be managed. Therefore sustainable development requires comprehensive information on the environmental conditions in combination with other land and property related data. Today, policy makers, planners and administrators who make decisions about land have to take keen interest in population growth, technological and social hazards and environmental degradation and therefore the need for detailed land information. This information can only be found using computerized systems, which improves ways of acquiring, storing, processing and retrieving such information. Good land resource management will help to promote economic and social development in both urban and rural areas.

Land supports other sector of the economy including agriculture, manufacturing, and infrastructure development. About 70% of Kenyan population depends on agriculture as their means of livelihood both as food and a source of employment (KIHBS, 2005/06). Proper administration and management of land will lead to the support of the 70% Kenyans and the whole population of about 38.6billion (Kenya Census 2009).

With the growing population which is expected to reach 70billion according to Kenya Vision 2030 by the year 2030, there is need for proper management of land information.

2.4 Land problems in Kenya

The importance of land to the Kenyan people cannot be overemphasized. Land was one of the key reasons for the struggle for independence in Kenya. The Kenyan people have a special

attachment with land and therefore land issues remains politically sensitive and culturally complex. As Mzee Jomo Kenyatta (1968), the First President of Kenya said, *"our greatest asset in Kenya is our land. This is the heritage we received from our forefathers. In land lies our salvation and survival."* This shows the significance of land to the people of Kenya. This implies that land should be managed in the most beneficial, equitable and sustainable way.

At the advent of colonialism, all land in Kenya then called the Kenya Colony and Protectorate was declared Crown Land, falling under control and administration of His Majesty the King of Great Britain. The consequent land tenure system was an alien concept to indigenous Kenyans who hitherto owned and held land under complex systems of customary tenure. Land in the colonial period was governed under English common law modified to suit the Kenyan colony. Since independence Kenya has had two land tenure systems namely customary and statutory land tenure systems. These tenure systems are operated under different legal regimes and the Ministry of Land in Kenya is charged with responsibility of ensuring efficient administration and sustainable management of our land resource which is critical to the socio-economic and cultural development of the country. The Ministry thus manages government and community land.

Over the years, due to increase in population, the proportions of government and community lands have continued to reduce as more land gets alienated to individuals or institutions under leasehold terms and more land get registered through setting apart or land adjudication and registration procedures. The proportion of private lands has also continued to increase as more community land gets registered and more government land gets alienated. This has resulted into increase of land records that date back to over one hundred years, which are mainly in manual form. This has further been compounded by the current manual system of lands record management which is not tenable for expeditious land transactions. The Ministry therefore requires to computerize its land records for efficient and effective delivery of services.

However, the management of land has not been done in a clear and codified manner. This has resulted to the country having perennial land problems which for many years have bedeviled the country. These problems have taken political, economic and legal dimension and they include; historical injustices which includes colonial policies/laws which led to mass disinheritance of communities of their land, land adjudication/registration laws, treaties/ agreements between local communities and the British, post independent period exacerbated by lack of clear, relevant and

comprehensive policies and laws, Coastal region land issues which include squatters on Government land, absentee landlords, tenants-at-will, idle land, mass eviction, lack of access to the sea, pastoral land tenure which includes dispossession of pastoral communities and their land based resources; land rights of women, minority and marginalized groups which includes culture and traditions that support male inheritance of family land, conflict between constitutional/international provisions on gender equality vis-a-vis customary practices that discriminate against women on land ownership and inheritance, land rights of the vulnerable are not protected and are subject to bias and discrimination. On the legal dimension, since independence the country had two land tenure systems namely customary and statutory which are operated under the following statutes; Registration of Titles Act(Cap 281); Government Lands Act (Cap 280); Land Titles Act (Cap 282); Registered Land Act (Cap 300); The Land (Group Representatives) Act (Cap 287); The Trust Land Act (Cap 288) and Sectional Properties Act No.21 of 1987. These problems has resulted to the following; landlessness and squatter problems, severe land pressure and fragmentation of land holdings into uneconomical units; deterioration in land quality due to poor land use practices, unproductive and speculative land holding, underutilization and abandonment of agricultural land, severe tenure insecurity, disinheritance of women and vulnerable members of society, uncontrolled development urban squalor and environmental pollution, wanton destruction of forests, catchment areas and areas of unique biodiversity, desertification in the arid and semi-arid areas and growth of extra legal administration processes. As Professor Wangari Mathaai said in 1997, that, *"if the Attorney General cannot prosecute known land grabbers and the ordinary citizens lacks the locus standi to take such cases to court, who will save Kenya?"*, this showed the extent with which land problems in Kenya had affected the country and solution was required sooner than later.

The climax of the land problems occurred during the Post-election violence that affected the country in 2008. Therefore land problems required a coherent land policy that addresses access to land, land use planning, restitution of historical injustices, the institutional framework, land information management systems, environmental concerns, conflict/dispute resolution, public land allocations, the informal sector, land ownership and land markets.

2.5 National Land Policy

In realizing the important role land administration and management would play in economic development and also minimizing conflicts and tensions between and among various communities and for contributing to national unity in diversity, the Government have made several initiatives to improve the management of the land sector. In particular the Development Plan I of Kenya (1979-1983) had recommended for the establishment of a land reform commission to investigate inter alia the rationalization of existing land laws and tenure systems, speculative dealing in land, illegal subdivisions of registered land, absentee landlordism and land mining. This land reform commission was not established. The government appointed a commission of inquiry into the land law system of Kenya (the "Njonjo Commission") with a view to making recommendations to improve land administration and management. The report which was produced in November 2002, recommended the need to formulate a National Land Policy. Further, the government appointed a commission on illegal and irregularly allocated public land "the Ndungu report" that gave recommendations on various land allocation issues but pointing in the direction of having a national land policy.

Having noted these efforts, the Government initiated the preparation of the National Land Policy in the year 2004 and it was adopted by Parliament in December 2009. The National Land Policy is a policy document that will guide the country in the management and administration of land also emphasizes the issue of land information management. Its main objective is to secure rights over land and provide for sustainable growth, investment and reduction of poverty in line with the Government's overall development objectives.

The National Land Policy addresses the following important issues:

- Constitutional issues;
- Land tenure issues;
- Land use management issues;
- Land administration issues;
- Land issues requiring special intervention;

- Institutional framework; and
- Implementation framework.

The National Land Policy is embedded in the following principles: to provide all citizens with opportunity to access and beneficially occupy and use land; provide economically viable, socially, equitable and environmentally sustainable allocation and use of land; provide efficient, effective and economical operation of land markets; provide efficient and effective utilization of land and land based resources; and provide efficient and transparent land dispute resolution mechanisms. Efficiency and effectiveness as highlighted in the National Land Policy principles can only be achieved by developing the national land information management system. The National Land Information Management System will be an important tool for institutionalizing the National Land Policy principles.

According to the National Land Policy, land administration refers to the process of determining, recording and disseminating information about ownership, value and use of land. An efficient land administration system guarantees the recording of land rights and land tenure security, guides land transactions, provides land users with appropriate forms of documentation to guarantee land rights and supports the processes of land allocation, land dispute resolution and land taxation. It states that the current administration system is bureaucratic, expensive, undemocratic and prone to abuse, resulting to inordinate delays and injustice in the administration of land. The Government therefore should implement the Land Information Management System in order to avert these land problems.

The Ministry of Lands technical departments feed into each other, for example for a land title deed to be registered by lands department it needs a survey plan and a land use plan. This implies that if the processes in these departments are automated and linked together via an information management system this can assist the various departments making decisions as fast as possible thus speeding up land transactions and eventually increasing government revenues through the land tax.

The above consideration shows that development of LIMS is inevitable. However the government has had earlier initiatives in its development which has not been implemented. The development of LIMS was initiated in 1985 and several survey documents have been done by

both the government and development partners. To make sure the LIMS project succeeds its important to focus on earlier initiatives to find the successes and failures.

The National Land Policy recommendations were utilized during the formulation of the land chapter under the New Constitution of Kenya. Therefore the principles of the National Land Policy and those of the New Constitution are the same.

2.6 Kenya Constitution 2010

With the promulgation of the Kenya Constitution 2010, the management of land took a fundamental change. Basically the management of land has to realign itself with the provisions of the Constitution. The governance structure of government has changed which will include the National Government and the Devolved Government or Counties.

In the Kenya Constitution 2010, land has been categorized into three namely; public, private and community land. Public land is land which will be held by a county government in trust for the people resident in the county and shall be administered on their behalf by the National Land Commission. Public land includes; all forests, minerals, mineral oils, all roads and thoroughfares, rivers, lakes and other water bodies, territorial sea, the exclusive economic zone and sea bed, continental shelf, and all land between the high and low watermarks. Community land will be held by communities identified on the basis of ethnicity, culture or similar community interest. Community land shall be held in trust by county governments on behalf of the communities for which it is held. Private land will be any land held by any person under any freehold or leasehold tenure.

The Kenya Constitution 2010 established the National Land Commission which will manage public land on behalf of the national and county governments, advise the national government on a comprehensive programme for the registration of title in land throughout Kenya, conduct research related to land and the use of natural resources, assess tax on land and premiums on immovable property in any area designated by law and monitor and have oversight responsibilities over land use planning throughout the country among others. This therefore requires comprehensive land reforms that will change the manner in which land will be managed in the country. Emphasis of land reforms is also highlighted in the Kenya Vision 2030.

2.7 Kenya Vision 2030

The Kenya Vision 2030 is a long-term development blueprint, which is meant to guide the country by the year 2030. Its aim is to create a globally competitive and prosperous country with a high quality of life by the year 2030. It aims at transforming Kenya into a "newly-industrializing, middle-income country providing a high quality of life to all citizens in a clean and secure environment".

The Kenya Vision 2030 highlights the importance of land in the economic advancement of the country. It emphasizes that for our country to develop, land reforms must be at the cornerstone of this advancement. According to the Vision, land reforms are one of the foundations of Vision 2030 that will anchor the economic, political and social pillars. Land reforms imply that the way land has been managed since independence has to change if the country is to achieve the aspirations of this Vision. In order to change land administration and management in the country, the country must establish an efficient land information management system.

One of the areas the government will focus on in land reforms is in management of land information which will result into computerizing the land registries where land documents are stored and this will result into a computerized Land Information Management System (LIMS).

2.8 Information Management

Information management involves management of information from one or more sources and distribution of that information to one or more stakeholders who have a right to this information. Management involves organization and control over the structure, processing and delivery of information.

2.9 Information Management System (IMS)

Information Management System involves collecting, processing, storing and disseminating of information in an organization. This information is used for making decisions. According to Leceit 1999 MIS comprises of four elements which are the actors who take decisions, data and information useful for decision making, procedures that determine how the actors relate to data and tools that facilitate the collection, analysis, storage and dissemination of information.

Currently world trend shows that organizations are reorganizing their business processes and operations to conform to the technological changes taking place and embracing the use of MIS or IMS in their day to day activities. Therefore MIS or IMS are assisting decision makers in organizations to be in touch with what is happening in the organization and to be able to make critical decisions for the future. Therefore information management is very crucial in today's world if an organization is to make any impact in the delivery of services.

2.10 Land Information Management System (LIMS)

Public expects government services to be comparable with the best services offered by the private sector in terms of quality, accuracy, timeliness and user friendliness. Today's citizens can no longer tolerate delays, bureaucratic mistakes or excessively time-consuming and difficult procedures. With this in mind, information technology has been identified as a strategic tool that can enhance efficiencies in government very significantly (Margetts 1999). It is also in this context that Governments world over are converting their existing non-electronic delivery government services into electronic delivery, thus transforming the existing believe that information technology can change the way of life of citizens (Tapscott 1998).

Development in electronics, computers and information technology is enabling authorities at national and international levels to automate and simplify the cumbersome, bureaucratic procedures, eliminate long chain of intermediaries and facilitate the direct interaction of citizens with governments (Thomas 2001). This mechanism of transforming the manual methods into mechanical methods and eliminate the long chain of intermediaries has made automation ensure improvement in service delivery besides bringing about transparency in functioning along with improved degree of accuracy which is the need for today (Evans 2003). Thus technology will enable online gathering, recording, warehousing, retrieving, disseminating and employing the data which will lead to improved effectiveness and efficiency of land management.

According to FIG, 1996, "Land Information System is a tool for legal, administrative and economic decision-making and an aid for planning and development which consists on one hand a database containing spatially referenced land related data for a defined area and on the other hand procedures and techniques for the systematic collection, updating, processing and distribution of the data". The foundation of a land information system is a uniform spatial

referencing system for the data and facilitates linking with other land related data. Therefore a Land Information Management System (LIMS) is a computer-based information system that will enable the capture, management and analysis of geo-referenced land-related data to produce land information for decision making in land administration and management.

In most countries worldwide, land data is held in silos and managed manually including survey data, land registration data, valuation data, land use planning data and infrastructure data. This manual system of handling data results into inefficient, time consuming and untimely decision making. The land data is always increasing as transactions are carried out, maintaining the ever increasing and massive land records data consisting of cadastral maps and alphanumeric data has always been a major challenge to many organizations that manage land. If this data is converted into digital form, processes and procedures automated and a Land Information Management System developed then this would result into efficient and effective delivery of services and thus assist the policy makers in making timely decisions and also for future planning. Land information is a prerequisite for making decisions related to land investment, development and management. The value of the information and the effectiveness of the decision making process are directly related to quality of the information and the manner in which it is made available.

Though, computerization has been identified as one of the most difficult components of land administration reform in developing countries (Williamson, 2000) with the current global challenges facing the continent on environmental degradation, climate change, food and fuel shortages and natural disasters implies that development of land information systems is a key aspect to be considered. This will go a long way in assisting in effective management of the land resource by availing timely, reliable and accurate land information. In order to be able to manage and control the use of land and land resources a reliable Land Information System is a prerequisite (Tuladhar et al, 2002).

It is important to note that in modernizing land administration systems, developing countries are faced with many challenges which are both external and internal and must be managed properly.

2.11 Integrated Land Information Management System

World over IT, systems have improved transparency by providing electronic access to records and standardizing services and fee structures for electronic records. As Steudler et al, 2010 says

introduction of IT systems to land registration is one of the most important opportunities for corrupt and non-transparent land management systems records and procedures are standardized and logically structured and introduced.

In many countries, especially the developing ones, land data is distributed in different parts of the country and departments. With the current globalization and demand for efficient services, countries are under a lot of pressure to organize their data and develop land information systems that manage this information in a timely and transparent manner. Land is a fixed asset and the world population is growing which leads to decrease in land to population ratio. With the increase in population the massive land records data consisting of cadastral and alphanumeric data is ever increasing and thus it has become untenable to continue managing these records manually. **Therefore** it is important to use Information Technology as a tool of maintaining and managing this voluminous land data. By developing Land Information System, we bridge the gap between the citizens and the government as is the aspirations of e-government (Srivatsara,2002). This implies that Information Technology is a strategic tool that can be used to enhance efficiency in government. The land records data can then be processed to meaningful information.

Information is one of the valuable assets to any government or society. If used properly information can be used to make timely decisions and have an impact in the well being of a country. Data mining and data warehousing are some of the tools that can be used to deliver strategic intelligence by decision makers, planners or policy makers. When land records are organized into meaningful warehouse, the decision makers are empowered with information that enables them make timely and informed decisions. This data warehouse containing history of property, transfer, division of land parcels, village trends, crop pattern and revenue details can be beneficial to the government decision makers professionals, companies and citizens.

A GIS based Land Information Management System is an information system that is used to input, store, retrieve and analyze geographically referenced land-related data in order to produce information on two forms; spatial information for decision making. Land information is base

and attribute information. Spatial information includes, maps or photographs and attribute information includes land ownership records. Establishment of a GIS based Land Information Management System will ensure efficient, accessible, affordable, transparent production of land information to support timely decision making and eventually contribute to economic growth.

Information management system is a system used for collecting, processing, storing and disseminating data in form of information which is required to carry out management functions. This information is converted from manual form into digital form, stored in databases and it can eventually be used in decision making.

Private and government organizations in the world have embraced information management in their day to day activities. As Tossavainer 2004 says implementing of ERP which is related to information systems management has three benefits business, technical and strategy based key drivers.

Land is critical resource to economic, social and cultural development of a country as articulated by Kenya Vision 2030 and Economic Recovery Strategy (2003-2007). It is a factor of production over which all other services are offered. The usefulness of land in economic development of Kenya can only be possible if land information is managed well.

Currently according to <http://www.ardhi.go.ke> land information is held in paper form and managed manually. This underscores the role this information will play in the development of Kenya. It has led to inefficient, time consuming and untimely decision making. Nevertheless Kenya lacks current data on amount of land under water, forests and infrastructure. This therefore complicates the issue of land use planning and overall management of urban and rural land.

A Land Information Management System will comprise of:

- Document management;
- Geo-referencing;
- Security of land parcels;

- Intellectual property rights;
- Disseminating of land information; and
- Pricing

The benefits that will result out of this will include guarantee of ownership and security of tenure, support for land and property taxation, provide security for credit, develop and monitor land markets, protect land resources and support environmental monitoring, facilitate management of state owned land, reduce land disputes, improve urban planning and infrastructure development, produce statistical data and revenue from sales of products and services.

2.12 Countries Case Studies in development of land information management systems

In examining the development of land information management systems in different countries will give a real life experience of how the systems were developed. It will also give us the weaknesses and strengths of these development modules adopted by these countries. Countries to be examined must have almost the same land administration systems with Kenya and must have working land information management system. Some of these countries include India, Singapore, Malaysia, Australia and Mauritius.

2.12.1 Development of Land Records System in India

The land records in India are important for socio-economic development of the country and their revision and update are important for capturing the changes in social dynamics. Though land reforms have been initiated in India, they have been unsuccessful due to the poor nature of land records. According to Habibullah et al 2005, the Government of India and the state governments have been grappling with the recurring problem of an inadequately maintained land records system. This weak land records system has been viewed as a systematic weakness. In India according to SD Meena et al 2003 the large quantities of land records data consisting of cadastral maps alphanumeric data containing record of rights and crop statistics has been a challenge to their revenue department. The Ministry of Rural Development and National Informatics Centre in India were geared towards devising an IT tool for maintaining this voluminous land records

data which will use the upcoming technologies such as GIS, Web, Open source, smartcard and data warehousing. They admitted that this will be a mammoth task although it will lead to effectiveness and efficiency of land management both for the members of public and managers implementing land based development activities at the grass root level.

Moreover, in India land records are in very poor shape and the rate of litigation in both rural and urban areas about ownership of land is at an alarming rate. It is estimated that India loses 1.3percent economic growth annually as a result of disputed land titles which inhibit supply of capital and credit for agriculture (Economic and Political weekly, 2002). Due to this its important a fundamental change is brought about in the way land records are maintained.

2.12.1.1 Karnataka State in India

This is one of the first states in India that have embraced e-government initiatives and implemented several projects for improving delivery of services to the citizens. Some of the projects are Bhoomi-Computerization of Land Records, Khajane-Computerization of Treasury Offices and Kaveri-Computerization of the registration process. There are also other projects being implemented which include establishment of rural telecentres, electronic procurement for government departments and public sector organizations and setting up a state wide area network. These projects are recognized nationally and internationally.

The state has adopted the model of Public Private Partnership (PPP) for implementation of e-government projects. Projects like Kaveri, e-procurement, Nemmadi (800 telecentres) and KSWAN (Karnataka State Wide Area Network) are being implemented using the PPP model. The government plays an enabling and regulatory role and the private sector brings its strength of customer focus and ability to achieve a speedy rollout of services.

Computerization of land records in Karnataka started in 1991 when the first pilot was initiated by the Ministry of Rural Development's Computerization of Land Records (CLR) project which was fully funded by the Government of India. In Karnataka, Bhoomi was initiated with a task of computerizing over 20million manually-managed land records, in respect of 6.7million farmers. A network of Bhoomi record access points was set up in 177 taluk (sub-districts) locations serving farmers of 30,662 villages in the state.

Development of Bhoomi-Computerization of Land Records

Bhoomi is the project of on-line delivery and management of land records in Karnataka state. It provides transparency in land records management with better citizen services. It is a model of accountability, transparency and efficiency and stability management land information services.

It has a built-in workflow automation, which moves transactions from one officer to another on the system. It has also been integrated with fingerprint (biometrics) technology to ensure a foolproof authentication system, instead of the traditional password system. Thus enforcing the concept of non-repudiation.

The objectives of the Bhoomi project were:

- Creating a database of basic records
- Collating the information to construct database regarding land revenue, cropping pattern, land use etc.
- Facilitating the issue of copies of records
- Reducing workload by eliminating drudgery of paper work
- Minimizing the possibilities of manipulation of land records
- Allowing farmers easy access to their records
- Creating a land management information system
- Utilizing the data for planning and for formulating development programmes
- Enabling usage of this database by courts, banks, private organizations and companies, ISPs

The Karnataka government planned to setup computerized land records kiosks known as Bhoomi centres across all Taluk Offices. These centres provided farmers with the Records of Rights, Tenancy and Cultivation (RTC) a document required for obtaining bank loans and also used as a

proof of ownership. This project was supposed to speed up delivery of RTCs without delays and eliminating corruption.

The project was fully funded by the Government of India and the following three agencies were involved in development of this system:

1. National Informatics Centre (NIC)

Its role was to upgrade district centres with the latest hardware, software, terminals and printers to expedite the work of data entry. It was also responsible for creating the software packages and providing training on the software to revenue officials.

2. Ministry of Rural Development (MORD)

It provided the financial support to the states for site preparation, data-entry, purchase of capital equipment and miscellaneous expenditures

3. State Governments

They were responsible for data collection, data verification and validation and distribution of the new records of rights to landowners.

The system works with the software called "BHOOMI" designed fully in-house by National Informatics Centre, Bangalore. The Bhoomi system was developed as follows:

Problems before Bhoomi was developed

Before Bhoomi was developed there was a manual system of managing land records which was cumbersome and imposed burdens, hindered collection and analysis of data and fell short of social and economic goals. Poor records led to litigation and unrest. Updating of records was neither regular nor accurate. Delays and errors hampered the economy. The following are some of the specific problems that affected the citizens:

- Opaque and monopolistic system. This led to farmers seeking out the Village Accountant to get a copy of Records of Rights, Tenancy and Crops (RTC) -a document needed for many tasks including a proof of ownership, obtaining bank loan.

- Delays and harassment
- Bribes had to be paid out
- Prone to manipulation-records were kept in a decentralized manner with no reporting system.

Conception and initiation of the Bhoomi System Project

The land records are maintained as per the KLR Act and Rules. Bhoomi was designed according to procedures and practices as required in law. The design was done by the National Informatics Centre of the Government of India which is the software developers.

A project leader with ICT knowledge and academic background; commitment and hard work was identified to work as the internal champion. The project leader has worked in the project since the inception of the project and this has greatly influenced the success of the project.

The huge task was to digitize the legacy data or to convert data into digital format. The other challenge was to ensure that data is updated on each day so that it can be accessed online for delivery and updating.

Procurement of system softwares and hardwares were planned at various stages as per requirements. The technology resources (hardware and software) are continually upgraded to keep pace with the increasing demand for quantum and efficiency of services.

The project was initiated in the field on pilot basis and scaled up to entire State in a few months time.

The challenges encountered during the initial stages of the project include large number of land records, low infrastructure, low literacy, diverse language dialects, skepticism about government, unfamiliarity with ICT, and entrenched vested interests. The biggest challenge was time target for the implementation of the project.

Design of the Bhoomi software system

A comprehensive data entry software 'Bhoomi' was designed after extensive discussions at various workshops at division, district and state level. Feedback from these workshops helped

the department in designing this data entry software. Selected field level personnel were invited to participate in the development process for various Bhoomi modules through a formal state level Bhoomi committee.

Data Conversion and Validation

Over 20,000 person-months involving 1,200 operators were invested to convert the handwritten legacy information for over 20million manual land records into electronic data. Over 10,000 officials underwent training on data preparation and validation processes.

About 20million records of land ownership of 6.7million farmers were to be captured in this system. A network of Bhoomi record access points were set up in 177 taluk locations, serving farmers of 30,662 villages in the state. This data was being held by Village Accountants.

Online data processing

All data had to be updated continuously to solve the discrepancies between the manual and computerized records; otherwise the movement from manual to computerized system would have been impossible. Manual records were withdrawn from the field in the whole state in a phased manner. A printout of the computerized records was individually signed after comparing with the manual registers to authenticate the data. The manual and computerized sets of records on the starting day now serve as original records and are kept in safe custody of taluk office. The deputy commissioner issued a notification declaring use of only computerized RTCs for all legal and other purposes.

Parallel running of the manual and computer system was not allowed to ensure that manual system does not act as cross purposes with computerized Bhoomi system.

To prepare field officials for the shift to computerization, twelve state-level information seminars and four divisional-level workshops were organized to train 2,000 officials. At the operations required huge domain knowledge as well as IT Knowledge, 900 young village officials were picked up among the 9000 village officials and were trained comprehensively to work on the Bhoomi project.

At the Bhoomi kiosks a comprehensive software programme provides for printing of land records and online updating of RTCs. It also records and identifies the fingerprint of the official who enters the change of ownership or sale of any piece of land in the state (to ensure no one hack into the system). Bhoomi also enables the scanning of original mutation orders and notices served to provide the revenue inspector with a record and ensure interested parties do not claim in court that they were not served with notice before the change was made. It also aims to facilitate more informed policy decisions through the generation of various reports based on type of soil, land holding size and type of crops grown.

Bhoomi software system

Bhoomi consists of database containing various types of data related to a cadastral land parcel. Manual processes were reengineered and integrated. There are different sub processes integrated to Bhoomi for online updating of data like Mutation process for updating of rights, phody process for updating the survey number and the extent, crop updating process etc. Bhoomi is built with three public interfaces for easier interaction with the public. The three main components or interfaces in the Bhoomi system are:

- Manned Application Kiosk or Computer centre where mutation and updating are done online. It includes finger print authentication and scanning of important documents to ensure robust and secured system. It allows public to apply for change of ownership and get the acknowledgement for the same. Most of the components of the Computer Centre are funded under the Central Scheme.
- Manned Land Records Kiosk from where the farmers can collect the copy of their record by paying Rs. 15. They can also lodge request for mutation to their land records. The kiosk is fully funded by state government.
- Touch screen kiosk where farmers can see their land related information without anybody's intervention or help.

Technology for Bhoomi system

Taluk level

Bhoomi software is running here as per business process. Back-end set-up and front-end set up has been provided to ensure smooth running of these system.

Taluk officials are operating and updating the records as per the process. In the Taluk the set up is as follows:

- Windows NT 4.0 as Server OS
- Windows 98/2000/XP as client OS
- MS SQL server 7.0 as RDBMS
- C-DAC's ISM soft for local language support
- MS Visual Basic 6.0 is for front-end development
- Finger print device for security to access data through software
- LAN through Hub
- Standalone set up and not in WAN

State Data Centre

A Wide Area Network was created for the Bhoomi application using a dedicated V-SAT Based network. All Taluk offices were connected to the network and Bhoomi data Centralized to the State Data Centre. The State Data Centre was created by e-Government. The data is replicated to the State Data Centre in Bangalore in a batch mode 4-5 times a day. It has the following:

- Windows 2003 as Server OS
- MS SQL Server 2000as RDMS
- IIS for web enablement

Data in the Bhoomi system

Land records document in Karnataka contains the following information on land parcel:

- Total extents of the land
- Unusable extents in that land
- Land revenue to be collected
- Soil type of the land
- Ownership details of that land-name of the owner, extents owned khatha number, acquisition type with descriptions, rights and liabilities of the owner.
- Trees details with the numbers of trees
- Irrigation details with extent irrigated
- Cultivator and tenancy details-year-wise, season-wise
- Year-wise, season-wise land utilization and
- Year-wise and season-wise crop details with extents of the crops

Some data management processes which are outside Bhoomi but may directly affect land records data are linked to the Bhoomi process. The Data from the registration of land transaction is linked to facilitate online updating in Bhoomi.

The Bhoomi updating process is maintained by 1000 in house trained staff of the department. More than 100 revenue officials have been comprehensively trained on hardware and networking. The Facility Manager maintains the Bhoomi centres, hardwares stationery UPS etc.

Different versions of the software are released as and when major developments and enhancements were made in the process. The working staffs are continually trained on new versions. The number of delivery points are extended to village level thus increasing access to land records.

Implementation of the Bhoomi project

The project was implemented in phases:

- Phase one- the system was implemented in five taluks
- Phase two-the system was implemented in 27 taluks with one taluk per district
- Phase three-the system was implemented in all the remaining taluks.

This strategy was adopted to ensure that lessons were learnt before up scaling the project throughout the state.

Different versions of software were launched at latter stages with enhancements and improvements derived from analysis and learning from the field. This ensured proper change management at the field level.

Security features for data access and authentication were added. In addition to password, biometric features were also introduced. All authentications in Bhoomi are now done through biometrics only.

To ensure the authentication of the origin of RTC from the Bhoomi kiosk only, holograms are affixed to the RTCs, which helps in containing the bogus RTCs.

Factors contributing to success of the Bhoomi project

- **Long stay of the project officer**-Identification of the internal champion was very critical for the success of the project. The project leader continuously analyzed and understood the domain knowledge thus making the project a success.
- **Involvement of the stakeholders from all levels**-Starting from the lowest level (Village accountants and the Revenue Inspectors) up to the highest level of bureaucracy, connected to management of land records and their commitment and hard work for implementation.
- **Political goodwill and continuous support by the administration**

- **A good self sustaining business model**-User charges collected are not credited to state consolidated fund and are used for the continuous maintenance and development of the system.
- **Training, capacity building and selection of computer operators from among the young and intelligent and motivated staff of the department.** Orienting and changing their mindset to suit the development of the scheme through workshops and seminars.
- **Incentive system for the working staff for quick adoption to the e-government environment.** Improvements in the working environment by providing better furniture and work accessories.
- **Making the required changes in policies, amending the laws quickly,** wherever required to facilitate implementation of new components and services in the system.
- **Identifying the outsourcing components**-the labour oriented works, engaging the facility managers for the maintenance of hardware, UPS, stationery etc thus freeing the regular staff from the burden of management of hardwares.

Features of Bhoomi

The important features of Bhoomi are as follows:

- Printing of land records when required.
- Real-time and online updating of to ensure that the RTCs provided to farmers is in sync with time.
- All the mutations to the land records database are done on the computer itself so as to ensure that data on computer remain current with time.
- Incorporates the state of the art bio-logon metrics system from Compaq which authenticates various users on the Bhoomi software on the basis of fingerprints. This ensures nobody can hack into the system by imitating other users.
- Scanning of original mutation of the revenue inspector.

- The administrators generate various reports based on type of soil, land holding size, type of crops grown etc. This information helps administrators make informed policy decision.

Benefits of Bhoomi system

After Bhoomi was developed the system was computerized, there was transparency, easy access, records were tamper proof, up to date, citizen friendly and secured. The Bhoomi have brought a lot of benefits to the Karnataka state and particularly to farmers, system administrators and others including financial institutions and private sector as follows:

To the farmers

- Farmers can quickly get their records from kiosks and are protected from harassment and extortion.
- Reduction in processing time for mutation
- Online tracking of mutation status
- Easy access to farm credit
- Ease in case of legal matters

Administrators

- Ease of maintenance and updating of land records documents
- Quick and easy access to land records
- Quick and easy access to land records for analysis
- Ease of monitoring of Government lands

Others

- For financial institutions, online farm credit related activities
- Information availability for private sector

2.12.1.2 KAVERI System

KAVERI is a land information system which computerized the registration department in Karnataka State in India. The system was fully implemented in the year 2003. In 2006, 201 sub Registrars offices were delivering three key services: on line registration of property sale/purchase deeds; issue of non-encumbrances certificate and issue copies of a previously registered deed.

According to an assessment done by Center of e-governance, Indian Institute of Management (2007), the total investment was Rs.400million in hardware, data entry and furniture. Yearly expenditure for the year 2005 was Rs.111.13million. This investment in technology has come from the private sector and would recover their investment from the fees charged to the users in return of top class world services provided. Therefore it was implemented under the concept of Build-Operate-Transfer (BOT).

Development of KAVERI system

The process of developing the system involves the following steps:

- Appointment of C-DAC as the Technical Solution Provider for the whole process
- The tenders will be called to invite the participation of the Private sector
- The district will be taken as a unit for computerization
- Constitution of a committee under the chairmanship of the IGR&CS, including the Government representatives namely, Revenue and Finance departments to avoid delays and regular governmental bureaucracies
- Development of the KAVERI software by the C-DAC
- Bank participation to avoid money handling by sub-registrars
- Training of the departmental staff in handling the software and to ensure the system can be transferred/ taken over by the department under any exigency

The project was envisaged to take 6months.

Scope of the project

It was envisaged to take care of the existing registration procedure, property valuation and report generation.

The scope of the system includes:

- Detailed system requirement study (SRS) document
- Detailed system design document (SDD)
- Development of KAVERI application suite
- Formulating network strategy for periodic data transfer
- Porting of master data to the system structure
- Installation of pilot version of software at Sub-Registrar office
- Fine tuning of applications wherever required
- Deployment of application suite at remaining SR Offices
- User training to private members and department persons (including operating system, RDBMS, Application, Miscellaneous)

KAVERI has the following nine modules:

1. Registration module
2. Valuation module
3. Reports module
4. Vendor Management System
5. Utilities module
6. Societies, Firms and Marriage Registration Module
7. Scan-Archival Module

8. Data Transmission module

9. Website

The KAVERI software was supposed to deliver the following:

- Computerized five step document registration process
- Auto valuation of property
- Auto scrutiny of document
- Immovable property valuation in urban and rural areas
- Bar coded report generation
- Daily report generation for sub registrar office including receipt, indexes, minute book, day book, a register, remittance etc
- Gateway screen with online information display
- Automation fees and stamp duty calculations
- Single data entry architecture
- Automation Database backup at local level
- Advanced scanning system with features like black border, skew removal
- Secure CD based Archival system
- Exhaustive document search based on different parameters
- Encumbrance Search certificate generation
- Marriage registration
- Firms and Societies registration
- Data transmission and reception over dial-up telephone lines
- MIS report generation at all levels in the hierarchy.
- Vendor Management software
- Web enabled info base
- Miscellaneous utilities to manage master info base like list of articles, jurisdiction etc
- User friendly KAVERI installable software on CD
- Bilingual interface (English and Kannada)

- Detailed User Manual in English

Benefits of KAVERI system

This systems brought twin benefits to the citizens of Karnataka; reducing the time spent on completing the registration from 45 days to half an hour and increasing the transparency in functioning by minimizing the need of dependence on middlemen for registration.

Conclusion

The two systems from the state of Karnataka India are similar to integrated land information management system. Therefore the approach of developing the two systems will serve as a very good case study in developing an appropriate model for development an integrated land information management system. The benefits highlighted in the two systems are some of the benefits which could be achieved when a Land Information Management System is developed and implemented.

The development of Land Information Management system (LIMS) is a system development project and remains a major challenge to the government. Therefore this project is expected to follow the System Development Life Cycle in its development.

2.13 System development

2.13.1 System

A system is an interrelated set of business procedures used within one business unit working together for a purpose. A system should have the following characteristics:

- Components
- Interrelated components
- Boundary
- Purpose
- Environment

- Interfaces
- Constraints
- Input
- Outputs

In order for a system to deliver its objectives, it should have four components namely:

- Decomposition-this is the process of breaking down a system into smaller components
- Modularity-process of dividing a system into modules of a relatively uniform size
- Coupling-subsystems that are dependent upon each other are coupled and
- Cohesion-the extent to which a subsystem performs a single function

2.13.2 Information System

An information system is a group of components working together to capture and deliver information to users. It is composed of people, processes, technology in both hardware and software and data.

2.13.3 System Analysis and Design

System or software development involves solving some problems in an organization. System development is a process which requires certain skills and capabilities to understand and follow a systematic procedure. System development is composed of four fundamental phases namely planning, analysis, design and implementation (as shown in Fig.3). These phases are what is composed of System Development Life Cycle. According to Wikipedia 2010, the main idea of the System Development Life Cycle has been to develop information systems in a deliberate, structured and methodical way, which requires each stage of the life cycle from inception of the idea to delivery of the system to be carried out rigidly and sequentially within the context of the framework. The Phases of System Development Life Cycle are given below:

Planning phase

, the fundamental phase of understanding why an information system should be built. This phase will be able to determine how the project will go about building the information system.

The planning phase is composed of two planning steps:

1. Initiation- the system's business value to the organization is identified. It answers the question, how will the system lower costs or increase revenue?

2. Project management-the project management creates a work plan, staffs the project and puts resources in place to help the project team control and direct the project through the entire project Development Life Cycle.

3. System Analysis phase

System analysis is the process of breaking down something into smaller components so that we can understand them. System analysis is the process of breaking down an information system. In this phase, requirement analysis is done in order to understand the problem which the software system needs to solve. The problem could be automating an existing manual process, or developing a completely new automated system or a combination of the two. In understanding the requirements of the system is very critical especially for large systems. The goal in requirements analysis is on identifying what is needed from the system and not how the system will achieve its objectives.

In system development there are two parties involved the client and the developer. The main problem is that the developer does not understand the client's problem domain and the client the developer is involved in system development. This causes a communication gap which has to be bridged during the requirement analysis.

The goal of the requirement specification phase is to produce a system requirement specification document. There are two major activities in this phase namely problem understanding and requirement specification in the problem analysis. The analyst must understand the problem and its context.

Once the problem have been understood and analyzed, the requirements must be specified in the system requirement specification. The requirements specification document must specify all functional and performance requirements, the formats of inputs, outputs and any other required standards and all design requirements specified in the document.

This phase ends with validation of requirements specified in the SRS document. The purpose of validation is to make sure that the requirements specified in the document, actually reflect the actual requirements or needs and that all requirements are specified. Validation is mostly done through requirement review, where a group of people including representatives of the client, critically review the requirements specification. The definition of SRS According to IEEE is:

- A condition of capability needed by a user to solve a problem or to achieve an objective;
- A condition or capability that must be met or possessed by a system to satisfy a contract, standard, specification or other formally imposed document.

Since the SRS describes the requirements of the proposed system, it describes the complete external behaviour of the proposed software.

(iii)System Design phase

The purpose of the design phase is to plan a solution of the problem specified by the SRS document. It is the first phase of moving from problem domain to the solution domain. The design of the system is the most critical factor affecting the quality of the system and has a major impact on the latter phases that is testing and maintenance. The output of the design phase is the design document. This document is similar to a blueprint or plan for the solution and is used latter during implementation, testing and maintenance.

The design phase is divided into two; system design and detailed design phases. System design also called top-level design, aims to identify the modules that should be in the system, the specification of these modules, and how they interact with each other to produce the desired results. At the end of system design all the major data structures, file formats, output formats as well as the major modules in the system and their specifications are decided.

(iv) System Implementation phase

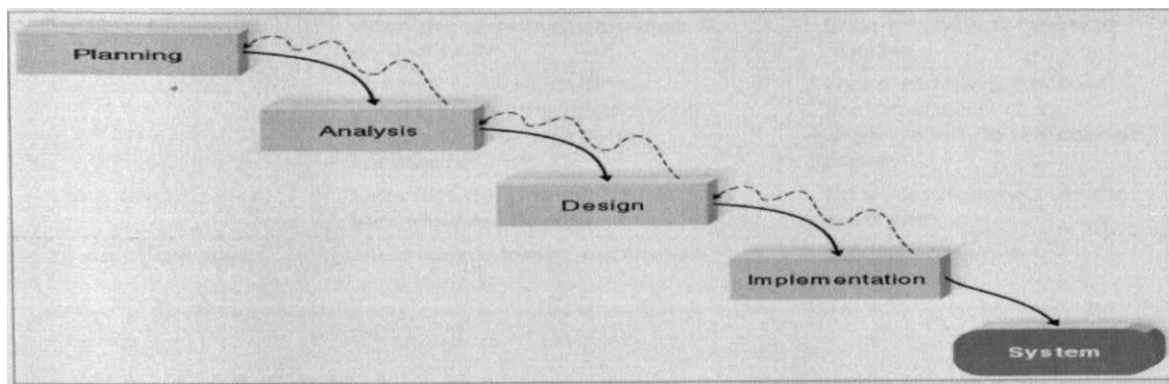
During this phase, the system is either developed or purchased. This is usually the longest and most expensive phase. It is composed of testing and maintenance. The phase has three steps:

System construction-the system is built and tested to make sure it performs as designed.

Installation-prepare to support the installed system

Support plan-includes a post-implementation review.

Fig. 2.3: System Development Life Cycle



Source: Chepken K.Cy, 2008

In developing a software system a formalized approach or methodology to implementing the System Development Life Cycle (SDLC) is followed as shown in Fig. 2.3. These methodologies will vary depending on whether the emphasis is on business processes or the data that supports the business.

Process-centered methodologies

The focus is on defining the activities associated with the system. The concentration is on representing the system concept as a set of processes with information flowing into and out of the process. The focus therefore is on flow, use and transformation of data in an information system. It involves creating of graphical representations such as data flow diagrams and charts.

Data-centered methodologies

This focuses on defining the content of the data storage containers and how they are organized. They utilize data models as the core of the system concept. Data model describe kinds of data and business relationships among the data. It also describes the rules and policies of a business. Business rules depict how an organization captures and processes the data.

Table 1.1: Key differences between the process-oriented and data-oriented methodologies

Table 1.1 Key Differences between the Process-Oriented and Data-Oriented Approaches to Systems Development

Characteristic	Process Orientation	Data Orientation
System focus	What the system is supposed to do and when	Data the system needs to operate
Design stability	Limited, because business processes and the applications that support them change constantly	More enduring, because the data needs of an organization do not change rapidly
Data organization	Data files designed for each individual application	Data files designed for the enterprise
State of the data	Much uncontrolled duplication	Limited, controlled duplication

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Source: Chepken K.C, 2008

2.13.3 System Development Methodology

System development methodology is a framework that is used to structure, plan, and control the process of developing an information system. There are various methodologies which can used and includes waterfall model, prototype model (incremental model), Throwaway prototyping model, spiral model, Rapid Application Development model, Extreme programming model, object oriented model, Dynamic Systems Development model, Capability Maturity Model of Integration model, View model. These methodologies have evolved over the years and they have their own strengths and weaknesses. There is no one methodology which is best suited for all software development projects.

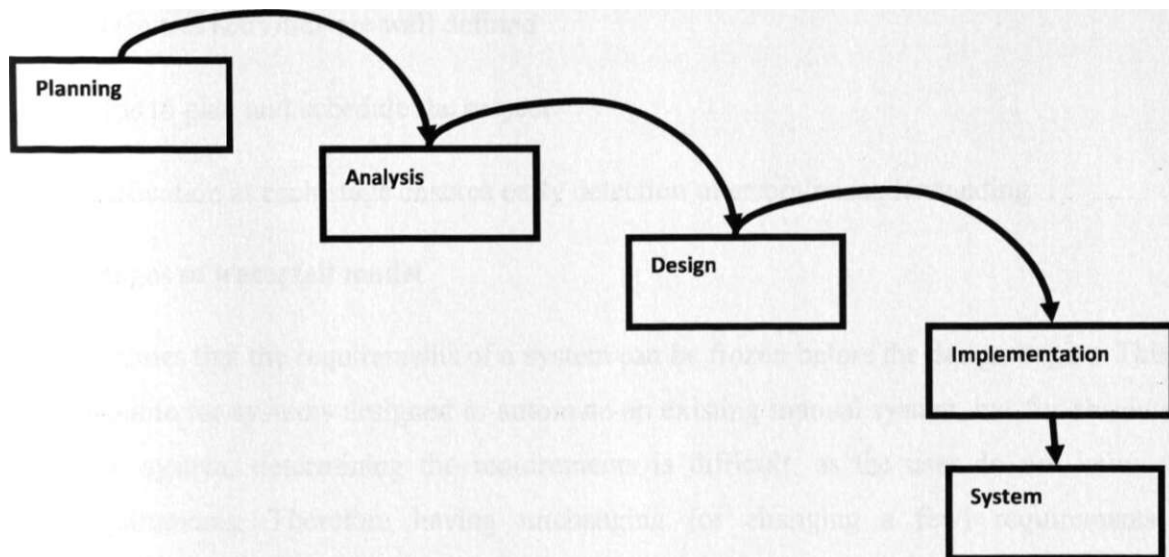
System development begins with the recognition of user needs. Then there is the preliminary investigation stage which includes evaluation of present system, information gathering,

feasibility study, and request of approval. Feasibility study includes technical, economic, legal and operational feasibility. In economic feasibility cost-benefit analysis is done, then detailed design, implementation, and testing and maintenance stages.

2.13.3.1 Waterfall Model

This is a sequential development approach, in which development moves steadily downwards through the phases of Planning, Analysis, Design, Implementation and delivery of the system. The phases are organized in a linear order. The project starts with planning which includes feasibility analysis, then the requirements analysis. The design phase begins after requirement analysis is done and the coding follows. Once the programming is done, the code is integrated and tested. On the success of the testing, the system is installed and regular maintenance of the system is done. Fig.2.4 shows the steps involved in the waterfall software development model.

Fig. 2.4: Waterfall software lifecycle model



Therefore the activities performed in the waterfall model are requirements analysis, project planning, system design, coding and unit testing, system integration and testing. These activities follow in a linear order. The outputs of the phases in the waterfall model are:

- System Requirements Specification (SRS) document
- Project Implementation plan
- System design document
- Test plan and test report
- Final code
- Software manuals (user manual, installation manual)
- Review reports

After every phase the outputs are verified and validated and they become input of the next phase until the last phase.

Advantages of waterfall model

- Easier to explain to the user
- Stages and activities are well defined
- Helps to plan and schedule the project
- Verification at each stage ensures early detection of errors/misunderstanding

Disadvantages of waterfall model

- Assumes that the requirements of a system can be frozen before the design begins. This is possible for systems designed to automate an existing manual system, but for absolutely new system, determining the requirements is difficult, as the user do not know the requirements. Therefore having unchanging (or changing a few) requirements is unrealistic for such project.
- Freezing the requirements usually requires choosing the hardware. For a large project it may take a few years to complete. If the hardware is selected early and due to the speed at which hardware technology is changing, the hardware may become obsolete.

- The waterfall method takes a long time before the system is implemented.

2.13.3.2 Prototyping Model

This is a software development model where the analysis, design and implementation phases are performed concurrently (as shown in Fig.2.5). The three phases are performed repeatedly in a cycle until the system is complete. A prototype is a smaller version of the system with minimal amount of features. It may also be referred to as incremental model.

Basic principles of the Prototyping Approach are:

- Not a standalone, complete development methodology approach, but rather an approach to handling selected portions of a larger, more traditional development methodology approaches.
- Attempts to reduce inherent project risk by breaking a project into smaller segments and providing more ease-of-change during the development process.
- User is involved throughout the development process, which increases the likelihood of user acceptance of the final implementation.
- Small-scale mock-ups of the system are developed following an iterative modification process until the prototype evolves to meet the users' requirements.
- While most prototypes are developed with the expectation that they will be discarded, it is possible in some cases to evolve from prototype to working system.
- A basic understanding of the fundamental business problem is necessary to avoid solving the wrong problem.

Advantages of prototype

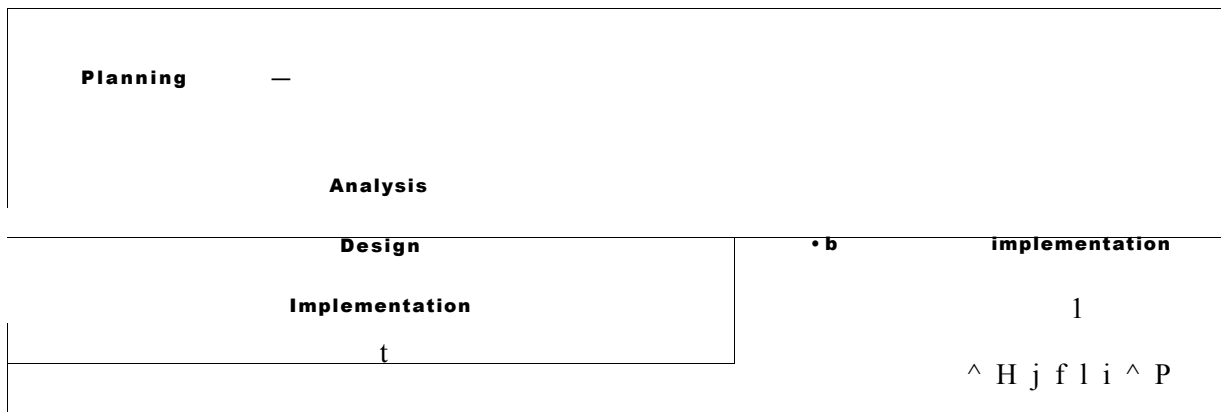
- It provides a system for the users to interact with, even if it is not initially ready for use.
- Users are actively involved in the development
- It provides a better system to users, as users have natural tendency to change their mind in specifying requirements and this method of developing systems supports this user tendency.
- Since in this methodology a working model of the system is provided, the users get a better understanding of the system being developed.

- Errors can be detected much earlier as the system is made side by side.
- Quicker user feedback is available leading to better solutions

Disadvantages of prototype

- Often the prototype undergoes such significant changes that many initial design decisions prove to be poor ones.
- Leads to implementing and then repairing way of building systems.
- Practically, this methodology may increase the complexity of the system as scope of the system may expand beyond original plans.

Fig. 2.5: Prototype model



Source: Chepken K.C, 2008

2.13.3.3 Throwaway Prototyping Model

This is similar to prototype model but the main difference is that it is completed during a different point in the system development life cycle (as shown in Fig.2.6). The prototype developed will not form part of the final solution and therefore the model is intended to be discarded to flush out the requirements. It is applied when facing uncertainty, ambiguity, incompleteness, or vagueness in the requirements.

Principles of throwaway model are:

- Before constructing the prototype, make an explicit and well-communicated decision that the prototype will be discarded.

- Ignore much you already know about the product - explore the areas you do not know.
- Emphasize quick implementation and modification over robustness, reliability, performance, and long-term maintenance.
- Don't make a prototype more elaborate than is necessary to meet the objectives. Resist the temptation to keep adding more capabilities.
- Evolving the prototype into the product - if that was your intent, use evolutionary prototyping.

Benefits of throwaway prototyping

- The speed at which throw-away prototypes can be generated and modified is a major reason for their use and why this method is sometimes referred to as 'rapid prototyping'.
- They also provide a useful and meaningful way for a developer to *walk* the client and/or end-user through the system requirements as interpreted by the developer. Feedback from the client and/or end-user should aid in allowing misinterpretations or unnecessary complexities to be picked up and addressed at an early stage.
- The speed of development and the potential to catch misinterpretations or missing features at an early stage can help to make the throw-away prototype a cost effective approach.

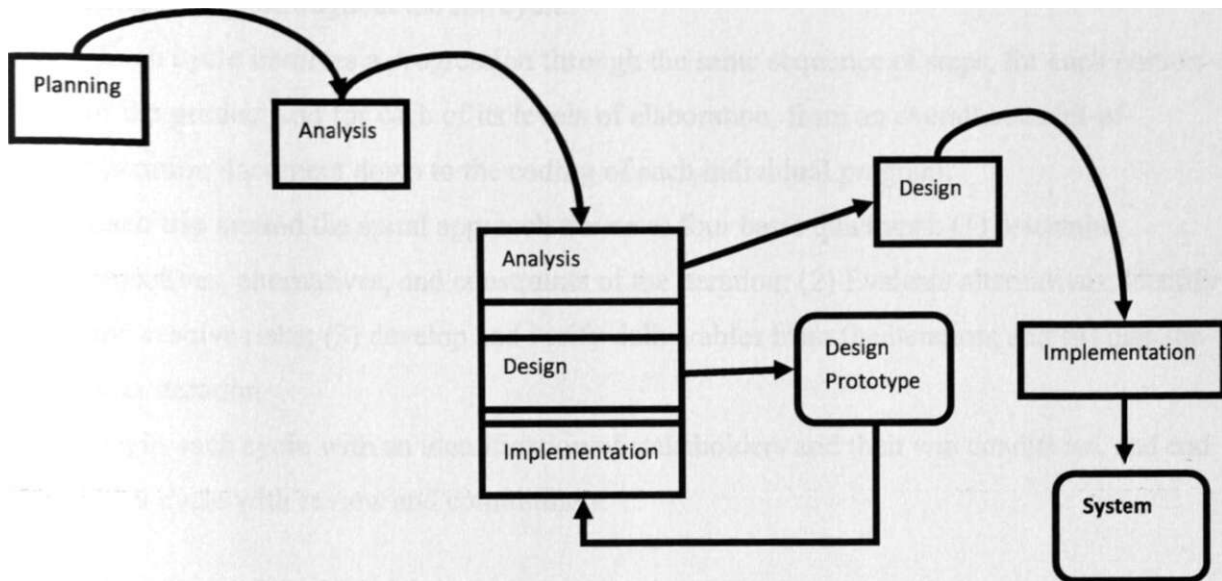
Advantages of throwaway prototype Model

- Clear project objectives.
- Stable project requirements.
- Progress of system is measurable.
- Strict sign-off requirements.

Disadvantages of throwaway prototype Model

- Time consuming.
- Never backward (Traditional)
- Little room for iteration
- Difficulty responding to changes

Fig. 2.6 Throwaway prototype model



2.13.3.4 Spiral Model

In the Spiral system development model activities are organized in a spiral and the spiral has many cycles. The radial dimension represents the cumulative cost incurred in accomplishing the steps done so far and the angular dimension represents the progress made in completing each circle of the spiral (as shown in Fig.2.7). Each circle in the spiral begins with the identification of objectives for that cycle and the different alternatives for achieving the objectives and the imposed constraints. The next step involves evaluating these alternatives based on the objectives and constraints. This involves identifying uncertainties and risks involved. The next step is to develop strategies that resolve the uncertainties and risks. This step may involve benchmarking, simulation and prototyping activities. The next step is development of software by keeping in mind the risks. Finally the next step is plan next phases.

Spiral methodology combines the features of the prototyping model and the waterfall model. This is done in order to get the advantages of top-down and bottom-up concepts. The spiral model is mostly used in large, expensive and complicated projects.

Basic principles of spiral model:

1. Focus is on risk assessment and on minimizing project risk by breaking a project into smaller segments and providing more ease-of-change during the development process, as

well as providing the opportunity to evaluate risks and weigh consideration of project continuation throughout the life cycle.

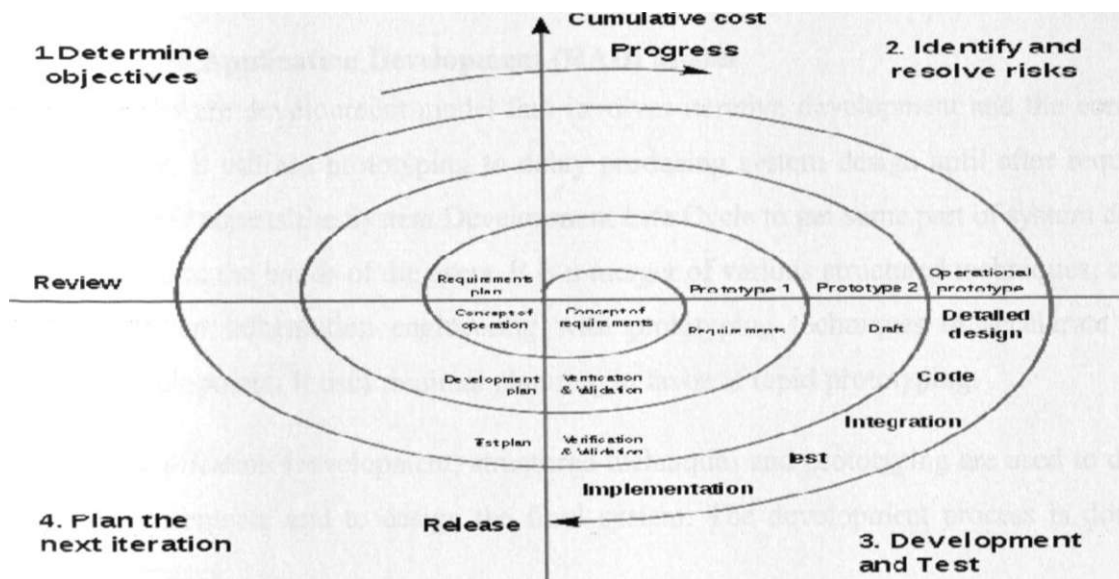
2. "Each cycle involves a progression through the same sequence of steps, for each portion of the product and for each of its levels of elaboration, from an overall concept-of-operation document down to the coding of each individual program."
3. Each trip around the spiral approach traverses four basic quadrants: (1) determine objectives, alternatives, and constraints of the iteration; (2) Evaluate alternatives; Identify and resolve risks; (3) develop and verify deliverables from the iteration; and (4) plan the next iteration.
4. Begin each cycle with an identification of stakeholders and their win conditions, and end each cycle with review and commitment

In specific, steps in Spiral Model can be generalized as follows:

1. Defining system requirements-detailed system requirements are defined. This involves interviewing internal and external users and other aspects of the existing system.
2. Preliminary design- This involves creating a preliminary design of the new system. In this phase all possible alternatives which can help in developing a cost effective project are analyzed and strategies to use them are decided. The main purpose of this phase is to identify and resolve all possible risks in the project development. If the risks indicate any kind of uncertainty in requirements, prototyping may be used to proceed with the available data and find out possible solution in order to deal with the potential changes in the requirements
3. First prototype- The first prototype of the new system is developed from the preliminary design. It represents an approximation of the final product.
4. Second prototype-This is developed using a fourfold procedure.
 - i. Evaluating the first prototype in terms of strengths, weaknesses, and risks
 - ii. Defining the requirements of the second prototype
 - iii. Planning and designing the second prototype
 - iv. Constructing and testing the second prototype

5. Project sponsor's option-In this step the entire project can be terminated if the risk is found to be too great. Risk factors might involve development cost overruns, operating-cost miscalculation or any other factor that might result into a less-than-satisfactory final product.
6. Evaluating existing prototype-The existing prototype is evaluated in the same way as was the previous one, and if necessary another prototype is developed from it according to the fourfold procedure outlined above.
7. Iteration of next steps-The preceding steps are iterated until the customer is satisfied that the refined prototype represents the final product desired.
8. Final system-The final system is constructed based on the refined prototype.
9. Evaluating and testing final system-The final system is thoroughly evaluated and tested. Routine maintenance is carried out on a continuing basis to prevent large scale failures and to minimize downtime

Fig. 2.7 Spiral model



Source: Boehm, 1986

The development spiral consists of four quadrants as shown in the Fig.7 above:

Quadrant 1: Determine objectives, alternatives, and constraints.

Quadrant 2: Evaluate alternatives, identify, and resolve risks.

Quadrant 3: Develop, verify, next-level product.

Quadrant 4: Plan next phases.

Advantages of Spiral Model

1. Avoidance of Risk is enhanced.
2. Strong approval and documentation control.
3. Implementation has priority over functionality.
4. Additional Functionality can be added at a later date.

Disadvantages of Spiral Model

1. Highly customized limiting re-usability.
2. Applied differently for each application.
3. Risk of not meeting budget or schedule.
4. Possibility to end up implemented as the Waterfall framework.

2.13.3.5 Rapid Application Development (RAD) Model

This is a software development model that involves iterative development and the construction of prototypes. It utilizes prototyping to delay producing system design until after requirements are clear. RAD adjusts the System Development Life Cycle to get some part of system developed quickly and into the hands of the users. It is a merger of various structured techniques, especially the data driven information engineering with prototyping techniques to accelerate software systems development. It uses minimal planning in favor of rapid prototyping.

In Rapid Application Development, structured techniques and prototyping are used to define the system requirements and to design the final system. The development process is done in the following phases:

1. Development of preliminary data and business process models-This is done using structured techniques
2. Requirement verification-The requirements are verified using prototyping in order to refine the data and process models.

3. Repeating the above stages iteratively
4. Development results-This result into a combined business requirements and technical design statement to be used for constructing the new system.

In the recent past the challenges facing software development can be summarized as more, better and faster. Rapid Application Development addresses these challenges by providing a means of developing systems faster, while reducing the cost and increasing quality. The four most essential aspects of RAD are: methodology, people, management and tools. All these ingredients must be adequate to ensure development of systems is of high speed. The fundamentals of the RAD methodology include the following:

- Combining the best available techniques and specifying the sequence of tasks that will make those techniques most effective
- Using revolutionary prototypes that are eventually transformed into the final product
- Using workshops, instead of interviews, to gather requirements and review design
- Selecting a set of CASE tools to support modeling, prototyping and code re-usability as well as automating many of the combinations of techniques
- Implementing timeboxed development that allows development teams to quickly build the core of the system and implement refinements in subsequent releases.
- Provide guidelines for success and describing pitfalls to avoid

Principles of RAD are:

- Key objective is for fast development and delivery of a high quality system at a relatively low investment cost.
- Attempts to reduce inherent project risk by breaking a project into smaller segments and providing more ease-of-change during the development process.
- Aims to produce high quality systems quickly, primarily through the use of iterative Prototyping (at any stage of development), active user involvement, and computerized development tools. These tools may include Graphical User Interface (GUI) builders,

Computer Aided Software Engineering (CASE) tools, Database Management Systems (DBMS), fourth-generation programming languages, code generators, and object-oriented techniques.

- Key emphasis is on fulfilling the business need, while technological or engineering excellence is of lesser importance.
- Project control involves prioritizing development and defining delivery deadlines or "timeboxes". If the project starts to slip, emphasis is on reducing requirements to fit the timebox, not in increasing the deadline.
- Generally includes Joint Application Development (JAD), where users are intensely involved in system design, either through consensus building in structured workshops, or through electronically facilitated interaction.
- Active user involvement is imperative.
- Iteratively produces production software, as opposed to a throwaway prototype.
- Produces documentation necessary to facilitate future development and maintenance.
- Standard systems analysis and design techniques can be fitted into this framework.

Rapid Application Development Lifecycle

Rapid Application Development is designed to ensure developers build systems that the users really need. The lifecycle has four stages which includes requirement planning, user design, construction and implementation.

1. Requirement Planning

This is also known as Concept Definition Stage. It defines the business functions and data subject areas that the system will support and determines the system's scope.

2. User Design

This is also known as Functional Design Stage. This stage uses workshops to model the system's data and processes and to build a working prototype of critical system components.

3. Construction

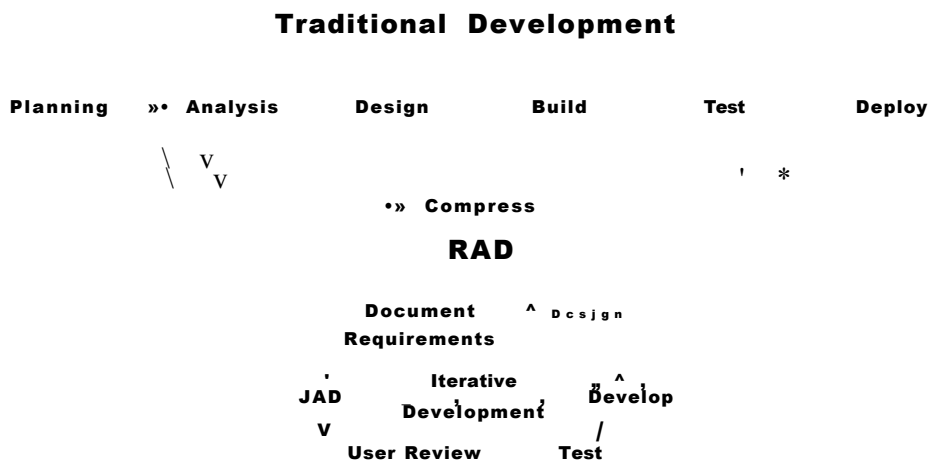
It is also known as Development Stage. This stage completes the construction of physical application system, builds the conversion system and develops user aids and implementation work plans.

4. Implementation

It is also known as Development stage. It includes final user testing and training, data conversion and the implementation of the application system.

Rapid Application Development Model compresses the conventional step-by-step development method into an iterative process (as shown in Fig.2.8 below). The RAD approach includes developing and refining the data models, process models and prototype in parallel using an iterative process.

Fig. 2.8: Rapid Application Development Model



Source: CASEMaker Inc., 2000

Advantages of the RAD methodology:

1. Flexible and adaptable to changes.

2. Prototyping applications give users a tangible description from which to judge whether critical system requirements are being met by the system. Report output can be compared with existing reports. Data entry forms can be reviewed for completeness of all fields, navigation, data access (drop down lists, checkboxes, radio buttons, etc.).
3. RAD generally incorporates short development cycles - users see the RAD product quickly.
4. RAD involves user participation thereby increasing chances of early user community acceptance.
5. RAD realizes an overall reduction in project risk.
6. Pareto's 80 - 20 Rule usually results in reducing the costs to create a custom system.

Disadvantages of RAD methodology:

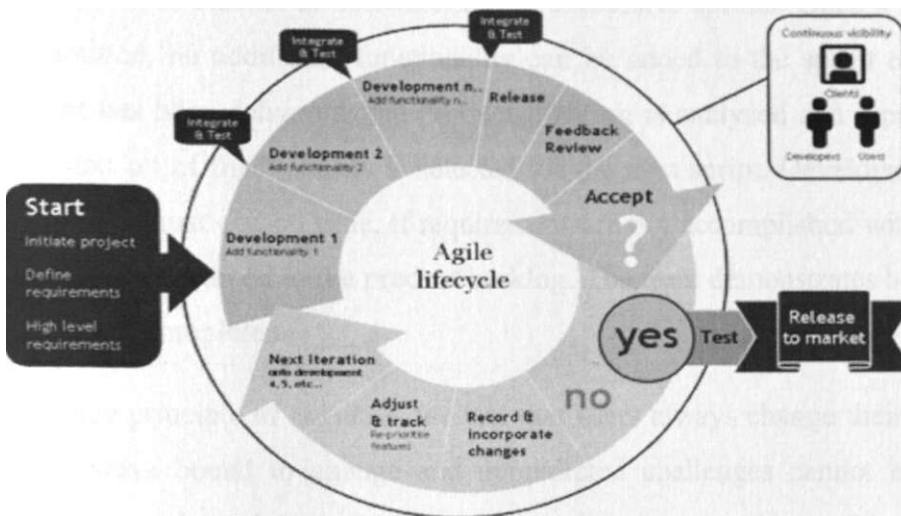
1. Unknown cost of product. As mentioned above, this problem can be alleviated by the customer agreeing to a limited amount of rework in the RAD process.
2. It may be difficult for many important users to commit the time required for success of the RAD process.

2.13.3.6 Agile Methodologies

This is a group of system development methodologies which are based on iterative and incremental whereby requirements and solutions evolve through collaboration between self-organizing and cross-functional teams. These methodologies promote development, teamwork, collaboration and process adaptability throughout the project life cycle.

Agile methodologies are characterized by breaking tasks into small increments with minimal planning and iterations. Iterations are short time frames or timeboxes which last one to four weeks. Each of the iterations involves a team working together through the System Development Life Cycle which includes planning, requirement analysis, design, coding, unit testing and acceptance testing. The teams are cross-functional and self organizing and are not based on the organization's hierarchy structure. The Agile methodologies are based on face-to-face communication rather than written communication and the team is in one location.

Fig.2.9: Agile methodology



Source: Wikipedia, 2010

Agile methodologies includes; Scrum, Extreme Programming, Crystal, Dynamic Systems Development Method(DSDM), Feature-Driven Development (FDD) and Lean software development

2.13.3.7 Scrum Model

This is an iterative and incremental methodology for development of information systems projects. This is done in sprints which is the time between 2-4 weeks in which development occurs on a set of backlog items. The set of features that go into sprint come from the product backlog which is prioritized set of work to be done. It contains a set of practices and predefined roles. The main roles are:

- Product Owner-presents the stakeholders and the business
- Scrum Master-the one who maintains the processes or the project manager
- Team-a cross functional group who do the actual analysis, design, implementation, testing

The Product Owner together with the team identifies and prioritizes system functionality in form of a Product Backlog. The Product Backlog consists of features that need to be done in order to

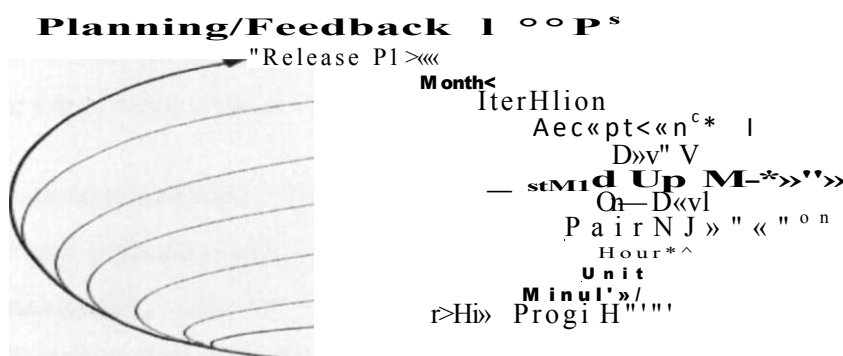
produce a working software system. They then estimate and **sign-up** the shippable increments of software during successive sprints. Once committed, no additional functionality can be added to the Sprint. After a Sprint has been delivered, the Product Backlog is analyzed and re-prioritized, and the next set of functionality is selected for the next sprint. Development is necessary, and the sprint must end on time, if requirements are not **accomplished** within the given time they are left out and returned to the product backlog. The team demonstrates how to use the software after a sprint is completed.

The key principle of Scrum is the fact that users always change their mind or user requirements are always bound to change and unpredicted challenges cannot be addressed adequately in traditional planned manner. The solution therefore to address this challenge is to accept that problems cannot be fully understood or defined and instead focus on maximizing the team's ability to deliver quickly and respond to emerging requirements.

2.13.3.8 Extreme Programming Model

This is intended to improve software quality and responsiveness to changing customer requirements. It advocates for frequent "releases" in short development cycles (timeboxing), which is intended to improve productivity and introduce checkpoints where new customer requirements can be adopted. It is a software development methodology that organizes people to produce higher quality software more productively. It is a type of agile software development methodology.

Fig. 2.10: Extreme programming model



Source: DonWells, 2001

Principles of extreme programming model are:

- Continuous testing
- Simple coding
- Close interaction with the end users to build systems very quickly
- Embracing change

XP Programming Activities

XP describes four basic activities that are performed within the software development process namely:

Coding

The advocates of XP argue that the only truly important product of the system development process is code - software instructions a computer can interpret. Without code, there is no working product. Coding can also be used to figure out the most suitable solution. Fellow programmers might code it and use the code to demonstrate what he or she means. Code, say the proponents of this position, is always clear and concise and cannot be interpreted in more than one way. Other programmers can give feedback on this code by also coding their thoughts.

Testing

This is done to ascertain that the function is working. Bugs and design errors are pervasive problems in software development. Extreme programming's approach is that if a little testing can eliminate a few flaws, a lot of testing can eliminate many more flaws.

- Unit tests determine whether a given feature works as intended. A programmer writes as many automated tests as they can think of that might "break" the code; if all tests run successfully, then the coding is complete. Every piece of code that is written is tested before moving on to the next feature.

- Acceptance tests verify that the requirements as understood by the programmers satisfy the customer's actual requirements. These occur in the exploration phase of release planning.

Listening

Programmers must listen to what the customers need the system to do, what "business logic" is needed. They must understand these needs well enough to give the customer feedback about the technical aspects of how the problem might be solved, or cannot be solved.

Designing

If coding, testing and listening activities are performed well, the result should always be a system that works. In practice, this will not work. One can come a long way without designing but at a given time one will get stuck. The system becomes too complex and the dependencies within the system cease to be clear. One can avoid this by creating a design structure that organizes the logic in the system. Good design will avoid lots of dependencies within a system; this means that changing one part of the system will not affect other parts of the system

Values

There are five values which are followed in XP model namely:

Communication

Communicating system requirements is a core aspect in building software systems. In formal development method this aspect is accomplished through documentation. Extreme programming is viewed as a programming technique of rapidly building and disseminating institutional knowledge among the development team. The goal is to give the developers a shared view of the system which matches the system users view. XP therefore favors simple designs, common metaphors, collaboration of users and programmers, frequent verbal communication and feedback.

Simplicity

XP advocates starting with the simplest solution and adding extra functionality later. The focus is on designing and coding for the needs of today instead of those of tomorrow, next week or future. This can be summed up as "You Ain't Gonna Need It" (YAGNI) approach. Though it can sometimes entail more efforts tomorrow to change the system, the main argument is that there is no need of investing in future requirements that can change before they become a reality.

Feedback

Feedback is in three aspects which include feedback from the system, feedback from the customer and feedback from the team. Feedback from the systems involves writing unit tests, running periodic integration tests; the programmers have direct feedback from the state of the system after implementing the changes. Feedback from the customer is functional tests and is written by the customer and the testers. The customers give concrete feedback about the current state of their system. Feedback from the team is where the customer comes up with new requirements in the planning and the team estimates the time that will take them to implement the changes.

Courage

The developers design systems for today not tomorrow. This is done to avoid being bogged down in design and requiring a lot of effort to implement. Courage enables developers to feel comfortable when reviewing the existing system and modifying it so that future changes can be implemented more easily. The other aspect of courage is to remove a source code that is obsolete no matter how much effort was used to create that source code. Courage also means persistence.

Respect

This involves respect for others and self-respect. Programmers should never commit changes that break compilation, make unit tests fail or that delay the work of their peers. They therefore respect their work by always striving for high quality and seeking for the best design for the solution at hand through refactoring.

Rules

Rules are given in the categories of planning, managing, designing, coding and testing

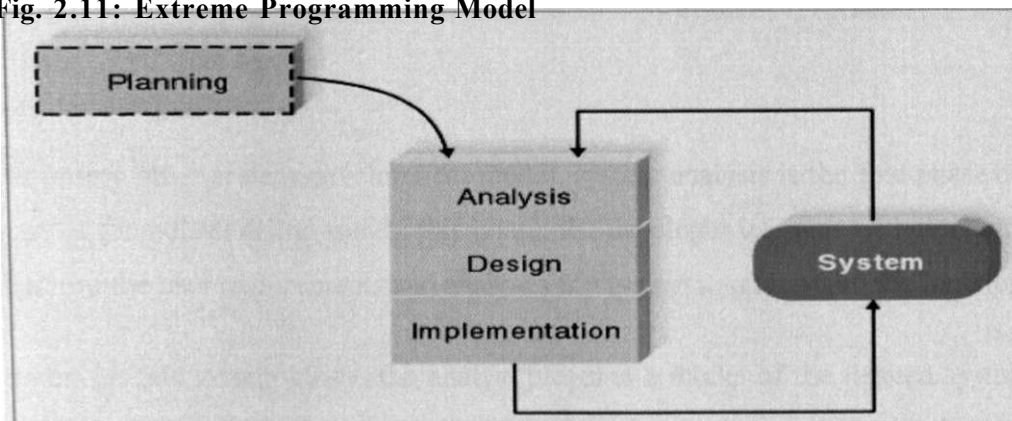
Advantages of Extreme programming model

- It delivers clean designs and high quality software on a realistic schedule.
- The XP teams have a laser-like focus on testing.
- It helps achieve a high degree of customer satisfaction, due to the way that every customer requirement is captured as a story (plain English, and can be tested).
- It encourages a high degree of teamwork, getting the entire team (including the customer) to work together in a room. Programmers work in pairs, with each pair sharing a monitor and keyboard.
- It delivers a schedule that is believable.
- Design is simple.
- Comprehensive test cases are generated as part of XP. Code is written such that it is suitable for test cases.
- Being able to add/modify features. Given that XP works on an iterative approach, it is much easier to be able to add features or modify these features based on reviews.
- The whole development process is visible and accountable. It is very easy to measure as to whether what has been achieved is as per the schedule.
- Team is less stress. With traditional waterfall, as you near the end schedules, you are able to more accurately measure consistency in the schedule, and any delays put a major amount of effort in order to get things in time. XP makes knowing progress much earlier, and hence sudden stress in the end.

Disadvantages of Extreme programming model

- A methodology is only as effective as the people involved, XP does not solve this
- Often used as a means to bleed money from customers through lack of defining a deliverable
- Lack of structure and necessary documentation
- Only works with senior-level developers
- Incorporates insufficient software design
- Requires meetings at frequent intervals at enormous expense to customers
- Requires too much cultural change to adopt
- Can lead to more difficult contractual negotiations
- Can be very inefficient—if the requirements for one area of code change through various iterations, the same programming may need to be done several times over. Whereas if a plan were there to be followed, a single area of code is expected to be written once.
- Impossible to develop realistic estimates of work effort needed to provide a quote, because at the beginning of the project no one knows the entire scope/requirements
- Can increase the risk of scope creep due to the lack of detailed requirements documentation
- XP is feature driven; non-functional quality attributes are hard to be placed as user stories

Fig. 2.11: Extreme Programming Model



Source: Chepken K.C, 2008

2.13.3.9 Object-Oriented Model

This is where object-oriented techniques are used during analysis and implementation of the system. This methodology asks the analyst to determine what the objects of the system are, how they behave over time or in response to events, and what responsibilities and relationships an object has to other objects. Object-oriented analysis has the analyst look at all the objects in a system, their commonalties, difference, and how the system needs to manipulate the objects.

Object Oriented Process

The Object Oriented Methodology of Building Systems takes the objects as the basis. The system to be developed is observed, analyzed and the requirements defined as in any other method of system development. Then, the objects in the required system are identified.

Therefore, Object Modeling is based on identifying the objects in a system and their interrelationships. Once this is done, the coding of the system is done. Object Modeling is similar to the traditional approach of system designing, in that it also follows a sequential process of system designing but with a different approach. The basic steps of system designing using Object Modeling may be listed as:

- System Analysis
- System Design
- Object Design
- Implementation

System Analysis

As in any other system development model, system analysis is the first phase of development in case of Object Modeling too. In this phase, the developer interacts with the user of the system to find out the user requirements and analyses the system to understand the functioning.

Based on this system study, the analyst prepares a model of the desired system. This model is purely based on what the system is required to do. At this stage the implementation details are not taken care of. Only the model of the system is prepared based on the idea that the system is made up of a set of interacting objects. The important elements of the system are emphasized.

System Design

System Design is the next development stage where the overall architecture of the desired system is decided. The system is organized as a set of sub systems interacting with each other. While designing the system as a set of interacting subsystems, the analyst takes care of specifications as observed in system analysis as well as what is required out of the new system by the end user.

The basic philosophy of Object-Oriented method of system analysis is to perceive the system as a set of interacting objects; a bigger system may also be seen as a set of interacting smaller subsystems that in turn are composed of a set of interacting objects. While designing the system, the stress lies on the objects comprising the system and not on the processes being carried out in the system as in the case of traditional Waterfall Model where the processes form the important part of the system.

Object Design

In this phase, the details of the system analysis and system design are implemented. The Objects identified in the system design phase are designed. Here the implementation of these objects is decided as the data structures get defined and also the interrelationships between the objects are defined. The following are components of object oriented technologies:

Class: A class is a collection of similar objects. It is a template where certain basic characteristics of a set of objects are defined. The class defines the basic attributes and the operations of the objects of that type. Defining a class does not define any object, but it only creates a template. For objects to be actually created instances of the class are created as per the requirement of the case.

Abstraction: Classes are built on the basis of abstraction, where a set of similar objects are observed and their common characteristics are listed. Of all these, the characteristics of concern to the system under observation are picked up and the class definition is made. The attributes of no concern to the system are left out. This is known as abstraction.

The abstraction of an object varies according to its application. For instance, while defining a pen class for a stationery shop, the attributes of concern might be the pen color, ink color, pen

type etc., whereas a pen class for a manufacturing firm would be containing the other dimensions of the pen like its diameter, its shape and size etc.

Inheritance: Inheritance is another important concept in this regard. This concept is used to apply the idea of reusability of the objects. A new type of class can be defined using a similar existing class with a few new features. For instance, a class vehicle can be defined with the basic functionality of any vehicle and a new class called car can be derived out of it with a few modifications. This would save the developers time and effort as the classes already existing are reused without much change.

Coming back to our development process, in the Object Designing phase of the Development process, the designer decides onto the classes in the system based on these concepts. The designer also decides on whether the classes need to be created from scratch or any existing classes can be used as it is or new classes can be inherited from them.

Implementation

During this phase, the class objects and the interrelationships of these classes are translated and actually coded using the programming language decided upon. The databases are made and the complete system is given a functional shape.

The complete OO methodology revolves around the objects identified in the system. When observed closely, every object exhibits some characteristics and behavior. The objects recognize and respond to certain events. For example, considering a Window on the screen as an object, the size of the window gets changed when resize button of the window is clicked.

Here the clicking of the button is an event to which the window responds by changing its state from the old size to the new size. While developing systems based on this approach, the analyst makes use of certain models to analyze and depict these objects. The methodology supports and uses three basic Models:

Object Model - This model describes the objects in a system and their interrelationships. This model observes all the objects as static and does not pay any attention to their dynamic nature.

Dynamic Model - This model depicts the dynamic aspects of the system. It portrays the changes occurring in the states of various objects with the events that might occur in the system.

Functional Model - This model basically describes the data transformations of the system. This describes the flow of data and the changes that occur to the data throughout the system.

While the Object Model is most important of all as it describes the basic element of the system, the objects, all the three models together describe the complete functional system.

As compared to the conventional system development techniques, OO modeling provides many benefits. Among other benefits, there are all the benefits of using the Object Orientation. Some of these are:

- **Reusability** - The classes once defined can easily be used by other applications. This is achieved by defining classes and putting them into a library of classes where all the classes are maintained for future use. Whenever a new class is needed the programmer looks into the library of classes and if it is available, it can be picked up directly from there.
- **Inheritance** - The concept of inheritance helps the programmer use the existing code in another way, where making small additions to the existing classes can quickly create new classes.
- **Programmer has to spend less time and effort and can concentrate on other aspects of the system due to the reusability feature of the methodology.**
- **Data Hiding** - Encapsulation is a technique that allows the programmer to hide the internal functioning of the objects from the users of the objects. Encapsulation separates the internal functioning of the object from the external functioning thus providing the user flexibility to change the external behaviour of the object making the programmer code safe against the changes made by the user.
- **The systems designed using this approach are closer to the real world as the real world functioning of the system is directly mapped into the system designed using this approach.**

Advantages of Object Oriented Methodology

- Object Oriented Methodology closely represents the problem domain. Because of this, it is easier to produce and understand designs.
- The objects in the system are immune to requirement changes. Therefore, allows changes more easily.
- Object Oriented Methodology designs encourage more re-use. New applications can use the existing modules, thereby reduces the development cost and cycle time.
- Object Oriented Methodology approach is more natural. It provides nice structures for thinking and abstracting and leads to modular design.

Disadvantages of Object Oriented Methodology

- Unavailability of object-oriented database management systems.
- Unavailability of object-oriented CASE tools.
- Confusion with too many different object-oriented development methods
- Decreased system / software performance

2.13.3.10 Dynamic Systems Development Model

This is an approach of system development which develops the system dynamically. It is independent of tools, in that it can be used with both structured analysis and design approach or object oriented approach. The Dynamic System Development Method (DSDM) is dynamic as it is a Rapid Application Development method that uses incremental prototyping. This method is particularly useful for the systems to be developed in short time span and where the requirements cannot be frozen at the start of the application building i.e., characterized by tight time schedules and budgets. Whatever requirements are known at a time, design is prepared, developed and incorporated into system. In Dynamic System Development Method (DSDM), analysis, design and development phase can overlap. In DSDM at one time some people will be working on some new requirements while others will be developing something for the system. In Dynamic System Development Method (DSDM), requirements evolve with time.

Dynamic System Development Method addresses the most common failures of information systems projects which include exceeding budgets, missing deadlines, and lack of user involvement and top-management commitment (Wikipedia, 2010). It thus advocates in delivering software systems on time and on budget while adjusting for changing requirements along the development process.

Principles of Dynamic System Development Model

Dynamic System Development Model has nine principles as follows:

- User involvement is the main key in managing an efficient and effective project. Both the users and the developers share a workplace to ensure decisions are made accurately.
- The project team has to be empowered to make decisions in order to ensure the progress of the project without waiting for higher-level approval.
- A focus on delivery of products, with assumption that to deliver something earlier which is good enough is always better than to deliver everything which is perfect in the end. In delivering a product in an earlier stage in the project, the product can be tested and reviewed and this can be taken into account in the next phase.
- The main criteria for acceptance of a deliverable are delivering a system that addresses the current business needs. It is not very important to deliver a perfect system which addresses all possible business needs but to focus on critical functionalities.
- Development is iterative and incremental and driven by user's feedback to produce an effective business solution.
- All changes during the development are reversible
- High level scope and requirements should be base-lined before the project starts
- Testing is carried out throughout the project life-cycle
- Communication and cooperation among all project stakeholders is required to be efficient and effective.

Life Cycle of Dynamic System Development Method (DSDM)

Dynamic System Development Method (DSDM) has a five-phase life cycle (as shown in Fig.2.12), which includes, feasibility study, business study, functional model iteration, Design and Build Iteration, and Implementation as explained below:

Feasibility study

In this phase the problem is defined and the technical feasibility of the desired application is verified. Apart from these routine tasks, it is also checked whether the application is suitable for Rapid Application Development (RAD) approach or not. Development continues only when RAD is found as a justified approach.

Business study

In this phase the overall business study of the desired system is done. The business requirements are specified at a high level and the information requirements out of the system are identified. Once this is done, the basic architectural framework of the desired system is prepared.

The systems designed using Rapid Application Development (RAD) should be highly maintainable, as they are based on the incremental development process. The maintainability level of the system is also identified here so as to set the standards for quality control activities throughout the development process.

Functional Model Iteration

This is one of the two iterative phases of the life cycle. The main focus in this phase is on building the prototype iteratively and getting it reviewed from the users to bring out the requirements of the desired system. The prototype is improved through demonstration to the user, taking the feedback and incorporating the changes. This cycle is repeated generally twice or thrice until a part of functional model is agreed upon. The end product of this phase is a functional model consisting of analysis model and some software components containing the major functionality

Design and Build Iteration

This phase stresses upon ensuring that the prototypes are satisfactorily and properly engineered to suit their operational environment. The software components designed during the functional modeling are further refined till they achieve a satisfactory standard. The product of this phase is a tested system ready for implementation.

There is no clear line between these two phases and there may be cases where while some component has flown from the functional modeling to the design and build modeling while the other component has not yet been started. The two phases, as a result, may simultaneously continue.

Implementation

Implementation is the last and final development stage in this methodology. In this phase the users are trained and the system is actually put into the operational environment. At the end of this phase, there are four possibilities, as depicted by Fig.11 :

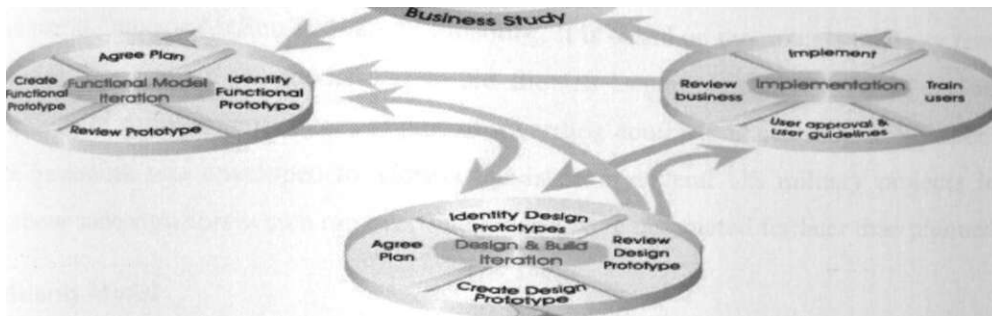
- Everything was delivered as per the user demand, so no further development required.
- A new functional area was discovered, so return to business study phase and repeat the whole process
- A less essential part of the project was missed out due to time constraint and so development returns to the functional model iteration.
- Some non-functional requirement was not satisfied, so development returns to the design and build iterations phase.

Dynamic System Development Method (DSDM) assumes that all previous steps may be revisited as part of its iterative approach. Therefore, the current step need be completed only enough to move to the next step, since it can be finished in a later iteration. This premise is that the business requirements will probably change anyway as understanding increases, so any further work would have been wasted.

According to this approach, the time is taken as a constraint i.e. the time is fixed, resources are fixed while the requirements are allowed to change. This does not follow the fundamental

assumption of making a perfect system the first time, but provides a usable and useful 80% of the desired system in 20% of the total development time. This approach has proved to be very useful under time constraints and varying requirements.

Fig. 2.12 Dynamic System Development Model



Source: Voigt B. J.J., 2004

DSDM Model Limitations

- It is a relatively new model. It is not very common. So it is difficult to understand.

DSDM Model Advantages

- Active user participation throughout the life of the project and iterative nature of development improves quality of the product.
- DSDM ensures rapid deliveries.
- Both of the above factors result in reduced project costs
- Flexible in terms of requirement evolution
- Provides a technique-independent process

DSDM Model Disadvantages

- Involves progressive development of requirements
- Focus on RAD can lead to decrease in code robustness
- Requires full commitment to DSDM process
- Requires significant user involvement

- Requires a skilled development team in both the business and technical areas

2.13.3.11 Capability Maturity Model

Capability Maturity Model contains standards and guidance for developing software engineering disciplines and management established by US Department of Defense Software Engineering Institute at Carnegie Mellon Institute in Pittsburg. It is based on the process maturity framework. The initial purpose of the model was to aid the US Department of defense in evaluating the capability of software contractors as part of awarding contracts. According to Wikipedia 2010, the framework was developed to address the issue of several US military projects involving software subcontractors which ran over-budget and were completed far later than planned.

Maturity Model

A maturity model is a set of structured levels that describe how well the behaviors, practices and processes of an organization can reliably and sustainably produce required outcomes. It may provide, a place to start, the benefit of a community's prior experiences, a common language and a shared vision, a framework for prioritizing actions and a way to define what improvement means for your organization. It can be used as a benchmark for comparison and as an aid to understanding. Therefore incase of CMM the basis of comparison would be the organization's software development processes.

Structure of CMM

The following are the aspects of CMM:

- Maturity levels- this is a 5-level process maturity continuum where the 5th level is the ideal state of where processes would systematically managed by a combination of process optimization and continuous improvement
- Key Process Areas (KPA)s)-this identifies a group of related activities which, when performed together achieve a set of goals considered important

- Goals-the goals of a Key Process Area is to summarize the states that must exist for that key process area to have been implemented in an effective and sustainable manner.
- Common features-include practices that implement and institutionalize a key process area. These are five namely; commitment to perform, ability to perform, activities performed, measurement and analysis and verifying implementation.
- Key practices-describes elements of infrastructure and practice that contribute most effectively to the implementation and institutionalization of the KPAs

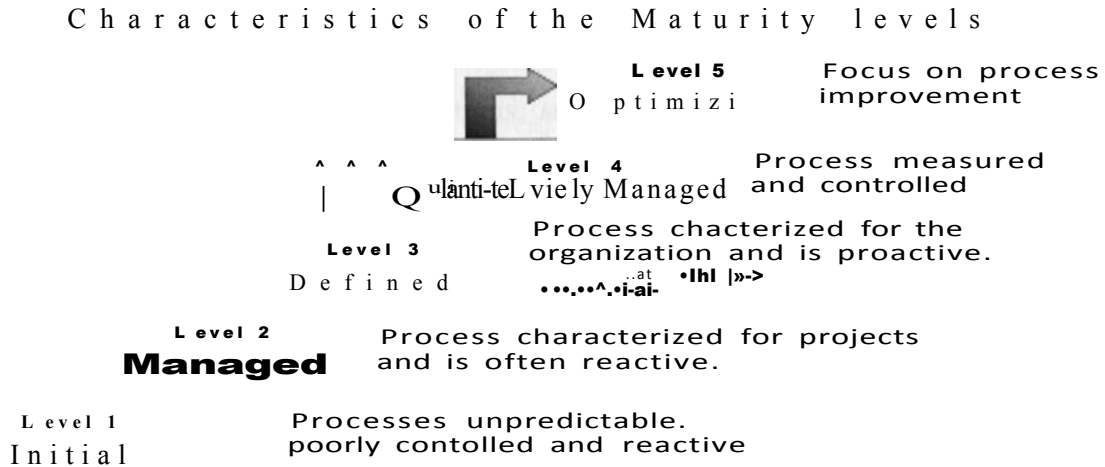
Levels of CMM

Capability Maturity Model is represented as a set of defined processes and practices at each of the five maturity levels. Predictability, effectiveness and control of an organization's software processes are expected to improve as the organization moves up the five levels. There are five steps which CMM had recognized towards organizational software maturity namely (as shown in Fig. 12):

- Level 1 (Initial)- This is the starting point of using a new process. The characteristic of processes at this level are mostly not documented and in a state of dynamic change, which tend to be driven in an adhoc, uncontrolled and reactive manner by users and events. This leads to a chaotic or unstable environment for the processes.
- Level 2 (Managed)-Basic project management processes are established to track cost, schedule and functionality. A process discipline is in place to repeat earlier successes on projects with similar applications. The process is managed in accordance with agreed metrics.
- Level 3 (Defined)-Management and engineering processes are documented and integrated into a standard software process. Projects use an approved, tailored version of the organization's standard software process.
- Level 4 (Quantitatively Managed)-detailed measures of the software process and product qualities are collected. Processes and products are quantitatively understood and controlled.

Level 5 (Optimizing)-continuous process improvement is aided by quantitative feedback from the process and from piloting innovative ideas and technologies.

Fig 2.13: Steps of Capability Maturity Model



Source: Godfrey S., 2011

CMM was initially used as a tool to evaluate the ability of government contractors to perform a contracted software project. According to Wikipedia 2010, CMM has been used extensively worldwide in government offices, commerce, industry, and software development organizations. Software Engineering Institute (SEI) rates organizations as CMM level X, where X is from 1 to 5. Most of the first organizations to receive the highest CMM rating were from India based software off-shoring companies (Wikipedia 2010).

Over the years, many organizations has used CMM model and it has proved useful, but its application in software development has sometimes become problematic. The main reason for the problem is to use multiple models that are not integrated within and across an organization. This could be costly in training, appraisal, and improvement activities. In order to solve this problem the Capability Maturity Model for Integration (CMMI) was formed. Therefore for software development processes, CMM has been superseded by CMMI.

Capability Maturity Model Integration (CMMI)

Capability Model Maturity Integration is a successor of Capability Maturity Model (CMM). This is a process improvement approach that provides organizations with the essential elements of effective processes that ultimately improve their performance. CMMI can be used to guide process improvement across a project, a division or an entire organization. It helps to integrate traditionally separate organizational functions, set process improvement goals and priorities, provide guidance for quality processes, and provide a point of reference for appraising current processes.

The main reason for creating CMMI is in response to the tremendous need for organizations to be able to create useful software efficiently and consistently. It is organized as a set of maturity levels that organizations achieve in their progress toward more consistent and effective development efforts. A CMMI model may also be used as a framework for appraising the process maturity of the organization.

CMMI Presentation

CMMI exists in two presentations: continuous and staged. The continuous representation is designed to allow the user to focus on the specific processes that are considered important for the organization's immediate business objectives or those to which the organization assigns a high degree of risk. The staged representation is designed to provide a standard sequence of improvements and can serve as a basis for comparing the maturity of different projects and organizations.

CMMI model framework

CMMI originated in software engineering but has been highly generalized over the years to embrace other areas of interest and currently it can be used in three different areas of interest as follows:

- Product and service development (CMMI for Development model)
- Service establishment, management and delivery (CMMI for Services model)
- Product and service acquisition (CMMI for Acquisition model)

CMMI models are collection of best practices that you can compare your organization's best practices and guide improvement to your processes.

Table 2.2: Capability Maturity Model Integration (CMMI) Model Framework (CMF)

Capability Maturity Model Integration (CMMI) Model Framework (CMF)			
Abbreviation	Name	Area	Maturity Level
REQM	Requirements Management	Engineering	2
PMC	Project Monitoring and Control	Project Management	2
PP	Project Planning	Project Management	2
CM	Configuration Management	Support	2
[MA	Measurement and Analysis	Support	2
PPQA	Process and Product Quality Assurance	Support	2
[OPD	Organizational Process Definition	Process Management	3
CAR	Causal Analysis	Support	

Source: Wikipedia, 2010

Version 1.2 of CMMI for development contains 22 process areas that describe the aspect of product development that are to be covered by organizational processes. In CMMI models, the processes are organized in alphabetical order according to their acronym. However, process areas can be grouped according to maturity levels or process area categories. There are five maturity levels. However, maturity level ratings are awarded for levels 2 through 5.

Maturity level 1

Maturity Level 2 - Managed

- CM - Configuration Management
- MA - Measurement and Analysis
- PMC - Project Monitoring and Control
- PP - Project Planning
- PPQA - Process and Product Quality Assurance
- REQM - Requirements Management
- SAM - Supplier Agreement Management

Maturity Level 3 - Defined

- DAR - Decision Analysis and Resolution
- IPM - Integrated Project Management +IPPD
- OPD - Organizational Process Definition +IPPD
- OPF - Organizational Process Focus
- OT - Organizational Training
- PI - Product Integration
- RD - Requirements Development
- RSKM - Risk Management
- TS - Technical Solution
- VAL - Validation
- VER - Verification

Maturity Level 4 - Quantitatively Managed

- QPM - Quantitative Project Management
- OPP - Organizational Process Performance

Maturity Level 5 - Optimizing

- CAR - Causal Analysis and Resolution
- OID - Organizational Innovation and Deployment

Benefits ofCMMI

The following are the benefits of using CMMI:

- An organization's activities are explicitly linked to the business objectives;
- The visibility into the organization's activities is increased to help one to ensure that the product or service meets the customer's expectations;
- One can learn from new areas of best practice (e.g., risk management)

Disadvantages of CMMI

- It is not possible to establish an overall rating for a set of processes



- When a maturity level is skipped it becomes counterproductive

2.13.3.12 View Model

This is a framework that provides the viewpoints on the system and its environment to be used in the system development process. It is a graphical representation of the underlying semantics of a view. It includes five views which are functional view, informational view, organizational view and infrastructure view and also four perspectives which includes planner, owner, designer and builder as shown in Fig. 2.15. The purpose of viewpoints and views is to enable human engineers to comprehend very complex systems, and to organize the elements of the problem and the solution around domains of expertise.

Fig. 2.14 View model: Treasury Enterprise Architecture Framework Matrix of Views and Perspectives

Views

	Functional View	Information View	Organizational View	Infrastructure View
r Planner				
 Owner				
K  Designer		^ 1 1 M r	1 T T r f l l T f T f t o	
Builder				

Source: Department of the Treasury Chief Information Officer Council, United States Federal Government, 2000

2.13.3.13 Unified Process Model

This is an Object Oriented Analysis and Design Methodology. It is an iterative and incremental software development process framework. It is based on Miller's Law which assumes that the development of a software system is too big and as a consequence it has to be broken into subsystems or modules and each subsystem or module developed incrementally and iteratively until a complete software system is produced.

The Unified Process Model is a **two dimensional model** consisting of **workflows** and **phases**. There are five workflows and four phases.

Workflows

The workflows of the Unified Process Model are:

1. Requirements Workflow

Its purpose is to ensure that the right information system is build by the developers

2. Analysis Workflow

Its aim is to analyze and refine the requirements.

3. Design Workflow

The purpose of this workflow is to refine the analysis workflow until the material is in a form that can be implemented by the programmers

4. Implementation Workflow

Its aim is to implement the target information system in the selected programming language.

5. Test Workflow

In this workflow the following is done:

Unit Testing-This is where each component or module is tested as it has been implemented

Integration Testing-This is where at the end of each iteration, the completed components are compiled, linked together (integrated) and tested

Product Testing- This is done when the system appears to be complete it is tested as a whole.

Acceptance-This is done when the system have been installed into the client's computer, the client tests it.

Phases

The four phases of the Unified Process Model are the increments and are as follows:

1. Inception Phase

It is the smallest phase in the project. Its purpose is to determine whether the proposed system is economically viable. The goals of the inception phase includes; establish a justification on business case for the project, establish the project scope and boundary conditions, outline the use cases and key requirements of the system, identify risks and prepare a preliminary project schedule and cost estimate. The **Life cycle objective Milestone** marks the end of the inception phase.

2. Elaboration Phase

The main purpose of the elaboration phase is to refine the System Requirements. This includes refining the use cases, architecture monitor the risks and refine their priorities, refine the business case and produce the project management plan. The **Life Cycle Architecture Milestone** marks the end of the phase.

3. Construction Phase

It is the largest phase in the project. The main aim of the construction phase is to produce the first operational-quality version of the information system which is

ta release. The **Initial Operational Capability Milestone** marks the ase.

'hase

nal project phase. In this phase the system is deployed to the users, n of this phase is to ensure the client's requirements have indeed been s driven by the feedback of the users of the beta release. The **Product estone** marks the end of the phase.

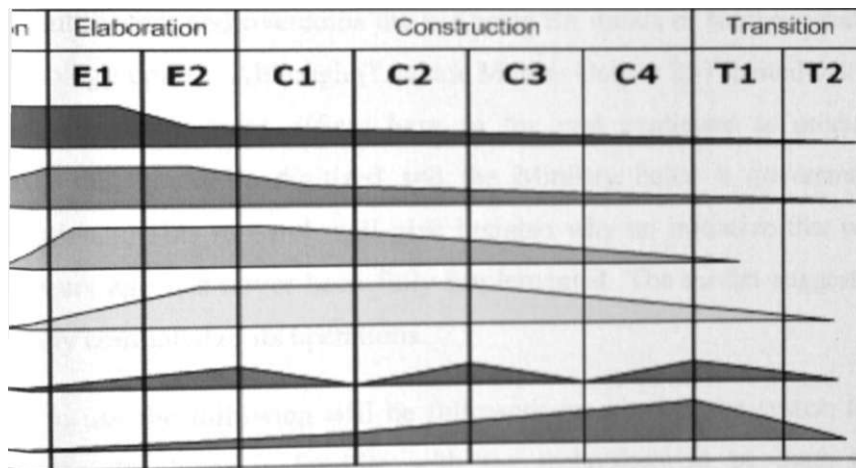
ast go through the five workflows iteratively.

is as shown in the Figure below:

vlodel

Iterative Development

Business value is delivered incrementally in time-boxed cross-discipline iterations.



07

1 the success of a project is measured on whether or not the project the budget and also fully utilizing the system to achieve improved

business practices. When examining LIMS the three aspects will be measured to find out the success or failure of the project. This will result in coming up with the appropriate methodology of developing the Integrated Land Information Management System.

As indicated each of the methodologies have their own weaknesses and strengths. One software development methodology cannot be used in all software development projects. Each of the methodologies is suited to specific kind of software development projects and is based on various technical, organizational, project and team considerations. The methodologies have to be considered in the context of the organization's business, applications, setup and technical environments. It is also important to note that to use the methodology effectively, processes defined in the methodology have to be followed consistently in the software development project.

In conclusion a case study of Ministry of lands in Kenya was chosen because the researcher wanted to zero down to the Ministry, to find out a model that can be used to develop Integrated Land Information Management System and overcome the notion in the minds of Kenyans that it lags behind in terms of technology uptake. Although (Lameck Makini Osinde 2007) sited that in Kenya many organizations and Government offices have in the past continued to produce thousands of paper annually that could be digitized and the Ministry being a government organization is not an exception. This research will give insights why an initiative that was started about twenty three years ago has never been fully implemented. The model suggested will enable the ministry to fully computerize its operations.

In selecting a methodology to use the following will be followed: on whether the system has unclear user requirements; the developer is familiar with the technology to be used; the methodology is complex, reliable; the duration of developing the system i.e., the time schedule and schedule visibility. In the selected methodology or combination of methodologies the researcher will develop a prototype of an integrated land information management system.

CHAPTER THREE

ADOPTED SOFTWARE DEVELOPMENT METHODOLOGY

3.1 Introduction

System development is a rational, goal-driven and managed process and which requires a method to facilitate this process. A system development methodology is a framework to organize, programme and supervise the process of developing an information system from the inception of the idea to the delivery of the final system. Software development models are tools which allow the development team to correctly follow the system development steps to create a software system that satisfies the business needs. Therefore the goal of software development methodology is to ensure the production of high-quality software that meets the needs of its end users within a predictable time schedule and budget.

System development methodologies vary depending on whether the emphasis is on business processes or on the data that supports the business or both. There are several development methodologies which include waterfall methodology, parallel development methodology, phased development method, Rapid Prototyping method and the Unified Process methodology.

3.2 Success in development of a software system

The most problematic issues in development of systems include unfinished projects, budget and time overruns, erroneous systems, systems which lack some functionality, lack of user involvement and top-management commitment. The best methodology is the one that will ensure a system is delivered on time, budget and meets the users needs.

According to Nazzaro et al, 2005, "good" software projects are the ones where specifications were completed upfront, designs had been frozen, projects were executed efficiently and teams built what they were meant to build, while "bad" projects are the ones where the final results were different from the original goal. The success of a software project largely depends on the involvement of the users and developers throughout the project life cycle. A project team should be established and would be composed of both the business and technical team. The roles and responsibilities of each member of the project team should be clearly stated.

Software projects need to be broken down in small components and give room for the project team to deliver functionalities of the system bit by bit at a time. This will encourage all participants including systems users and developers to be involved throughout the project life. It also promotes early risk mitigation by breaking down the system into mini-projects and focusing on the riskier elements first. The other fundamental issue is to recognize the reality of changing requirements and establishing the project goal or objective, deliverables and scope. The inability to manage software development process is one of the major set-back or fundamental problem in producing quality software.

In developing a software system, an organization is solving a certain problem. Therefore in determining the development methodology to use, problem situations can be used as a factor for selecting a methodology. There are five problem situations which can determine the methodology to use and includes:

1. Well-structured problem situations with a well defined problem and clear requirements
2. Well-structured problem situation with clear objectives but uncertainties user requirements
3. Unstructured problem situations with unclear objectives
4. Situation where there is a higher user interaction with the system
5. Complex problem situations

According to chapter 2, in the recent past, iterative and incremental methodologies have gained a lot of popularity. These methodologies are very essential for software development projects which are complex, large in scope and have medium to very high risk. The characteristics of these methodologies include:

- Recognizes the reality of changing requirements. This implies that system requirements keep on changing despite the development of the system and they should be considered in the development of a software system despite the phase of development.
- They promote early risk mitigation by breaking down the system into mini-projects and focusing on the riskier elements first.

- They allow one to "plan a little, design a little and code a little"
- Encourage both system developers and system users to be involved throughout the development process of the system.
- They allow the process itself to modulate with each iteration, allowing you to correct errors sooner and put into practice lessons learned in the prior iteration.
- They allow for software to evolve not to be produced in one huge effort.
- They allow the software to improve by giving enough time to the evolutionary process itself.
- Forces attention on stability, for only stable foundation can support multiple additions
- Allows the system (a small subset of it) to actually run much faster than with other processes.

The iterative software development methodologies leads to implementation of "mini waterfall" projects that ends with a delivery of something tangible in code, available for scrutiny by the interested parties which produces validation or correctness. The result of an iteration is an increment which is a release of the system that contains added or improved functionality compared with the previous release.

3.3 Adopted Methodology

According to Jacobson, the Unified Process is the best solution to date for treating a large problem as a set of smaller, largely independent sub-problems that provide a framework for increment and iteration. The scope of an integrated Land Information Management System is very large, the risks of developing the systems are also very large and the system is very complicated. It is important to divide this system into components and modules and develop them iteratively and incrementally until the whole system is developed. In this research we have adopted the Unified Process Methodology as the appropriate model for developing the Integrated Land Information Management System.

3.4 Overview of Unified Process

The Unified Process was released to the general public in the form of a book "The Unified Software Development Process" written by Jacobson, Booch, Runmbaugh in 1999. The Unified Software Development Process is a software development process that is use-case driven, architecture-centric, iterative and incremental. It is component based and has recognized the four aspects of software development being equally important. These aspects are people, project, product and process. It is also both process centered and data centered methodology.

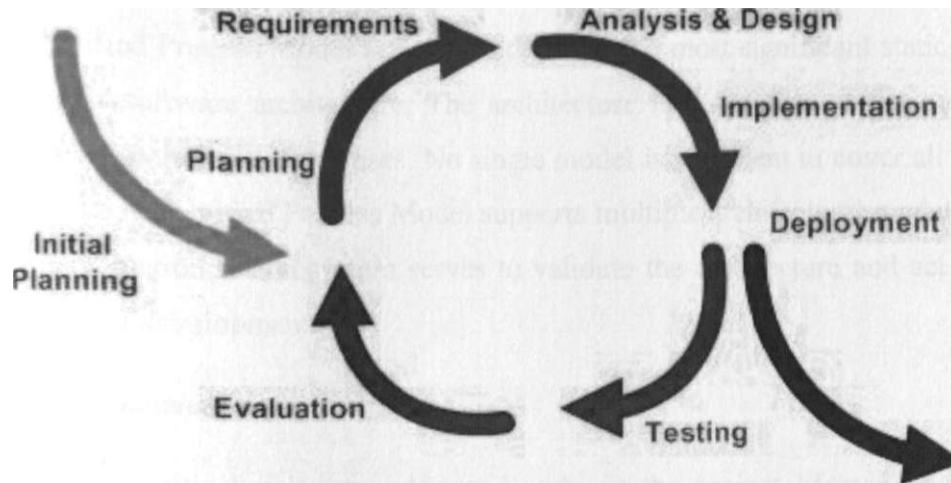
The traditional or structured software development methodologies are one-dimensional methodologies e.g., the waterfall methodology. They adopt a formal step-by-step approach to System Development Life Cycle that moves logically from one phase to the next. In waterfall methodology, the system developers and the users proceed sequentially from one phase to the next. It is assumed that each phase would be completed before the next phase is started. However, the Unified Process Methodology is a two-dimensional model with technical aspect and business aspect. The technical aspect is the workflows and business aspect or model is the phases.

3.5 Characteristics of Unified Process

1. Iterative and incremental

The software system being developed is sometimes too large e.g., the Integrated Land Information Management System. This system is broken down in smaller mini-projects or subsystems or modules and implemented iteratively and incrementally. The development of subsystems or modules starts with planning and ends with deployment with cyclic interactions in between (as shown in Fig 3.1 below). This starts with simple implementation of a subset of the software requirements and iteratively enhances the evolving versions until the full system is implemented. The main idea is to develop a system through repeated cycles (iterative) and in smaller portions at a time (incremental). This helps the developer to take advantage of what he learned during development of earlier portions or versions of the system. Learning is both the development of the system and the use of the system. At each iteration, design modifications are made and new functional capabilities are added.

Fig. 3.1 Iterative development



Source: Westerhoff, 2006

2. Use Case driven

The unified Process Model employs the Use Cases to drive the development process from inception to deployment. Use Cases are used to capture the functional requirements and to define the contents of the iterations. A Use Case models an interaction between the information system itself and the users of that information system (actors). It describes "who" can do "what" with the system in question. Each Use Case focuses on describing how to achieve a goal or a task.

A Use Case should:

- Describe what the system shall do for the actor to achieve a particular goal
- Include no implementation-specific language
- Be at the appropriate level of detail
- Not include detail regarding user interfaces and screens

Use Case diagrams are created to visualize the relationships between actors and use cases. They consist of a set of use cases and actors and their relationships. Each iteration takes a set of use cases or scenarios from requirements through implementation, testing and deployment.

3. Architecture centric

The unified Process Model seeks to understand the most significant static and dynamic aspects in terms of software architecture. The architecture is a function of the needs of the users and is captured in the core Use Cases. No single model is sufficient to cover all aspects of a system and therefore the Unified Process Model supports multiple architectural models and views. The partial implementation of the system serves to validate the architecture and act as a foundation for the remaining development.

4. Risk focused

The most critical risks are addressed early in the project lifecycle by the project team. The deliverable of each iteration, especially in the Elaboration Phase must be selected in order to ensure that the greatest risks are addressed first.

3.6 Organization of Unified Process Model

The Unified Process Methodology has four phases of system development and five workflows (as shown in Fig. 3.2 below). Each phase must go through the five workflows iteratively. The workflow is represented in a technical context while phases are represented in a business context.

3.6.1 Phases of Unified Process Model

The phases include:

1. Inception Phase

This is where the economic viability of the proposed information system is determined. In this phase we gain the understanding of the domain, build the business model, identify the project scope and boundary conditions and begin to make the initial business case. The overall aim of the inception phase is to obtain the initial version of the business case. The initial business case should answer the following questions:

- Is the proposed information system cost effective?
- How long will it take to obtain return on investment?

- Can the information system be delivered in time? If delivered late what will be the impact?
- What are the risks involved in developing the information system and how can these risks be mitigated?

The deliverables of the inception phase are:

- Initial version of the domain model, business model and requirements artifact (i.e., the Use Case)
- A preliminary version of the analysis artifacts and architecture
- Initial list of risks
- The plan for the elaboration phase

2. Elaboration Phase

This is the refinement phase where the initial requirements are refined. The following is done:

- Refine the Use Cases
- Refine the architecture
- Monitor risks and refine their priorities
- Refine the business case
- Produce the project implementation plan

The deliverables of the elaboration phase include:

- The completed domain model
- The completed business model
- The completed requirements artifacts
- An updated version of the architecture

- An updated list of risks
- The project management plan for the rest of the project
- The completed business case

3. Construction Phase

This is the largest phase in the development of the system. This is where the system is built on the foundation laid in the elaboration phase. The system features are implemented in a series of short timeboxed iterations.

The deliverables of this phase are:

- The initial user manual and other manuals as appropriate
- All the artifacts (beta release)
- The completed architecture
- The updated list of risks
- The project management plan (for the remainder of the project)

The common UML diagrams used during this phase include; Activity, Sequence, Collaboration, State (Transition) and Interactions overview diagrams.

4. Transition Phase

In this phase the system is deployed to the target users. Feedback received from the beta release (or initial release) may result in further refinements to be incorporated over the course of several transition phase iterations. It also includes system conversions and user training. The aim of the phase is to ensure that the client's requirements have indeed been met. The following are activities of this phase:

- Faults in the system are corrected
- All the manuals are collected

- Attempts are made to discover any previously unidentified risks

The deliverable of this phase is final version and completed manuals

3.6.3 Workflows of Unified Process Model

As indicated earlier, the Unified Process Model is a two-dimensional system development model, where the workflow is represented in a technical context and phase is represented in a business context. The system development phases of the waterfall model correspond to the workflows of the Unified Process Model i.e., requirements workflow, analysis workflow, design workflow, implementation workflow and test workflow. Each phase must go through the five workflows iteratively. Further to the four workflows there are three core supporting workflows which include; Project Management workflow, Configuration and Change Management workflow and Environment workflow.

There are five core workflows:

1. Requirements workflow

Its goal is to describe what the system should do and allows the developers and users to agree on that description. The artifacts of the requirement workflow must be expressed in a natural language that can be understood by the client. The following is developed in this workflow:

- A vision document is created and stakeholders needs are elicited
- Actors are identified-representing the users or any other system that may interact with the system.
- Use Cases are identified representing the behavior of the system. Each Use Case is described in detail. Use Case description shows how the system interacts step by step with the actors and what the system does.

2. Analysis workflow

Its aim is to analyze and refine the requirements. The analysis artifacts must be precise and complete enough for the designers.

3. Design workflow

Its purpose is to refine the analysis workflow until the material is in a form that can be implemented by the programmers. Non functional requirements are finalized at this stage and they include; choice of programming language, reuse issues, portability issues.

4. Implementation workflow

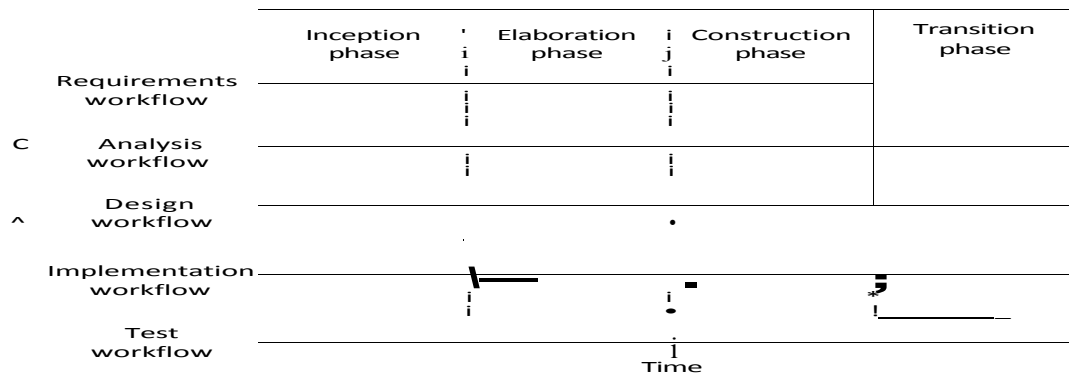
The aim is to implement the proposed information system in the selected implementation language. A large information system is partitioned into subsystems and they consist of components or code artifacts.

5. Test workflow

In this workflow testing is done as follows:

- Unit testing-each component is tested as it has been implemented
- Integration testing-at the end of each iteration the completed components are compiled and linked together and tested.
- Product testing-when the product is completed it is tested as a whole
- Acceptance testing-once the completed product has been installed on the client's computer the client tests it.

Fig. 3.2 Unified Process Model



Source: Mburu, 2010

3.7 Reasons for adopting Unified Process Methodology in developing an Integrated Land Information Management System

In developing an Integrated Land Information Management System we must ensure that the system is implemented on time and on budget. The software should also be of high quality that satisfies the land administration and management user needs. This implies that the system should ensure the services are rendered in an efficient and effective manner. We must ensure that we offer one stop shop in offering of services to clients. This is where clients are offered services without referring them to go to certain departments for approval of certain documents. Information from the Ministry of Lands should be obtained seamlessly.

The Integrated Land Information Management System exhibits the following characteristics:

- Complex problem situation in integrating the spatial information and land records information and data or attribute information.
- The scope of the system is very large since all the four technical departments must be served from a unified interface and the distributed system represented in the 51 districts in the country. The number of stakeholders who will be accessing the system on daily basis is large including but not limited to: financial institutions, hospitals, law firms, investors, members of public, construction companies, county governments, public institutions, academic institutions, research institutions.
- The risk is high especially when the Ministry will be depending on the system on daily basis without reference to the manual system. The issues of fraud, system security, physical security and network security are major risks.

It is thus important to note that apart from focusing on budget and time, we must ensure that the user requirements are accurately captured and addressed. The methodology selected must ensure iterative and incremental approach that emphasizes on continuous user involvement. Users must be part of the development of the system.

The most common failures of information system projects which could affect the implementation of the Integrated Land Information Management System should be carefully addressed. These

include exceeding budgets, missing deadlines, lack of user involvement and lack of top-management support or commitment.

The Unified Process Methodology was selected since it has the following characteristics that fit very well in development of Integrated Land Information Management System:

- User involvement should be the main key in ensuring the project of developing the system is done in an efficient and effective manner. Both the developers and the users should share the same workplace to ensure decisions are made accurately. It is therefore important to ensure that different actors or users of the project are motivated from the start and remain involved throughout the project.
- The project team should be empowered to make decisions that are important for the progress of the project without waiting for higher-level approvals. This will eliminate delays in the development of the system.
- We should focus on delivering of components of the system. This will ensure users do not get fatigued while waiting for the delivery of the final system.
- Development should be iterative and incremental and driven by the feedback from the users. The iterative model should start from planning, analysis and design, implementation, testing and evaluation of the components.
- High level scope, objectives, expected outcomes and the implementation master plan should be prepared before the project starts.
- Communication and cooperation among all stakeholders should be encouraged.
- The system development project should be decomposed into smaller components and implemented in phases which will enable iterative approach. The phases of development of the project are inception, elaboration, construction and transition. In each of these phases iterative should be carried out.

Regardless of the type of methodology chosen, documentation is very crucial. This is done in parallel with the development process. It is also important to note that the most important factor

for success of a software development project is how closely the particular methodology was followed.

RESEARCH METHODOLOGY

Introduction

The main objective of the research was to explore the best system model for Developing the Integrated Land Information Management System (ILIMS) and developing the prototype of the system. In this chapter we describe the tools used to collect data which helped us in making a decision. It is important to develop the Integrated Land Information Management System and to address the user requirements of the system.

CHAPTER FOUR

RESEARCH METHODOLOGY

4.1 Introduction

The main objective of this research was to explore the best system model for developing the Integrated Land Information Management System (ILIMS) and developing the prototype of the system. In this chapter we describe the tools we used to collect data which helped us in making a decision on whether it is important to develop the Integrated Land Information Management System and to collect the user requirements of the system.

4.2 Research Design

The methodology utilized in this research was survey and onsite interviews in order to decide whether it is important to develop a prototype of the Integrated Land Information Management System and to collect the user and system requirements of the proposed system. Document reviews was also used to determine the requirements of the system.

4.2.1 Target population and sampling frame

The target population in this research was the Ministry staff and our customers in the 51 district offices.

4.2.2 Random Sampling

Random sampling was done to ensure that the data collected is scientifically representative. However district offices were mainly categorized in regions and also the areas which had land problems over the years.

4.2.2.1 Estimated sample size

In order to get a representative sample, we used a statistical determination of the sample size using the formula:

$$n = \frac{Z^2 * D * Q * N}{e^2 * (N-1) + Z^2 * p * q}$$

Where

n=the estimate of the sample size

- Z=area under the normal curve as per the table of normal curve given confidence level of 95% which in our case is 1.96
- p=percentage of picking a choice, expressed as decimal (in our case 0.5 for sample size needed)
- q=1-p percentage of picking the other choice
- e=confidence interval expressed as decimal, in our case 0.02
- N=1,000 customers

Sample size for the customers is

$$n = \frac{(1.96)^2 * (0.02) * (1-0.02) * 1,000}{0.02^2 * (1000-1) + (1.96)^2 * 0.02 * 0.98}$$

$$= 159$$

Sample size for the staff where N= 1,500

$$n = \frac{(1.96)^2 * (0.5) * (1-0.5) * 3,500}{0.02^2 * (3,500-1) + (1.96)^2 * 0.5 * 0.5}$$

$$= 167$$

We did random sampling in 10 district offices which include Thika, Kiambu, Machakos, Kajiado, Nakuru, Nyandarua, Mombasa, Kwale, Kilifi and Nairobi. We were only managed to collect 159 responses from the clients and 162 from the staff.

4.3 Data sampling frame

The sampling frame for this survey was the Ministry of Lands in Kenya and the respondents were staffs from the five departments and clients who seek services in the Ministry.

The sampling method was used in order to realize an unbiased sample that would be as representative as possible. Two sampling methods were used which are:

4.3.1 Purposeful sampling method

In this method those who were included in the sample were more or less handpicked because of their experience and insight. This method dealt very much with those staffs that have been in the Ministry for a very long time and also in service. This sampling method was used in collecting the user requirements of the system that was developed.

4.3.2 Cluster sampling

In this method the identified categories rather than individuals were randomly selected. In this case all the members of selected groups had similar characteristics and were spread over the large geographical area which is the Ministry of Lands. This was done in terms of departments especially when collecting data on staff.

4.4 Information gathering techniques

A combination of the following techniques was used in gathering information relevant to the Ministry of Land's Integrated Land Information Management System within its operational boundaries.

4.4.1 Questionnaires

Primary data was collected using two structured questionnaire having both closed and open-ended questions. The main objective of these questionnaires was to determine whether it was necessary to develop a land information management system and whether the system developed

should be integrated. Service delivery parameters which includes, speed of services and quality were used. The two questionnaires were:

1. A client's questionnaire
2. A Ministry of Lands questionnaire.

The Client's questionnaire

The questionnaire was divided into two sections namely the background information and services section. The background information section gave the age, sex and occupation of the respondents while the services section had modules on services sought, service delivery satisfaction, speed of service delivery, quality of services rendered, frequency of seeking services, reception of clients by staff, times when customers are referred from one office to the other, services that they need computerized, and integration of Ministry services.

The Staff questionnaire

The questionnaire was also divided into two sections namely background information and services section. The background Information section contained the duty station, the department/section, sex, age, designation and duration have been employed in the Ministry of Lands. The services section had the following; services not offered satisfactory by the departments and those that need to be computerized, speed of services, services that should be integrated.

The questionnaires were used to collect quantitative data particularly on specific areas on computerization. These questionnaires were administered by a research assistant and they were delivered to respondents by hand. Open-ended questions were used to collect qualitative data while closed-ended were used to collect quantitative data.

The questionnaires were also utilized during on-site visits and interviews.

4.4.2 On-site Interview

Interviewing staff was to enable us to collect the system and user specifications of the Integrated Land Information Management System. This was done to all the staffs that would use the system in their day to day activities. These included Surveyors, Physical Planners, Land Administrators,

and Registrars, Land Valuers and Cashiers. The information collected includes their day to day activities and the challenges they face while delivering the services to clients.

4.3 Document Review

policy documents (e.g., New Constitution, National Land Policy, Ministry of Lands Strategic plans 2000-2005, 2006-2009, 2008-2012), Kenya Vision 2030, First Medium Term Plan 2008-2012, Ministerial Reviews, Ministerial Medium Term Review Framework documents, performance contract reports and Land information Management System project reports were reviewed. These documents provided the researcher with some insights of what was happening in the last twenty three years since LIMS was initiated.

Documents from other countries which have implemented computerization programmes of land records and international organization e.g World Bank, UN, UN-Habitat, UN-ECE, FIG were also reviewed. Downloads and documents from the internet were also used as a source of knowledge to enrich the research study.

4.4.4 Focus Group Discussions

This was done to the envisaged system users to ensure all the information gathered is accurate. The purpose of it was to give an in-depth understanding of the current and future requirements of the system. Since this was unstructured interviewing the researcher was able to get more information than interviews and questionnaires. This was mainly used to clarify some user requirements that had been collected through interviews and observations.

4.5 Data Processing and Analysis

In the data processing and analysis the process involved data editing, coding, classification, tabulation and finally analysis.

4.5.1 Data Editing

This was done after the data had been collected through the administration of questionnaires to both client and staff. The questionnaires completed were examined in order to detect errors and omissions and to correct them where possible. We ensured that data collected was as complete as much as possible, consistent with other facts gathered and accurate. The questionnaires were also well arranged to facilitate coding and tabulation.

4.5.2 Data coding

This involved assigning numerals or symbols to answers so that responses could be put into a limited number of classes. This ensured efficient analysis and through it several replies from the questionnaires were reduced to a small number of classes which contained the critical information required for analysis. For example in questions that required one to choose either of the two answers we assigned one answer a zero (0) or a one (1). In the clients questionnaire Yes was assigned 1 while No was assigned 0, Male was assigned 1 while Female was assigned 0.

4.5.3 Data classification

The data collected from clients was arranged in groups or classes in terms of common characteristics e.g age and sex. The staff questionnaires was also grouped in terms of departments.

4.5.4 Data tabulation

We assembled the collected data and arranged it in a logical order. This data was summarized and displayed in tables ready for analysis. However this was mainly done during the analysis of data.

4.5.5 Data Analysis

Data collected was captured using Statistical Package for Social Scientists (SPSS Version 11.5). The analysis was done using Strata Version 10.0. The report was written using Microsoft word and the tables were formatted using Microsoft Excel. We input all data into the system using the coding system we had developed. We started with the client's questionnaire and then the staff questionnaire. For the clients questionnaire our constant variable was integration of various services offered by the Ministry while the dependent variables were speed, quality of services, satisfaction of clients, response on service delivery and various services requested by our staff. Statistical tables were developed and the graphs. Also for the staff questionnaire the constant variable was integration and computerization while independent variables included speed of services, services offered by various departments.

CHAPTER FIVE

RESULTS, FINDINGS AND ANALYSIS

5.1 Introduction

The purpose of collecting data was to find out whether it was necessary to develop an integrated land information management system and also to collect the user requirements. In this chapter we present the research findings and interpretations from the data collected from the Ministry of Land's clients and Staff.

The following are the results and findings of the information collected from clients.

5.2 Response rate

The response rate for the client's category was 100 percent while that of staff was 97 percent as shown in Fig. 5.1 below. This implies that the response rate was very good and can be depended upon for the research study.

Fig. 5.1 Response Rate



5.3 Sex and Age

5.3.1 Client's Sex and Age

We examined the age and the sex to determine the age group and the gender of the clients that seek services in the Ministry of Lands and the Ministry staff. The main purpose of this was to

know which kind of applications to develop in consistent with the age of the clients. Age was grouped into four categories namely; 18-28yrs, 29-38yrs, 39-48yrs, 49-58yrs and 59 and over yrs, while gender was grouped into male or female categories. From the results it shows that majority of clients that is 39 percent, that seek services in the Ministry of Lands are in the age groups of 39-48yrs. It also shows other age groups that seek services in the Ministry are in the age group of 49-58 yrs and 29-38yrs forming a percentage of 32 and 26 respectively. This is in consistent with the 2009 Kenya Population and Housing Census which categorizes the working class to be between the age 28yrs and 58 yrs. Further according to Kenya Integrated Household Budget Survey (KIHBS) 2005/06 the age groups 0-14yrs and 65yrs and above is taken to be the dependent population. This is why in our study the age group 18-28yrs and 59 and over yrs had each a 2 percent of the respondents. The age group between 29yrs and 58yrs are the working class and those who are mostly carrying out land transactions. Out of these 28 percent are female and 72 percent male. The Fig 5.2 shows the age group categories, Fig 5.3 gender categories while Table 5.1 shows both age group and gender.

Fig 5.2: Clients Age group

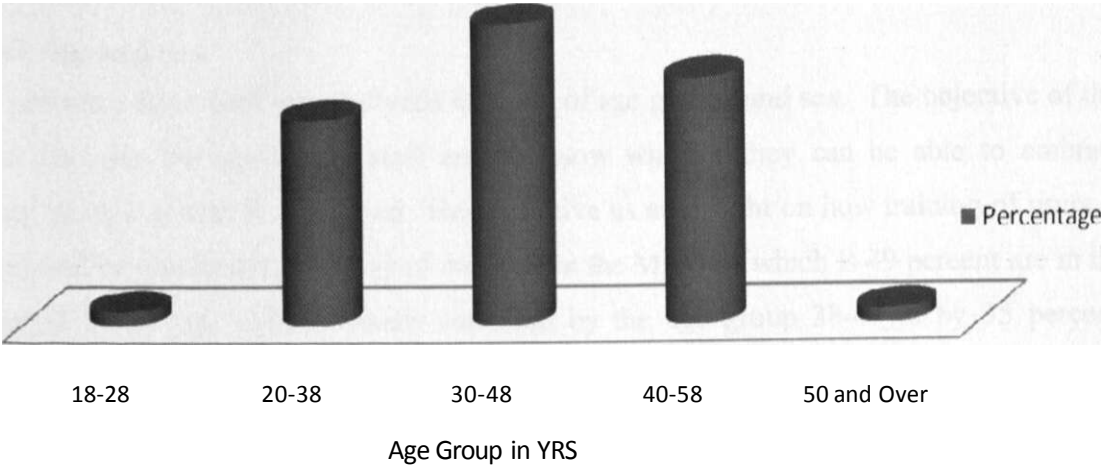


Fig. 5.3 Client's Gender

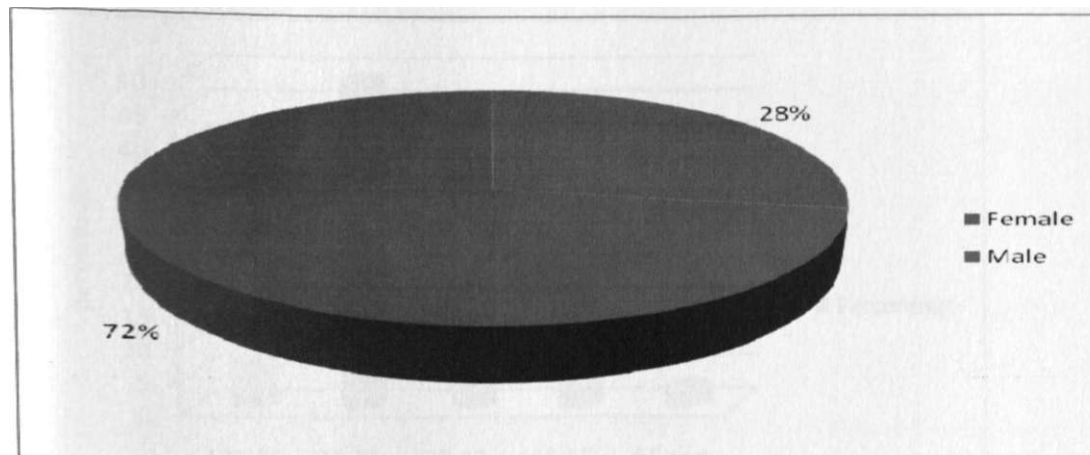


Table 5.1: Client's Age and Gender

Age Group	Sex		Total
	Female	Male	
18-28yrs	0	2	2
29-38yrs	8	35	43
39-48yrs	22	39	61
49-58yrs	14	37	51
59yrs & Over	0	2	2
1 Total	44	115	159

5.3.2 Staff Age and Sex

The data collected from staff was analyzed in terms of age groups and sex. The objective of this data is to find out the age of the staff and to know whether they can be able to embrace technology when a system is developed. This will give us an insight on how training of users of the system will be conducted. Majority of the staff in the Ministry which is 49 percent are in the age group of 28-37 yrs. This is closely followed by the age group 38-47yrs by 35 percent. Majority of the staff are between the age bracket of 28 and 47 years which is 85 percent as shown in Fig. 5.4. Only 3 percent of the staffs are above 56 years while those below 27 years are 6 percent. This is inconsistency with the KIHBS 2005/06 on dependent or working population. Out of this population 75 percent are male while 25 percent are female.

Fig. 5.4: Staff Age group

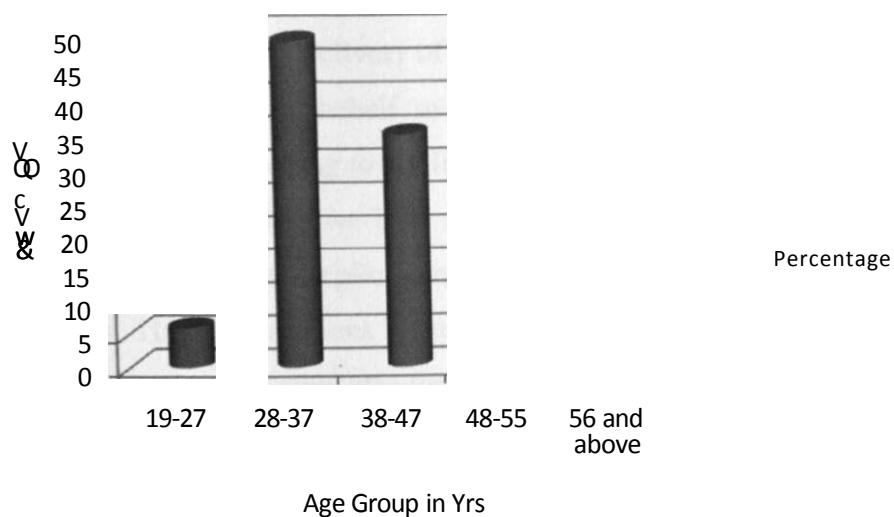
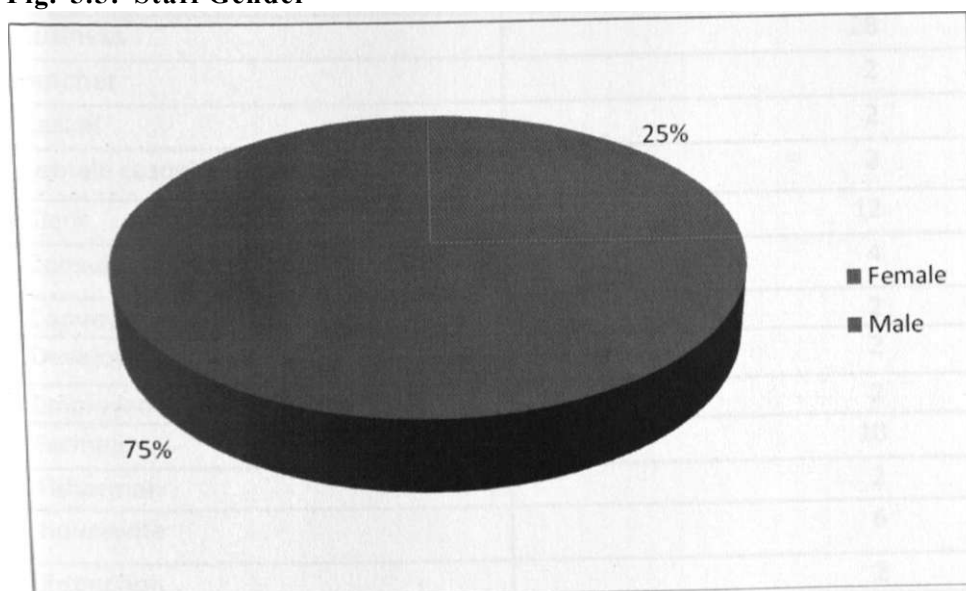


Fig. 5.5: Staff Gender



5.4 Occupation

The main objective of this module was to collect information on the occupation of the Ministry's clients to ensure that the system to be developed targets this occupation group. It will also form a basis of stakeholder engagements during the public awareness campaigns. Majority of clients that seek services in the Ministry of Lands are business people which form 28 percent. This is followed by clerks, farmers, advocates and brokers with 12 percent, 10 percent and 9 percent respectively as shown in Table 5.2 below. The people with disposable incomes in the country are

the business people and there are the people who can buy and sell properties. This is the reason why they are the majority in the Ministry's clients. They are also very busy people and would like efficient and effective delivery of services. Most advocates and estate managers use clerks to transact business on their behalf so that is why there is a high percentage of clerks as the Ministry's clients. According to KIHBS 2005/06, 71.7 percent of agricultural parcels are owned by farmers and that is why we have a high number of farmers as our clients. Most of the land services have some legal implications and so the advocates play a very significant role in land transactions. These transactions include transfer of land, registering inhibitions, cautions. This is the reason why the advocates also form part of the majority clients in the Ministry.

Table 5.2: Occupation of the Ministry's clients

Occupation	Percent
Advocate	9
1 Broker	9
1 Business	28
[Butcher	2
1 Casual	2
Female casual	2
1 Clerk	12
Consultant	4
1 Conveyance	2
1 Developer	2
1 Employed	2
1 Farming	10
Fisherman	2
1 Housewife	6
1 Inspection	2
Nurse	2
1 properties Management	2
1 Public Communication	2
! Self Employed	2
purvey	2
Total	100

5.5 Seeking of Land Services

* trv of

In this module we wanted to know those clients who have sought services from the Ministry of Lands in the last one year and also how often they seek those services. This will help us know whether those clients who were responding to our questionnaire were giving us accurate information or were guessing. It will also show us how these clients visit the Ministry of Lands for services. The results show a majority of the Ministry's clients which is 96 percent had sought services in the Ministry for the last one month. Out of these 96 percent, 30 percent sought services on monthly basis. This is closely followed by the clients who seek services on weekly and daily basis with 28 and 26 percent respectively. This implies that majority of our clients visit the Ministry of Lands offices on daily, weekly and monthly basis. Therefore in developing a system it would be very important to address the issues they come to seek in order to reduce cost and time of accessing the land services from the Ministry.

Fig. 5.6 Clients who have sought services for the last one month

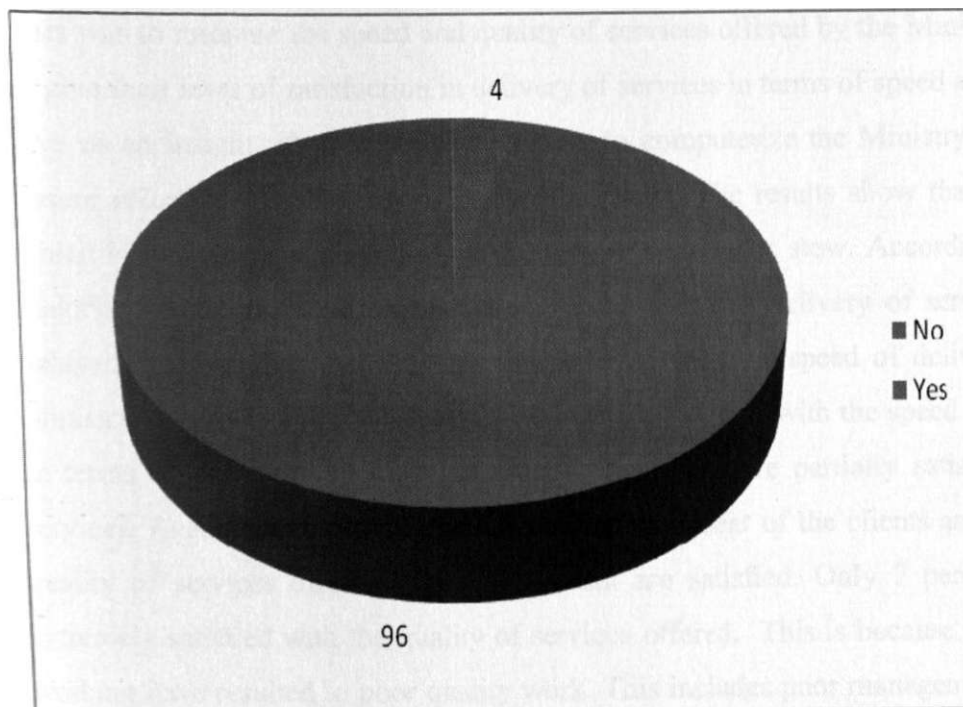
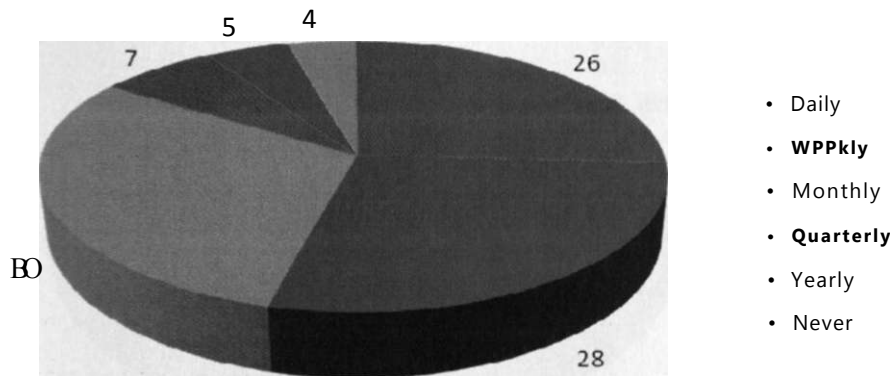


Fig. 5.7: How often Clients seek services



5.6 Speed and quality of services offered

This was to measure the speed and quality of services offered by the Ministry. The client's were to give their level of satisfaction in delivery of services in terms of speed and quality. This would give us an insight whether it was necessary to computerize the Ministry's services in order to ensure effective and efficient delivery of services. The results show that a majority of clients which is 68 percent believe that the delivery of services is slow. According to Fig 5.6 below, a majority of clients 74 percent believe that the speed of delivery of services is either slow or delayed. This implies that they are not satisfied with the speed of delivery of services in the Ministry. A minority of the clients 26 percent are satisfied with the speed of delivery of services. In terms of quality, a majority of clients 68 percent are partially satisfied by the quality of services. According to Fig. 5.7 indicates that 74 percent of the clients are not satisfied with the quality of services offered while 26 percent are satisfied. Only 7 percent of the clients are extremely satisfied with the quality of services offered. This is because the manual methods of working have resulted to poor quality work. This includes poor management of records, missing records, misfiled records.

Fig. 5.8: Speed of delivery of services

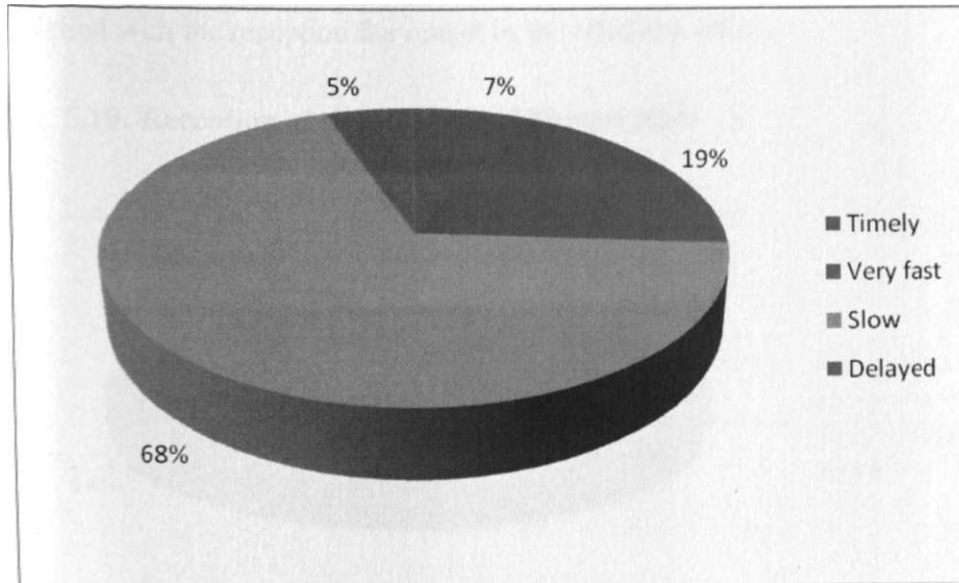
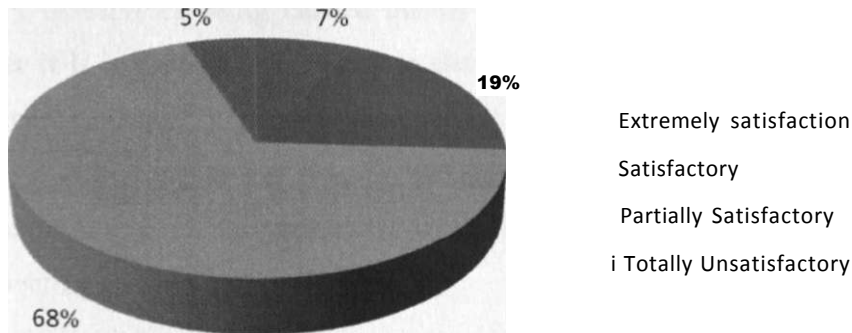


Fig. 5.9: Quality of services delivered

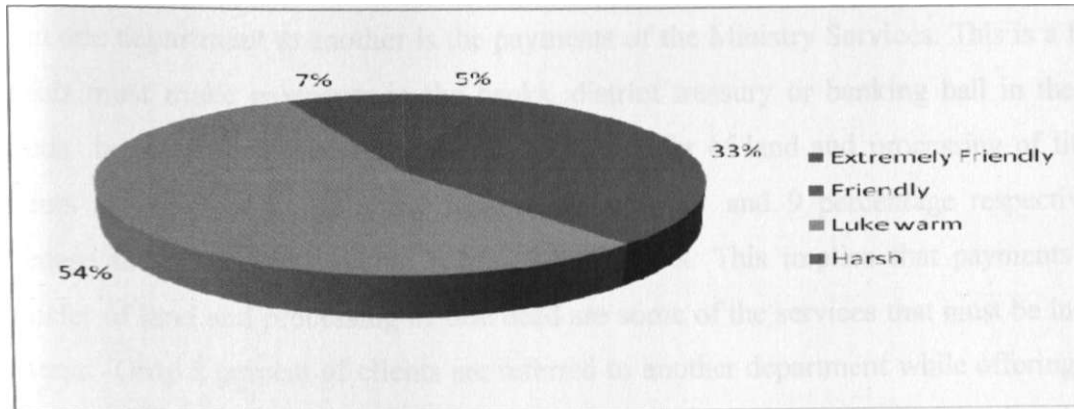


5.7 Reception of clients by the Ministry staff

This was to measure how the clients are received by the Ministry staff when they come to seek for services in the Ministry. This will give us an indication whether we need to develop a system that will ensure there are very few instances the clients come to the Ministry to seek for services. The results show that majority of clients 58 percent are received in a lukewarm manner. According to Fig. 5.8, 61 percent of the clients are not received well by the Ministry staff while

39 percent of the clients are received in a good way. Only 5 percent of the clients are extremely satisfied with the reception they meet in the Ministry offices.

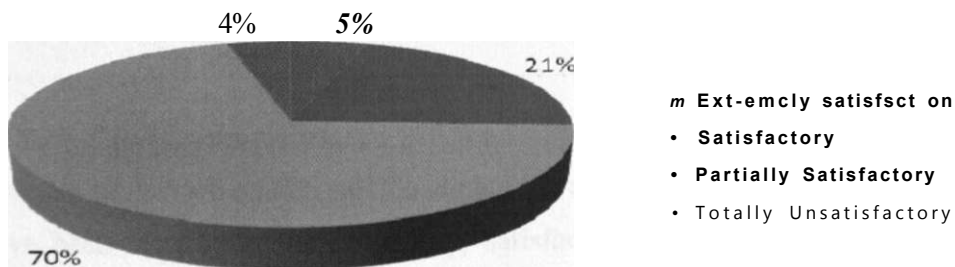
Fig. 5.10: Reception of clients by the Ministry staff



5.8 Mode of service delivery

The main purpose of this was to measure whether the clients are satisfied with the mode of delivery of services being carried out by the Ministry. This would help us make a decision whether it is important to improve on the mode of delivery of services. The results show that majority of clients 70 percent are partially satisfied with mode of services offered by the Ministry. According to Fig 5.9, 74 percent of the clients are not satisfied with the mode of service delivery while 26 percent are satisfied. Only 5 percent are extremely satisfied with mode of delivering the services by the Ministry.

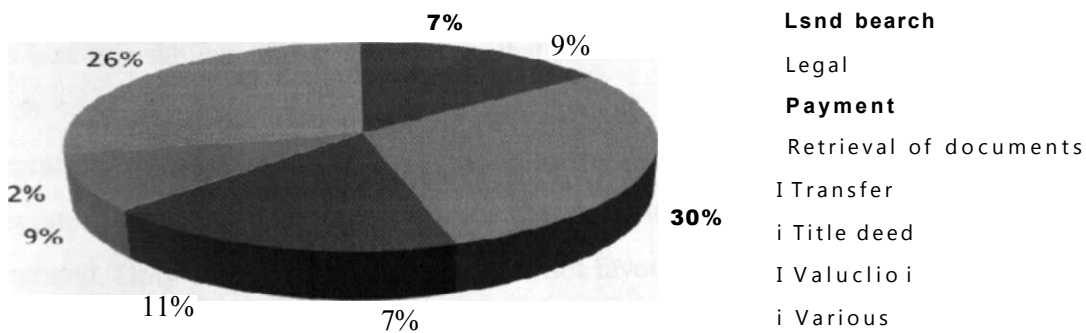
Fig. 5.11: Mode of service delivery



s,9 Services clients are referred to different departments in the Ministry

This was to measure the specific services that the clients are referred from one department to another when they come to seek services at the Ministry of Lands. This will show us the services which the clients are mostly referred in order to know which services would require to be computerized. The results show that services that clients are referred most which is 30 percent from one department to another is the payments of the Ministry Services. This is a fact since the clients must make payments in the banks, district treasury or banking hall in the Ministry of Lands headquarters. According to Fig 5.10, transfer of land and processing of title deeds the clients are referred to different departments with 11 and 9 percentage respectively. This is because these services involve several departments. This implies that payments of services, transfer of land and processing of title deed are some of the services that must be included in the system. Only 2 percent of clients are referred to another department while offering valuation of property. This is because valuation is only done by the Valuation section in the Lands department and can only be done on the actual parcel of land.

Fig. 5.12: Services clients are referred to different departments in the Ministry



5.10 Services to be computerized

This was to establish which services the clients felt should be computerized based on other issues that have been tested i.e., speed, quality, satisfaction. This was necessary to determine the services that would be given the first priority when developing the Integrated Land Information Management System. According to Table 5.3, majority of clients 67 percent would require the registration of documents computerized. Other services that the clients prioritized include

•registration of Title Deeds, Search of Title Deed and transfer of documents which are 54, 46 and 37 percent respectively. This implies that in developing the system registration of documents, registration of Title Deeds, Search for a Title and Transfer of documents must be computerized. The valuation of parcels of land and survey of land had low priority because they must be done on the ground, however the percentage was significant and information obtained from the two services must be updated in the system to be developed. This is because these services affect other services that had been given priority e.g. Registration of documents, Title Deeds and transfer of documents.

Table 5.3: Services to be computerized

Services	Percentage
Registration of documents	67
Registration of Title Deeds	54
Search of Title	46
Transfer of documents	37
Valuation of plots	19
Access of survey documents	18

5.11 Integration of Services

This was to establish among the services that have been suggested by clients to be computerized which services need to be integrated. This was to help us know whether the clients favour integration of services offered by the Ministry and which particular services need to be integrated. Majority of clients which is 84 percent would like the Ministry services to be integrated. Only 16 percent of the clients do not favour integration of the Ministry services. This implies that while developing the system integration of different functions of the Ministry is required and should be considered. According to Table 5.4, among those clients who have sought services in the Ministry of Lands 82 percent would like the services to be integrated while 14 percent do not favour integration. Majority of clients which is 86 percent would like all Ministry of Lands services to be integrated according to Fig. 5.12 shown below. This therefore implies that due to speed of service delivery, quality of services, mode of service delivery, satisfaction of the clients the clients would like the Ministry to computerize its services and further to integrate these services. This will enable the Ministry to offer services from one service point.

fig. 5.13: Integration of Ministry Services

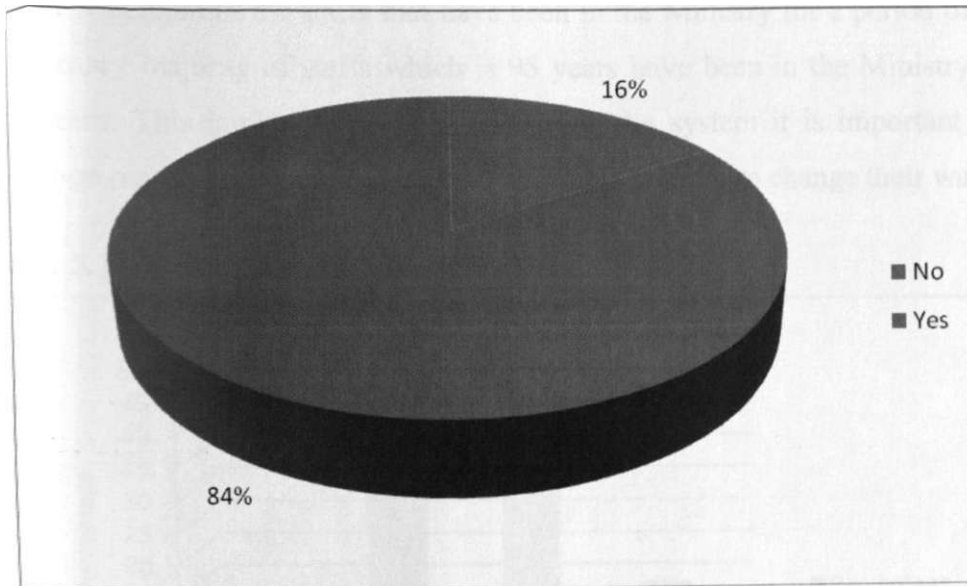
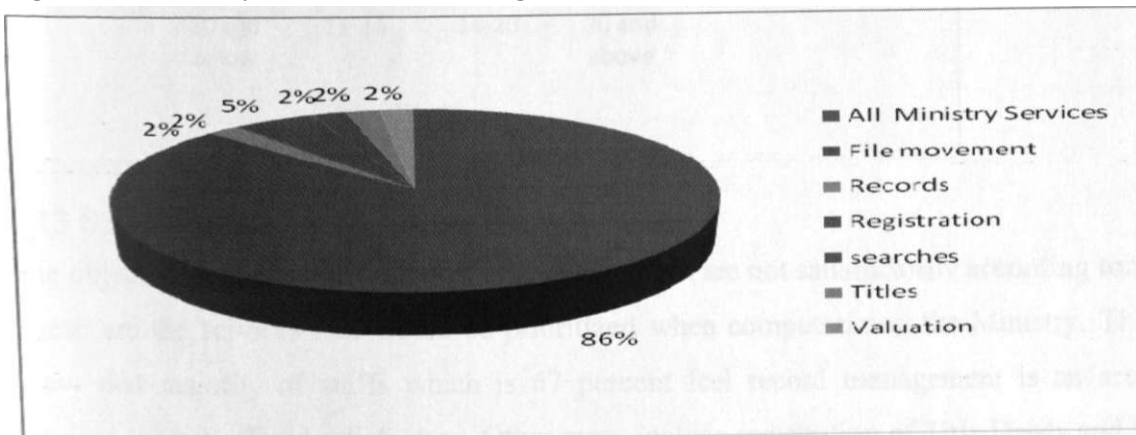


Fig. 5.14: Ministry Services to be integrated



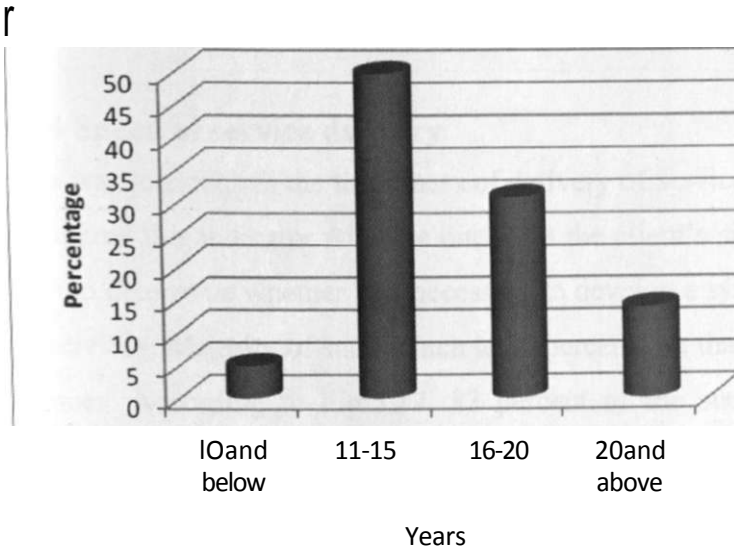
The following were the results and analysis of the staff data:

5.12 Years the staff has served in the Ministry

The purpose of this was to show the experience staff. This will imply that whatever suggestions the staffs are going to give will be based on real life experience. It will also give us an insight whether on the strategy to use in implementing the system especially on change management for those staffs who have been in the Ministry for long. As indicated in Fig. 5.15 below, the results show that majority of staff which is 50 percent have been in the Ministry for a period of 11 to 15

years. This is followed by the staffs that have been in the Ministry for a period of 16 to 20 years. Only 5 percent of the staffs that have been in the Ministry for a period of less than 10 years. In summary majority of staffs which is 95 years have been in the Ministry for a period of 11 to 20 years. This implies that when developing the system it is important that a comprehensive change management sessions be held with staff in order to change their way of thinking.

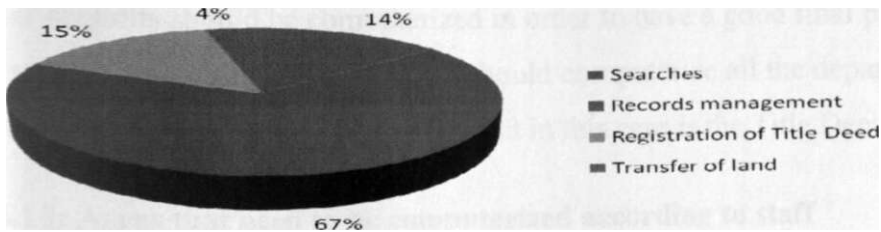
Fig. 5.15 Years the staffs have served



5.13 Services not offered satisfactorily

The objective of this was to establish the services that are not satisfactorily according to the staff. These are the services that would be prioritized when computerizing the Ministry. The results show that majority of staffs which is 67 percent feel record management is an area where services are not offered satisfactory. Other areas include registration of Title Deeds and Searches which are 15 and 14 percent respectively. These services are mostly carried out in the Land Registration division in the department of Lands and thus when developing the system they should be given first priority.

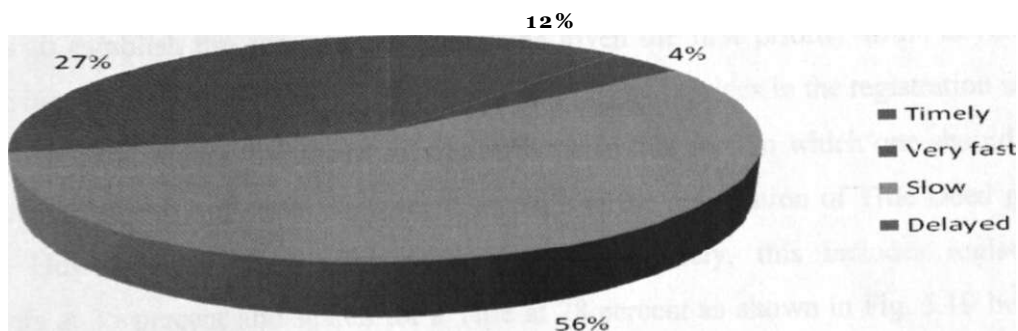
ig. 5.16: Services not offered satisfactorily according to staff



5.14 Speed of service delivery

This was to establish the timeliness of delivery of services according to the staff perspective. We compared this indicator with the one from the client's side to see whether they rhyme. This will help to determine whether it is necessary to develop a system to reduce the time taken in delivery of services. Majority of staff which is 56 percent felt that the Ministry delivers services in a slow manner. According to Fig.5.17, 83 percent of the staffs felt that the service delivery is not satisfactory. Only 4 percent of the staffs felt that the services delivered by the Ministry are very fast. This implies that we need to develop a system to ensure efficiency and effectiveness in delivery of services.

Fig. 5.17: Speed of service delivery according to staff

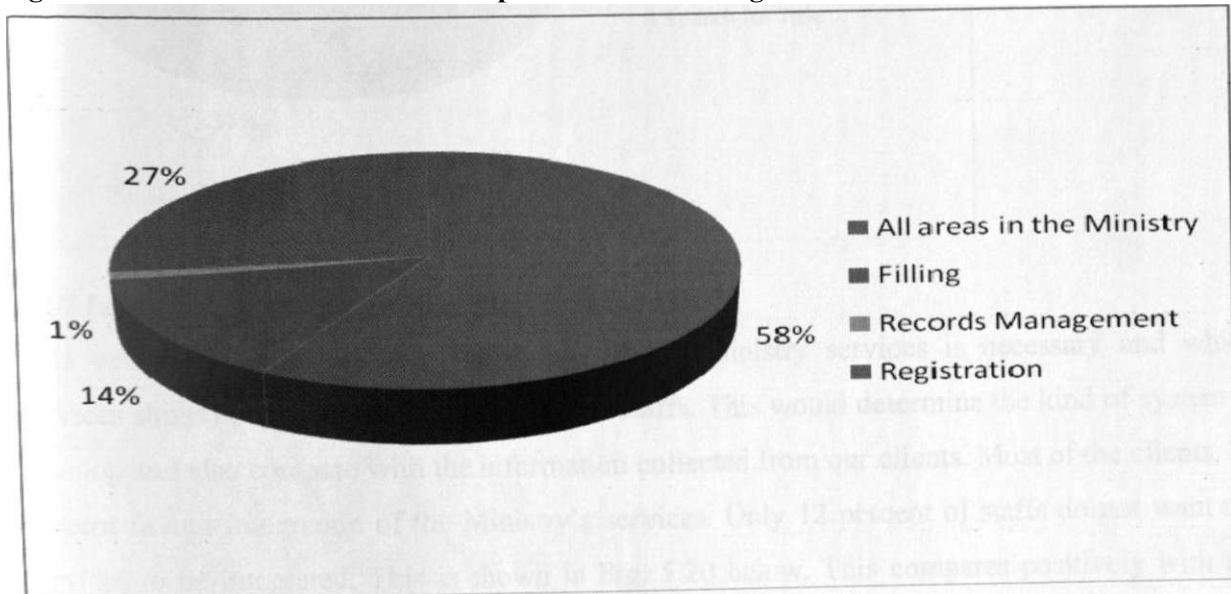


5.15 Area that should be computerized

This was to get a feeling from the staffs on the areas that need to be computerized. This will ensure that when we develop the system these areas need to be included. Majority of staff i.e, 58 percent felt that we should computerize all areas in the Ministry. Only 1 percent felt we should

computerize the records management section as shown in Fig. 5.18. The main reason for this is because all records originate from other departments and are finally kept in the records office, so all other sections should be computerized in order to have a good final product. This implies that when we are developing the system we should computerize all the departments and sections that determine the final output. The final output in this case is the Title Deed.

Fig. 5.18: Areas that need to be computerized according to staff

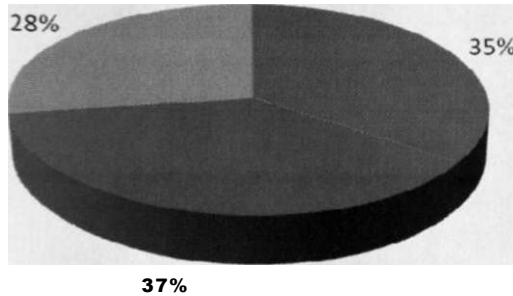


5.16 Services that should be given first priority according to staff

This was to establish the services that should be given the first priority while developing the system. Since there were a lot of complaints for delivery of services in the registration section we sought to find out among the major services offered in this section which one should be given first priority. Majority of staffs 37 percent would like the registration of Title Deed given first priority. However the other services are following closely, this includes registration of documents at 35 percent and search for a Title at 28 percent as shown in Fig. 5.19 below. This therefore implies that all the services in the registration section should be included in the development of the system

fig. 5.19: Services that should be given first priority in computerization according to staff

I



- Registration of documents
- Registration of Title Deed
- Search for Title

5.17 Integration of Services according to staff

This was to establish whether integration of the Ministry services is necessary and which services should be integrated according to the staffs. This would determine the kind of system to develop and also compare with the information collected from our clients. Most of the clients, 88 percent favour integration of the Ministry's services. Only 12 percent of staffs do not want the services to be integrated. This is shown in Fig. 5.20 below. This compares positively with the clients suggestion.

In terms of which services should be integrated the staffs favoured all the services which is 53 percent. Issuance of title deeds, valuation had 22 percent and 12percent respectively. This implies that all Ministry services should be integrated and in particular issuance of titles and data collected from valuation should be updated into the system. This is indicated in Fig.5.21 shown below. In conclusion the staff suggest that in developing the system integration of services is necessary and that all services in the Ministry should be integrated.

fig. 5.20: Integration of Ministry services according to staff

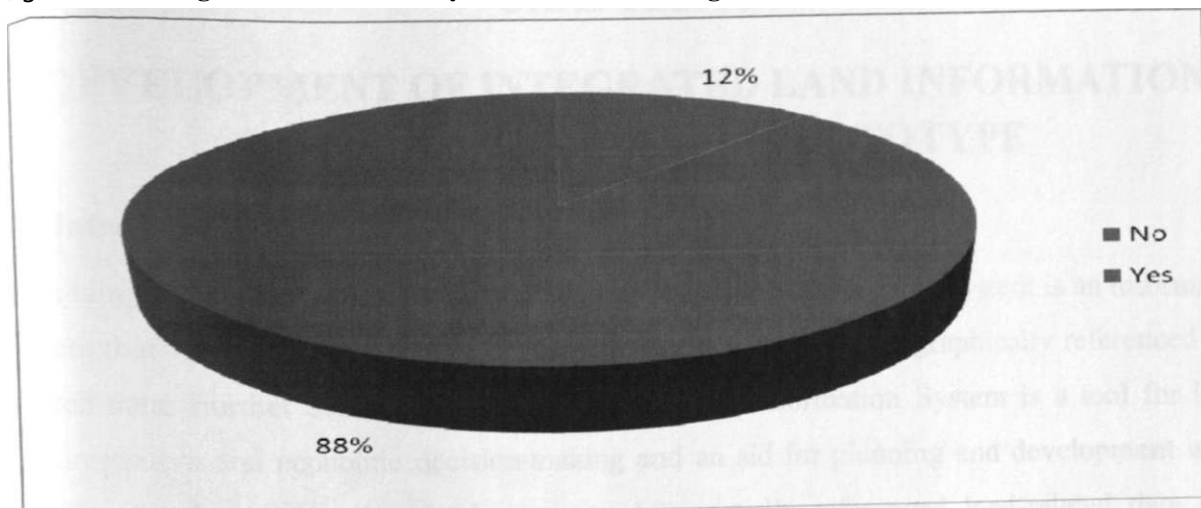
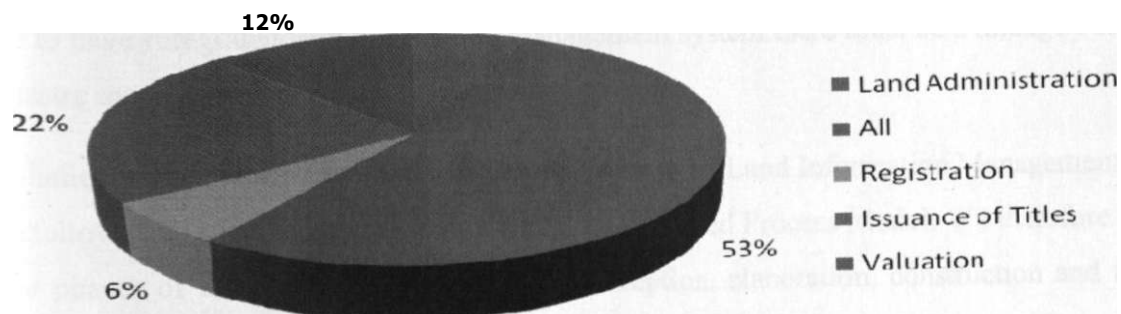


Fig. 5.21: Ministry services that would be integrated according to staff



5.18 Conclusion

The study shows that the service delivery is not offered to the satisfaction of the clients and staff in terms of speed of service delivery and quality of services. The clients and staffs have suggested that we need to computerize the Ministry's services and integrate them. We therefore concluded that we need to develop and implement the Integrated Land Information Management System to ensure efficient and effective delivery of services.

CHAPTER SIX

DEVELOPMENT OF INTEGRATED LAND INFORMATION MANAGEMENT SYSTEM PROTOTYPE

6.1 Introduction

According to chapter two, an Integrated Land Information Management System is an information system that will enable the capture, management and analysis of geographically referenced land related data. Further according to FIG 1996, "a Land Information System is a tool for legal, administrative and economic decision-making and an aid for planning and development which consists on the one hand a database containing spatially referenced land-related data for a defined area, and on the other hand procedures and techniques for the systematic collection, updating, processing and distribution of the data." This shows that land information system has two parts that is the textual part and spatial part. The textual part contains the land ownership details or records while the spatial part has the cadastral maps. It is therefore important to note that to have integrated land information management system there must be a linkage between the cadastre maps and land ownership records.

As indicated in chapter four in developing the Integrated Land Information Management System, we followed the adopted methodology which was Unified Process Model. We therefore followed four phases of this methodology namely the inception, elaboration, construction and transition and five workflows namely requirements, analysis and design, implementation, test and deployment.

6.2 Inception Phase

In this phase we dealt with five areas namely:

- Purpose of the Integrated Land Information Management System
- Identification of the Key Requirements of the system
- Establishment of the project scope and boundary conditions
- Identification of risks

- Preparation of a preliminary project schedule and cost estimate

.2.1 Purpose of the project

The main objective of developing the Integrated Land Information Management System is to improve service delivery in the Ministry of Lands. The system will facilitate efficient and effective service delivery in land management in Kenya. This system will integrate different functions of the Ministry and ensure the services are offered at one stop shop.

The services being offered by the Ministry include:

Registration of Land Transactions;

Issuance of Titles;

Issuance of Searches;

Issuance of Consents;

- Issuance of Land Rent Clearance Certificates;
- Processing Development Applications;
- Preparation of Regional Development Plans;
- Preparation of Local Physical Development plans;
- Preparation of Zoning plans;
- Preparation of Part Development Plans;
- Preparation for Land Registry Maps;
- Preparation for Deed Plans;
- Maintenance/inspection of international boundaries;
- Survey of rural plots (general boundaries);

- Processing of sub divisional surveys;
- Valuation for Stamp Duty;
- Preparation for Valuation Rolls;
- Documentation of Settlement plots;
- Preparation of Discharge of Charge and Transfer;
- Adjudication and Registration of Land Rights;
- Registration of group ranches;
- Resolution of Boundary Disputes;
- Submission of Environmental Impact Assessment Report;
- Issuance of Certificate of Compliance;

Over the years due to increase in land transactions the Ministry of Lands has accumulated massive land records which have grown to unmanageable levels. This has further been compounded by the current manual methods of managing the records which is not tenable for expeditious delivery of services. The Ministry is also facing the following challenges in the processes of delivering services:

- Lack of departmental integration
- Outdated and bureaucratic procedures and processes
- Unauthorized land allocations
- Poor communication between departments and between district offices
- Lack of readily available and accurate land information
- Lack of data backup facilities

- Inefficient updating of land records
- Poorly maintained and tattered land records
- Many and conflicting land laws
- Insecurity of land records
- Inadequate space for the storage of land records due to massive land records
- Land grabbing
- Missing and misplaced files or land records
- Fraud leading to emergence of forged land documents like Title Deeds, allotment letters, Deed plans etc.
- Inadequate human and financial resources
- Corruption
- Cumbersome manual land information systems

These challenges have been made worse by the fact that the Ministry is composed of four technical departments namely Lands, Land Adjudication and Settlement, Survey and Physical Planning dealing with specific functions. These departments have over the years operated in silos despite the fact that they all deal with a parcel of land. This has resulted to poor service delivery.

In order to address the issue of managing the land information and challenges the Ministry is facing, an Integrated Land Information Management System should be developed and implemented. This will ensure that the Ministry delivers services to the expectations of the clients. The system must meet the following goals:

- Ensure efficient delivery of services
- Integrated key technical departments and functions of the Ministry
- Ensure security of land information

- Enable clients to access land information easily by providing it online
- Ensure land ownership records are linked to map data geographically,

lie intended beneficiaries of the Project are:

- Members of the Public;
- Ministry staff;
- Government of Kenya;
- Business Community;
- Investors;
- Development Partners;
- Learning and Research institutions;

6.2.2 Outline of Use Cases and Key Requirements of the system

6.2.2.1 Outline of the Use Cases

The Actors and their respective use cases are given below:

Actor	Use Cases
Land Administrator 1	identifies land requests surveyor to survey parcel of land and issue parcels numbers requests Physical Planner to prepare land use plan requests Land Valuer to value a parcel of land requests Land Registration Officer to register land receives request for allocation of land

	opens a file for the parcel of land
Land Surveyor	Surveys and issues parcel numbers Digitizes cadastral maps
Physical Planner	Prepares land use plan of the area Updates records on the type of land use of a parcel of land
1 Land Valuer	Values the parcel of land Updates records on the value of parcel of land
1 Land Registration Officer	Registers a Parcel of land Registers land transactions Issues a Title Deed to the clients Issues a Certificate of Official Search Updates the land records
1 Client	Requests for allocation of land Pays for land services Requests for Land transactions Requests for a Title Deed Requests for Certificate of Official Search Conducts personal search on a parcel of land

,2-2.2 Key Requirements of the system

a order for the Integrated Land Information Management System to achieve its objective the following are the key requirements:

- Link the Ministry's key departments namely Survey, Physical Planning and Lands departments (Administration, Land Valuation and Registration)
- Provide a workflow from the Land Surveyor to the Land Registration Officer
- Ensure real time updating of land records
- Ensure clients are served from one service point
- Provide land information online
- Provide services on real time
- Ensure clients can conduct a land search online
- Provide Title Deeds, Certificate of Official Search on real time
- Provide reports to the management on number of official search conducted, amount of revenue collected from searches, number of title deeds issued, types of land uses and the parcels, valuation amounts

6.2.3 Project Scope and Boundary Conditions

The Integrated Land Information Management System will link three departments in the Ministry namely Survey, Physical Planning and Lands. In Lands department the system will also link the following divisions Administration, Valuation and Registration. Staff from one department should not be able to view information or carry out any transaction in another department. A staff from one **County**/District should only offer services within his/her jurisdiction.

A client should be able to get the following services anywhere in the republic so long as he/she can access internet; search of a parcel of land.

The system will cover Buruburu Phase IV and V as a prototype.

.2.4 Project Risks

In pursuit of developing this system we identified the following as the potential risks which would affect the successful implementation of the project. We also assessed the extent to which specific risks would cause to the implementation of the project on time, within the estimated budget and meet the user needs. The values for the risk assessment are: 5-Very high, 4-High, 3-Moderate, 2-Low and 1-Very low

Risk	Assessment of Risk
Political goodwill	5
Security of land information	5
Lack of cooperation with staff	4
Inadequate funding	3
Lack of software and hardware	2
Lack of top management support	4
Lack of stakeholders support	3
1 Resistance to change among the staff and stakeholders	5
1 Lack of up to date land information	3

6.3 Elaboration Phase

In this phase we explored the functions of the Ministry in order to come up with the system requirements of the Integrated Land Information Management System. Using the Use Case analysis we established the use cases of the system, the actors, the conceptual diagrams and

ackage diagram. The risks involved in developing the system were also examined and evaluated. Eventually we established the system architecture.

j.3-1 Organizations of the Ministry

The Ministry of Lands is charged with the responsibility of ensuring efficient and effective administration and management of the land resource. This is achieved by carrying out its mandate which includes, Formulation and implementation of Land Policy; Undertaking Physical Planning; Land Registration and Transactions; Undertaking Land Surveys and Mapping; Undertaking Land Adjudication and Settlement; Undertaking Land Valuation; Administration of State and Trust Land and Land Information System (Presidential Circular, 2008). In order to deliver this mandate the Ministry is organized into four technical departments which include Lands, Land Adjudication and Settlement, Survey and Physical Planning while the coordinating department is Administration and Planning. The technical departments are represented in at least 51 districts all over the country. The following are the functions of the technical departments:

6.3.1.1 Lands department

- Management and custody of the land resource records
- Administration of Government and Trust Lands
- Registration of titles and various land transactions
- Land valuation for various purposes
- Resolution of land and boundary disputes
- Generation of revenue through assessment of stamp duty, land rent and collection of A.I.A
- Management of Land Control Boards and Land Tribunals.

6.3.1.2 Land Adjudication and Settlement department

The department is in charge of:

- Ascertaining land rights and interests through Land Consolidation and Adjudication
- Settlement of poor landless Kenyans under the Settlement Fund Trustees
- Management of the Agricultural Settlement Fund
- Administration of group ranches.
- Arbitration of land adjudication disputes.

6.3.1.3 Survey and Mapping department

The department offers the following services:

- Provision of Survey (Geodetic) Control Networks.
- Surveying and Mapping
- Photogrammetric and Remote Sensing Services
- Map Printing and publishing
- Quality Control and Quality Assessment of Surveying and Mapping data.
- Maintenance of land registration maps.
- Inspection and re-establishment surveys of National and International boundaries
- Provision of Hydrographic Survey Services.

6.3.1.4 Physical Planning department

The department is responsible for:

- Initiating national, regional and local physical development policies and guidelines
- Preparation of regional and local physical development plans
- Provision of advisory services on appropriate land use and alienation of land
- Requiring local authorities to ensure proper execution of physical development controls and preservation orders
- Undertake or direct studies and research in to matters concerning physical planning.

6.3.2 Functions of the Integrated Land Information Management System

The function of the Integrated Land Information Management System was based on two issues. The first was on the mandate of the Ministry and the functions of the following departments/sections; Survey, Physical Planning, Land Administration, Land Valuation and Land Registration. The other was a scenario on land allocations.

.3-2.1 Functions based on the Mandate of the Ministry

tie Integrated Land Information Management System will facilitate the Ministry in carrying out the following functions as indicated in the Mandate of the Ministry:

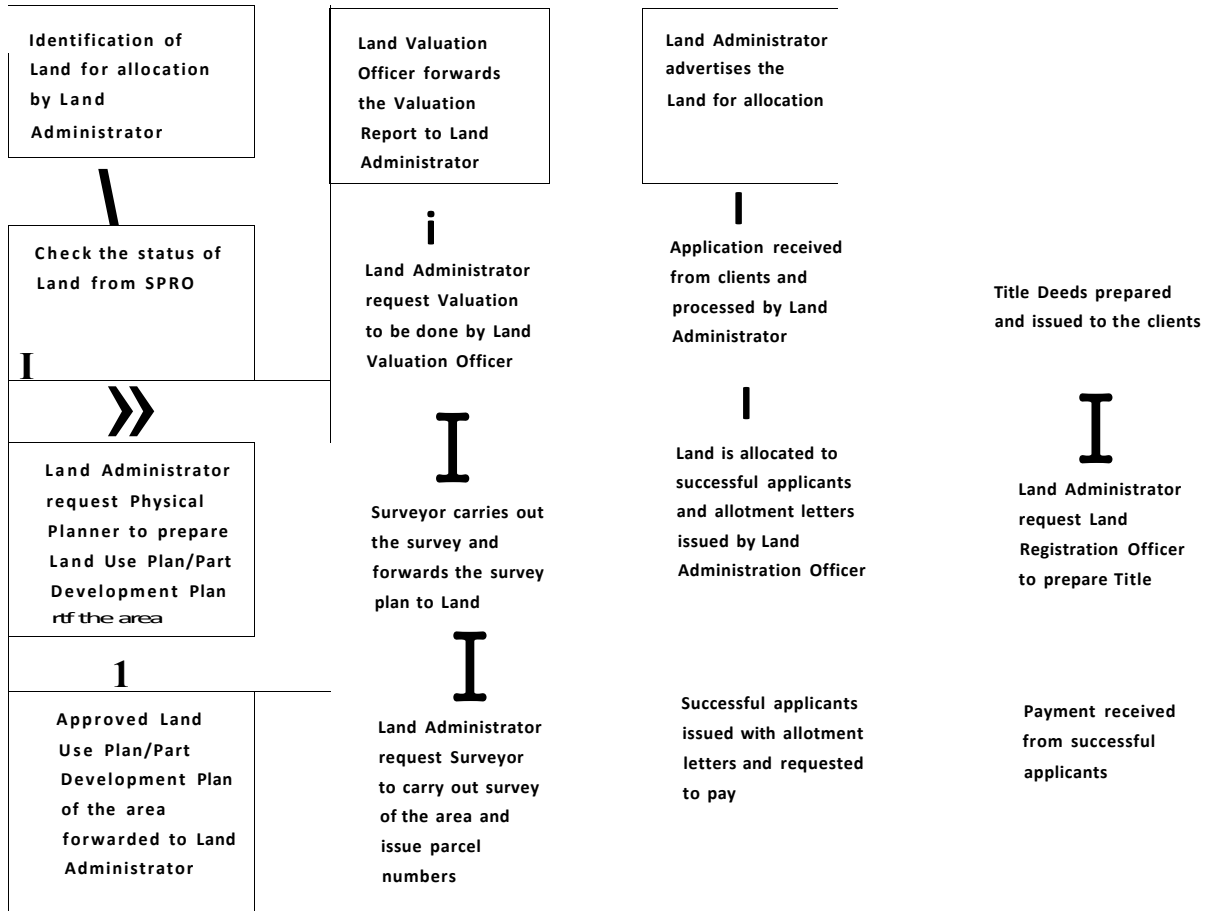
- Undertaking Land Surveys and Mapping;
- Undertaking land use Planning;
- Administration of parcels of land
- Undertaking Land Valuation;
- Land Registration and Transactions;
- Updating of land records; and

- Conducting land searches both personal and official searches

6.3.2.2 Land Allocation Scenario

In order to come up with the design of the Integrated Land Information Management System, we came up with one scenario which comprises of the major processes in the allocation of land in the Ministry and which integrates all the three departments i.e., Survey, Physical Planning and Lands and which reflects its mandate. The pictorial illustration of the land allocation processes is as shown in Fig 6.1 below:

g. 6.1: Land Allocation Processes



6.3.2.3 Specific functions of the Integrated Land Information Management System

Finally, considering the two issues we came up with the functions of the Integrated Land Information Management System as follows:

- Issuance of Title Deeds
- Issuance of Certificate of Official Search
- Conduct personal search through the web
- Issuance of Letter of Allotment

Registering of a parcel of land

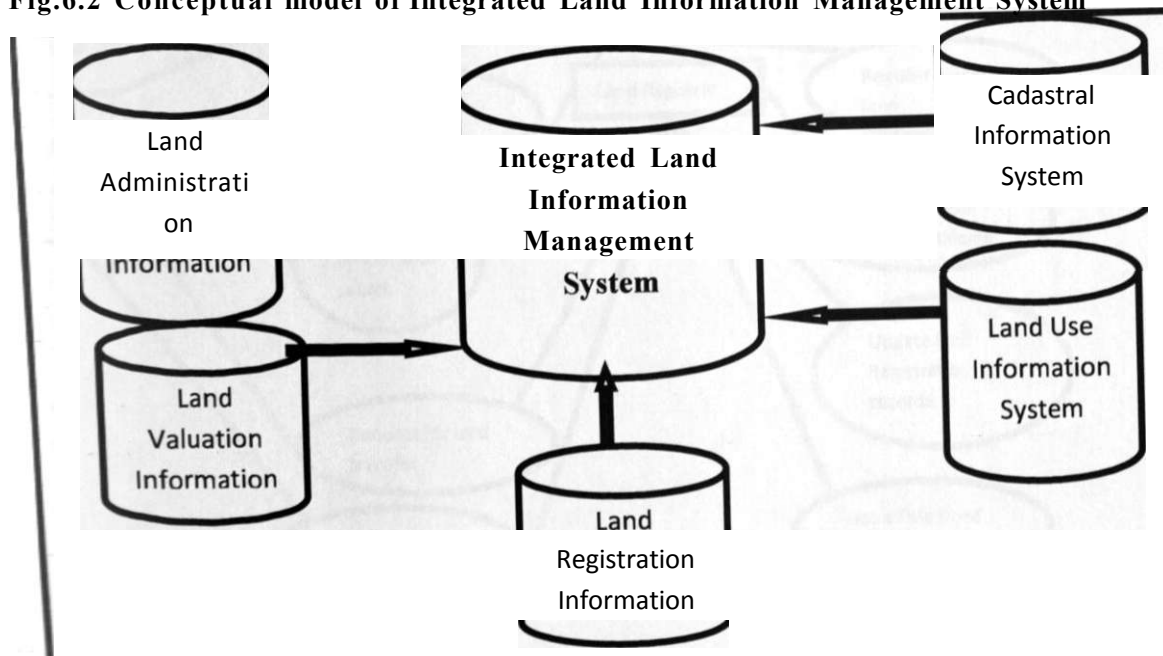
Registering land transactions

- Payments of Land Revenue
- Issuance of Revenue Receipts
- Updating of land records on parcel numbers, land use, value of land , land rent, land tenure, lease period, land ownership
- Prepare a geographically referenced cadastral map with parcels and parcel numbers
- Produce reports to the Land Administrator, Physical Planner, Land Valuer, Land Registrar e.g., number of parcels registered, number of official searches conducted, total amount collected from searches, values of parcels, types of land uses.

6.3.3 System architecture

The Conceptual Model, the Use Case Diagrams and the Class Diagrams of the Integrated Land Information Management System are shown in the figures below:

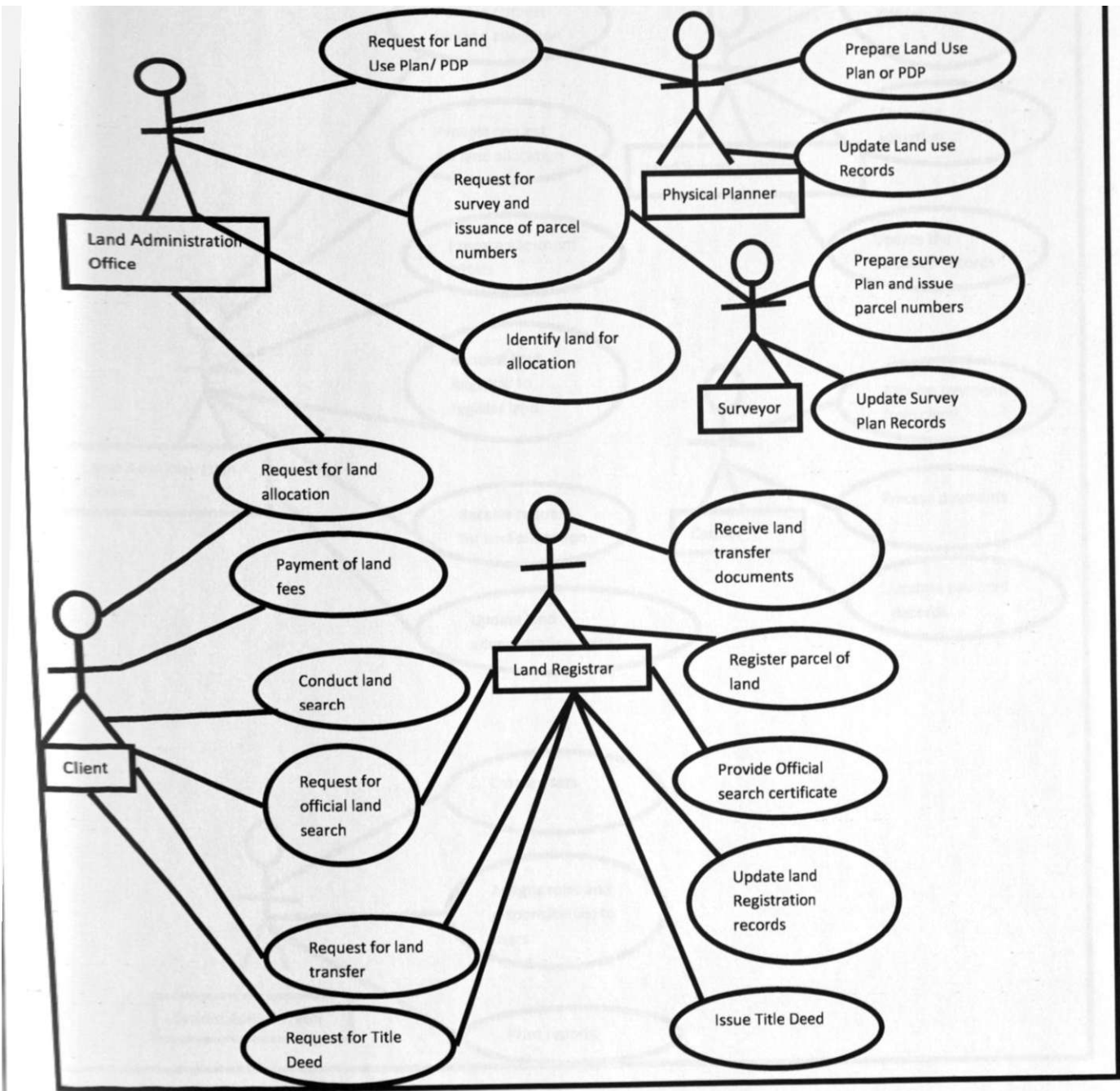
Fig.6.2 Conceptual model of Integrated Land Information Management System

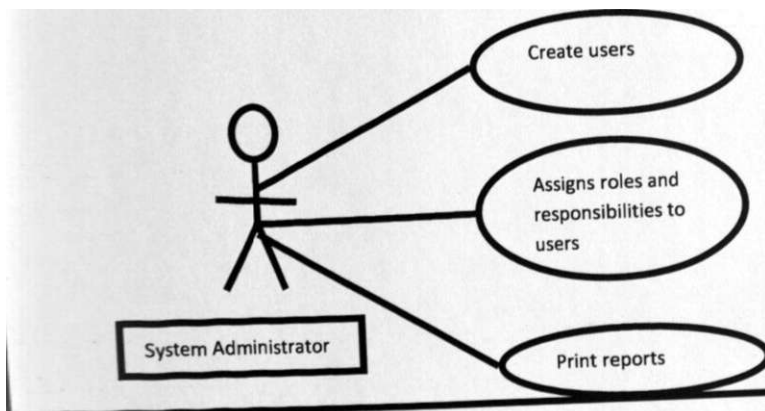
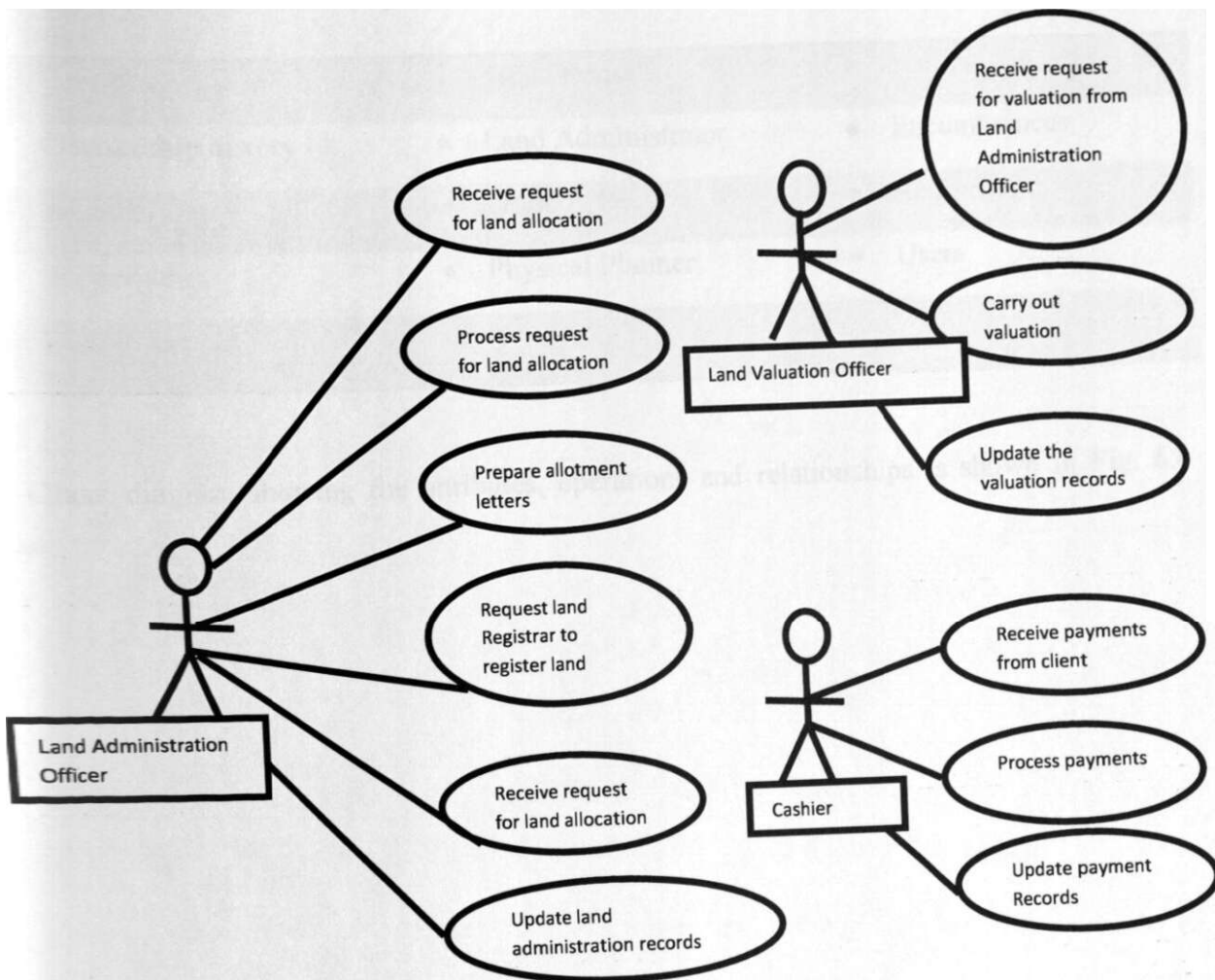


g. 6.3 Use Case diagram of Integrated Land Information Management System

The Use Case diagrams for the Integrated Land Information System are as given below:

Integrated Land Information Management System





3.3-3 Class Diagram

Classes identified in the Integrated Land Information Management System are:

- Ownership
- Ownership history
- Search
- Receipts
- Surveyor
- Title Deeds
- Land Administrator
- Property Section
- Physical Planner
- Valuer
- Encumbrances
- Registries
- Users

The Class diagram showing the attributes, operations and relationships is shown in Fig. 6.4 below.

bH 0.4: End* DWim

ZJ

ownership
 idno INT(9)
 name VARCHAR(3 >)
 address VARCHAR(20)
 par_no VARCHAR(40)
 commence DATE
 date DATE
 time TIME
 officer VARCHAR(25)
 search_id INT(11)

search
 id INT(11)
 par_no VARCHAR(50)
 date DATE
 time TIME
 officer VARCHAR(25)
 rcts_rctno VARCHAR(20)
 title_details_prop_sec_g INT(11)

title_details
 par_no VARCHAR(40)
 status INT(10)
 officer VARCHAR(20)
 date DATE

> i
i *

pp
 parno VARCHAR(5)
 use VARCHAR(40)
 date DATE
 time TIME
 officer VARCHAR(30)
 encumsecid INT(11)
 land_admin_par_no VARCHAR(40)



par no VARCHAR(14)
 value DOUBLE
 rctno INT(11)
 wef DATE
 date DATE
 time TIME
 officer VARCHAR(25)
 pp_par_no VARCHAR(40)
 pp_encum_secid INT(11)

land_admin
 par_no VARCHAR(40)
 nature VARCHAR(20)
 term VARCHAR(20)
 from DATE
 date DATE
 time TIME

2

3

it

registries
 code INT(11)
 registry VARCHAR(10)
 users_ uname VARCHAR(10) users

encum_sec
 id INT(11)
 state INT(11)
 nature VARCHAR(20)
 par_no VARCHAR(80)
 entryno VARCHAR(10)
 date DATE
 details VARCHAR(80)
 rctno VARCHAR(20)
 officer VARCHAR(20)
 time TIME

>
±4
<14

fname VARCHAR(15)
 lname VARCHAR(15)
 registry VARCHAR(50)
 uname VARCHAR(10)
 pass VARCHAR(10)
 state VARCHAR(1)
 privi VARCHAR(2)
 date DATE
 time TIME
 creator VARCHAR(30)

ownership_history
 idno VARCHAR(9)
 name VARCHAR(35)
 address VARCHAR(20)
 par_no VARCHAR(40)
 commence DATE
 ended DATE
 date DATE
 time TIME
 officer VARCHAR(30)
 ownership_idno INT(9)
 ownership_par_no VARCHAR(80)
 ownership_search_id INT(11)

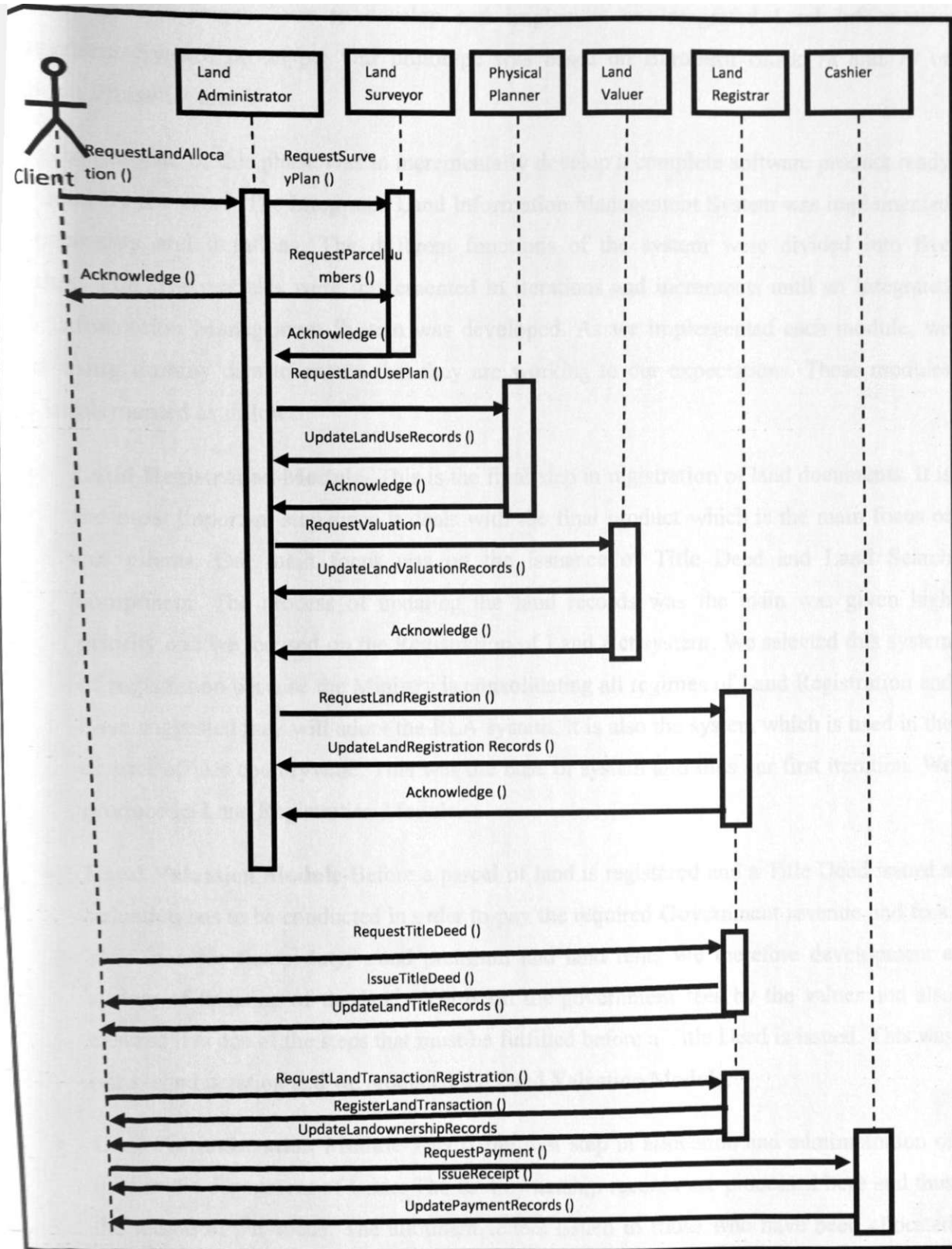
rets
 par_no VARCHAR(80)
 state INT(1)
 app VARCHAR(20)
 rctno VARCHAR(20)
 amt VARCHAR(20)
 cashier VARCHAR(20)
 date DATE
 time TIME
 prop_sec_id INT(11)

prop_sec
 id INT(11)
 state INT(11)
 nature VARCHAR(20)
 par_no VARCHAR(80)
 entryno VARCHAR(10)
 date DATE
 details VARCHAR(80)
 rctno VARCHAR(20)
 officer VARCHAR(20)
 time TIME
 encum_sec_id INT(11)



j6.5: Sequence diagram

ie sequence diagram of the Integrated Land Information Management System is shown below:



4 Construction Phase

his is where we implemented the Integrated Land Information Management System. The objective of our project was to develop and implement an Integrated Land Information Management System prototype. Our prototype was based on Buruburu Block 78 and 79 or Juniburu Phase IV and V.

The main purpose of this phase was to incrementally develop a complete software product ready to be used by the users. The Integrated Land Information Management System was implemented in increments and iterations. The different functions of the system were divided into five modules. The five modules were implemented in iterations and increments until an Integrated Land Information Management System was developed. As we implemented each module, we tested using dummy data to ensure that they are working to our expectations. These modules were implemented as follows:

- **Land Registration Module-** This is the final step in registration of land documents. It is the most important step since it deals with the final product which is the main focus of our clients. Our main focus was on the issuance of Title Deed and Land Search component. The process of updating the land records was the main was given high priority and we focused on the Registration of Land Act system. We selected this system of registration because the Ministry is consolidating all regimes of Land Registration and have suggested they will adopt the RLA system. It is also the system which is used in the district offices countrywide. This was the base of system and thus our first iteration. We produced a Land Registration Module.
- **Land Valuation Module-** Before a parcel of land is registered and a Title Deed issued a valuation has to be conducted in order to pay the required Government revenue and fees. This includes stamp duty, stand premium and land rent. We therefore developed a system of updating of the land records on the government fees by the valuer and also ensured it is one of the steps that must be fulfilled before a Title Deed is issued. This was our second iteration and we produced the Land Valuation Module.
- **Land Administration Module-** This is the first step in allocation and administration of land in the department of lands. The first ownership records are processed here and thus the reason of our focus. The allotment letters issued to those who have been allocated

land is performed at this step. It was our third iteration and a Land Administration Module was produced.

- **Land Use Module**-Before any land is allocated the land uses must be established. This is done at this step and it is one of the processes of registering a parcel of land. This was our fourth iteration and a Land Use Module was produced.
- **Cadastral Information Module**-This is the base of registering parcels of land. It contains the parcel map of Buruburu Block 78 and 79 and the parcel numbers. The process of developing a model GIS-based Cadastral Information System that links land ownership records and land registration maps is as follows:

The process for developing a model GIS- based cadastral database should be centered on the following bases;

- (a) Survey
- (b) Data capture
- (c) Data scanning
- (d) Data transformation
- (e) Geo-referencing of data
- (f) Digitization/Vectorization of data
- (g) Data editing
- (h) Attributing
- (i) Data security

(a) Survey

The first activity in this process is the field survey which includes establishment of parcel measurements, area and location, preparation of survey plan, issuance of parcel number. In our case this had been done earlier by the department of Survey. The data of our prototype was therefore available at Survey of Kenya.

(b) Project coverage:

The area of our prototype was Buruburu block 78 and blocks 79 sheet 1 and sheet 2. The choice of the prototype area was based on availability of data and various land use cover tor

be area such as residential, commercial and Public utilities. Buruburu is proximity to Nairobi ifld the cost for data collection and travelling is minimal. It also represents a good Registered Lands Act (RLA) registration area.

(c) Data Source

Data for the project was identified to be both Cadastral and adjudication maps from the Survey Department. The maps used were obtained from the Survey of Kenya and the Database was generated from both maps details and data available from the Lands department. The setting up of the Cadastral Information System should link cadastral information available at the Survey Department to the property information obtained from the Lands Department. The two sections should work together under one agency to form an effective information system.

(d) Data scanning

The base for all cadastral information is the maps which contain information about details of an individual property. The maps can only be effectively made available and secure for the public by keeping a safe and secure data. This is achieved by scanning these paper maps to turn them from hard to soft copy for purposes of vectorizing the data. The soft copy is efficient and easy to store and retrieve for the users.

(e) Data Transformation

The data used was in Cassini projection. For the purpose of the database users, transformation from Cassini projection system to Universal Transverse Mercator (UTM) was done. It involved converting the coordinates from meters to feet's in Cassini projection system. The coordinates were then checked and ran through a transformation programme generated by the Geodetic Section for the Nairobi area in order to transform to UTM projection system.

(f) Geo-referencing of data

Geo-referencing is the process of bringing the coordinates on the map to the ground. This is to ensure that the coordinates on the maps reflects the true position on the ground to reflect the mirror principal of land **registration**. This is achieved by using a Geographical based

that are which enables the corner coordinates to be identified and the image is rectified to reflect the position on the ground.

H digitizing of data

The process of converting analogue data to digital format. The scanned image is vectorised by using a GIS software and in this case we used ARCGIS. The layers were defined to shape files which enable digital data to be retrieved as separate layers and can be used for various purposes depending on the needs of the user. For the purpose of the study, only the parcels were digitized and land use. In this case polygons were used since the parcels and land use are all defined by area coverage. The road network was also captured as polylines.

(h) Data editing

The digitized data has anomalies such as overshoot or undershoot which needs to be edited in order to have a complete polygon or polyline. It is achieved by editing the data and creating overlays with the scanned base map to ensure that the vector data falls or overlays the base map.

(i) Attributing the data

The digitized map forms the vector data which is easy to manipulate and analyze. To attain complete cadastral information, data entry was done to form the attribute tables. The data used was the parcel numbers, and the block for locality purposes. This was attained from the survey department.

Other modules were used to input other data types into the Integrated Land Information Management System database which includes; land use type data, valuation data type, and land ownership data, land registration type data from Physical planning, Valuation section, Land Administration Section and Land Registration section respectively.

An essential requirement for separate data entry is a common identifier also called a key that can be used to relate object geometry and attributes together following data capture. Database obtained from lands section was linked to the base map by using the parcel as the unique identifier (key). This enables data to be queried and the result also reflects on the vectorised data as the base. It becomes easy to manipulate the data and retrieve all information by

creating queries depending on user specifications.

data security

data security can be E-data security or physical security. It is essential in maintaining a database for up to date and reliable information system. E- data security can be achieved by creating passwords of limited access to only the authorized personnel. Data can only be changed by officers handling the database and has to be maintained for authenticity.

Physical security involves putting up buildings that are theft proof and also fire proof. CCTV cameras can also be considered for safe and secure buildings.

Therefore the data here is in spatial form while the rest of the data is in attribute form. The attribute form is linked to spatial form using the parcel numbers. This was our fifth iteration and the final.

In developing the Integrated Land Management System prototype we integrated all the five modules or components and ensured that staff from one department or section or dealing with one module/component cannot be able to access information in other department or section or module/component.

6.4.1 Choice of Softwares

In the Integrated Land Information Management System prototype we used open source softwares and databases namely WampServer, MySQL Version 5.0, PostgreSQL Version 8.4.

The main reasons for using open source softwares were:

- Affordability-The softwares are not charged any money to use. They utilize low cost hardware while their scalability and performance are very high. They are easy to maintain and support since at the open source any problem can be found with those using it.
- **Scalability and flexibility** - The softwares can handle large amounts of data running into terabytes which is very important in our system since it hold both attribute data and spatial information which is in images. These softwares can also be used by a variety of operating systems e.g. Windows, UNIX, Linux
- High performance- These softwares can meet the most demanding performance expectations of any system. These softwares have high speed and utilities, distinctive high speed

memory caches and full text indexes. Since our system is required to be a web based system and real time information required at any one time the open source softwares are thus very important to us.

Security-These softwares have security features that ensures absolute data protection. In terms of database authentication, they have powerful mechanisms of ensuring that only the authorized users have entry to the database server with the ability to block users down to the client machine level. They have also backup and recovery utilities which allow complete logical and physical backup as well as full and point-in-time recovery. Security is one of the key requirements of our system. This is because the Integrated Land Information Management System is a web based system where our clients will also be accessing our database. Moreover the attachment of the Land Resource to the Kenyan people requires that land ownership data is well protected from manipulation or fraud.

In specific the following table indicates the software that was used when designing the Integrated Land Information Management System and reason for the choice:

Software	Why the choice
PHP (Scripting Language)	This is an open source server-side scripting language that can in the simplest way connect to the MySQL database. It ensures maximum security because it runs on the server-side. It is also a powerful tool when it comes to the designing of web-based systems
Apache (web-server)	This is an open source web based server. It used to host the web pages and ensure a number of users are able to access the system simultaneously
MySQL (database)	This is an open source database. The database can hold millions of records and support simultaneous connections to the database. The database has built in security, a feature that makes the data held secure.
MySQL Workbench	This is an open source database querying / modeling tool. This tool assists a user to access the data held in the databases, design the relationship between the tables in a database and also manage the MySQL server engine.

This is a powerful open source Object-relational database system. It possesses the following key features: reliability, data integrity and correctness. The database can support geospatial information through PostGIS. It uses the client/server model. It can be linked with MySQL in order to pick the parcel numbers from the map file. It has free space Map Implementation and Visibility Map features which allow easy and improve performance of manipulating map files.

4.1.1 Programming Languages

The programming languages used in development of the Integrated Land Information Management System are:

- **PHP**-This was used on the MySQL and PostgreSQL softwares
- **Java Script** -Used in the PostgreSQL software

6.4.2 Installation of the System

The system was deployed in two levels:

• Server side

- Install the Wamp server software pack that contains PHP, Apache and the MySQL database. This software has an installation wizard to make it easy for any user to install it. We were keen on where you to install the local host folder.
- Install the MySQL Workbench.
- Create/restore the database that the system is going to use
- Copy the web pages to the local host folder.
- You are now done with the installation. Access the system through this url: localhost/
[systemfoldername]

• Client side

- Install your preferable web browser and apply the settings for your organization.
- Try to access the internet of an intranet to ensure that the browser is properly configured.
- Go to the local host/ *[systemfoldername]* url to access the system

System Requirements

- fi requirements can be analyzed from two perspectives:

Server-side

- ¹ Server O/S - Windows server 2003 and above
- Hard disk - 200 GB
Memory - 2gb
Two Ethernet Ports
- Two power supply units

Client Requirements

Client O/S - Windows XP SP3 and above
Clock speed - 2.0 Ghz and above
Hard disk - 40 Gb and above
Memory - 1 Gb DDR2 and above
Web browser e.g. internet explorer, Google chrome
Ethernet port and drivers

6.4.4 System Security

The Integrated Land Information **Management** System is a web based system that allows the users access a shared database through the web interface. Some of the security features that are built in to ensure that the data captured is safe will include:

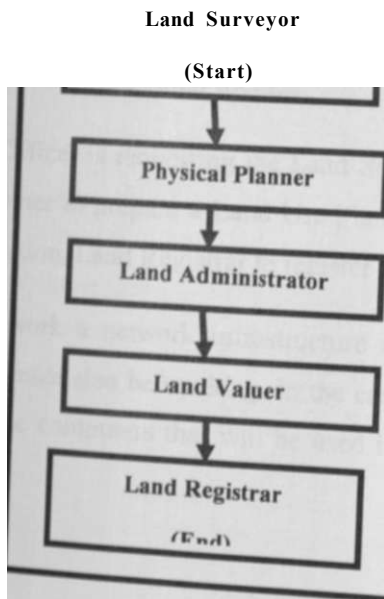
1. Each user has his/her scope of work. This is defined in the number of functions a user is able to access. Some of the users are only able to capture the data while others are able to edit the data captured
2. Each user has to authenticate him/her before accessing the functions to be offered by the system. These users have to be registered in the system
3. When any user performs any kind of transaction, the user's id is appended to the transaction to ensure that the user can easily be traced in case there are some questions to be answered
4. The system resides in the server and uses some server side scripting language to access the database. If a user is to access the database in some unknown means, the user has to have physical access to the server and crack a number of passwords before accessing the system

and a prototype of the **Integrated Land Information Management** * V and IV. **this** was our **Beta release**. It is a web-based system and **used** was **Mozilla Firefox**. This **is** because the maps we used were in browser.

Information Management System is a centralized system with six interfaces, namely; Land Surveyor interface, Physical Planner interface, Land Administrator interface, Land Valuer interface and Cashier interface and Land Registrar interface as also the System Administrator interface who manages the system, all can be accessed if you are authorized to work on these areas. You need to enter a password and the system directs you to the interface you are authorized to use.

For security and integrity, the Integrated Land Information Management System workflow starts with the Land Surveyor and ends with the Land Registrar.

Integrated Land Information Management System



Anything that can be done:

Working on a parcel of land
 ** authorized person to issue

must originate from the surveyor. The parcels numbers to be used by all other

users of the system.

Users can only be able to work on their own component or area e.g. only the authorized surveyors who can be able to work on the Land Surveyor or Cadastral Information module or authorized Land Registrars on Land Registration module.

Users in a preceding component in the flow chart cannot be able to view the data of the step following that component. For example the Surveyor cannot be able to view the data of all other components except his/her own, Land Administrator can be able to view the data for the Physical Planner but the Physical Planner cannot be able to view data for the Land Administrator. However the users can only be able to view but not to work on the data.

- The Land Registrar is the final person in the system which ends with issuance of Title Deed.

In order for the Integrated Land Information Management System Prototype to work perfectly the communication between different departments must be enhanced through an active e-mail system. This will ensure that there are no delays in delivering the services to the clients. Some of issues that will be communicated through email include:

- Land Administration Officer is requesting the Land Surveyor to survey and issue Parcel numbers, Physical Planner to prepare a Land Use Plan or Part Development Plan, Land Valuer to conduct valuation, Land Registrar to register the land and issue Title Deed.

Therefore for the system to work a network infrastructure must be installed and should be working. An internet explorer must also be working. In the case of this system the best internet explorer to be installed in those computers that will be used is Mozilla Firefox. This is due to visibility of maps.

6.5 Transition Phase

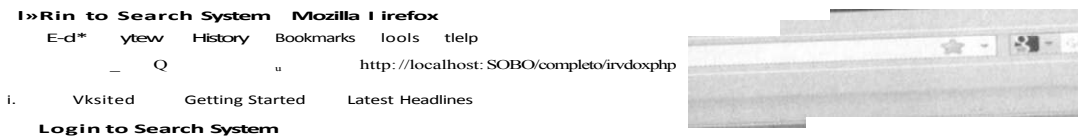
The main purpose of this phase was to test the beta release which was the Integrated Land Information Management System Prototype. Since during construction each module was tested using dummy data and when the system was integrated we also used dummy data to test whether the system worked to our expectation, at this phase our main focus is to test using real data. The

rated Land Information Management System prototype was installed in one of the paters and using the Local Area Network at the Ministry of Lands headquarters in Ardhi se was shared between the five departments/sections i.e., Survey department, Physical rnfag, Land Administration Section, Land Valuation Section and Land Registration.

earlier indicated the Integrated Land Information Management System is a web based system, e following are the access windows or interfaces of the various modules or components of the egrated Land Information Management System:

- **Login interface:** This is where the authorized officers login into the system. They must use their username and password. The users must be created by the system administration. The login interface is as shown in Fig 6.7 below.

Fig. 6.7: Login Interface



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Login

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f) Login to Seach System.

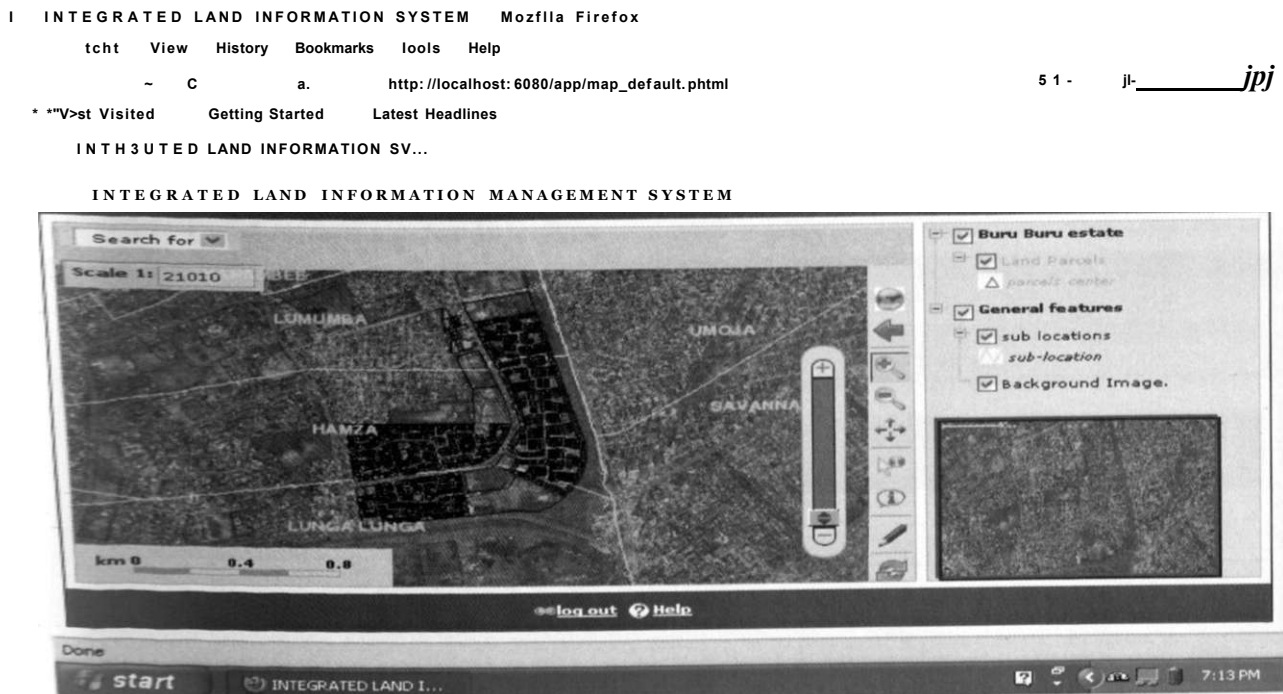
System administrator: All users of the Integrated Land Inform**o f4anagmen System must be given rights by the system administrator to acces the s e m ^ ^ system administrator can therefore create or dereg.ster a -erres.oreauerspassword, print reports. The interface of the system administrator ,s as shown m F.g. 6.8 below.

^ System Administrator Interface



- **Surveyor Interface:** This is where we upload our maps after digitizing and geo-referencing. In this interface we issue parcel numbers, indicate the map sheet number and the registry area. The surveyor can also overlay the cadastral map with other maps of the area e.g roads, schools. The interface of the surveyor as indicated in Fig. 6.9 shown below.

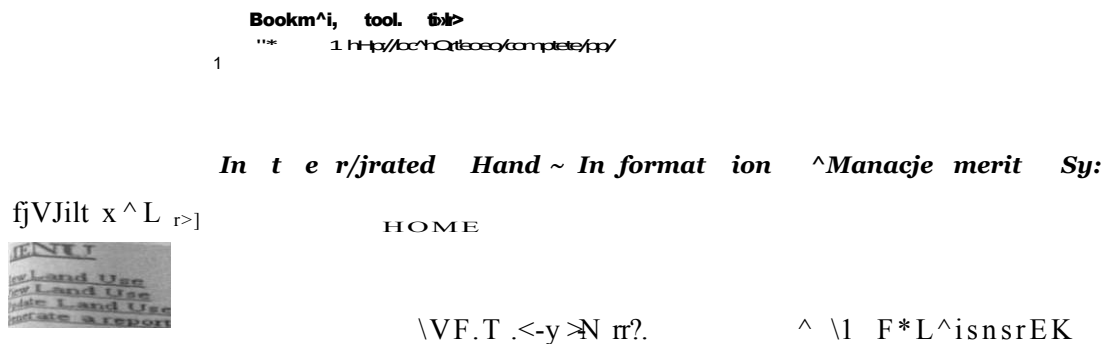
Fig. 6.9: Surveyor Interface



- **Physical Planner:** Through the Physical Planner interface the uses of land are identified. This information is input on the different parcels of land. The use of the land includes agricultural, residential or commercial. The Physical Planner can generate land use report on various parcels with different land use in the area. The Physical Planner Interface is

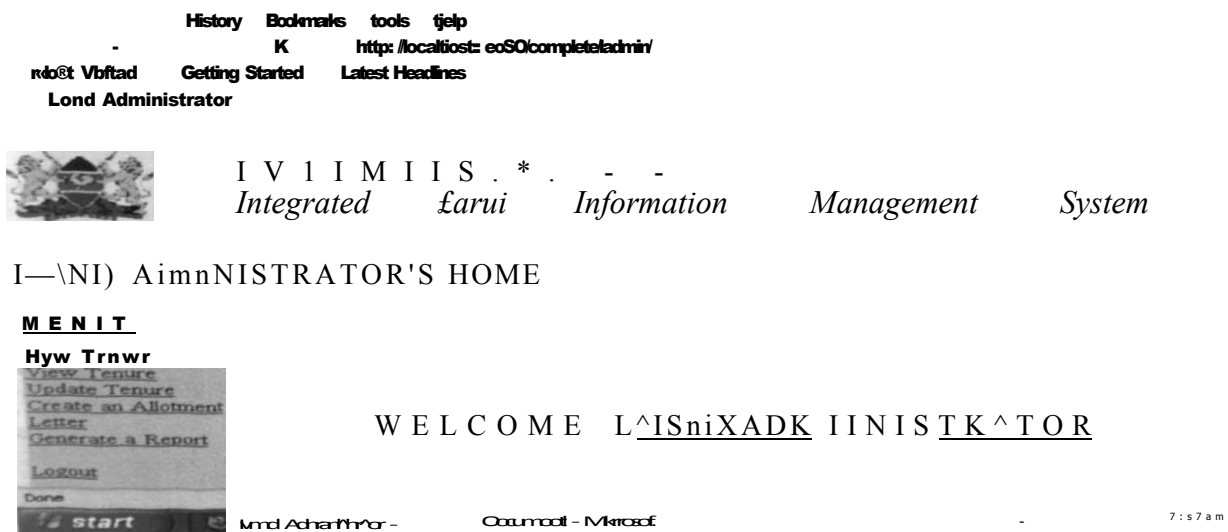
shown in Fig. 6.10 below.

10: Physical Planning Interface



- **Land Administrator:** This is where the authority to survey, plan, value and register comes originates. This is done through email. After surveying, planning and valuation is done the clients are issued with Letters of Allotment. The type of tenure, lease period in case of leasehold and start date of lease hold is done using this interface. The Land Administrator is the head of Lands Department and thus can generate reports. These reports include number of parcel of land registered, number of official searches issued and amount of revenue collected from searches. The Land Administrator's interface is shown in Fig.6.11 below.

Fig. 6.11: Land Administrator Interface



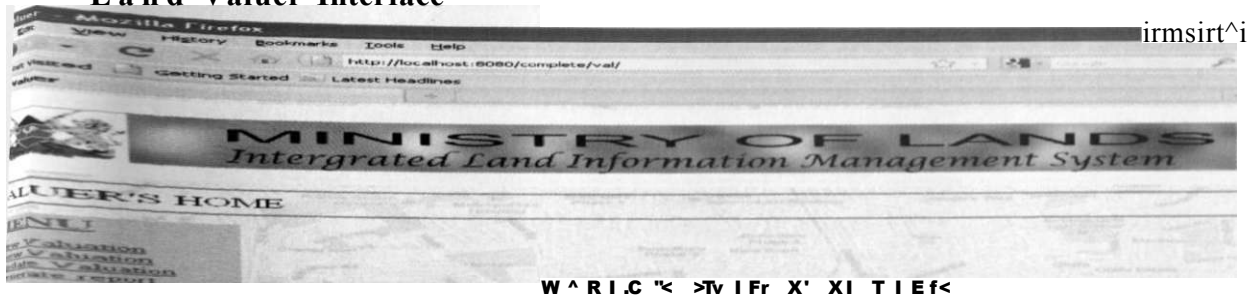
Land Valuer: This is where the information on the value of land and Land Rent is input into the system. This is done by conducting a valuation on the ground and feeding the

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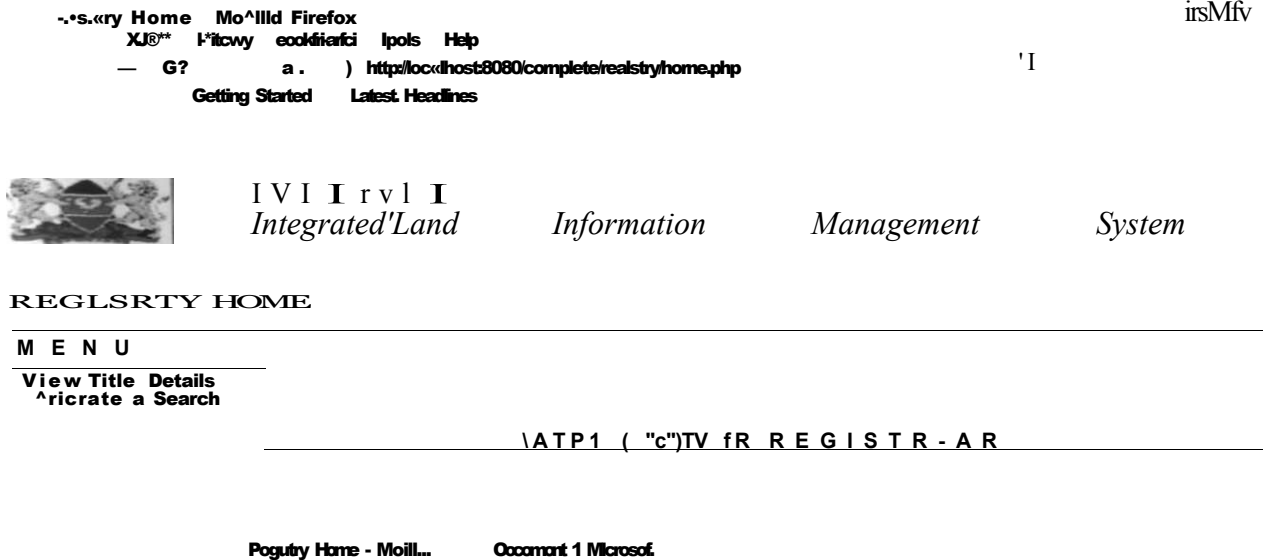
system. The valuer in charge can generate report on value of parcels of ^vithin a certain value range. An Interface showing the Land Valuer interface is shown in Fig. 12 below.

Land Valuer Interface



Land Registrar-This is where a parcel of land is registered, Title Deed issued, official search conducted, registration of land transactions is done. The Final product of the land process is given at this stage. The Land Registrar can also generate reports e.g., searches done in a registry and number of parcels The Interface that allows the Land Registrar to perform these functions is as shown in Fig. 13 below.

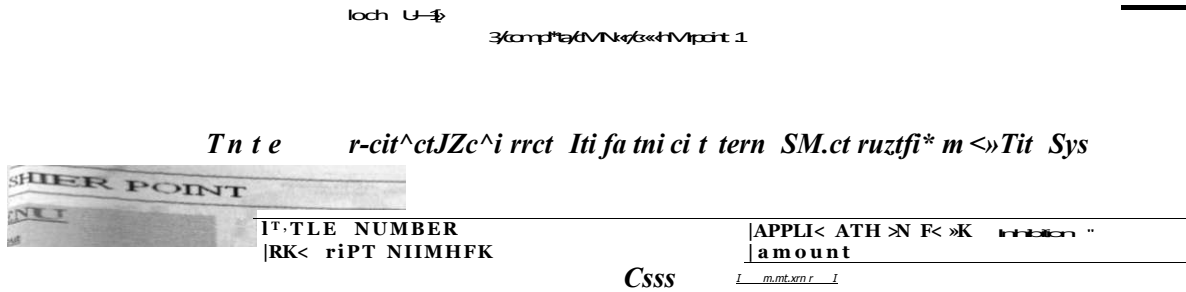
Fig. 6.13: Land Registrar Interface



- **Cashier Interface:** This is where payments is done by the client. No land transaction can be done without payment and issuance of a receipt. This includes payment of official searches, registration of encumbrances and inhibitions. The interface that facilitates this

Place as indicated in Fig. 14 shown below.

14: cashier Interface



- **Client Interface:** A client or member of public can conduct a search in our system. The members of public must input his name, Identification number and mobile number. This is for security purpose incase fraudsters would use the information given to commit crime with it. However s/he cannot print the official search but can view all the details. This is done through the interface indicated by Fig. 14 shown below

fig. 6.15: Client Interface



The authorized users were allowed to input data specifically for Buruburu Block 78 and 79 and tested their respective modules. The Integrated Land Information Management System prototype was working as expected. However users in specific departments wanted more functionality to be added which includes flowcharts within their departments but this was beyond the scope of the project. This can also be done through more iterations and increments.

nd Registration Division was very much impressed by the system and since they have to develop the Registration of Land Act system they said they can develop one from what we them. A Senior Land Registration Officer who is currently handling computerization in the division had to say this *"this is what we have been waiting for we must implement 'Stern in our department"*

Conclusion

Conclusion our main objective of developing and implementing an Integrated Land Information Management System prototype was met. The prototype is for Buruburu Block 78 and 79 or Buruburu Phase IV and V. The following can be performed by the system on all parcels of land in Buruburu Block 78 and 79 or Phase IV and V:

- Issuance of Certificate of Official Search
- Members of public can conduct land searches through the web
- Issuance of Letter of Allotment
- Register a parcel of land
- Register land transactions
- Payments of Land Revenue
- Issuance of Revenue Receipts
- Updating of land records on parcel numbers, land use, value of land, land rent, land tenure, lease period and land ownership
- Cadastral map with parcels and parcel numbers
- Produce reports to the Land Administrator e.g., number of parcels registered, number of official searches conducted and total amount collected from searches

The use of the Unified Process Methodology was a major milestone in delivering the system. This was particularly important since the whole project was able to be divided into modules and each module developed iteratively and incrementally until we delivered the whole system. Iterations and increments enabled us to work with specific users in these departments and

5. We were able to work with the users throughout the development process and which was a major requirement of this system. Using this model we were able to identify risks which could affect the delivery of the system. This was done in our initial part of developing the system and it helped us to address these risks as we implemented the system. We were able to develop the architecture of the system early enough in our development process which helped us in developing the right system. Finally, the availability of open source softwares and the expertise in using them was a major breakthrough in our project. This reduced the cost and also we were able to get the support from open source whenever we had any challenges.

CHAPTER SEVEN

CONCLUSION AND RECOMMENDATIONS

inclusions

ne title key factors of production, the others being labour and capital. It is the only fu ^ o a u c t i o n that

cannot be created. It is thus important for social, economical and development of any country. The attachment the Kenyan people have with land makes it set our country. Land should therefore be administered and managed in an equitable, productive and sustainable manner. For this to happen an efficient and effective .rated Land Information Management System must be developed and implemented. It is for sreison that we decided to carry out a research project to:

- Find out existing models for developing integrated land information management system.
- Determine the challenges of developing integrated Land Information Management System.
- Propose appropriate model for developing integrated land information management system.
- Develop a prototype for an integrated Land Information Management System based on the proposed model.

In conclusion we highlight each objective based on our research findings.

7.1.1 Models for developing integrated land information management system

We accomplished our first objective by investigating the various existing models for developing integrated land information management system as indicated in the literature review. Since integrated land information management system is an information system, we explored the various models of developing information systems. The existing models which are explained in chapter two includes; Waterfall Model, Prototyping Model, Throwaway Prototyping Model, Spiral Model, Rapid Application Development Model, Scrum Model, Extreme Programming Model, Object Oriented Model, Dynamic Systems Development Model, Capability Maturity Model, View model and Unified Process Model. The characteristics, benefits, advantages and

W of these models were described.

of development of the Integrated Land Information Management System, Management Services, and implementing an integrated system faced with a lot of challenges which will include a complex system challenges which includes people, technology and processes. We addressed these challenges because we had identified the risks and we tackled them as well as with the development of the system. It is also important to note that in using the M*ss Methodology where we were able to break the system into modules and *He*h module iteratively and incrementally. This was the major breakthrough in our

ing an Integrated Land Information Management System which will manage all land in Kenya is a mammoth task and this is a very large information system which requires adequate resources both human and financial for it to succeed. Moreover, the project management skills would be required to manage the project. Accuracy and consistency is very essential in developing this system as it ensures that the spatial data on one side and ownership data on the other hand are unified.

Challenges of developing an integrated Land Information Management System include:

- **Political goodwill**-The willingness of the Government including the Minister and the Permanent Secretary in implementing the system must be assured for the project to succeed. Since currently the Ministries are operating under performance contract we suggest that development of this system must be included as one of the targets in the Performance Contract.
- **Commitment of Heads of departments** in supporting the development of the integrated Land Information Management System. We propose that each head of department play a role on which his/her department will play in ensuring that the system is developed. This role should be used to identify the department's contribution to the system. These targets should be put in the department's Performance Contract.
- **Wishing a team that is Political and Technical** fee composed of both the technical and business sub-teams. **Integrated Land Information Management System champions** should be identified across all departments in the Ministry.

one on this team especially on project management skills. Power and authority should be given to the team to ensure they deliver the system within the stipulated time, budget and according to the users expectations

^ hange management-Poor attitude towards change both from the Ministry staff and also other stakeholders. In order to address this we suggest that a comprehensive change management programme be carried out both to the Ministry staff and to the clients to ensure the whole organization moves in the same direction in the process of implementing the system. This will address the issues of fear for the unknown, suspicion between staffs and also between the Ministry and stakeholders.

Voluminous land records data that need to be captured and scanned-the land records in the Ministry of land date back to over 100 years ago. This is a challenge in terms of capturing these records into the system and digitizing it while at the same time ensuring its updated. A strategy need to established for capturing and digitizing these records in all the departments.

- Establishing a uniform modern Geodetic Control Network framework and resurveying all the parcels to ensure accuracy and update information. This will ensure our parcel measurements and the information we input in our system are accurate. This is key in developing the GIS component in the system.
- Legal and institution changes which may affect the handling of data and information. This is important in order to address the different regimes of registering land. The institution changes will also address the issue of the custodian of the land information.
- Security of land information both physically and logically. This will ensure the information being captured into the system is authenticated and any information in the Integrated Information Management System is secure from fraud. This is because a system is as good as the data it has. Physical security will ensure that the areas where this information is stored is secure. This includes Personal Computers, Server rooms and the buildings. Installation of biometric access and CCTV is very essential.
- Rapidly-changing technology. Globally the technology is changing very rapidly. When an institution decides to develop a system using certain softwares and this takes some time, it may lead to some technologies that the institution had settled on becoming

obsolete. This can be addressed by ensuring the implementation of a system is done within a short time and the softwares to be used should be able to be upgraded just in case the technology changes.

- High cost of developing the Integrated Land Information Management System. A well thought out implementation plan of the project is very necessary. This will enable the Ministry to source for funds from both the Government and the Private Sector. However, the use of open source softwares can drastically reduce the cost of implementing the system.

7.1.3 Adopted Model for developing Integrated Land Information Management System

We identified the weaknesses, strengths and gaps of the various existing models as indicated in our literature review. This was done visa a vis the characteristics of the integrated Land Information Management System. We were able adopt the Unified Process for developing the Integrated Land Information Management System. The main characteristics of this model which includes; Iterative and Incremental, Use Case Driven, Architecture Centric and Risk Focused were some of the major points that made us adopt the methodology

7.1.4 Development of Integrated Land Information Management System Prototype

Using the Unified Process Model we developed a prototype of Integrated Land Information Management System. This prototype was for **Buruburu block 78 and 79 or Buruburu Phase IV and V.**

7.2 Recommendations

As indicated in chapter five, the findings show that both staff and clients are in need of an integrated land information management system. This will ensure that land will be held, used and managed in equitable, efficient, productive and sustainable manner as stated in the New Constitution.

Research has shown that at least 80 percent of any Government decision-making is based on land or spatial information. In order to ensure accurate, reliable and up to date land information is available we must develop the Integrated Land Information Management System.

We therefore recommend to the Ministry of Lands the use of Unified Process Model as a methodology of developing the Integrated Land Information Management System. We also

recommend the Integrated Land Information Management System prototype of Buruburu block 78 and 79 as a basis of developing the envisaged National Land Information Management System by the Ministry.

We also recommend that the Integrated Land Information Management System should be interfaced with the Registration of Persons database to ensure that only the genuine Identification (I.D) number details are used.

7.3 Further Research

In the recent time the country is being faced with challenges of hunger, environmental degradation, trade imbalances, competition within the region and globally and also the need to attract investors. Further advancement in technology, the requirements of faster land decision making processes, and faster ways of delivering services to the clients will require the government to develop computerized land information systems.

This research implemented a prototype of Integrated Land Information Management System of Buruburu Block 78 and 79. This was due to availability of up to date data, inadequate resources and time constraints. This implies the samples used in this research consisted of a limited number of users both staff and clients. This may have caused some bias and sampling errors.

We therefore recommend for a further research in the whole country where the Ministry of Lands Offices are based and implement the Integrated Land Information Management System in the whole country. This will ensure that issues of system security and capacity of the databases will be examined. The system should also contain all the information on land including soil type, depth, climate, type of crops to grow on the land in case of agricultural land. It is also important to carry out a research on the uptake of Information Technology in the Ministry of Lands to determine the preparedness of the Ministry in implementing the Integrated Land Information Management System.

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APPENDIXES

APPENDIX II - USER MANUAL

ILIMS SYSTEM

USER MANUAL

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INTRODUCTION

The Integrated Land Information Management System (ILIMS) is a system that was designed with the major objective being improving service delivery in the Ministry of Lands. It is a web-based system that holds data pertaining to the various registered titles in the various registries.

The LIMS functions across all departments in the Ministry of Lands. The system is divided into a number of privilege levels to allow each user have access to some kind of user-specific data. The levels include:

1. Administrator
2. Manager
3. Physical planner
4. Land administrator
5. Valuer
6. Registrar
7. Public

Each of these user(s) is in a position of keying in data related to their departments. All these records will at the end be consolidated to form a whole title and its entries.

ACCESSING THE SYSTEM

Launch your preferred web browser. In the URL section, key in the server's name/IP address followed by '/complete'. If you are not aware of the server's name or IP address, contact your systems administrator for more information.

On the login interface, key in your username and password and if the system finds them to be valid, you will be redirected to your respective home page.

ADMINISTRATOR

The user is in charge of ensuring that all the persons required to access the system are in a position of doing so. He/she is in charge of adding new users to the system, resetting their passwords, removing users who left the Ministry and finally adding new registries.

For a user to be able to access the system, the user must first go through the Login screen. This is where you will provide your username and password and if they are valid, the user will be redirected to their respective page.

Each user in the system must be assigned to a particular registry. Having this measure in place will ensure that only users in that registry are able to update/add records for the particular registry.

Registry

- ^ To add a new registry, go to the 'New Registry' hyperlink, click on it. Against the New registry label, fill in the name of the registry in the textbox and click next. A notification will be sent when the process is complete.
- ^ To edit a registry, against the 'Edit Land Registry' label, select the registry in the drop down list and hit the Next button. Fill in the correct name of the registry in the text box that appears and hit the Update button.
- ^ To delete a registry, against the 'Delete Land Registry' label, select the registry in the drop down and hit the Next button.

User administration

- ^ To add new users to the system, on the Menu to your left, select the 'New User' hyperlink. Fill in the required fields. Hit the Register button when done. A notification will be sent when the process is over.
NB: To have usernames that can be easily identified, one is advised to pick the first letter of the first name and concatenate it with the last name so as to have the username e.g.
First Name: Gideon
Last Name: Mwangi
Username: GMwangi
- S To reset a user's password, click on the 'Reset user's Password' hyperlink. Fill in the required details for the user and then key in and confirm the new password. When done, hit the Reset button. A notification will be sent when the process is done.
- ^ To delete a user, click on the 'De-register User' hyperlink. Key in the username you wish to delete and click on the Search button. A table will appear bearing the details of the user. If you are sure, hit the Delete button.

Sample Screens

j w i w m c m m o u m m t t m m ^ m r s y m y

ADMINISTRATOR'S HOME PAGE

MINI

EsseBeVbsEsri

WELCOME TO THE ADMINISTRATOR'S HOME PAGE

IOCS

Fig 1.1 Administrator's home page

LAND REGISTRIES



Fig 1.2 Registry registration

MANAGER

The overall person in this process is the manager. This is the user who is in charge of overlooking the whole process, ensuring that all the measures put in place are working. The manager generally pulls different reports and compares the data to see if there are any issues.

To generate a report, on the manager's home page, select the type of report you want to pull out by checking the radio button beside the description.

In the registry area, when you select all, the report will be for all registries in Kenya. If you want data for a specific registry, select the specific registry.

In the period area, select the dates by clicking the calendar icon to the right of the textbox. A calendar will pop up and you can now select the specific date.

Before submitting, ensure that you fill in all the fields. When done, hit the 'Generate report' button and the report will appear.

1 mTEf&wrEC OWC INTOKMarjON -MAWE-MFNr SVSTE-M

MANAGER'S REPORTS

SUH
OP*

1. Name of report
 Check against "P^ you wa-f1"
 Number of related parcels
 Number of parcels
 Total amount collected from within
 tt-i>trv
 Select the reports and check on to be used to put the report
 Report ALL
 Site/Unit/da'
 Photo.

C-b) Grid

PHYSICAL PLANNER

When the surveyor is done with determining the boundaries of a parcel, it's now up to the

physical planner to determine the primary use of the land. S/He then fills these details to the system.

For a new entry, click on the 'New Entry' link and key in the parcel number in the text box provided. If the title is in the database and an entry has not been made, a table will appear which will require you to select the use of the land (Land Use) from the drop down. When done, hit the register button.

To view an existing entry, on the home page click in the 'View existing entry' and key in the parcel number in the text box provided. If the parcel exists in the system, the details for the parcel will be displayed otherwise an error message will appear.

To update an existing entry, click on the 'Update an Entry' link and key in the parcel number in the text box provided. The details for the title will be displayed with those editable placed in a textbox. Make the necessary corrections and hit the update button.

LAND ADMINISTRATOR

S/He works on the files that the physical planner is done with. The land administrator is in charge of determining the amount of time one can own whichever parcel of land and also issues allotment letters for those parcels the government wishes to privatize.

To create a new record, click on the 'New Entry' link and key in the parcel number in the text box provided. If the parcel number exists in the database and there's no existing entry, a new window will appear and will require you to fill in the nature of the title, term and when the tenure will commence. In case the title is a freehold, there's no need of filling the term.

To view an existing entry, on the home page click in the 'View existing entry' and key in the parcel number in the text box provided. If the parcel exists in the system, the details for the parcel will be displayed otherwise an error message will appear.

To update an existing entry, click on the 'Update an Entry' link and key in the parcel number in the text box provided. The details for the title will be displayed with those editable placed in a textbox. Make the necessary corrections and hit the update button.

To issue an allotment letter, click in the 'create an allotment letter' link and key in the parcel number in the fields provided. The system will automatically generate the letter provided that all the necessary milestones are met.

To generate a report, on the manager's home page, select the type of report you want to pull out by checking the radio button beside the description. In the registry area, when you select all, the report will be for all registries in Kenya. If you want data for a specific registry, select the specific registry. In the period area, select the dates by clicking the calendar icon to the right of the textbox. A calendar will pop up and you can now select the specific date. Before submitting ensure that you fill in all the fields. When done, hit the 'Generate report' button and the report will appear.



ENTRY

[mjgsj

laam

PARCEL NUMBER 98 LOCALITY CITY OF NAIROBI
AREA 0 REG. DISTRICT NAIROBI
LAND I"SE RESIDENTIAL NATURE FREEHOLD -
TERM <Y>an) EFFECTIVE DATE

WSS

VALUER

Under the directions of the Land Administrator, the Valuer is in charge of determining the value of a parcel of land among other functions.

To create a new record, click on the 'New Entry' link and key in the parcel number in the text box provided. If the parcel exists in the system and no entry has been made by the valuer, you will be prompted to key in the details pertaining the parcel. When done, hit the register button. Note that if the parcel is not a leasehold title, the details pertaining the rent and when one is supposed to start paying from will not be required.

To view an existing entry, on the home page click in the 'View existing entry' and key in the parcel number in the text box provided. If the parcel exists in the system, the details for the parcel will be displayed otherwise an error message will appear.

To update an existing entry, click on the 'Update an Entry' link and key in the parcel number in the text box provided. The details for the title will be displayed with those editable placed in a textbox. Make the necessary corrections and hit the update button.

ONTEMWrEV

MM

ONTO^MATOON

MNMFtfinT

SymM

C — 3 —

Valuation for a new Parcel

PARCEL NUMBER 98 AREA 0
LOCALITY CITY OF NAIROBI LAND ISE RESIDENTIAL
NATURE LEASEHOLD EFFECTIVE DATE 2011-08-07
VALVE RENT FROM

Clear

ffGISTRAR

In the Ministry of lands, these are the officers who are mainly concerned with the transactions done to the land. They keep the records for the parcels which are called the title deeds and updates where necessary.

To add an entry or to update any entry made to the title, click on the 'View Title Details' link and key in the title number in the text box provided. If the parcel exists in the database and all the necessary entries have been made, the next window will contain all the necessary details pertaining the title and the links that one can use to add entries.

Ownership section

This is the section which holds the details for the current title owners.

To add an owner to a parcel, click on the 'Add Owner' link and key in the name, address, ID number and when the tenure starts for the particular owner. When done hit the Add button to save the entry.

Transfer of ownership removes the current owners and replaces them with a whole new set of owners. To perform this, while on the view page under the ownership section, click on the 'Transfer Ownership' link and key in the details for the new owner. This is the person who will assume ownership of the title as from that moment. Other owners can therefore be added to the parcel.

Proprietorship section

This section holds details about the inhibitions, cautions or restrictions on this land. All the active/non-active entries can be found in this section. Before making any entry, the owner must have gone through the cashier, made the necessary payment.

To add a new entry, click on the 'Add an entry' link and key in the details pertaining the entry. The receipt number will be obtained from the receipt that the owner has been given after paying at the cashier's office. When done, hit the Done button.

To withdraw an entry, click on the 'Withdraw an entry' link. The next window will have all the active entries with a checkbox appended to the left of each entry. Check the boxes for the entries you would like to withdraw/make them inactive.

Encumbrance Section

This section holds details about the leases and charges on the land. All the **active**/non-active entries will be found in this section. Still, before making any entry, the owner is to pay some amount at the cashier's desk and attach the receipt with the other documents.

The processes for adding a new entry and withdrawing an entry are similar to those done in the proprietorship section.

VIEW A TITLE

1, Title details
 TITL MAER (O), ASSOCIATI ARA O NATIU
 REGSTRM SAIQU VAIATION IOWOOD UASTHOLD
 K I M J VO W I J 29UM-QT I S I
 ttrm << ntoi xn-oi-o' usa> ismL
 r. owner Deta*
 D Nc Vmnn Won
 t-n PATROA 134
 Trmm Qanmkw
 Proprietorship Se Im
 AMmtmy
 4: trcuntvjwvSKt!®!
 BKTY NMBR DATE DETAILS
 1 20150 LEASD TO RC MUD 13
 20150 WVMR of UK hvl 6v 13
 AMBQ *MvMv



PART C (ENCUMBRANCE SECTION*)

MA	NATCH Cate » RECEPT NO
SHEZc	DESCRIPTION
SKTafedad	CB

SUPERVISOR

S/He works hand in hand with the registrar to ensure that the processes of registration and regular updates to the titles happen in a timely fashion and that the entries that are made do not have errors.

To update a record, click on the 'View a Title' link and key in the title number in the text box provided. The emerging window will have all the sections of with the title with the update link below the section.

To update the owner details, click on the 'Update an Owner' link and after selecting the entry you wish to update, hit the next button. In the next window, make the necessary corrections on the fields placed in a text box and save the changes by clicking on the update button.

To update the **proprietorship**/encumbrance section, click on the 'Update an Entry' link below the table and after selecting the entry you wish to update, click on the Next button. Make the necessary amendments on the record and click on the Update button.

CASHIER

This is the officer in charge of receiving money from the public on behalf of the ministry. Most

of the entries/updates made to the titles are usually charged. After the cashier has received and drafted the receipt, s/he keys in the details of the transaction in the system so that they can be used when validating the specific entry, be it a proprietorship or encumbrance entry.

to key in a new record, feed in the receipt details in the system. This will include the title number for which the application is made, the type of entry to be made (caution, restriction, inhibition, lease e.t.c), receipt number and the amount paid. When done, click on the 'Register button.

PUBLIC ACCESS

Any member of public is allowed to conduct a search for any parcel of land of interest. Such information assists a person when one intends to make any informed decision.

To access the public's interface, key in the server name/IP address followed by `-/public'`. One will be re-directed to a page where one will fill in the parcel number and on submission of the form, the current status of the parcel will be displayed.

APPENDIX II - QUESTIONNAIRES

A MODEL FOR DEVELOPMENT OF AN INTEGRATED LAND INFORMATION MANAGEMENT SYSTEM

MINISTRY OF LANDS CLIENT QUESTIONNAIRE

I am Gideon Mwangi a student at the University of Nairobi School of Computing and Informatics. I am currently undertaking a research for my Master of Science degree in **information** Systems on development of an Integrated Land Information Management System titled: *A model for development of an Integrated Land Information Management System* The focus of my research is to propose a model for development of an integrated Land Information Management System and to develop a prototype using this model.

The research is purely academic, confidential and will be solely used for that purpose. Your details or data provided will not be passed to any third party without your prior permission.

Please spare a few moments to read each question carefully and tick [^] appropriate. Your co-operation will be highly appreciated. Please feel free to contact me for any clarifications.

Gideon Mwangi

Tel: 0721-429124

Email: gwathuo@yahoo.com

1. Date...../...../2010

2. Age group bracket: - Please tick (S) as appropriate.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
(18-28 yrs)	(29-38 yrs)	(39-48 yrs)	(49-58 yrs)	(59 yrs & Over)

3. What is your gender?

- Male
- Female

What do you do for a living?

In the past one year have you sought services in the *Ministry of Lands*'?

Please tick (S) as appropriate.

- Yes
- No

>• If your answer in No. 5 above is Yes, please comment on whether your service satisfaction concerns were met by the *Ministry of Lands*. *Please tick (S) as appropriate.*

- Fully met
- Partially met
- Not met at all

7. Among the services you receive from the *Ministry of Lands*, which ones are you **most satisfied** with?

- a)
- b)
- c)
- d)

8. Is the mode of services delivery satisfactory?

- a) Extremely satisfactory
- b) Satisfactory
- c) Partially satisfactory
- d) Totally unsatisfactory

9. Which services are you **least satisfied** with regarding the way they are delivered to you?

- a)
- b)
- c)
- d)

10. What suggestions can you make regarding the improvement of the delivery of services to you by the *Ministry of Lands* personnel to your satisfaction?

- a)
- b)
- c)
- d)

11. How would you rate the quality of services that you receive from *Ministry of Lands*? *Please tick (0 as appropriate.*

- Extremely Satisfactory
- Satisfactory
- Partially satisfactory
- Totally unsatisfactory

12. How would you rate the speed of services provided? *Please tick (S) as appropriate.*
- Timely
 - Very fast
 - Slow
 - Delayed
13. How often do you interact with those providing services to you in the *Ministry of Lands*? *Please tick (S) as appropriate.*
- Daily
 - Weekly
 - Monthly
 - Quarterly
 - Yearly
 - Never
14. How do those providing services to you receive you? *Please tick (S) as appropriate.*
- Extremely Friendly
 - Friendly
 - Luke warm
 - Harsh
 - Extremely harsh
 - Not applicable (if response in Qn. 13 above is "Never")
15. is there any time when you are seeking services to the Ministry you are asked to go and get a service to a certain department? *Please tick (S) as appropriate.*
- Yes
16. Among the following services, which one would you like the Ministry to computerise? *Please tick one M as appropriate.*
- Registration of documents
 - Registration of title deed
 - Search of title
 - Transfer of documents
 - Valuation of plots
 - Access of survey documents
 - Any other
17. Do you think the Ministry services should be integrated? *Please tick (S) as appropriate.*
- Yes
 - No
18. According to you what would you like to be included in this system?
- 0)
- (ii)

7J* Iou very much *for taking your time to give th/s interview*; „e hope that you *enjoyed participating*.

**A MODEL FOR DEVELOPMENT OF AN INTEGRATED LAND
INFORMATION MANAGEMENT SYSTEM**

MINISTRY OF LANDS STAFF QUESTIONNAIRE

I am Gideon Mwangi a student at the University of Nairobi School of Computing and Informatics. I am currently undertaking a research for my Master of Science degree in Information Systems on development of an Integrated Land Information Management System titled: *A model for development of an Integrated Land Information Management System*. The focus of my research is to propose a model for development of an integrated Land Information Management System and to develop a prototype using this model.

The research is purely academic, confidential and will be solely used for that purpose. Your details or data provided will not be passed to any third party without your prior permission.

Please spare a few moments to read each question carefully and tick your **response where** appropriate. Your co-operation will be highly appreciated. Please feel free to contact me **for** any clarifications.

Gideon Mwangi

Tel: 0721-429124

Email: gwathuo@yahoo.com

SECTION A: BACKGROUND INFORMATION

1. **Where is your duty station?**

2. **Please indicate your department and section.**
Department

Section

3. **What is your substantive designation?**

4. What is your age group?

- > 19-27
- > 28-37
- > 38-47
- > 48-55
- > 56 and above

5. What is your gender?

- a. Male
- b. Female

6. How long have you been an employee of the « of Lands' (Please tick one M "S *applet*).

- > 0-10
- > 11-15
- > 16-20

- > More than 20 years

Services Section

satisfactory?

(i)

(ii)

(iii)

(iv)

first priority in computerizing?

Please tick one (S) as appropriate.

- Registration of documents
- Registration of title deed
- Search of title

10. How would you rate the seeftofservices in the identified service in no. 9 above provided? **Please tick(^)**

as appropriate,

- Timely
- Very fast
- Slow
- Delayed

11. What would you like to be included when developing the system in the serv.ces identified in 9 above?

0)

00
(Hi)
(iv)

12. Do you think the Ministry services should be integrated? *Please tick (S) as appropriate.*

Yes

No

13. According to you which services would you like integrated?

(iii)

Thank you very much for taking your time to give this interview we hope that you enjoyed participating.