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Management information system for enhancing land use planning in Tanzania: a case of Arumeru and Mvomero districts

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MANAGEMENT INFORMATION SYSTEM FOR ENHANCING LAND USE PLANNING IN TANZANIA: A CASE OF ARUMERU AND MVOMERO DISTRICTS

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A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of Master's in Information and Communication Science and Engineering of the Nelson Mandela African Institution of Science and Technology

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ABSTRACT

Land as a natural resource plays a major role in the livelihood and in a growth of any country, therefore an effective land management can help communities and Governmental institutions to easily plan and manage land resources. Due to the complexity involved in land issues, land management has not been an easy task especially in developing countries. Land information in Tanzania is kept manually especially at districts land offices. This is due to the lack of proper and computerized systems such as the proposed Land Information System (LIS). The manual way of handling land use information cause unnecessary issues which causes land resources management practices difficult.

Literature review, Analysis and feasibility study were done to understand the context of land use information management which is important to determine the system user requirements. The study look at how districts do land administration and how LIS can be applied in supporting land administration processes. We then propose, design and develop the LIS. The structures and functionalities of the LIS are developed using UML notation. The implemented prototype of the LIS system demonstrates the system features. This dissertation aims to improve land administration at the districts in Tanzania particularly allocation of land uses and valuation by using LIS.

To conclude, application of LIS in land administration at district level have impact towards improving performance in delivering land services to the customers as well as enhancing valuation process. This is based on the fact that LIS can ensure the availability, security and accuracy of land information. The proposed LIS helps in optimizing decision making when it comes to land issues.

DECLARATION

I, **MICKY THAMBIKENI** do hereby declare to the Senate of Nelson Mandela African Institution of Science and Technology that this dissertation is my own original work and that it has neither been submitted nor being concurrently submitted for degree award in any other institution.

MICKY THAMBIKENI

Name and signature of candidate

3/5/2016

Date

The above declaration is confirmed

ANAEL SAM

Name and signature of supervisor

12th April, 2016

Date

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CERTIFICATION

The undersigned certify that has read and found the dissertation acceptable by the Nelson Mandela Institution of Science and Technology.

ANAEL SAM **14th April, 2016**

Name and signature of supervisor **Date**

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DEDICATION

To our Almighty God,

To my beloved wife, son and daughter.

To my beloved; brothers, sisters, closed relatives, friends and colleagues.

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LIST OF ABBREVIATIONS AND SYMBOLS

LIS	Land Information System.
ICT	Information and Communication Technology.
GIS	Geographic Information System.
DBMS	Database Management System.
NSDI	National Spatial Data Infrastructure.
L.V	Land Valuer.
L.O	Land Officer.
C.L.V	Chief Land Valuer.
UML	Unified Modelling Language.
DFD	Data Flow Diagram.
E-R	Entity Relationship.
OS	Operating System.
SDLC	System Development Life Cycle.
RAD	Rapid Application Development.
CASE	Computer Aided Software Engineering.
PHP.	Hypertext Preprocessor.
HTML	Hypertext Markup Language.
NM-AIST	Nelson Mandela African Institution of Science and Technology.
CGI	Common Gateway Interface.
IMAP	Internet Message Access Protocol.
POP	Post Office Protocol
SMTP	Simple Mail Transfer Protocol.
HTTP	Hypertext Transfer Protocol.
SQL	Structured Query Language.
CSS	Cascade Style Sheet.
ISO	International Organization for Standardization.

CHAPTER ONE

Introduction

Good Land Administration provides the infrastructure for implementing land policies and land management. The efficient and effective land administration depends upon the availability of good land information. The proposed Land Information System (LIS) is an integral tool in improving the operations such as land tenure, land markets, allocation of land uses and valuations of land administration by making information services more readily available in support of sustainable development.

Lugoe (2002) discussed how land information are handled at the districts in Tanzania and explained that, most of data exists in hard copies and often misplaced when they are required. He suggested that, in order to plan land use and monitor the implementation of land development, there is a need for land management information system so as to underpin the definition, allocation transfer, and use of land parcels.

According to Mwaikambo and Hagai (2013) the volume, complexity, and expected processing times of land transactions can no longer be handled in an efficient and transparent manner through manual processes and this increase the necessity of having proper LIS at the districts land offices.

Mclaren and Stanley (2011) showed that LIS can support greater access to and sharing of information, improve data quality and completeness, increase security and transparency of operations and information and increase revenue generation to the government by supporting land valuation.

It will be a huge contribution to the districts land offices by facilitating land officers in land administration particularly management of allocation of land uses and valuation analysis. The LIS will also facilitate decision makers in decision making by the use of accurate and consistent reports.

The research focuses on the development of Land Information System, specifically to support allocation of land uses and valuation.

1.1. Background and literature review

This chapter provides an overview of the developments in the field of information system and land administration. It describes the context of change as reflected in the continuing studies of concepts in the literature and the emerging ways of improving land administration. Concepts change through time as new issues arise and measures are adapted to changing environment. These evolving concepts and emerging trends are mapped out based on research studies and innovations happening in practice. This literature review establishes what has been already done in the areas of land management and shows what is missing, i.e. the gap that the research intends to fill.

4.2.1. Information System (IS)

Laudon and Laudon (2006) define an information system technically as a set of interrelated components that collect (or retrieve), process, store, and distribute information to support decision making, coordination and control in an organization. In addition to supporting decision making, coordination, and control, information systems may also help managers and workers analyze problems, visualize complex subjects, and create new products. Information systems contain information about significant people, places, and things within the organization or in the environment surrounding it.

From a business perspective, an information system is an organizational and management solution, based on information technology, to a challenge posed by the environment. Examine this definition closely because it emphasizes the organizational and managerial nature of information systems: To fully understand information systems, a manager must understand the broader organization, management, and information technology dimensions of systems and their power to provide solutions to challenges and problems in the business environment.

4.2.2. Land Use

Cruz (2004) describe that land use is about relationship of man to land and how man act upon this relationship. Land use therefore should be viewed more as process than an output. It should not be equated to a map layer of a GIS or a land use classification scheme, rather should be seen as the process of determining, allocating and realizing the use of land for sustainable development. This makes land use dynamic concept denoting complex interaction and changes occurring over time.

4.2.3. Valuation

Land/property valuation is the process of analysing land/property for the purpose of determining the current market value of the land or property. German *et al* (2000) found that due to the rapid increase of volume of valuation information to be processed, valuation process can no longer be handled by manual processes and that the single greatest challenge to any type of land value taxation system is accurate valuation of land on a large scale. Thus the need for land use information system has become necessary to underpin valuation process for more accurate valuation and hence proper value taxation.

4.2.4. Land Use and valuation for the purpose of Land Administration and Management

UNECE (1996) define land administration has been defined by the United Nations as the "process of recording and disseminating information about the ownership, value and use of land and its associated resources". The UNECE UNECE (1996) goes on to recommend that: A good land administration system should permit the integration of records of land ownership, land value and land use with sociological, economic and environmental data in support of physical planning.

Tanzania's legal framework for land is recognised as being progressive in the context of existing tenure regimes in Africa and provides the basis for greater tenure security of its citizens, however, in its current state, Tanzania's land administration system does not have the ability to meet the challenges of rapidly growing interest in agricultural land Locke *et al* (2013).

Until recently, the government had no comprehensive information about the amount of land allocated to large investors and the government and civil society in Tanzania have had no means of monitoring the overall impact of large-scale land-based investments Locke *et al* (2013).

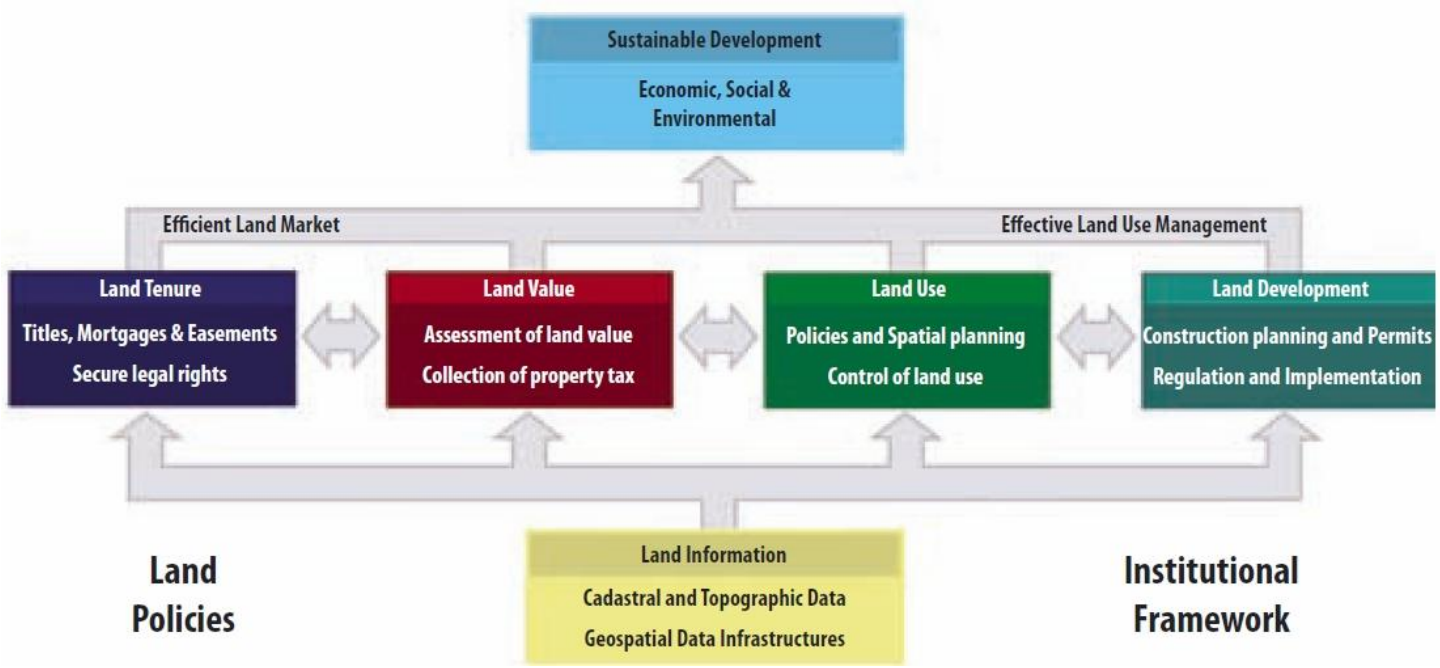


Figure 1. Global land administration perspective. Source Adopted from Enemark (2009)

According to Lugoe (2002) land information that are handled at districts in Tanzania most of them exists in hard copies and often misplaced when they are required. Lugoe (2002) in his paper suggested that, In order to plan land-use and monitor the implementation of land development, there is a need for land management information system so as to underpin the definition, allocation transfer, and use of land parcels.

4.2.5. Land Information System (LIS)

Cruz (2004) in his thesis found that land uses relies on varied information from different databases. The information requirement is in fact, becoming complicated as planning and monitoring are now being integrated into various applications such as economics, demography, agriculture etc. The expected output are also becoming diverse as land use information is widely being used in many activities of different sectors. Thus the author proposed land information system for helping the local government in Philippines to deal with issues concerning land use planning and monitoring. This system might be working fine in the Philippines environment but may fail to work in our environment i.e the districts environment because of some differences in business processes but also the author's proposed system didn't consider the land conflicts mitigation which is one of the key component in our proposed LIS.

Urban Management Land Information System (UMLIS) project was carried out in 2005-2009 in Accra Ghana, the aim of the project was to develop LIS which enhances revenue collection by improving the storage of land valuation such as buildings, owners, land parcels etc. (Yeboah and Johansson, 2010). Though the UMLIS seems to improve the efficiency of revenue collection in Accra municipal but it lacks some important features such as automatic valuation analysis, which forces users to use conventional ways of valuation analysis which decrease the accuracy of the data. Also UMLIS lacks the import mechanism to allow users to import data to the system if are in digital form to increase data consistence instead of manual data entry.

(Mclaren and Stanley 2011) urged that where there is little land information, there is little land administration and management. Conventional land information systems cannot adequately serve areas that do not conform to the land parcel approach applied in the developed world. A more flexible system is needed for identifying the various kinds of land administration. UNECE (1996) emphasizes this point by stating that developing countries can learn much from western experiences. They need however to build their own systems within their own social, economic and cultural environments.

1.2. Problem Statement

The conventional ways of handling land information at district level in Tanzania, results to poor land decisions such as double allocation of land, inefficiency in delivering land services to land stakeholders, inconsistence and inaccuracy in performing valuation. The results summaries of problems are as shown in the table below.

	Challenge	Effect
1	Inefficiency in delivering land services.	Delaying in delivering land services.
2	Poor land decisions.	Double allocation of land leading to land conflicts.
3	Poor storage of valuation records.	Inaccuracy of valuations leading to under or over taxation.

Table 1. Challenges and the effects of the conventional methods of handling land information at district level in Tanzania.

1.3. Objectives

1.3.1 General objective

To develop Land Information System for enhancing land use management.

1.3.2 Specific objectives.

- To identify user requirements and obtain requirement specification document.
    - Review available literature related to land use planning at district level.
    - Analyze land use planning process at district level.
- To design a system blueprint for land management information system.
    - Define guidelines for developing land Information System.
    - Determine user requirements.
    - Model the structure and functionalities of the system.
- To implement the designed system.

    - Apply the design through prototyping.
- To test and validate the implemented system.
    - Demonstrate that we are developing the system right (checking of documents and files, also going through the design and code).
    - Demonstrate that we have developed the right system from the end user perspectives (i.e. executing the code to see that the system works as prescribed by the users).

1.4. Research questions

	Specific objective	Research question
1	To identify user requirements and obtain requirement specification document	What is the current state of art of the land administration at the districts?
2	To design a system blue print for Land Information System (LIS)	What are the needs or conditions for the LIS design?
3	To implement the designed system.	How can maps and database be implemented in a LIS and maintain better system performance?
4	To test and validate the implemented system	How are we developing the proposed system? Does it satisfies the specified business requirements?

Table 2. Specific objectives and research questions.

1.5. The scope of the study

The scope of this research is the development of Land Information System (LIS) which will automate and enhance the land administration processes specifically allocation of land uses and valuation at district level.

The geographical study of this research will involve two districts, Arumeru (Arusha) and Mvomero (Morogoro). We chose these districts as the areas of the research because, one of the aim of the proposed LIS is to mitigate land conflicts by facilitating allocation of land use, therefore these areas are important to the research because there are several land conflicts of different types.

Most of land conflicts in Arumeru involve community and investors especially commercial farming for example the one of karama estate Tanzania plantation against the msitu wa mbogo community and those in Mvomero district involve pastoralists and peasants.

1.6. Significance of the study

The increased value for both land and land related properties as well as a fast growing population increased high demand for land and contributed to complexity in land management issues which cause difficulties in handling of different land transactions, poor storage of land records, general inefficiency in delivering land management services to the customers.

1.6.1 The community will benefit in the following ways

- The proposed LIS aims to mitigate land conflicts which cost people's lives and destruction of their properties, this is due to the fact that different groups of people want to use land for different purposes. Pastoralists want to use land for grazing their livestock, farmers want to use their land for agriculture, investors want to use land for commercial farming. Thus land use planning and management is very important and LIS is an indispensable tool for managing the allocation of land uses.

1.6.2. Governmental Benefits

- LIS will also increase the revenue to the government by supporting the valuation process. This is due to the fact that, one of the problem caused by conventional valuation analysis is the under valuation which cost the government's revenue, therefore by supporting valuation analysis process and enabling the transparency of the valuation information the proper tax will charged and the revenue will increase hence government will benefit from the proposed LIS.

1.7. Dissertation Organization

Chapter 1: General introduction of the research which covers, Introduction, Background and literature review, Problem statement, General objective, Specific objectives, Research questions, Scope of the study, Significance of the study.

Chapter 2: Manuscript of paper 1 (entitled: Analysis of ICT application in mitigating land conflicts: A Case of Tanzania).

Chapter 3: Manuscript of paper 2 (entitled: System requirements and design for Land Information System for enhancing land use planning in Tanzania.).

Chapter 4: Manuscript of paper 3 (entitled: System implementation for Land Information System for enhancing land use planning in Tanzania)

Chapter 5: Results and discussion, Conclusion and recommendations.

CHAPTER TWO

ANALYIS OF ICT APPLICATION IN MITIGATING LAND CONFLICTS: A CASE STUDY OF TANZANIA[1]

Abstract

Land conflicts are common phenomena in Tanzania. They can be understood in the context of history, social relations and the process of commoditization of natural resources such as land and land resources. One of the factors causing land conflicts is the poor land use planning and management. Tanzania has about 44.0 million hectares of arable land in Tanzania, but only 23% (about 10.5 million hectares) is being utilized, In this study literature review is done to understand the context of land information management, then take a look at how land use plan is being practiced at district level and how ICT is applied in land use plan towards land conflicts mitigation. The study aims to analyze ICT potential role by identifying factors causing land conflicts that can be solved by ICT and establishing ways of mitigating the conflicts. This can be accomplished by integrating ICT in land use planning and management for easier inventory and allocation of land resource. The study conclude that, implications of ICT for the land use management at district level have impact towards land conflicts mitigation, because ICT can enhance land administration through modern ways of keeping land information and can help policy and decision makers in reaching good decision making.

Keywords: Land Conflicts, Land use, Arable land, ICT, LIS, GIS, DBMS.

2.1. Introduction

In the past two decades emergence of land conflicts has been increasing between different land users. Land conflicts cause negative impact to the society such as loss of lives and destruction of properties IPPMEDIA (2014). One of the factors causing land conflicts in Tanzania is poor land use planning and management Mugabi (2013), which may be associated with the use of inappropriate tools or technology to facilitate land records keeping. However Information Communication Technology (ICT) has the potential to overcome this among other factors and hence aid in mitigating land conflicts by the use of ICT tools such as Land Information System (LIS), Geographical Information system (GIS)

Currently, there is no LIS at district level in Tanzania to facilitate land management processes and activities. This cause difficulties in land management processes because of the complexity involved in the land management issues which eventually leads to land conflicts.

The recent land conflicts in Tanzania between different land users such as pastoralists and farmers

[1] A paper by Micky Thambikeni and Anael Sam, Accepted to International Journal of Computer Science and Information Security (IJCSIS) ISSN 1947 5500, Paper ID: Paper ID: 31081506.

have raised the need of applying ICT tools such as GIS and LIS for effective and efficient land administration and management. ICT is very useful especially where optimization in decision making is required. It is envisaged to be reliable tool for developing, planning and long run land programs. It will be a huge contribution to land offices at various levels i.e district, regional and national levels hence reducing land conflicts.

This study aims to analyse the potentials of ICT in mitigating land conflicts and state how ICT can play such role. Literatures indicate that this can be accomplished by integrating ICT in land administration and management and electronic inventory and allocation of land resource.

2.2. Problem statement

The conventional ways of handling land information at district level in Tanzania results to poor land decisions such as double allocation of land leading to land conflicts and delaying of delivering land services to land stakeholders.

2.3. Objectives

2.3.1. Main objective

The main objective of the study is to analyse the potential of ICT by identifying factors causing land conflicts and establishing ways of mitigating the conflicts.

2.3.2. Specific objectives

- To identify factors causing land conflicts that can be solved by ICT.
- To analyse the role of ICT in mitigating land conflicts.

2.4. Factors causing land conflicts that can be solved by ICT

Land conflicts between different land users in Tanzania have been recurring for a long time claiming lives of many innocent people and creating major economic impacts to the nation. There are various factors that are causing land conflicts to persist that ICT can play part to solve them. These include the following.

i. Inefficiency in delivering land services. This resulting to delaying in delivering land services. According to Mwaikambo and Hagai (2013), general inefficiency of delivering

core land functions is caused by the increased value for both land and land related properties as well as a fast growing population which increased high demand for land.

ii. Double allocation of land is another factor causing land conflicts. This problem greatly exists as two or more people find to be claiming on plot of land each with a valid certificate right of occupancy Mwashambwa (2012). Double allocation is caused by poor management of land records.

iii. Tanzania has total land area of 945,000 km2 out of which only 11% has been registered with the legal administration Mithofer (2006). This may be associated with the use of inappropriate tools or technology to facilitate land registration. Land registration is important in reducing or avoiding land conflicts because it clears doubts that can arise over the real owner of a certain parcel of land and the conditions under that land. According to Mclaren and Stanley (2011) land registration in many societies became customary to document the transfer of land rights in the form of legal deeds and certificates. To provide additional security, official copies of these records were kept in deeds registries, or what in some countries are called land books.

iv. Land use planning refers to the process by which a society, through its institutions, decides where, within its territory, different socioeconomic activities such as agriculture, housing, industry, recreation, and commerce should take place. This includes protecting well-defined areas from development due to environmental, cultural, historical, or similar reasons, and establishing provisions that control the nature of development activities World Bank (2012). One of the factor that cause land conflicts in Tanzania is poor land use planning and management Mugabi (2013). This may also be related with the use of inappropriate tools in facilitating land use planning and records keeping.

v. Poor decision making has been mentioned as one of the source of the land conflicts. MOST land use conflicts in Tanzania are caused and escalated by decisions and acts of the state through its various agencies Haki ardhi (2009). Many of the decision makers perform poorly due to lack of enough information. For instance village council may give the area to the investors without knowing that, the area has been demarcated

for other uses for the interest of the village. This may cause conflicts between villagers and investors.

2.5. The role of ICT in mitigating land conflicts

ICT has fundamental role in improving the operations of land administration and in making information services more available in support of urban and rural economic development and conflicts mitigation. ICT can have positive impacts in land administration by ensuring that its benefits reach many people by determining, recording, and disseminating information about various attributes of land. According to UNECE (2005), one of the benefit of good land administration system is that it reduces land disputes, therefore ICT can be seen as integral tool in reducing land conflicts.

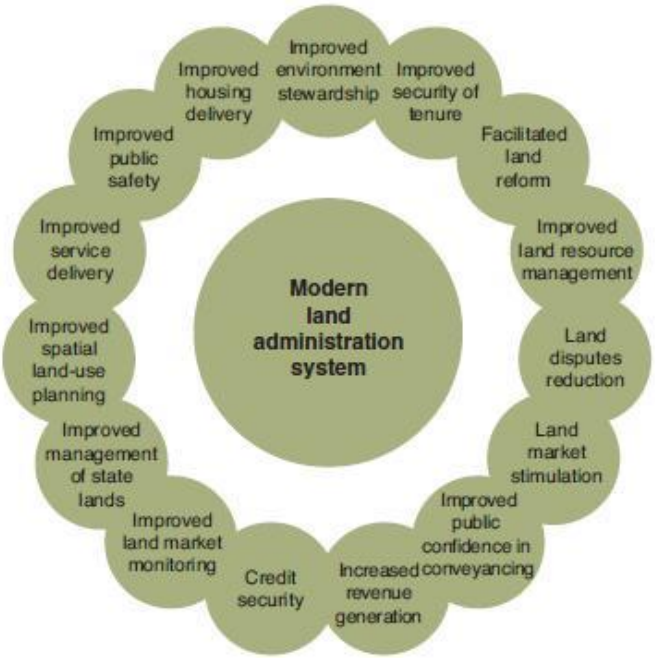


Figure 2. Benefits of good land administration. Source: adopted from UNECE (2005)

In Tanzania land records are still kept and processed in paper based way and only available in land offices at the district council. ICT significantly supports good governance in land administration by facilitating open, transparent access to land records for all Mclaren and Stanley (2011). Therefore if ICT is well applied to the land information management it can provide transparency to the land records. Lack of transparency to the land records is one of the causes of land conflicts Locke *et al* (2013). ICT can enable land records to be accessed through mobile phones, either

through web or SMS-based information services. As the example from Indonesia indicates, ICT greatly improve the outreach of land administration services, especially for groups that were long excluded from such information hence increase transparency of the land information to the customer or key stakeholders Mclaren and Stanley (2011).

Land tenure refers to the way in which land rights are held. Good land information systems can surpass customary land tenure systems by ensuring the security of land Tenure. According to McIntyre (2010), tenure recording system has great role in reducing conflicts over land and its use for Pacific Island Countries & Territories (PICTs) provided that their specific needs are well addressed. For this to be achieved, information systems need to be enhanced to increase the knowledge base and provide a system of two-way communication between national governments and remote communities.

Poor land use planning and management is another problem facing many developing countries such as Tanzania and hence leading land conflicts. However ICT tools such as Database management systems (DBMS) and other sophisticated applications GIS and E-planning can be useful in keeping records and in helping planners to easily plan the uses of the land and towns.

ICT significantly support land use planning and management. In countries fortunate to have mature ICT infrastructures, governments have established e-planning portals that allow citizens to access land-use control information, including,

- Access to zoning development plans, planning regulations, and general land-use information.
- Submission of development applications.
- Access to proposed developments, associated drawings and their current status.
- Access to the results of development control decisions.

E-planning portal is one of the most advanced portals in Denmark. The solution provides public access to all statutory land-use plans such as municipal plans and development plans (called a lokalplan), both adopted or proposed, across Denmark. The map-based interface provides a range

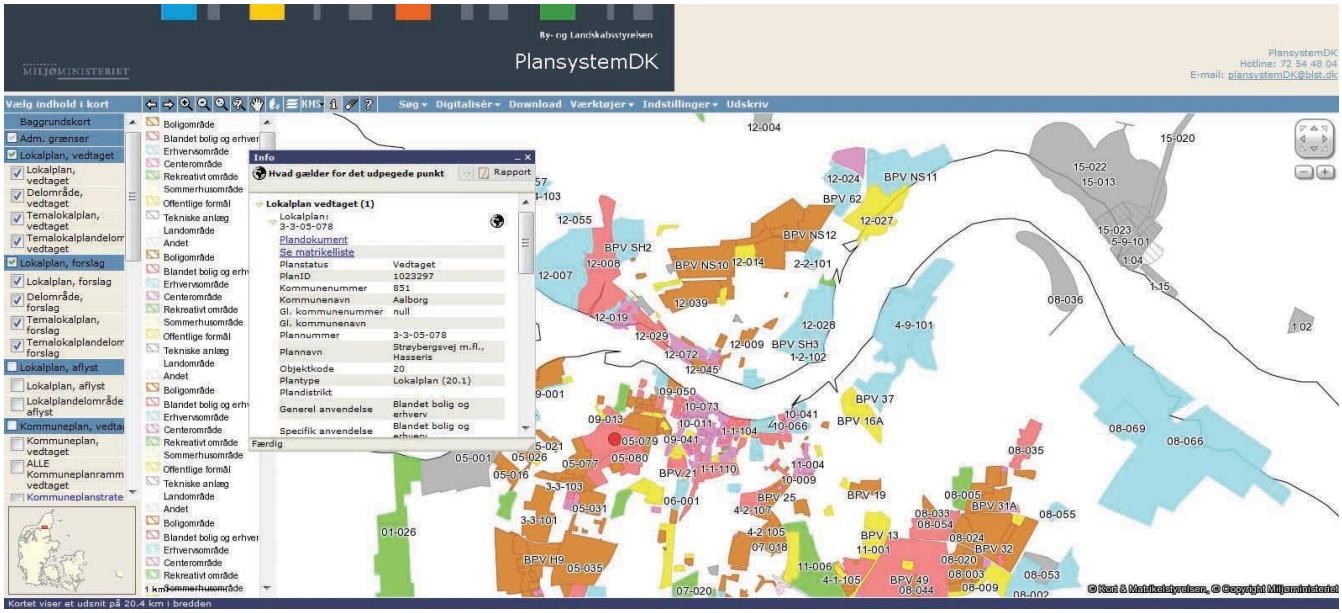


Figure 3. Example of E-Planning Portal. Source: adopted from Mclaren and Stanley (2011).

of navigation tools, including address, cadastral parcel number, municipality, and area polygons. The areas of the development plans can be displayed in combination with cadastral maps, topographic maps, orthophotos and other kind of land use constraints, such as conservation areas and coastal protection zones Mclaren and Stanley (2011). Citizens preparing to build or extend their house can use the system to determine what planning restrictions apply in their areas and hence reduce or avoid many land conflicts which would have happened if there was no E-planning system.

Mobile phones are also opening channels for citizen participation in the development control process and have significant potential to increase constituents' participation. For example, citizens can register for mobile phone alerts on specific types and/or locations of new development proposals and can text objections to development proposals to the planning authorities with associated authentication McLaren (2010).

One of the major important component of any land administration system is a record of landownership. This is because of the uncertainties that can arise over who owns the land and under what conditions Mclaren and Stanley (2011). Land registration is a process of official recording of rights in land through deeds or title (on properties). It means that there is an official record (the land register) of rights on land or of deeds concerning changes in the legal situation of defined units of land. It gives an answer to the questions "who" and "how" Zevenbergen *(2004)*.

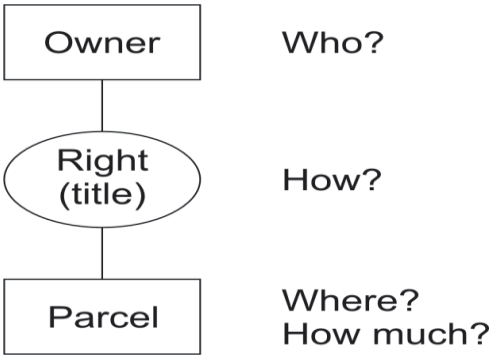


Figure 4. Core entities of land administration system. Source: adopted from (Zevenbergen, 2004).

As populations gradually increase in most societies, land become scarce resource and there are various types of rights to use the land developed. Hence registration is important to clarify ownership and minimize disputes, but also important for governments to collect property taxes. Without knowing the owner of the land and how that land is being used for, disputes may increase and governments cannot charge property taxes. ICT significantly can facilitate land registration. Through the ICT land registration process can be easily implemented efficiently and effectively.

2.6. Discussion

In Tanzania Land information are obtained from individual Institutions such as (N.G.Os, Survey companies, Researchers, district council), which collect them for their own purposes. Therefore it is difficult for the district particularly land office to use these information if critical decisions are to be made concerning land use plan and management, due to the fact that these information are not integrated with other aspects of social economic development. ICT has a crucial role to play in sharing and analyzing land information among agencies and in communicating and testing

change scenarios with the citizens involved. The ICT has the potential to make land information available to the key customers or stakeholders, through internet or mobile phones which support internet access. This new channel bridging land administration services to a wider range of society many of whom are currently excluded McLaren (2010).

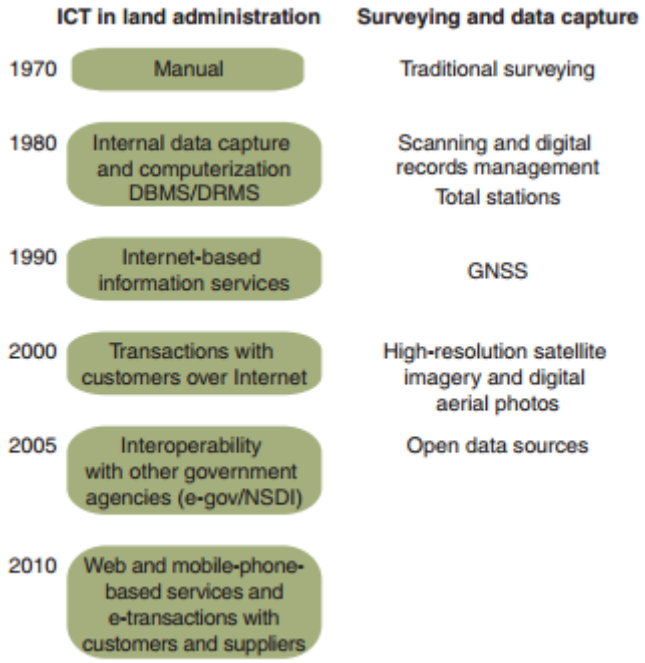


Figure 5. Evolution of ICT in Land Administration. Source: adopted from Mclaren and Stanley (2011).

paper based method of handling land information at the land office in is still practiced at district level whereby when a customer come to ask for the information about specific land, land officer has to look for a flat file to search for the information and if the file is not found the customer is told to go and come back later after sometimes. The paper based method of handling land information brings a lot problems such as land conflicts but also the process is expensive and time consuming.

ICT tools such as GIS and LIS, provide the infrastructure for implementation of land policies and land management strategies and facilitate operations of the land registration, valuation and cadastre. It provide robust and secure repositories to manage the significant volumes of land information (textual and geospatial) in a distributed environment and to support efficient searching and querying of the information.

GIS efficiently store and retrieve raster scanned documents such as paper deeds. GIS supports the capture and editing of geospatial information such as parcel boundaries and interfaces to the land information repositories and wider national spatial data infrastructures (NSDI) to support spatial analysis and visualization, including a map-based interface for web information services.

The increased value for both land and land related properties as well as a fast growing population increased high demand for open access to land administration information and contributed to complexity in land management issues. This causes difficulties in handling different land allocations due to poor and conventional ways of keeping land information leading to inefficiency in delivering land services, example double allocation of the land resulting to land conflicts. LIS is an integral tool for effective and efficient land delivery services and hence reducing land conflicts. LIS can significantly support greater access to and sharing of information, improve data quality and completeness, increase security and transparency of operations and information increase revenue generation around new services, and provide a basis for monitoring and evaluation.

LIS has tremendous value in land use planning and management in terms of ensuring the availability of land information for planning, analysis of growth and development trends, monitoring land resource and its uses. LIS can also lead policy and decision makers to reach the appropriate decisions for the benefits of the public which is vital in mitigating land conflicts.

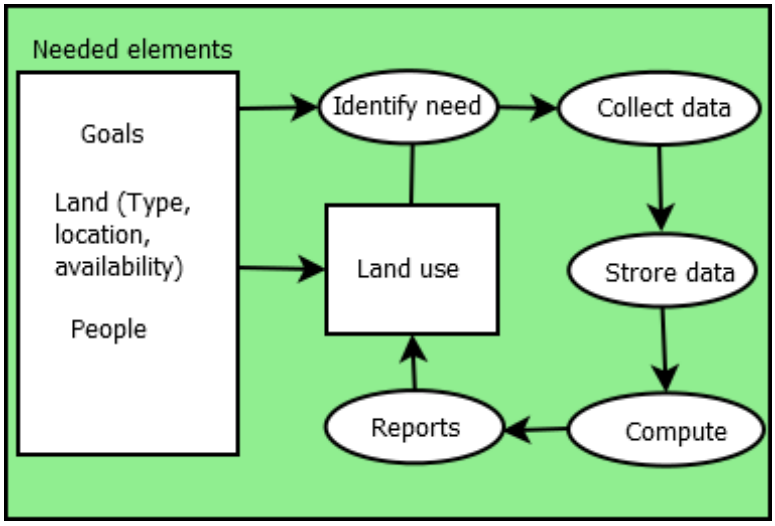


Figure 6. Land Information Management Link

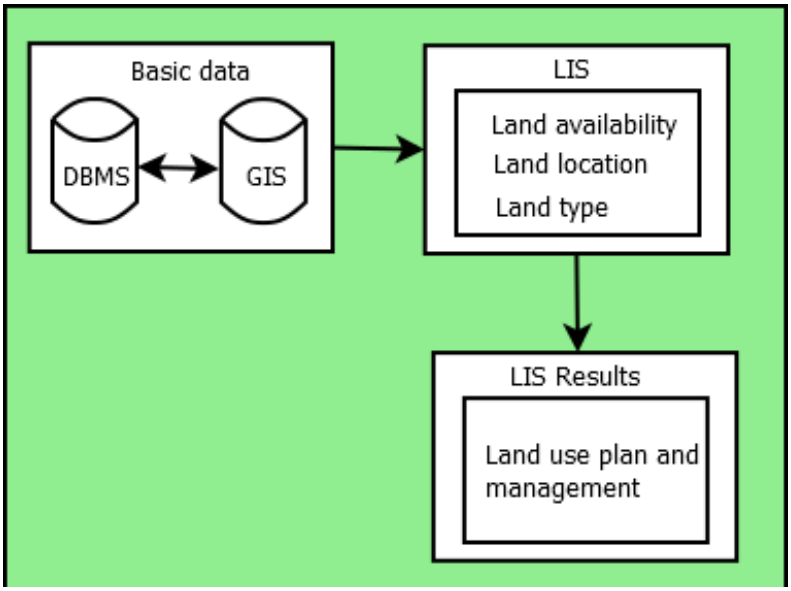


Figure 7. Decision support system pattern for land information management.

2.7. Conclusion

Absence or poor ICT in delivering land services is among the factors accelerating land conflicts, However many land conflicts can be solved when the use and importance of ICT technology such as Land Information System (LIS) and Geographical Information System (GIS) in land use planning and management will be recognized especially at district level.

Most of the operations that require land information, are continuous due to the fact that information need to be revised, updated and monitored continuously, it is very useful in tracking various issues of land use such as if there is land conflicts or possibility of conflicts to occur at certain places, this cannot be sustainable without proper land information system. LIS will also increase awareness concerning land issues to the planning officers, policy and decision makers as well as customers. This is a step ahead to efficient deliverance of land services resulting to reduction of conflicts.

CHAPTER THREE

LAND INFORMATION SYSTEM REQUIREMENTS AND DESIGN: A CASE STUDY OF TANZANIA[2]

Abstract

The absence of land information system in Tanzania causes land officer to use manual ways of keeping records, which causes a lot of problems such as loss of information and delay in delivering land services. The proposed Land Information System (LIS) in this study aims to enhance land administration by improving the land records keeping and valuation process at the land offices in the districts.

Use case diagrams are used in this paper for capturing system requirements, activity diagrams to capture dynamic behavior of the system and data flow diagrams to show how data moves between different processes in a system. This paper aims to identify functional and non-functional system requirements for the proposed land information system. The proposed LIS has two main components which are valuation and allocation of land uses with the aim of enhancing land administration at the districts in Tanzania by easing the storage and retrieval of the land information and proper valuation hence improve revenue collection.

To conclude, requirement specification and design have two contribution to the development of the proposed LIS. The first one is the requirement specification which helps the developer to develop LIS that meets the user needs. Second the design of the proposed LIS ease the LIS development by showing the components and functionalities of the LIS.

Keywords— Land Information System (LIS), Data Flow Diagrams (DFD), Unified Modeling Language (UML), Entity Relationship Diagram (ERD), Use cases.

3.1. Introduction

Requirements gathering process is one of the factors for the success of any software project. Getting the requirements right and getting the right requirements can mean the difference between a successful projects one that satisfies the needs of its users and is delivered on time and on budget and one that fails Nevo Technologies (2004). Analysis by Ghai and Kaur (2012) shows that 37% of the problems occurred in the development of challenging systems are due to the requirement specification.

System requirements describe the required functionalities of the required software. Therefore requirements collection is the first process in the software development. Requirements gathered in

[2] A paper by Micky Thambikeni and Anael Sam, submitted for publication to the journal of Computer Engineering and Intelligent Systems (CEIS).

this study are functional and non-functional. Jain and Ingle (2011) in their paper describes system functional requirements as the ones which describes the functionality of the product whereas the non-functional requirements define attribute to quality features of the software.

This paper presents functional requirements, non-functional requirements and the design for the proposed Land Information System. Based on the method used in the field study at Arumeru and Mvomero districts in Arusha and Morogoro regions respectively, different techniques of data collection such as interview, literature review, and observation were used during data collection phase.

Use case diagrams were used to capture and clarify system requirements for the proposed LIS. According to Nevo Technologies, Inc (2004), through elaboration of the Use Cases, business requirements are thoroughly explored, fully understood and documented. The resulting Use Cases serve as effective bridge from the business requirements phase to the system requirements phase where a technology team explores the technical components that must be created or changed to meet the needs of the business.

3.2. Exposure of Land Information System (LIS) from literature review

Different studies have been carried out concerning user and system requirements in relation to Land Information System (LIS) and most of them show that there is need to have LIS especially in developing countries but the LIS should be based on the requirements of the specific society. UNECE (1996) found that, European countries started the use of LIS long time ago, but many of them failed to meet user requirements, as a result they failed to deliver the proper land services to the customers. UNECE (1996) emphasize that developing countries can learn much from western countries experiences that they need to build their own systems based natural conditions, social, economic and cultural environments.

Capturing right requirements and requirements right can be an issue and one of the factor of the failure of many software development projects. Ghai and Kaur (2012) found that 37% of the problems occurred in the development of challenging systems are related to the requirement specification phase. Therefore requirement engineering is an important activity of the project because it can uncover and analyzes various future problems which can become a cause of failure of the software project Ghai and Kaur (2012).

Understanding user requirements can be a challenge, this is due to the fact that some users don't know or can't explain what they really want. According to Young (2002) the most difficult part of requirement gathering is the effort of helping users to figure out what they need that can be successfully provided within the cost and schedule parameters available to the development team.

UCAR (2006) describes software design as the process of defining software methods, functions, objects and overall structure of the system so that resulting functionality will satisfy user requirements. UCAR (2006) also indicated that software design should include description of the overall architecture, this should include the hardware, database and third party frameworks the system will interact with and may also allow project stakeholders to assess the complexity and budget of the development and can reduce risks of mistakes that may occur during system coding.

Microsoft Microsoft (2009) emphasize that software must be built on a solid foundation hence failing to design for common problems, can put the application at risk. Microsoft (2009) found that System should be designed with the consideration for the user, the system (IT infrastructure) and the business goals and that for each of these areas important quality attributes such as reliability, performance, etc should be identified.

3.3. Problem statement

There is no LIS for managing land information in land offices at the districts in Tanzania, this causes land officers to use conventional ways of keeping land records which results to poor land decisions such as double allocation of land, Inaccuracy of valuations information, which results to improper tax charging and general inefficiency in delivering land services to land stakeholders.

3.4. Requirement Specification

This study captures both functional and non-functional requirements to show services the system should provide and constraints on the services offered by the system. The requirements for land information system have been specified in Tables 3 and 4 below.

ACTOR	USE CSAE	REQUIREMENT
System admin	• Login. • System settings management. • Staff management. • Create user acc.	• To login • To monitor system settings. • To manage staff • To Create user acc.
Land Valuer (L.V)	• Login. • Land valuation management. • Search land.	• To login • To manage land valuation information • To search land
Land Officer (L.O)	• Login. • Allocation of land uses management. • Inquiry management. • View reports	• To login. • To manage land information. • To manage customer inquiry. • To view reports
Chief Land Valuer (C.L.V)	• Login. • View valuation report. • Approve valuation.	• To login. • To view valuation report. • To approve valuation.

Table 3. Functional requirements for Land Information System.

REQUIREMENT	DESCRIPTION
Software requirements	• PHP 4.0 and above • Apache 2.0 and above • MSQL 5.0 and above • PDF reader • Dedicated link with the minimum of 2 public IP addresses.
Hardware requirements	• Minimum processor 2core 2GHZ • Minimum RAM 2GB DDR3 • Hard drive 500GB
Performance	System should provide high performance in loading pages, valuation analysis hence rateable value computation and in generating reports.

Security	System enforces authentication, authorization, and accounting before users are able to access the system.

Portability	• System should run on the following platforms.
	  ○ Linux (Ubuntu server, Fedora, Redhat).
	  ○ Windows
	  ○ Mac

Reliability	• System works properly without failure. • System should have backup and recovery mechanism. • System admin should create a backup plan.

Table 4. Non-functional requirements for Land Information System.

3.5. LIS design

LIS is a computerized application which contains many components. The LIS design in this paper focuses on the key components which are valuation and allocation of land uses. Other supportive components which are system settings, inquiry management, staff and customer management are also included in the design. The system design is based on captured user requirements, during data collection phase. The users of the LIS are Land Officer (L.O), Land Valuer (L.V), Chief Land Valuer (C.L.V) and System administrator (System admin).

3.5.1. Main components of the system

Valuation.

Land/property valuation is the process of evaluating land/property for the purpose of determining the current value of the land or property. This is done by gathering and analysis of property information. Valuations are used for many purposes including setting limits for the sale and purchase of properties, setting rental levels, determining compensation following the compulsory acquisition of property, asset accounting and management, property settlements and property rating and taxation. With the valuation component, L.V enter or upload data to the data capture, the data capture send them to valuation analyser for analysis and rateable value computation, the after the analyser send the analysed information to the DB and send the valuation report to back to L.V for data confirmation, then L.V upload the picture of valuated area or property. After data confirmation the valuation analyser send the valuation report to C.L.V by setting the valuation report status as submitted. The C.L.V receives the report and if satisfied he send the approve

command to the valuation analyser and valuation analyser update the status to approved else the valuation status becomes rejected.

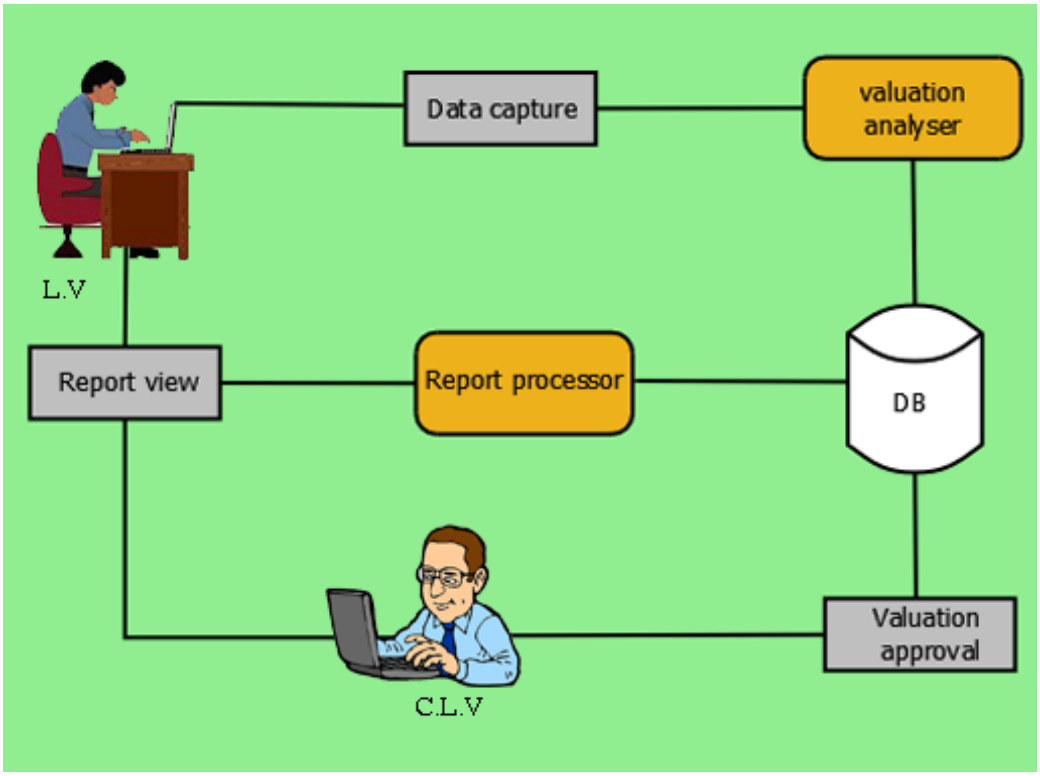


Figure 8. Valuation component architecture

Allocation of land uses.

Allocation of land uses refers to the process by which a society, through its institutions, decides where, within its territory, different socioeconomic activities such as agriculture, housing, industry and commerce should take place. This includes protecting well defined areas from development due to environmental, cultural, historical, or similar reasons, and establishing provisions that control the nature of development activities World Bank (2012). With the allocation of land uses component L.O feed or import data from GIS to the data capture, then the data capture module sends the data to the database and send back the land profile to the L.O. L.O verify the data and correct them if there are some errors and upload the map of the area. L.O can also use the report view module to view allocation of land uses reports, the report view sends the request to report processor and then the report processor ask the requested data from DB. After getting the requested data the report processor generate report then send back to report view.

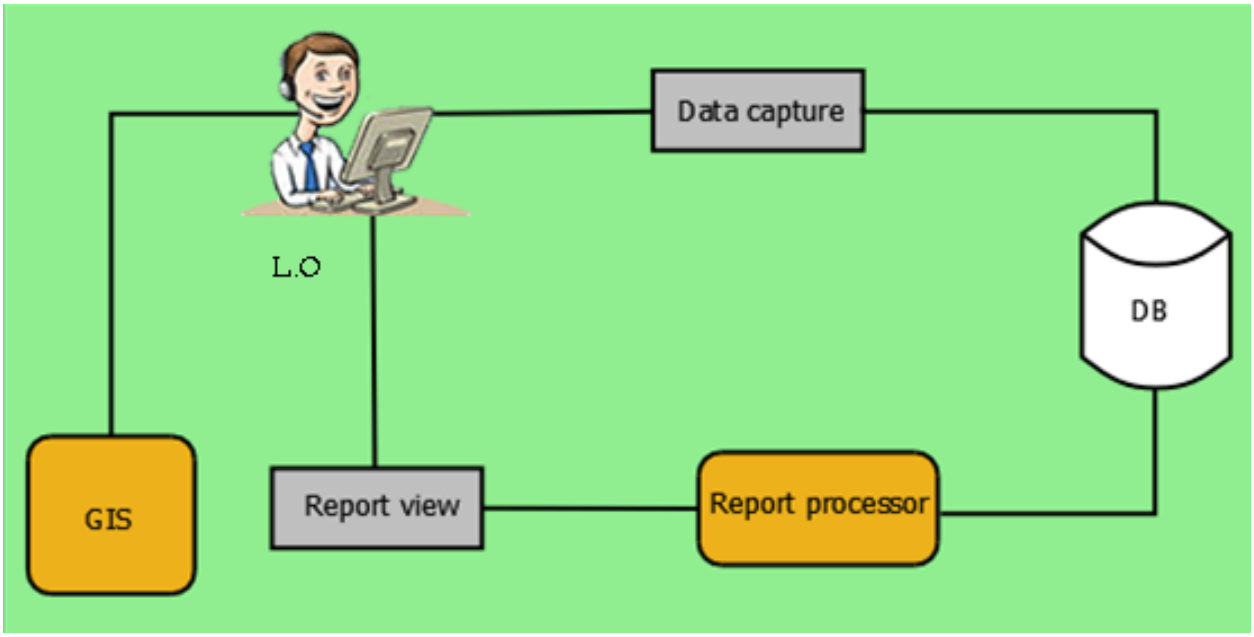


Figure 9. Allocation of land uses component architecture

3.5.2. Use case diagrams

According to Bredemeyer consulting (2001), a use case defines a goal-oriented set of interactions between external actors and the system under consideration. Bredemeyer consulting (2001) continue to explain that actors are parties outside the system that interact with the system and that an actor may be a class of users, roles users can play, or other systems, thus, use cases capture who (actor) does what (interaction) with the system, for what purpose (goal), without dealing with system internals. Based on the user requirements use case diagrams of the LIS are illustrated below showing how primary actors (i.e System admin, L.O, L.V and C.L.V) interact or communicate with the system features in performing their duties and meet their needs. Figure 10 show the general use case diagram for LIS, whereby, system admin interact with three use cases staff management, create user and system settings management. To interact with these use cases the system admin is required first to communicate with the login use case which is also mandatory to all use cases.

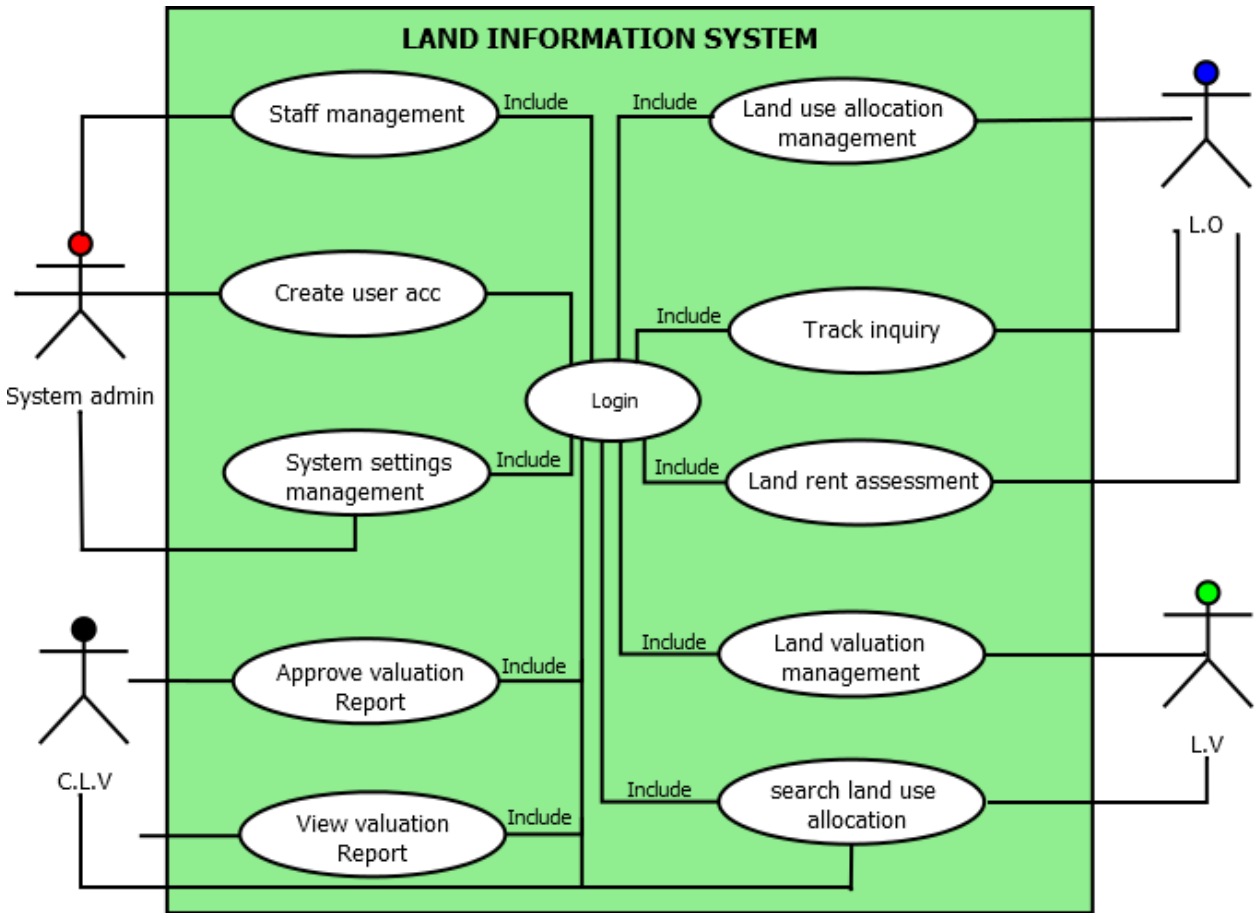


Figure 10. LIS Use case diagram

Detailed use case diagrams.

In figure 11, the primary actor (L.O), communicates with all use cases. Its role is to manage allocation of land uses information. The L.O performs these duties by obtaining land data from the field, feed them to the GIS analyse and generate map them then feed them to the LIS by either importing or entering manually and upload map. From this point Land Officer (L.O) can manipulate information in various ways such as update, delete and search. Land Valuer (L.V) interacts with one case (i.e search land).

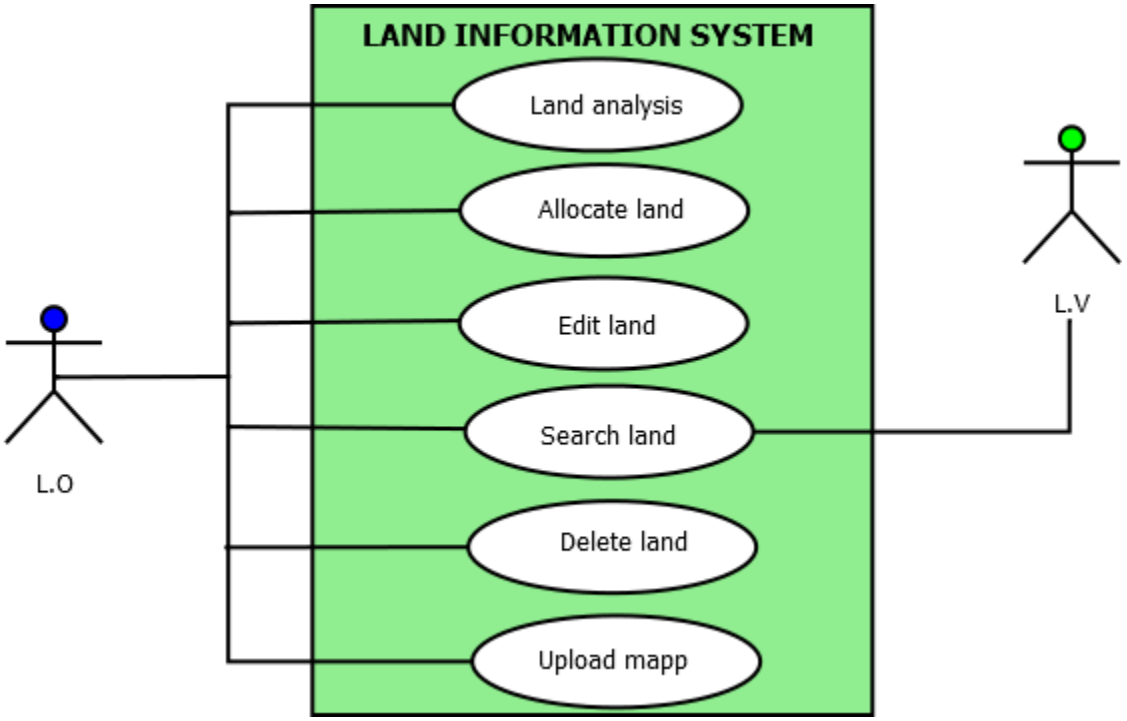


Figure 11. Allocation of land uses case diagram

In figure 12, L.V communicates with two use cases, feeding data to the system and view report. On the other hand C.L.V first views the report and if it is satisfied with the report it approves the valuation for further processes.

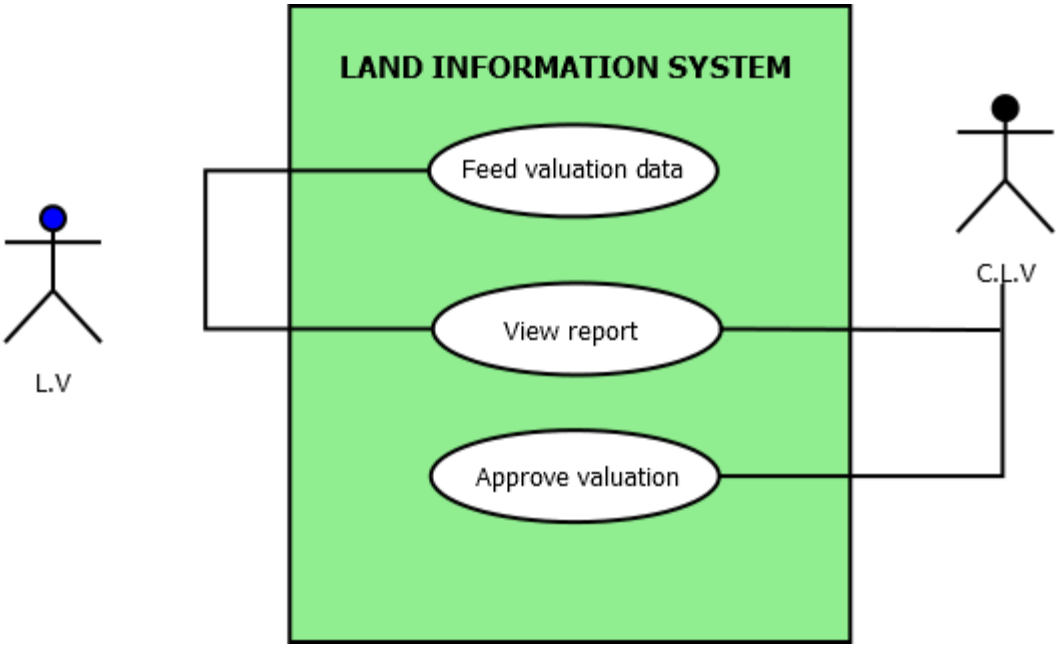


Figure 12. Valuation use case

In figure 13, System admin is responsible for setting up various system parameters before other actors or users start using the system. System admin performs the following functions, setting up inquiry types, land use and creating system user accounts.

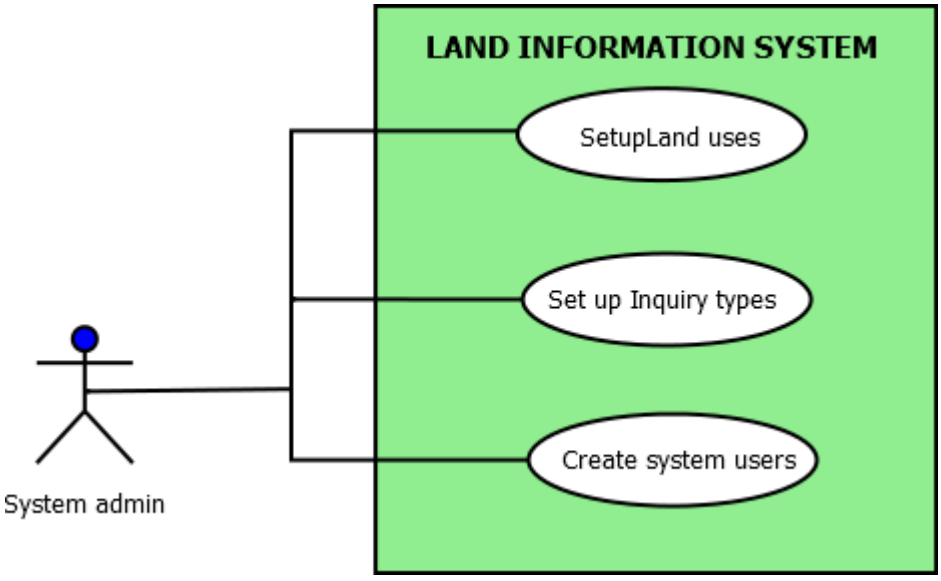


Figure 13. System settings use case

3.5.3. Activity diagrams

Nanda *et al* (2008) argued that UML Activity Diagrams are commonly used to model business processes, basic control and data flow in software systems. UML activity diagrams describe the sequential or concurrent control flows of activities. They can be used to model the dynamic aspects of a group of objects, or the control flow of an operation.

In this study activity diagrams are used to elaborate valuation and track inquiry use cases. They define activities or processes taking place in these high level use cases.

In figure 14 L.V obtains valuation data, then perform valuation analysis, after analysis and obtain value it generates valuation report. The valuation report is sent to C.L.V, the C.L.V reviews the report and if satisfied it approves the valuation, if not satisfied it rejects then L.V start valuation analysis and repeat the rest activities.

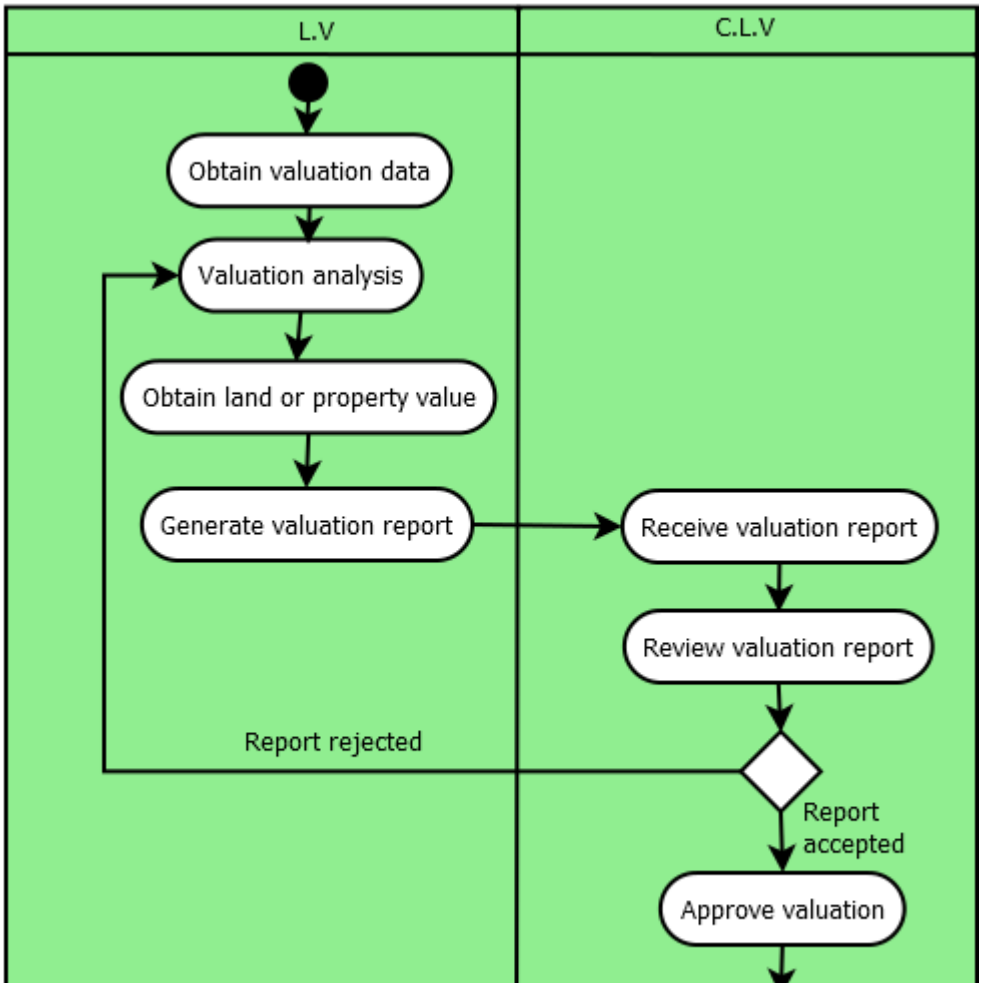


Figure 14. Valuation activity diagram

With inquiry management activity diagram in figure 15, customer makes inquiry to the L.O, the land officer determines the type of inquiry denoted by diamond and processes the request if it is related to allocation of land uses, otherwise sends it to the appropriate officer such as L.V.

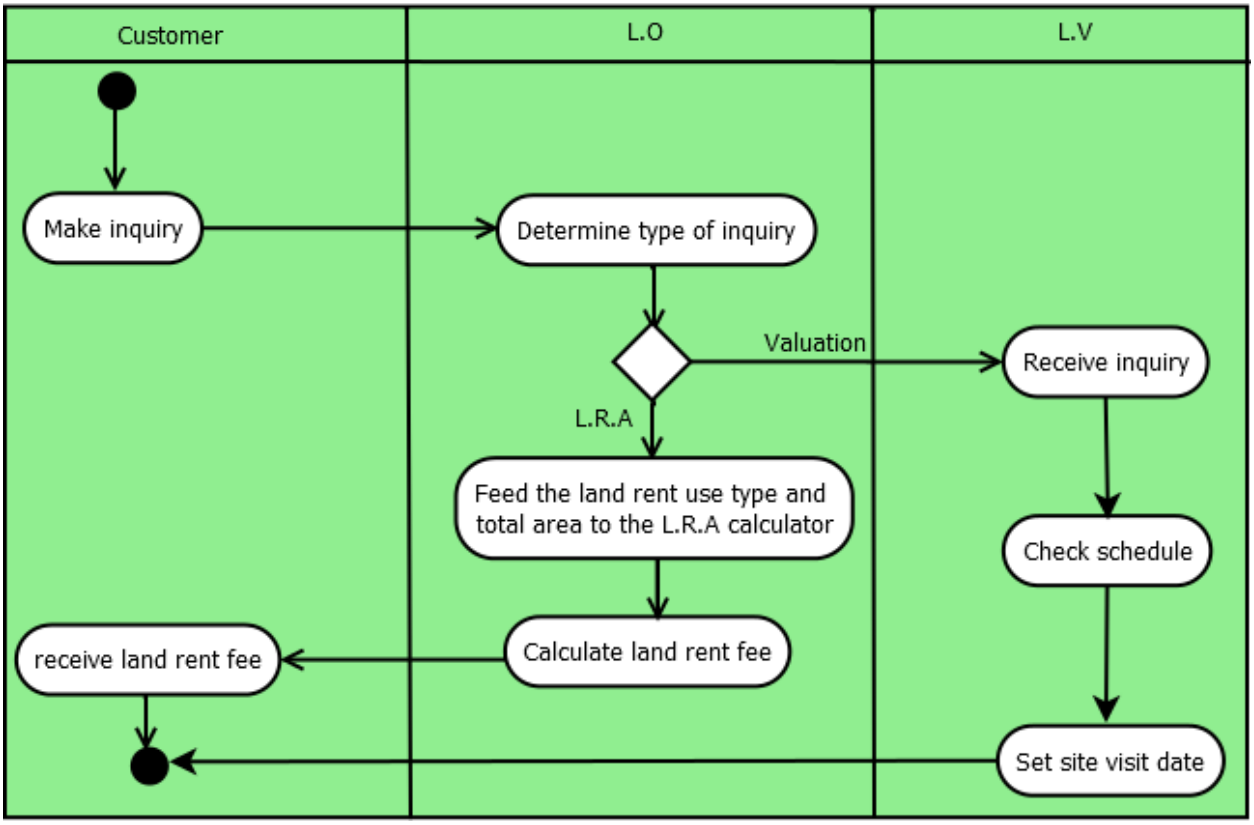


Figure 15. Customer inquiry management activity diagram

3.5.4. Data Flow Diagrams (DFD)

Ibrahim and Yenn (2010) shows that DFD is a graphical diagram for specifying, constructing and visualizing the model of a system. According to Majik Consulting (2006) Data Flow Diagrams are an excellent means to create functional views from a system's perspective. Ibrahim and Yenn (2010) describe that in data flow diagram, the highest-level view of the system is known as context diagram, the next level of data flow diagram is called the level 0 data flow diagram which represents a system's major processes, data flows and data stores at a high level of detail. Data flow diagram consists of four symbols which are processes, data flows, data stores and external entities.

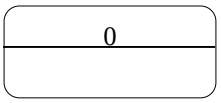
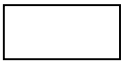
Symbol	Element name
	Process
	Data flow
	Data store
	External entity

Table 5. Symbols for DFD elements. Source: adopted from Ibrahim and Yenn (2010).

Context data flow diagram.

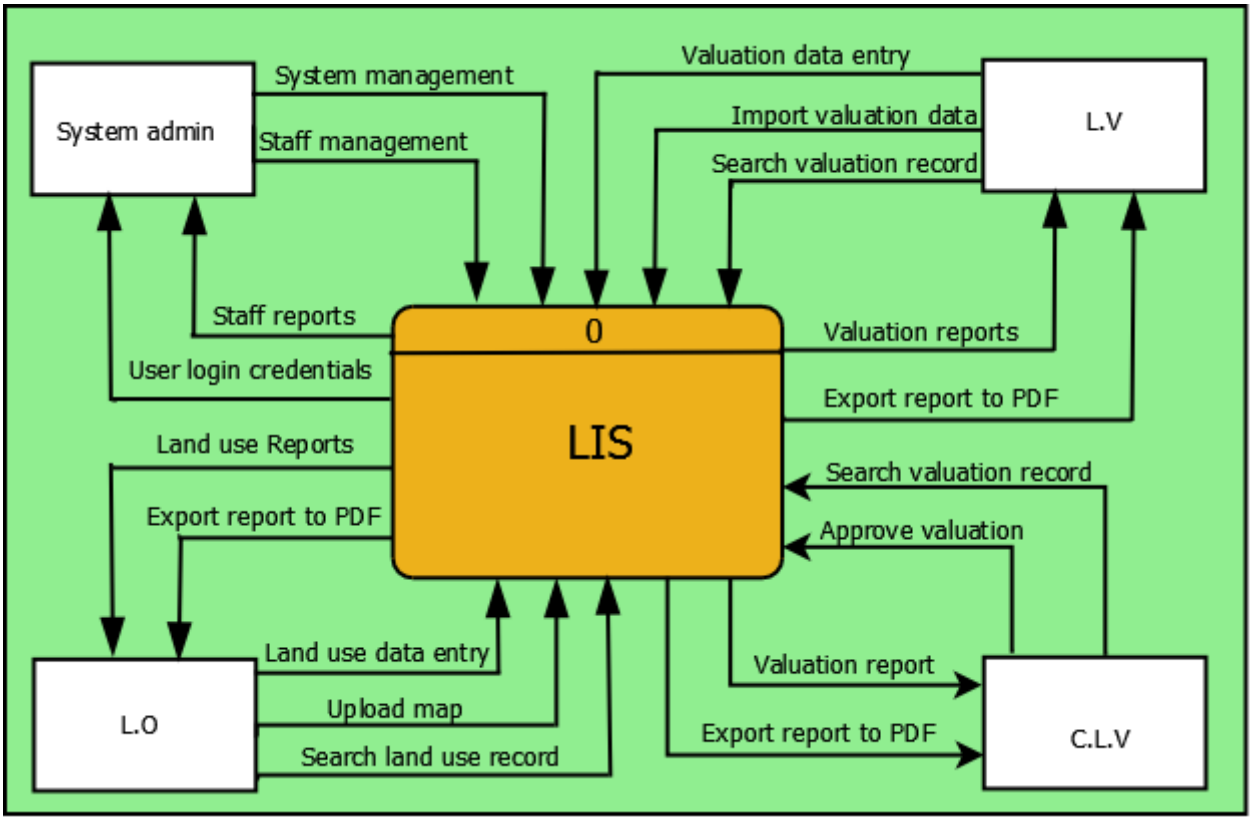


Figure 16. LIS context DFD

The context DFD is the highest level in a data flow diagram and contains only one process, representing the entire system. It provides an overview of the data entering and leaving the system. It also shows the entities that are providing or receiving that data and the diagram does not contain any data stores. Figure 16 show the context DFD of the LIS.

Data flow diagram levels.

The DFD levels are child diagrams of the context diagram which shows decomposition of processes. DFD levels also show external entities and data stores. They show the details how information flow from one process to another and one entity to another. The DFD levels can start from level 0 and onwards depending on the decomposition of the processes.

The level 0 DFD of the LIS in figure 17 is a child diagram of the context DFD. It shows in much details the inputs, outputs and external entities present in the context diagram. It also shows processes as follows.

- System admin manages the system settings in process 1.0 which are predefined variables of the system.
- System admin manages staff who are in the system in process 2.0
- Process 3.0 L.O manages allocation of land uses.
- Process 4.0 L.V perform valuation analysis.
- L.O manages inquiry and L.V search to see if there is valuation inquiry in process 5.0.
- C.L.V approve valuation in process 6.0.
- In process 7.0, L.O perform land data analysis to generate map of the area.

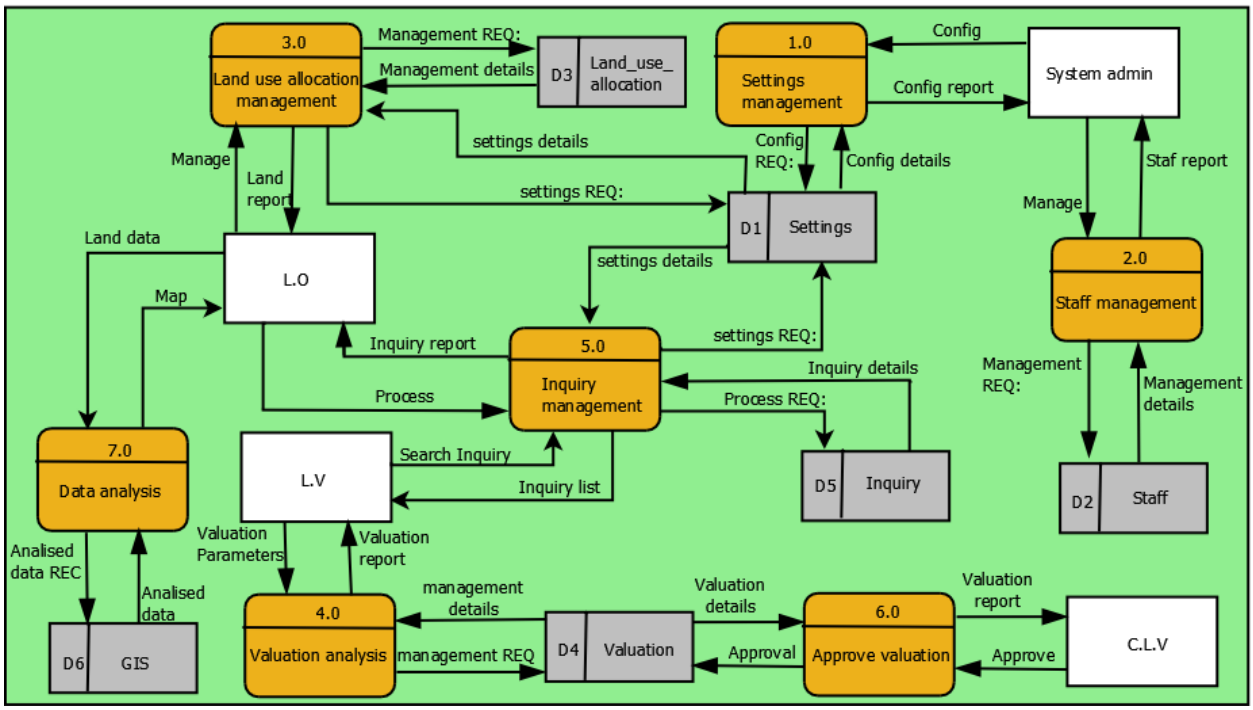


Figure 17. Level 0 DFD of the LIS.

Figure 18 is the level 1 DFD of the LIS which is a child diagram of the level 0 DFD. It shows the decomposition of the processes 4.0 that are present in the level 0 DFD in the following way.

- L.V processes transfer valuation in sub process 4.1, for customers who want to sell or change the land or property ownership.
- In sub process 4.2 L.V processes rating valuation, for estimating ratiable value / tax amount for land properties such as buildings.

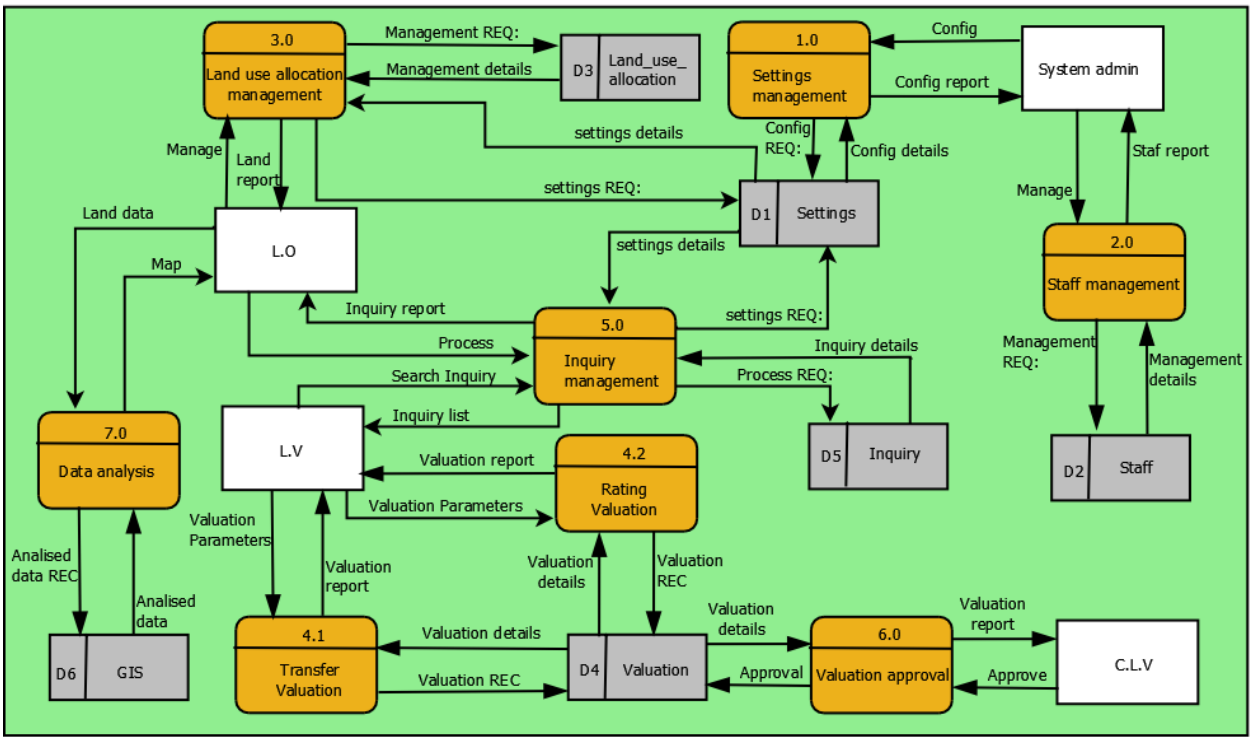


Figure 18. Level 1 DFD of the LIS

3.5.5. Conceptual database design

According to Cannolly and Begg (2005), conceptual database design is the process of constructing a model of the information used in an enterprise, independent of all physical considerations but also allows easy communication between end-users and developers. Cannolly and Begg (2005) continue to emphasize that the conceptual database design phase begins with the creation of a conceptual data model of the enterprise, which is entirely independent of implementation details such as the target DBMS, application programs, programming languages, hardware platform, performance issues, or any other physical considerations. The conceptual data model is supported by documentation, including ER diagrams and a data dictionary. Figure 19 shows the ER diagram of the LIS database data as entities, attributes and relationships.

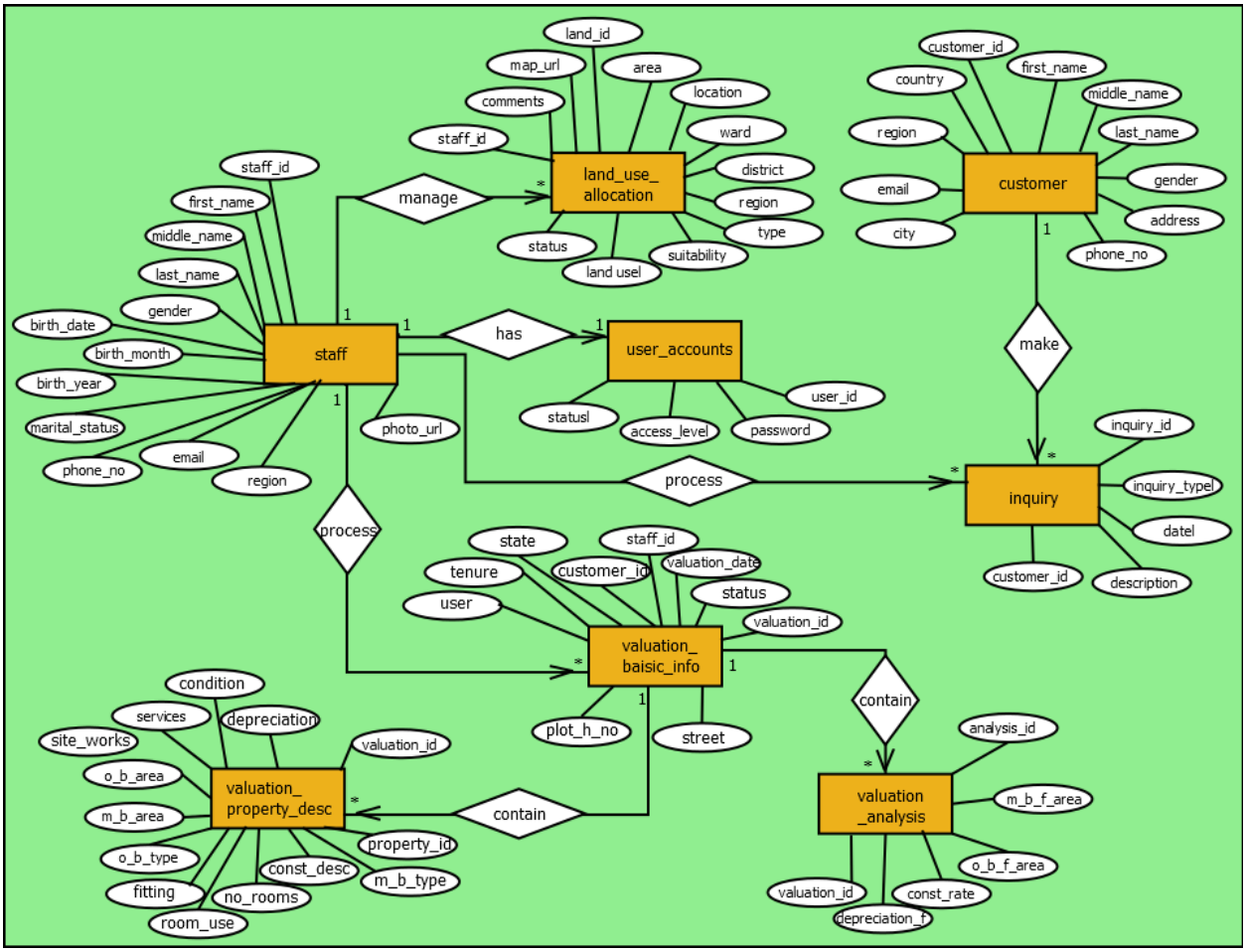


Figure 19. ER diagram describing conceptual database design of the LIS

3.5.6. Database schema

Figure 20 shows the database schema of the LIS. The database schema is the structure of the database showing tables, attributes and relationships. The database schema shows the logical view of the database but independent of the physical consideration i.e DBMS, platform, programming language etc.

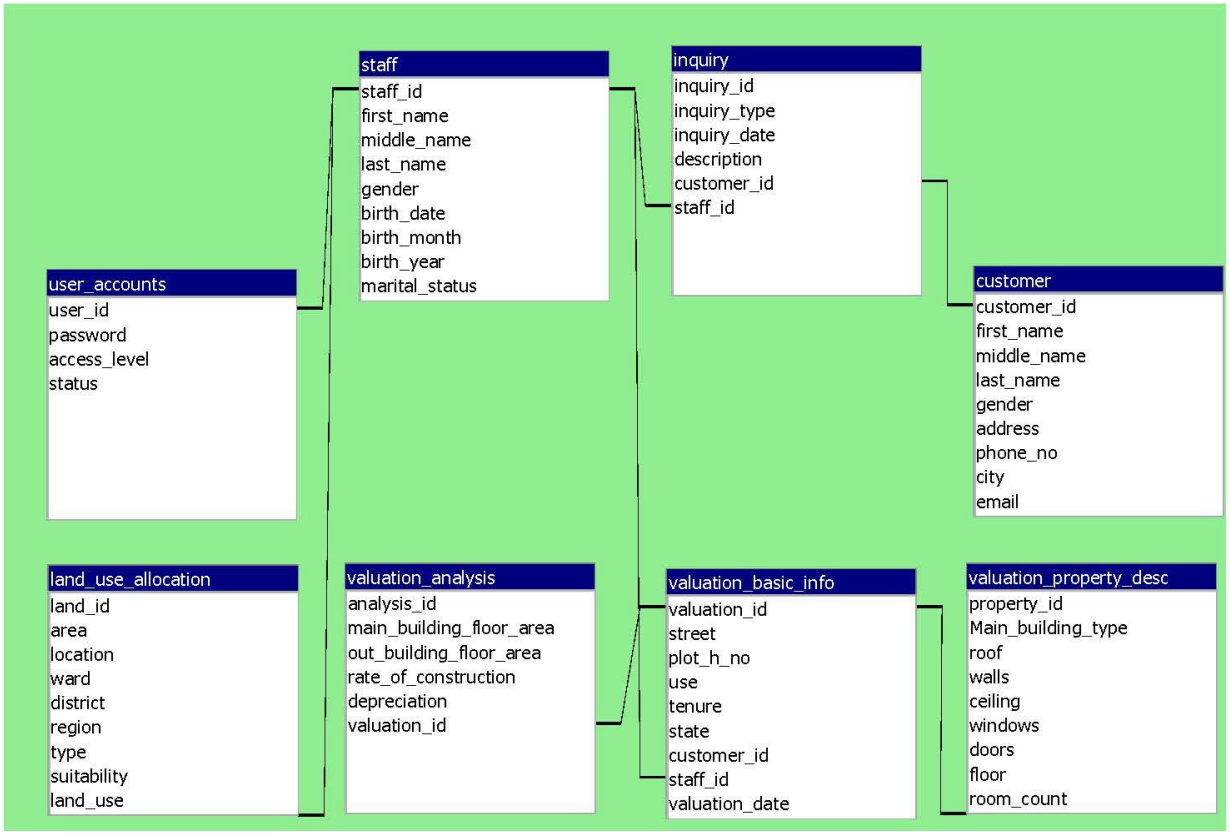


Figure 20. LIS database schema

3.6. Conclusion

This study was conducted to identify user requirements and develop the design for the proposed LIS. There are two contribution provided by this study. The first one is that the identified user requirements help the developer to develop LIS that meets the user needs specified in this study. The second contribution is the design of the proposed system which show the components and functionalities of the LIS. The proposed LIS has two main components which are allocation of land uses and valuation. The functionalities provided by these components are the storage and retrieval of land uses and storage and retrieval of valuation information and valuation analysis. These components aim to improve the efficiency and effectiveness of the land administration at the districts in Tanzania by easing the work of decision makers by providing them with the accurate information and proper valuation hence enhance revenue collection.

CHAPTER FOUR

SYSTEM IMPLEMENTATION FOR LAND INFORMATION SYSTEM FOR ENHANCING LAND USE PLANNING IN TANZANIA[3]

Abstract

System implementation is the construction of a new system and delivery of that system to the client. Due to the fact that the current method of handling land information in land offices at district level in Tanzania is inefficient, this study proposes land information system for an effective and efficient land information storage, retrieval and valuation analysis. This paper discusses the implementation of land information system for enhancing land use planning in Tanzania. In this system rapid application model is employed for system development, PHP and JavaScript programming language for building application and MYSQL DBMS for building the system database. The system interfaces have been built by using HTML, CSS to provide easy and interactive view to the user. The paper also presents the testing and system evaluation reports which obtained after testing and evaluation processes.

Keywords: LIS, DBMS, MYSQL, CSS, HTML, JavaScript, PHP. Unit testing, User acceptance testing.

4.1. Introduction

Good land administration provides accurate, interoperable, timely, secure and complete information about land and property in an affordable and efficient way that promotes confidence between the public, its commercial enterprise and government. This depends upon the availability of good land information. The proposed Land Information System (LIS) has fundamental role to play in underpinning the operations of land administration such as land tenure, land markets, allocation of land uses and valuations as illustrated in figure 21, by making information services more readily available in support of sustainable development. LIS improve accuracy and security of land information as well as the level of providing.

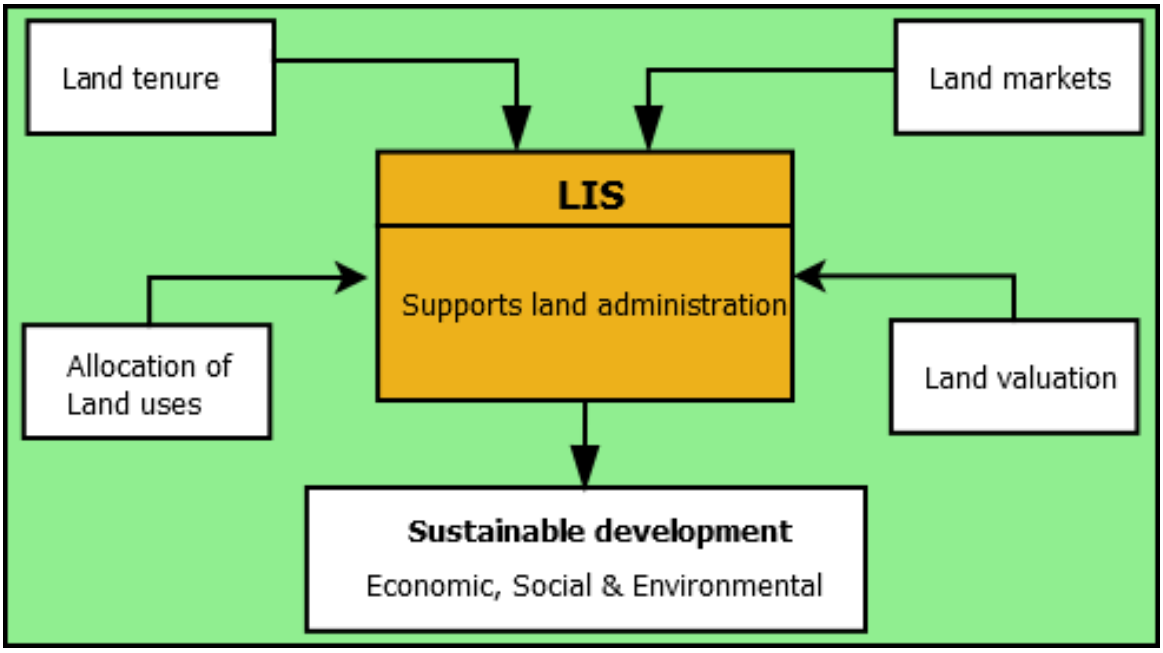


Figure 21. LIS supporting land administration.

The system implementation focuses on key components which are valuation and allocation of land uses and other supportive components which are system settings, inquiry management, staff and customer management. The system is expected to be useful at in land offices at the districts as it supports the business processes from that area. Land valuer, Land Officer, Chief Land Valuer and System administrator are the users of the System. The system is a web based and it is interactive and easy to use.

4.2. System features

4.2.1 Valuation

Valuation is one of the main feature of the proposed LIS. It provides the interface which land valuer can use to feed valuation data obtain from the field into the system. The analyser module perform data analysis and compute the rateable value (market value), this avoid the manual valuation and improve the accuracy of the valuation information hence the rateable value. The report generator module compile the report and display to the land valuer to confirm the valuation report and once confirmed the report is sent to the chief land valuer for approval. The valuation feature also provide easy access for Chief land valuer to view the report and approval module to

approve the report when satisfied for valuation and rateable value implementation. Provision of reports from this feature enhances the decision making in implementing the valuations and rateable values and increases the government revenue through tax charging by reducing under valuation and charging the proper tax. But also with this feature the comparison process between land/properties is simplified as well as comparison between property market value of different period of time for the decision makers.

4.2.2 Allocation of land uses

This is another main feature of the proposed LIS. The allocation of land uses feature provides the infrastructure of easy storage and retrieval of land allocation data. It provides the interface which land officer can use to feed land use data obtain from the field or GIS application into the system. The report generator module enable the land officer to view various land use reports, for instance allocated areas for agriculture, industries, town planning or conservation areas as well as the status of the areas such as if the area is under conflict, or occupied by investor or used by the society for the specific activity. This facilitates the management of land allocation abut also leads decision makers in decision making and hence avoid double allocations of land. This feature will play key role in reducing land conflicts especially those related to pastoralism against famers and those of society against investors. This is due to the fact that the reports will show which area is allocated for which uses and for which group or investor. Also tracking areas with land conflicts is simplified with this feature as land officer can simply query areas with which are under conflicts and report generator displays them. This may help land officer to disseminate information to the authorities earlier before the impacts of conflicts become severe.

4.2.3 Customer inquiry management

The customer inquiry is the supportive feature of the proposed LIS. The feature provide platform to store customer information visit the land office and the inquiries they make in an effective and efficient way. The feature disseminate inquiry information to the specific officer such as land officer and valuer for inquiry processing. Also the feature contain report generator module to generate customer and inquiries reports for easy tracking of inquiry status as well as the number of customers visit the land office per specific period of time.

4.2.4 Staff management

The staff management is another supportive feature of the proposed LIS. The feature enable system administrator to manage system users in using the system. The feature implements the authorization mechanism whereby each staff will only interact with authorized features and information. This mechanism enforces security constraints to the system so as to maintain system integrity.

4.2.5 Login

The login feature implements the authentication mechanism to the system. System Users uses this feature to enter username and password. The authentication mechanism check whether the user exist in the system and has provided the correct username and password before it allows the user to access the system features. This feature provides the security control to the system.

4.2.6 System settings

This feature is used to set up various predefined system parameters. System administrator identify constant parameters from other system modules and configure them to the system. If a system module is performing some operations and meeting a constant parameter it has to contact the system settings module. This improve the usability of the system as system users do not have to repetitively entering the constant parameters and concentrate only on variable ones.

4.3. Implementation tools and techniques

4.3.1. System Development Life Cycle (SDLC)

For successful development of a land information system, the System development Life Cycle (SDLC) technique was used. SDLC is overall process of a software development through a multistep process from analysis, design, implementation and maintenance. There many different SDLC models and methodologies, but each generally consists of a series of defined steps or phases. The Rapid Application Development (RAD) model was used as it is faster development technique with high quality results.

4.3.2. Rapid Application Development (RAD)

According to Liang (2005) RAD is a software development process. The concept behind RAD is that the product can be developed faster and of higher quality through methodology that involves (ICU);

- I – Iterative development.
- C – Construction of prototypes.
- U – Use of Computer Aided Software Engineering (CASE) tools.

The limitation of time for LIS development and the ability of RAD methodology in developing higher quality software and faster is the reason of choosing RAD out of many SDLC models.

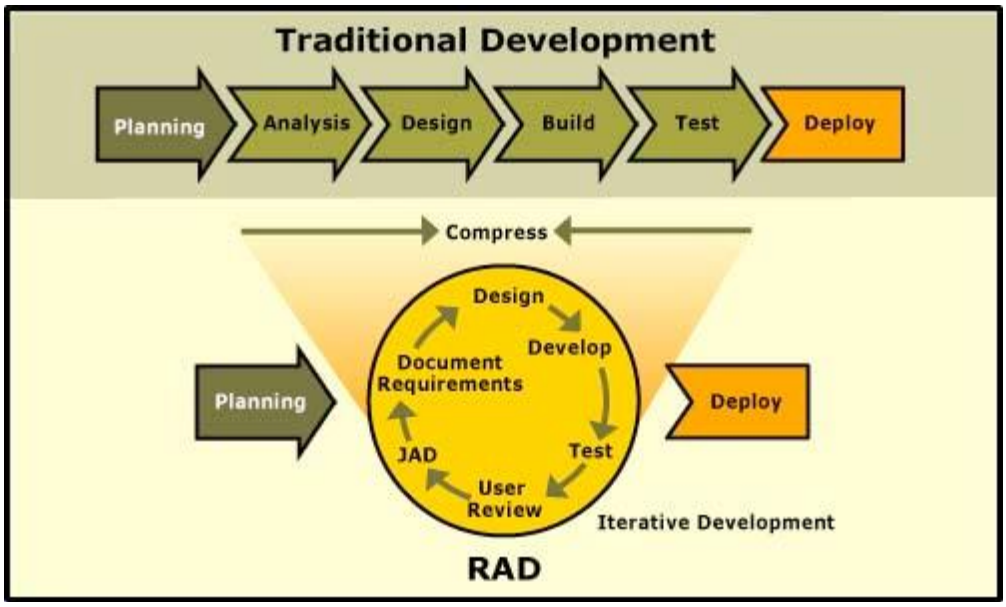


Figure 22. Rapid Application Model. Source: adopted from Liang (2005).

4.3.3. Programming languages

Hypertext Preprocessor (PHP) is a programming language used to develop the land Information System. PHP is an open source, server side, HTML embedded scripting language used to create dynamic web pages. Because the execution of a PHP program is taking place on the server, the client cannot view the PHP code, rather just the results which are displayed on a client's browser.

Apart from the fact that PHP is a programming language which developer is most competent with among factor which motivate developer to choose PHP is that, PHP is one of the most popular scripting language for the web applications hence very common to many developers. Therefore

even if the LIS developer is not around the proposed LIS custodians do not have to worry about the system maintainability because it easy to find PHP developers who can continue to maintain the proposed LIS application.

PHP can perform any task that any common gateway interface (CGI) can do, but also its ability of being compatible with various types of DBMS and web servers makes PHP very strong. Also PHP can talk across networks using IMAP, SMTP, POP3, HTTP etc. PHP is also powerful in implementing security to the applications such as the login mechanisms and the session implementation.

JavaScript was used to add more interactivity to the LIS interfaces. JavaScript is a script programming language that enables web authors to create interactive web pages. JavaScript can enable web authors to add dynamic contents to their sites. Unlike PHP the execution of the JavaScript program is done on the client side i.e the browser. JavaScript is an open language that any developer can use without purchasing a license.

4.3.4. Database Management System (DBMS)

MySQL DBMS is used in LIS development for effective and efficient land information storage, retrieval and easy manipulation. MySQL is a freely available open source Database Management System (DBMS) based on Structured Query Language (SQL). Halvorsen (2014) define SQL as a database computer language designed for managing data in relational database management systems (RDBMS). It uses declarative statements in altering and defining relational databases.

Some reasons why MySQL was chosen is the fact that MySQL is open source you just download and start to use though MySQL enterprise edition is not free you have to pay in order to get support from oracle. But other reasons is that MySQL is scalable in essence that it can grow as volume of information grows up. It can support massive data warehouse holding terabytes of information. Also MySQL flexibility of running on various platform such as Linux, UNIX, Windows and Mac makes it to be more favorable.

High performance is another reason for choosing MySQL. According to MySQL (2011) MySQL can meet the most demanding performance expectations of any system. With high-speed load utilities, distinctive memory caches, full text indexes, and other performance-enhancing

mechanisms, MySQL offers all the right ammunition for today's critical business systems MySQL (2011).

MySQL offers exceptional security features that ensure absolute data protection. In terms of database authentication, MySQL provides powerful mechanisms for ensuring only authorized users have entry to the database server, with the ability to block users down to the client machine level being possible. SSH and SSL support are also provided to ensure safe and secure connections. MySQL also offers a variety of high-availability options from high-speed master/slave replication configurations, to specialized Cluster servers offering instant failover MySQL (2011). Unlimited support is another good thing with MySQL. There are unlimited source to get support in case you have got problem with MySQL operations.

4.3.5. Apache webserver

The apache webserver is used in hosting LIS application. Apache webserver is one of the most widely used webserver. Like MySQL apache webserver is open source that is free of charge to use it. Apache can operate on lesser, contain standards and simple configuration. Also its flexibility to operate on various OS such as Windows, Linux etc, is among the factors apache webserver was chosen in developing proposed LIS.

4.3.6 User interface development tools (HTML, CSS)

The LIS user interfaces were built up using the three technologies HTML, CSS and JavaScript. HTML is a markup language used to create web documents. HTML defines the structure and layout of a web by using tags. The markup tells the web browser how to display a web page contents.

To create user interface styles CSS was used.CSS is a way for web developers to define the look of their web pages. It was intended to allow developers to separate content form design so that HTML could perform more of the function it was originally based on i.e the markup of content without worrying about the design.

4.4. User interfaces

A use interface is a set of commands or graphics which a user uses to communicate with a software. A command-driven interface is the one in which user enter commands to control a software. A graphic-driven or graphical user interface is one in which user uses set of graphics such as menus, windows, icons etc, to control a software or program. The user interface is one of the most important parts of any program because it determines the usability of the system how easily user can operate a program. A proposed LIS provides a number of user friendly interfaces which a user can use to operate a system.

4.4.1. Land manager dash board

The land manager dash board is an interface which land officer (L.O) and Land valuer (L.V) access features which they use to perform their tasks, i.e allocation of land uses and customer inquiry management for L.O and valuation for land valuer. The search and reports features can be used by all users including chief land valuer (C.L.V), but very one is limited to search or view report of his/her category.

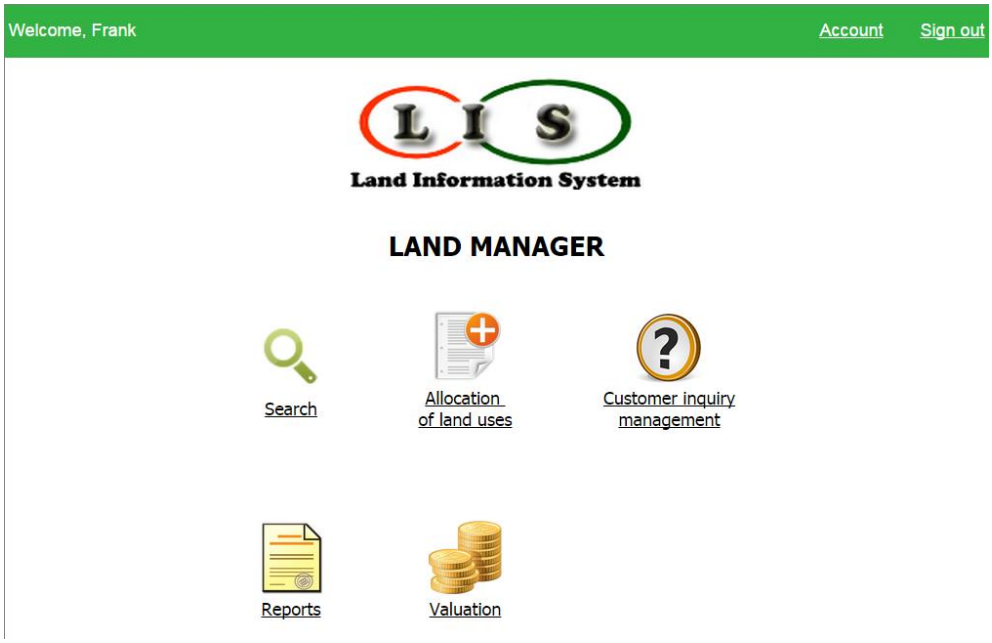


Figure 23. Land manager dash board

4.4.2. Allocation of land uses interface

The allocation of land uses interface enables land officer to feed the land allocation information to the system. The land officer obtain these information from the site visit then feed them to the GIS for generating map. Then feed these information to the LIS. After feeding the information to the LIS, the land profile interface appears where land officer can verify information and if there are mistakes he can update the details and also upload a map of the area. To improve the accuracy and consistence of the data, land officer can export data from GIS or from data collection application to excel then import to the LIS without entering them manually.

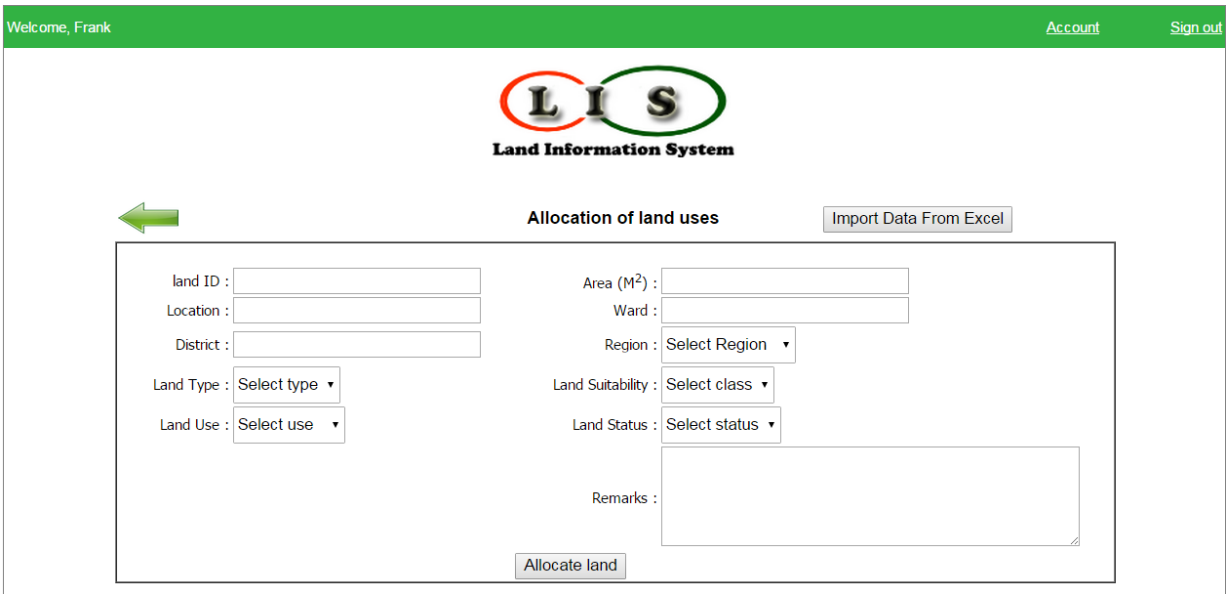


Figure 24. Allocation of land uses interface.

4.4.3. Valuation interface

The valuation interface enables land valuer to feed the valuation data to the system. The land valuer obtain these information from the field. After feeding these data valuation analysis report appears where he can verify information and if there are mistakes he can update the details and also upload a picture of the valuated area or property. Also land valuer can use collection application such as GeoODK to collect valuation data, export them to excel then import to the LIS without entering them manually.

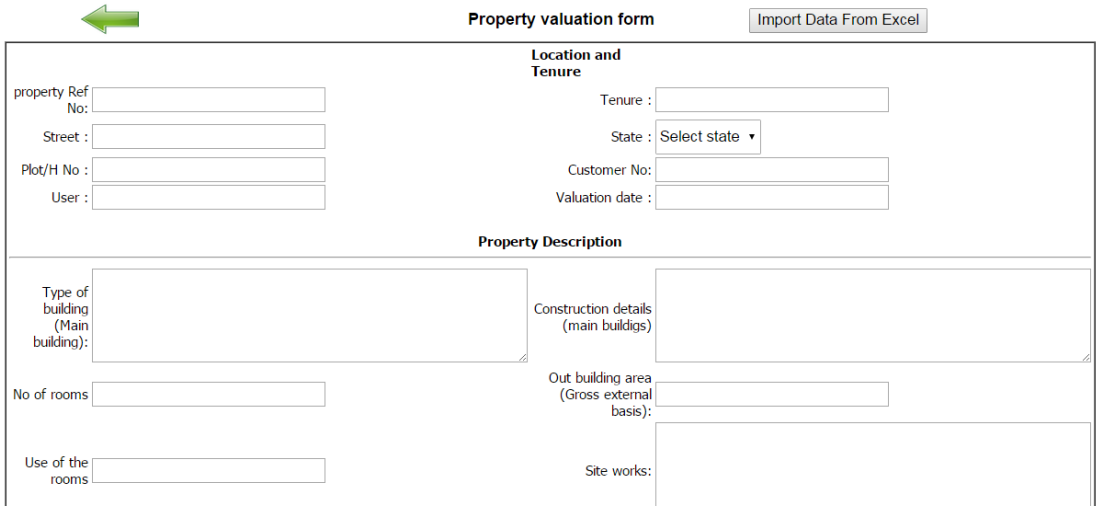
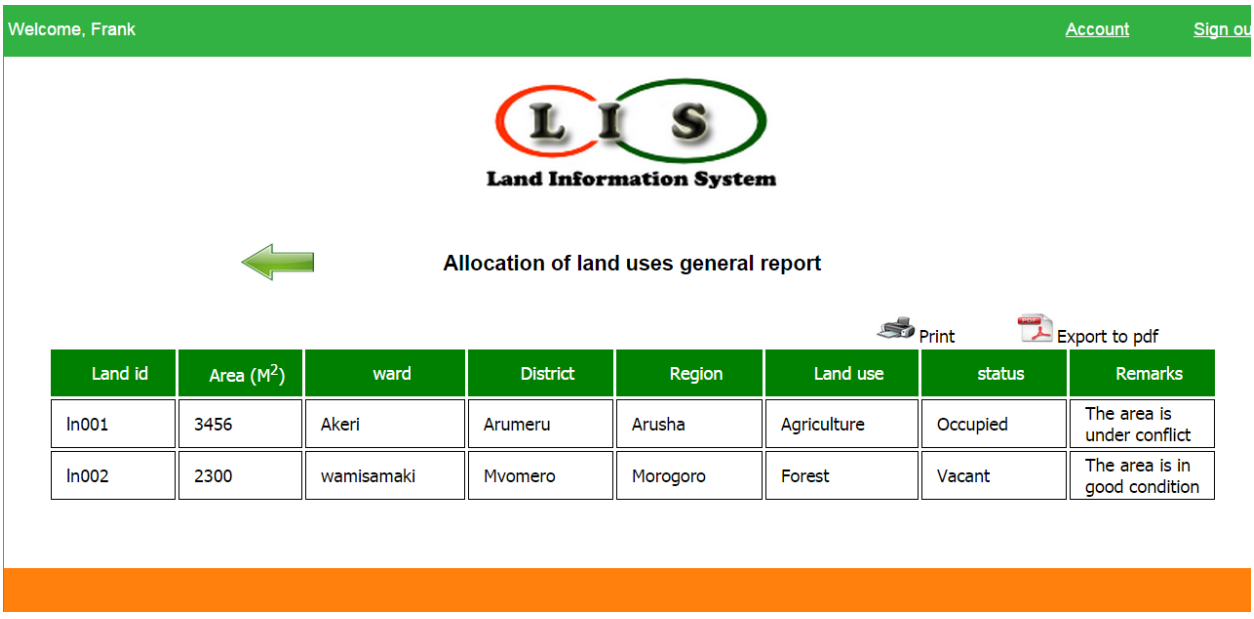


Figure 25. Valuation interface.

4.4.4. Reports interface

The reports interface enables all system users to view various reports as requested and based on the user rights of accessing reports. Reports assist decision makers in reaching good decisions.



Land id	Area (M^2)	ward	District	Region	Land use	status	Remarks
ln001	3456	Akeri	Arumeru	Arusha	Agriculture	Occupied	The area is under conflict
ln002	2300	wamisamaki	Mvomero	Morogoro	Forest	Vacant	The area is in good condition

Figure 26. Reports interfaces.

4.5. System testing

System testing is the process of checking the behavior of the whole system based on the requirements specification documents. The main focus on system testing is to verify that system works properly and it meets the specified requirements. The testing process is usually required before and after the system is put in place. System should be tested in an environment that resembles the environment where the system will be finally installed. The proposed LIS was tested based on unit testing, functional/non-functional testing and user acceptance testing.

4.5.1. Unit testing

Buechner (2007) describes that in unit testing, testing of individual modules of the system is performed after the completion of the development of the system unit. The purpose of this testing is to verify that the tested system module is functioning correctly as expected. In unit testing a module is tested rigorously and in isolation from the rest of the application (B. Basically unit testing is typically performed by the developer.

4.5.2. Functional and non-functional testing

Functional testing is the process of testing developed system against business requirements. The purpose of functional testing to check how well the system executes the required functions such as data manipulation, data storage, user interface etc. functional requirements is performed with the help of functional requirements specifications.

Eriksson (2012) shows non-functional testing is concerned with the non-functional requirements and designed to evaluate the readiness of a system according to several criteria not covered by functional testing. It enables the measurement and comparison of the testing of non-functional attributes of the system. Examples of non-functional testing includes; performance testing, security testing, recoverability testing, load testing Eriksson (2012).

4.5.3. User acceptance testing (UAT)

According to Hambling and Goethem (2013) UAT is a type of testing performed by the user of the system to validate the system against the agreed requirements. In other words this is called beta testing of the system and evaluated by the actual end users. Hambling and Goethem (2013)

emphasize that the primary objective of UAT is to ensure that the new system does what it set out to do and meets the requirements the business has of it.

4.5.4. Test report

Unit testing and functional/non-functional testing were performed during the testing process, tables 6 through 14 bellow show the report of the testing performed.

AUTHENTICATION TESTING		
S/N	**Test**	**Result**
1	Allow access to the system for the user who provides correct username and password	PASS
2	Deny access to the for the user who provides correct username and password	PASS

Table 6. Authentication testing.

AUTHORIZATION TESTING		
S/N	**Test**	**Result**
1	Allow L.O to operate allocation of land uses, customer and inquiry modules only and deny him from operating the rest modules.	PASS
2	Allow L.V to operate valuation modules only and deny him from operating the rest modules.	PASS
3	Allow C.L.V to view valuation reports and operate valuation approval modules only and deny him from operating the rest modules.	PASS
4	Allow System admin to operate settings and staff modules only and deny him from operating the rest modules.	PASS

Table 7. Authorization testing.

VALUATION ANALYSIS TESTING		
S/N	**Test**	**Result**
1	Analyse valuation data and compute rateable value.	PASS

Table 8. Valuation analysis testing.

UPLOADING FILES TESTING		
S/N	**Test**	**Result**
1	Uploading map	PASS
2	Uploading picture of valuated area/property.	PASS

Table 9. Uploading files testing.

IMPORTING DATA TESTING		
S/N	**Test**	**Result**
1	Importing allocation of land uses data.	PASS
2	Importing valuation data.	PASS

Table 10. Importing data testing.

REPORTING TESTING		
S/N	**Test**	**Result**
1	Generate allocation of land uses and valuation reports.	PASS
2	Export reports to pdf.	PASS
3	Print allocation of land uses and valuation reports.	PASS

Table 11. Reporting testing.

DATABASE TESTING		
S/N	**Test**	**Result**
1	Insert data to the database.	PASS
2	Update data in the database.	PASS
3	Delete data from the database.	PASS

Table 12. Database testing.

DATABASE BACKUP AND RECOVERY TESTING		
S/N	**Test**	**Result**
1	Backup the database.	PASS
2	Recover the database.	PASS

Table 13. Database backup and recovery testing.

PORTABILITY TESTING		
S/N	**Test**	**Result**
1	Installed and working on windows	PASS
2	Installed and working on Linux (Ubuntu)	PASS
3	Installed and working on Mac	PASS

Table 14. Portability testing.

4.6. System evaluation

According to Alrawashdeh *et al* (2013) system evaluation is the process of assessing a system to check if the system meets the specified user requirements. The idea is to determine how best the system being evaluated can improve the current client's system. The evaluation process is performed by looking at quality characteristics which are functionality, reliability, usability, Efficiency, maintainability and portability as defined by ISO 9126 model Alrawashdeh *et al* (2013). Evaluation helps the researcher or developer to understand if the system will be useful to the client. Therefore the LIS evaluation is important to ensure that it will improve the performance of business process of the land offices at the districts.

4.6.1. Evaluation method

The study adopted the ISO 9126 model for the system evaluation. The evaluation process was conducted by System admin, Land officer and Land valuer by testing the system and provide their opinion on how they observed the system. The evaluation forms were prepared and distributed to the evaluation participants.

4.6.2. Evaluation results

The evaluation process was conducted by system users (experts) and provided their feedback by filling the evaluation form. The feedback were then fed into ms excel for analysis and the results are presented in the figures below. The results show that, all system users are strongly agreed with the developed Land Information System.

The level of agreement; 5 = strongly agree, 4 = Agree, 3 = I don't know, 2 = disagree, 1= strongly disagree.

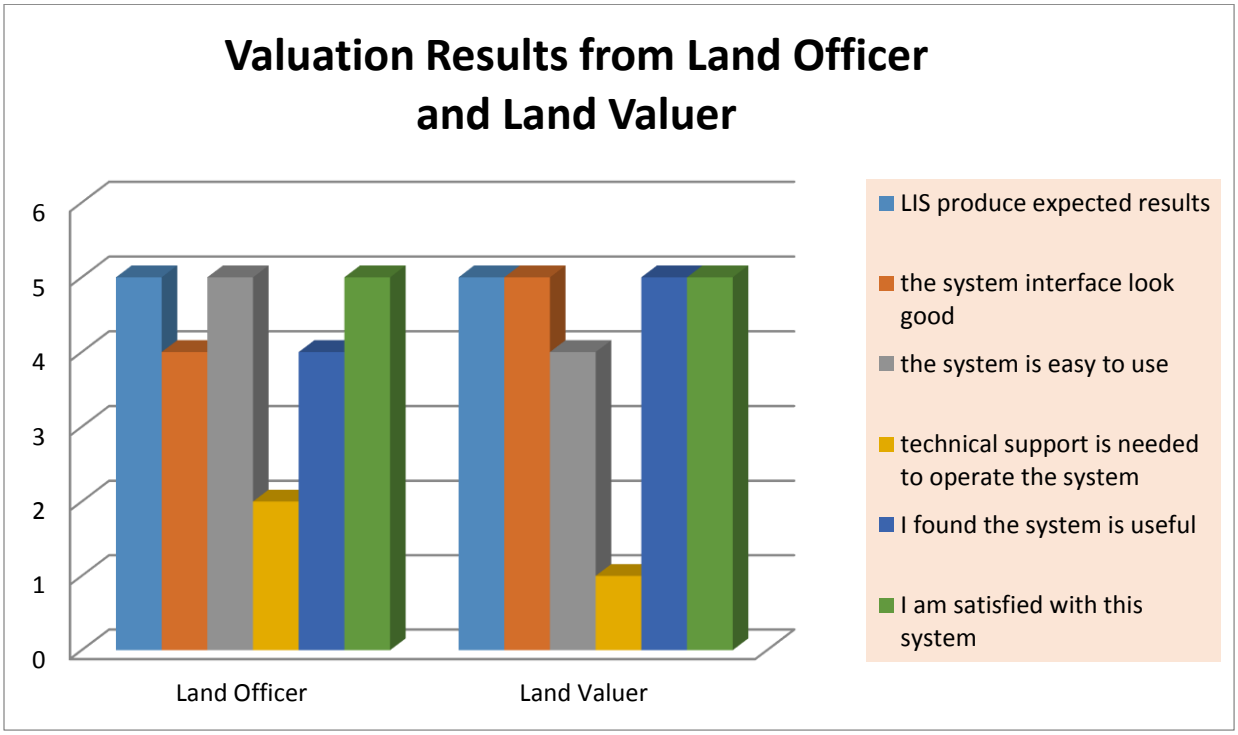


Figure 27. Evaluation results from Land Officer and Land Valuer

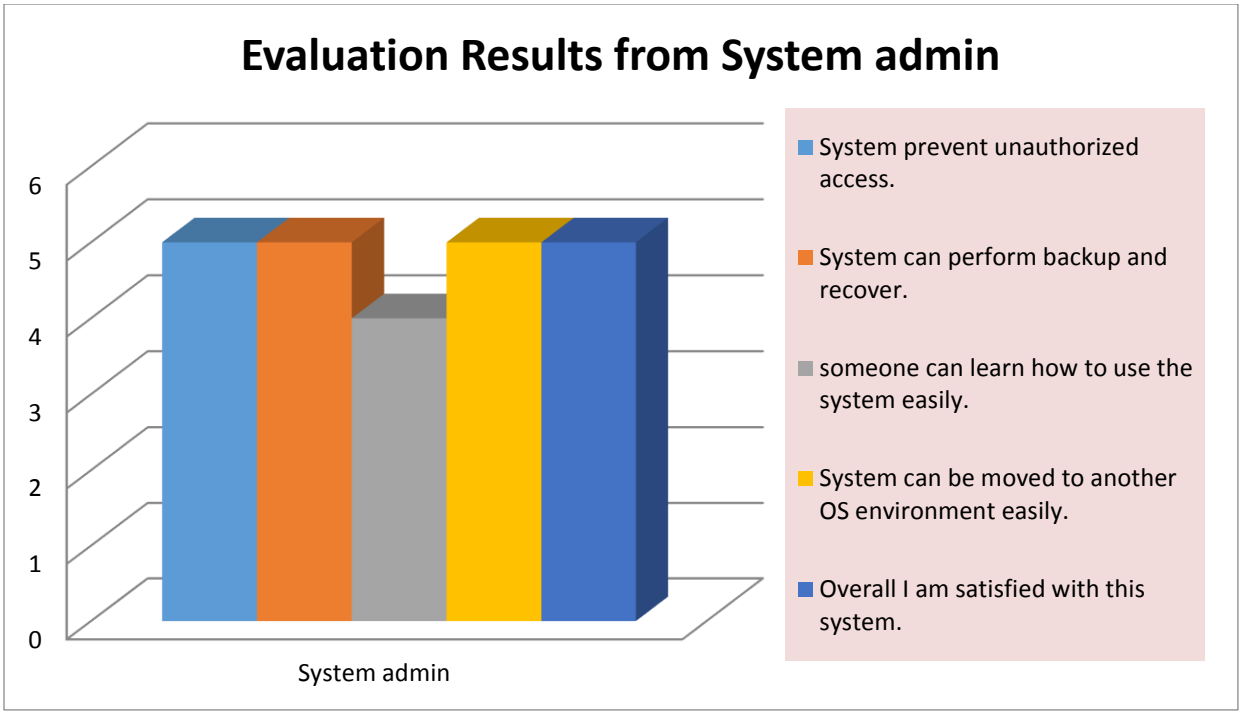


Figure 28. Evaluation results from System admin

4.7. Conclusion

Land information system as whole is a very big system. But the proposed land information system focuses on two main areas which are allocation of land uses and valuation. This is due to the fact that the research finds the necessity of having LIS particularly on these areas at the districts, so that to reduce the impacts of the problems caused by the absence of the LIS at the districts, impacts such as land conflicts, under or over valuation. Development tools used to develop the system were selected based on the availability, cost, and ability to develop effective and efficient system as well as the technique that is fast and can develop high quality system. Researcher put into consideration the usability of the system and user friendly interfaces were developed so that system users can easily operate the system. Some security concerns were also implemented to the proposed LIS to ensure the integrity and accuracy of the land information. The system was also tested to verify that it works properly. System users also provided their views on the system which all of them strongly agreed with the proposed system as shown on the figures 27 and 28.

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1. Discussion

Conventional method of handling land information and manual evaluation analysis is still used at the districts land offices. These methods cause a lot of problems in land administration such as delaying delivering land services and unfairness of land/property valuation.

The proposed LIS was designed and developed according to requirements and business processes of the land office at the districts in Tanzania. According to UNECE (1996), to develop an effective and efficient LIS, user requirements must be well understood. European countries started the use of LIS long time ago, but many of them were failing to meet user requirements and hence fail to deliver the proper land services to the customers. Developing countries can learn much from western experiences, they need however to build their own systems within their own social, economic and cultural environments UNECE (1 996).

The proposed LIS significantly facilitate operations of the allocation of land uses and valuation. It provide robust and secure repositories to manage the significant volumes of land information in a distributed environment and supports efficient searching and querying of the information.

The increased value for both land and land related properties as well as a fast growing population increased high demand of land administration information and contributed to complexity in land management issues Mwaikambo and Hagai (2013). The proposed LIS is an integral tool to meet these demands due to fact that it can significantly support greater access to and sharing of information, improve data quality and completeness, increase security and transparency of operations and information, increase revenue to the government by supporting valuation process, and provide a basis for monitoring and evaluation.

5.2. Conclusion

The proposed land information system has two main contributions to the land administration at the districts in Tanzania that are: facilitates allocation of land uses and supports valuation process. In facilitating allocation of land uses the proposed LIS enable land officers to manage the uses of the land. With this tool it easier to know which parcel of land is demarcated for which uses such as agriculture or conservation area, industrial etc. which areas are free and can be given to investors. By supporting valuation process, the proposed LIS allows land valuer to easily perform valuation analysis, generating reports which help to implement the proper tax and hence increase revenue to the government.

Generally the proposed LIS has tremendous value in land use planning and management in terms of ensuring the availability of land information for planning, analysis of growth and development trends, monitoring land resources. LIS can also lead policy and decision makers to reach the good decisions for the better land administration in Tanzania.

5.3. Recommendations

This research was conducted to improve the efficiency and effectiveness of the land administration at the district level, in other words to replace the conventional tools used in keeping and processing land information specifically valuation and allocation of land uses information by the modern technology i.e. the LIS. Due to the limited time and scope, not all important components of the LIS were made. There is a need of integrating more components to LIS to make it more effective such as land tenure, land markets etc. But also the proposed system excluded other stakeholders such as customers to from accessing the open land information. Further studies are needed to improve the proposed system so that customers can be able to access the open land information or make inquiries without the need to visit the land offices at the districts and hence improve the customer participation in land administration. This can be achieved by the use of integrated web or mobile applications.

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APPENDICES

Appendix 1: Interviews Questions list guide

Land officer questions guide list.

Existing situation.

1. What activities are involved in land use planning and management?
2. What challenges do you face during planning?
3. Who are key stakeholders in formulating a land use plan?

Land conflicts

4. Are there land conflicts in this district?
5. What are the sources of land conflicts in this district?
6. Who are most involved in land conflicts in this district?

Need for the System.

7. How do you store land information? And what type of data.
8. What type of data are most requested by customers/stakeholders?
9. Is the system on land information necessary?
10. What challenges do you face with the current methods of keeping land information?

System functionalities (Functional requirements).

11. What are the questions on land information should the system be able to answer?
19. What specific outputs should the system generate?
    a. Information
    b. Reports
    c. Forms
    d. Maps
    e. Others.
20. Do you think the system would have an impact on mitigating land conflicts?
21. Do you think the system would have an impact on land management issues?

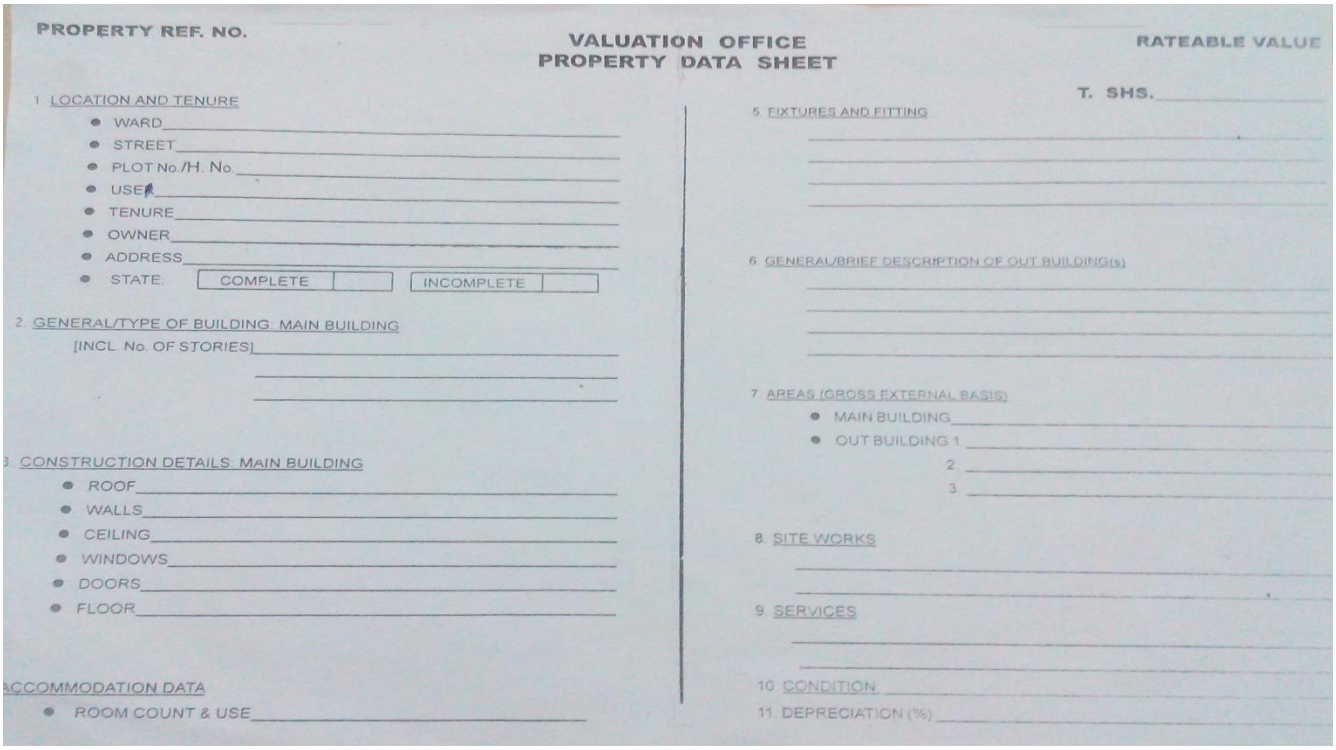
Data.

22. What type of data do you use to formulate land use plan?
23. Where does the district get the data?
24. How are they stored and organized?

Land valuer questions guide list.

1. What are the processes in doing valuation?
2. What are the types of valuations?
3. What are needed to be valued in valuation process?
4. What approach do you use in valuation analysis?
5. How do you keep valuation information?
6. What are the challenges do you face with the current valuation approach?
7. What challenges do you face with the current valuation records keeping?
8. What other activities do you perform during valuation?

Appendix 2: Data collection tools and storage management at the districts.



PROPERTY REF. NO.

VALUATION OFFICE
PROPERTY DATA SHEET

RATEABLE VALUE

T. SHS.

1. LOCATION AND TENURE
- WARD
- STREET
- PLOT No./H. No.
- USE
- TENURE
- OWNER
- ADDRESS
- STATE: COMPLETE | INCOMPLETE

2. GENERAL/TYPE OF BUILDING: MAIN BUILDING
[INCL. No. OF STORIES]

3. CONSTRUCTION DETAILS: MAIN BUILDING
- ROOF
- WALLS
- CEILING
- WINDOWS
- DOORS
- FLOOR

ACCOMMODATION DATA
- ROOM COUNT & USE

5. FIXTURES AND FITTING

6. GENERAL/BRIEF DESCRIPTION OF OUT BUILDING(s)

7. AREAS (GROSS EXTERNAL BASIS)
- MAIN BUILDING
- OUT BUILDING 1
2.
3.

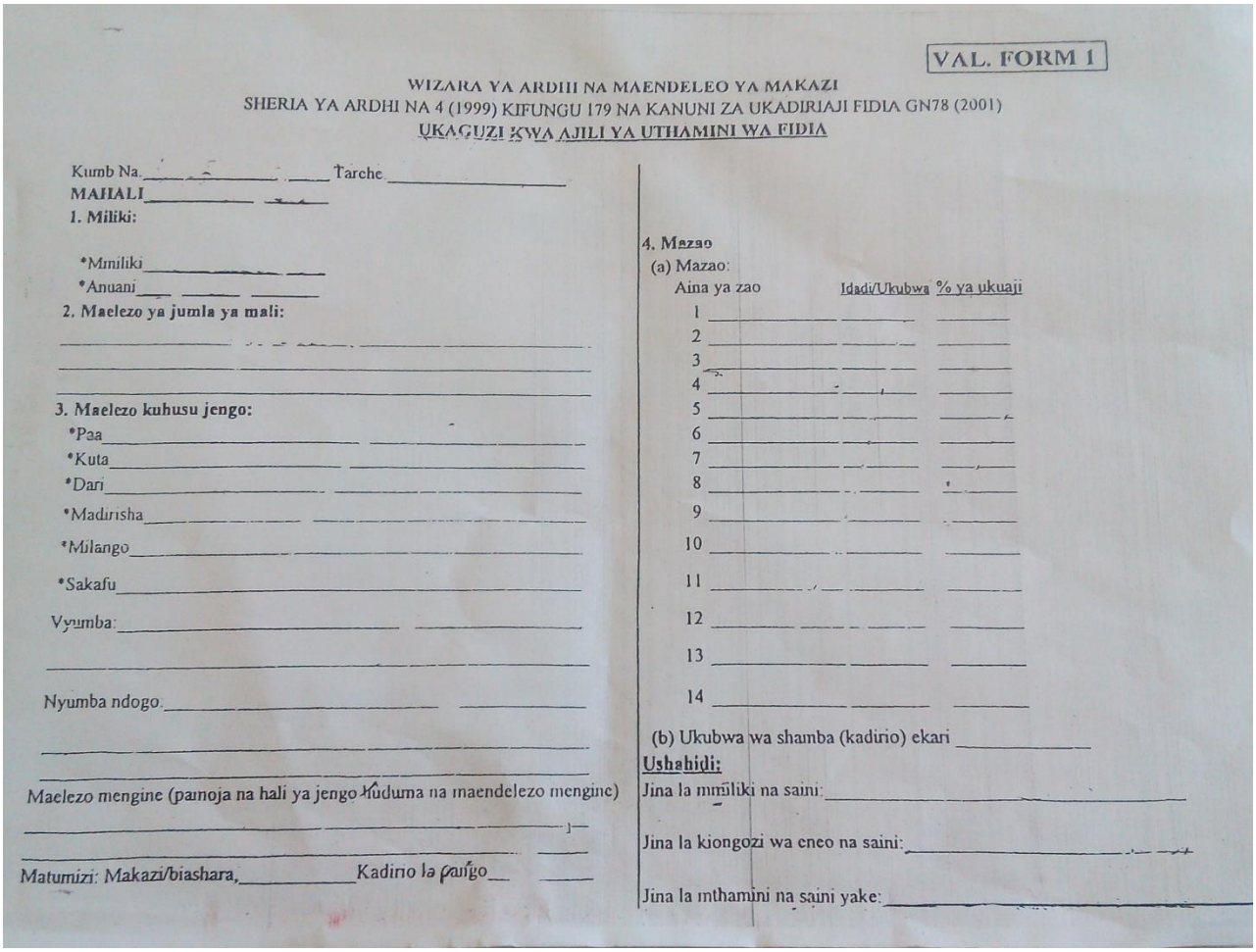
8. SITE WORKS

9. SERVICES

10. CONDITION

11. DEPRECIATION (%)

Valuation data collection form at Arumeru district.



VAL. FORM 1

WIZARA YA ARDHI NA MAENDELEO YA MAKAZI
SHERIA YA ARDHI NA 4 (1999) KIFUNGU 179 NA KANUNI ZA UKADIRIAJI FIDIA GN78 (2001)
UKAGUZI KWA AJILI YA UTHAMINI WA FIDIA

Kumb Na. _____ Tarehe _____
MAHALI _____
1. Miliki:

*Miliki _____
*Anuani _____

2. Maelezo ya jumla ya mali:

3. Maelezo kuhusu jengo:
*Paa _____
*Kuta _____
*Dari _____
*Madirisha _____
*Milango _____
*Sakafu _____
Vyumba: _____
Nyumba ndogo: _____
Maelezo mengine (pamoja na hali ya jengo Huduma na maendelezo mengine)
Matumizi: Makazi/biashara, _____ Kadirio la gafigo _____

4. Mazao
(a) Mazao:

	Aina ya zao	Idadi/Ukubwa	% ya ukuaji
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			

(b) Ukubwa wa shamba (kadirio) ekari _____
Ushahidi:
Jina la mmiliki na saini: _____
Jina la kiongozi wa eneo na saini: _____
Jina la mthamini na saini yake: _____

Compensation valuation form used at the districts.

Mapendekezo ya gharama za viwanja ni kama ifuatavyo:

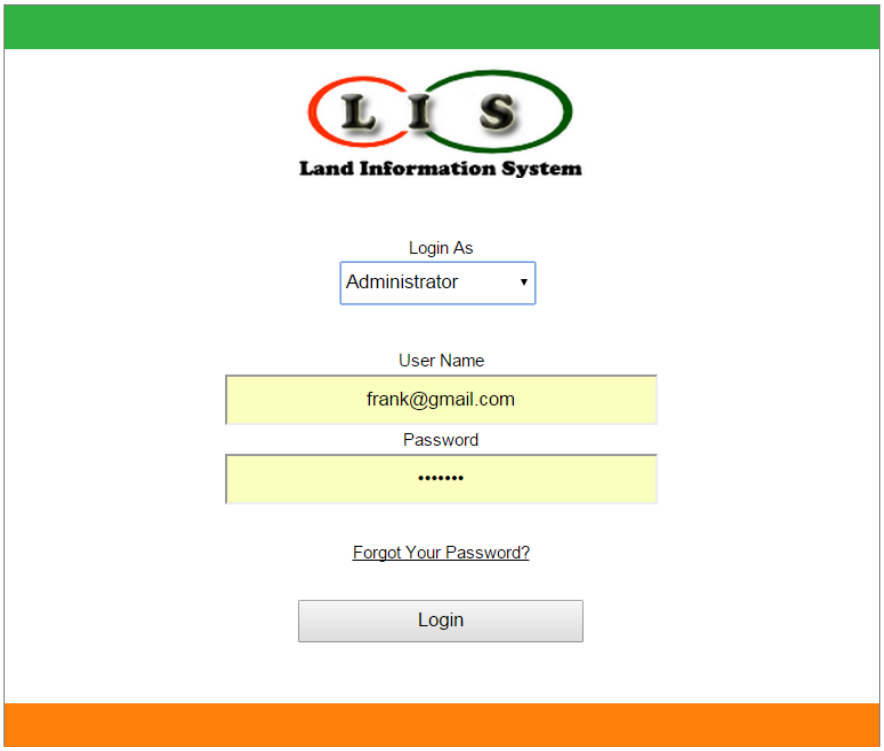
Matumizi ya Ardhi	Kiwango cha Zamani (Tshs kwa mita ya Mraba)	Kiwango Kipya (Tshs kwa mita ya Mraba)
Makazi	800	1200
Makazi na Biashara	1200	1500
Housing Estate	1500	2500
Nursery School	1000	1000
School	1000	1000
Petrol Station	5000	15,000
Hotel Site	1500	2500
Institutions	1000	1000
Service Industry	2000	3000
Public Building	1000	1000

Wallace Karia
Mkurugenzi Mtendaji
Halmashauri ya Wilaya Mvomero

Chart showing plot price per $M^{2.}$

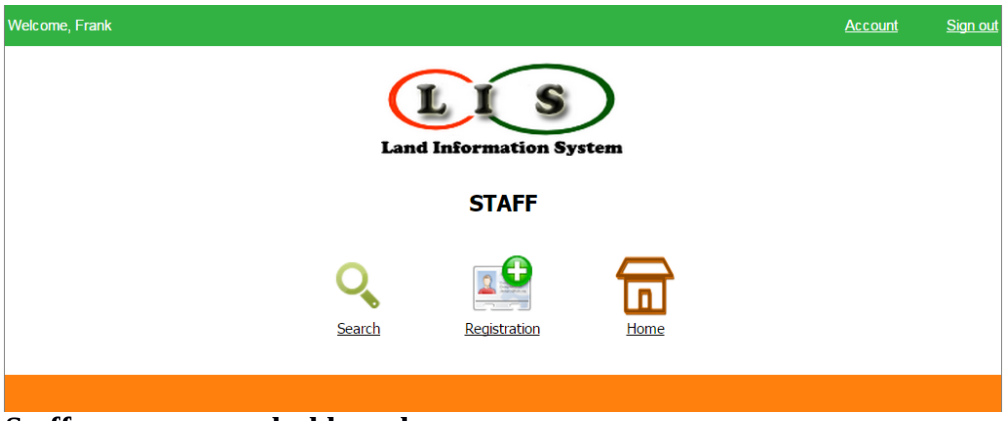
Shelves for storing land information at Arumeru district.

Appendix 3: User interfaces of the LIS.

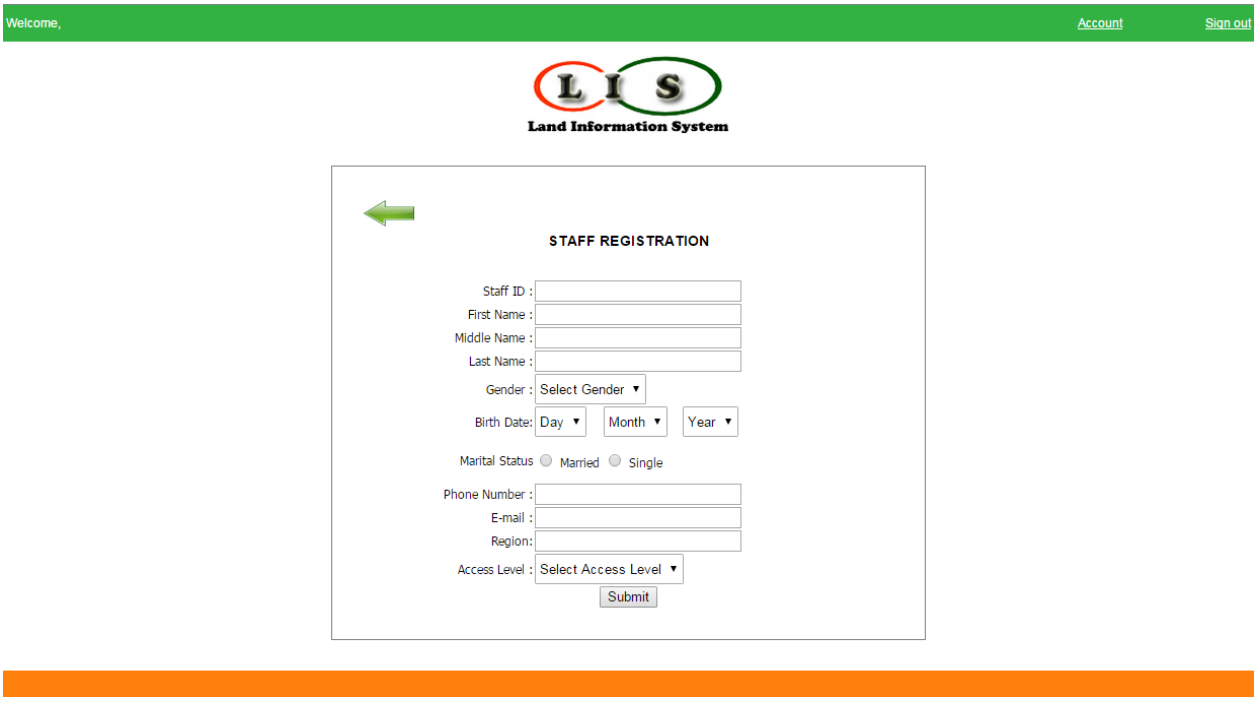


Login interface

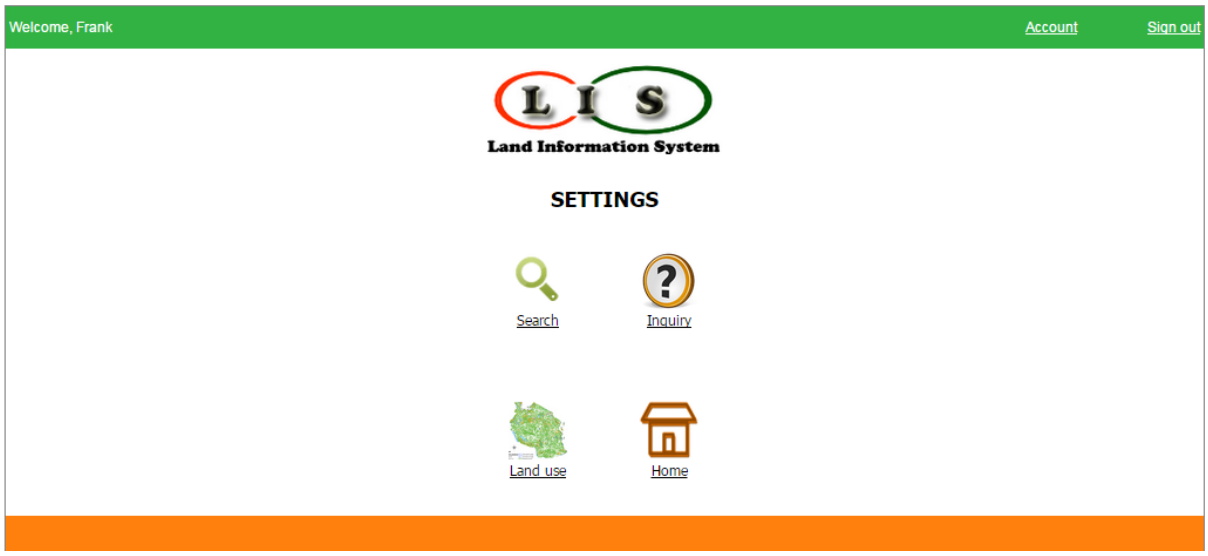
System admin dashboard



Staff management dashboard

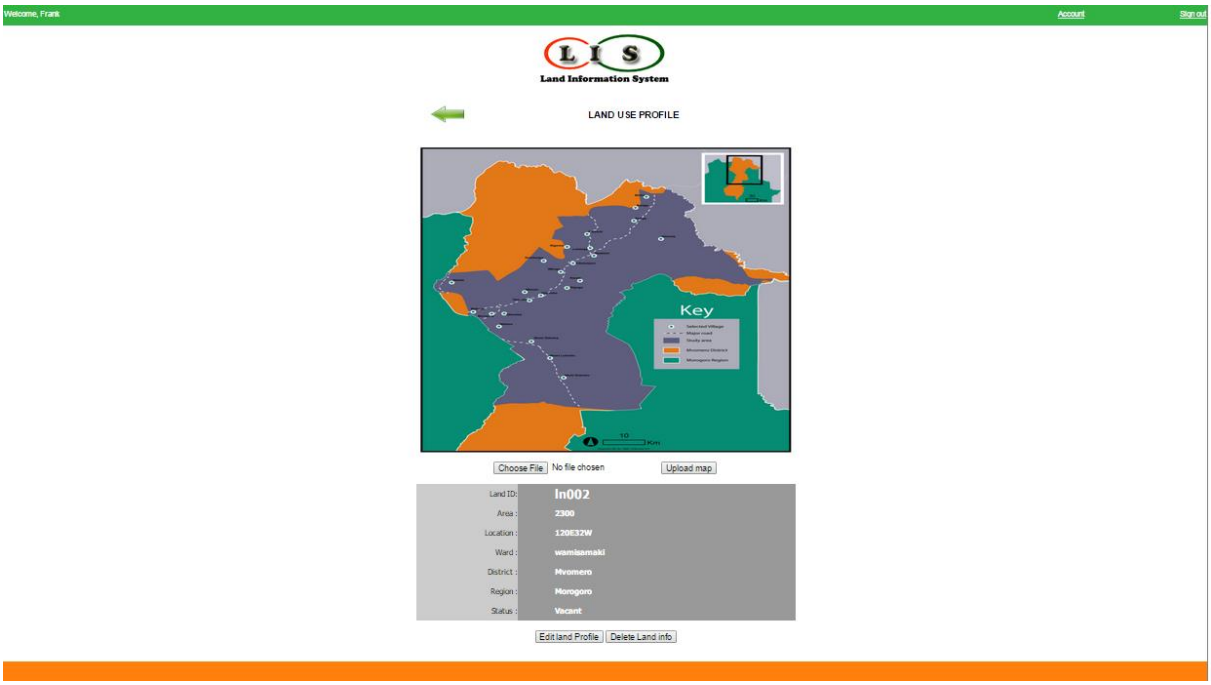


Staff registration interface

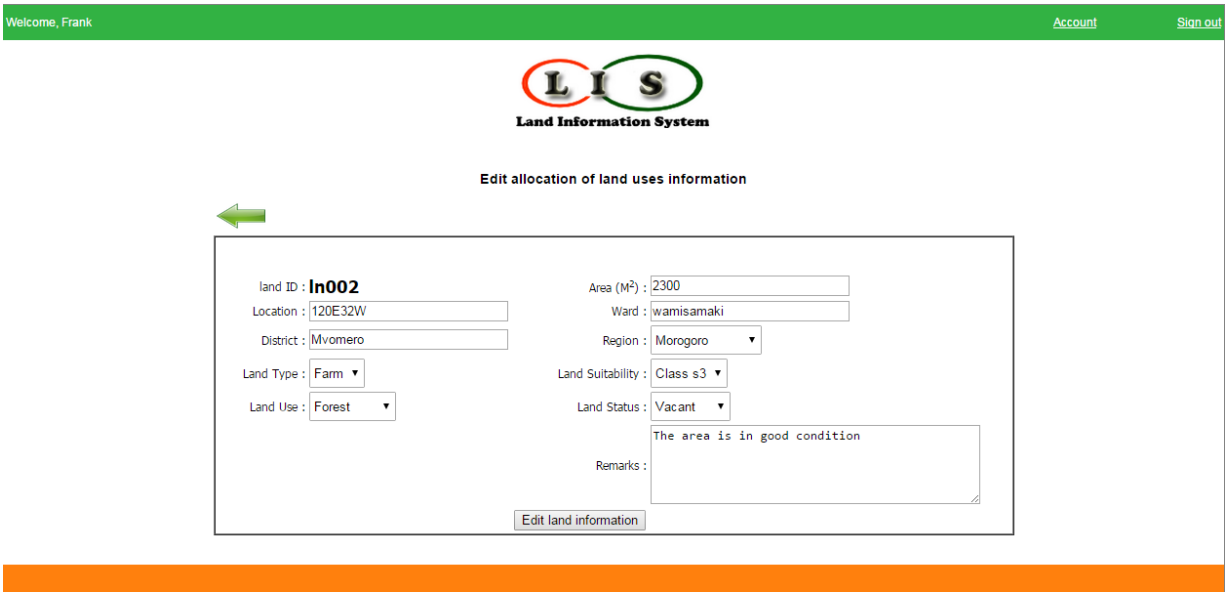


Settings dashboard

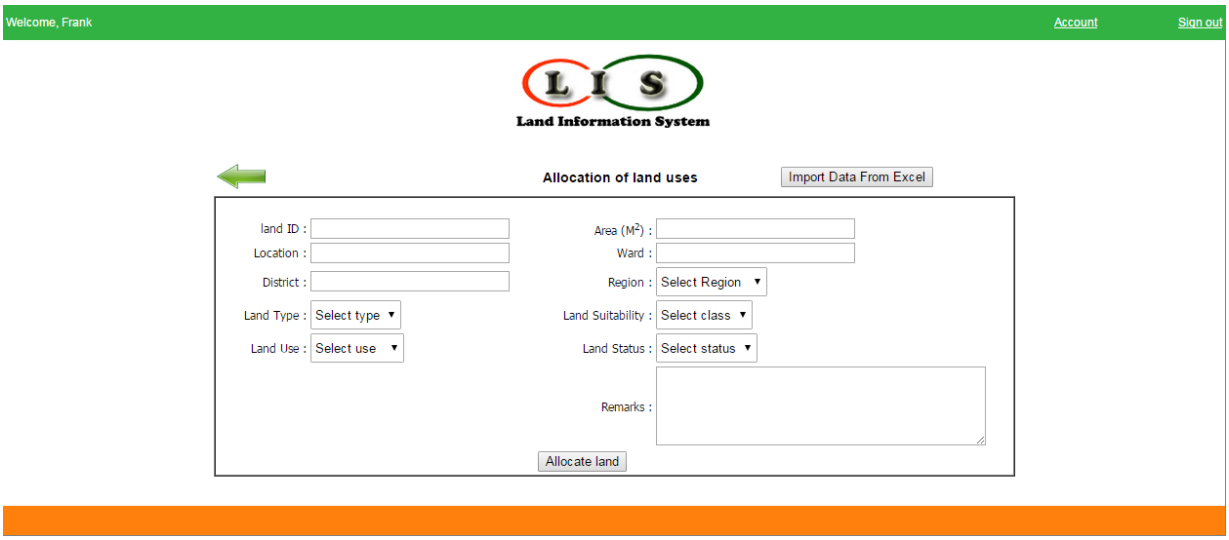
Land use allocation search interface



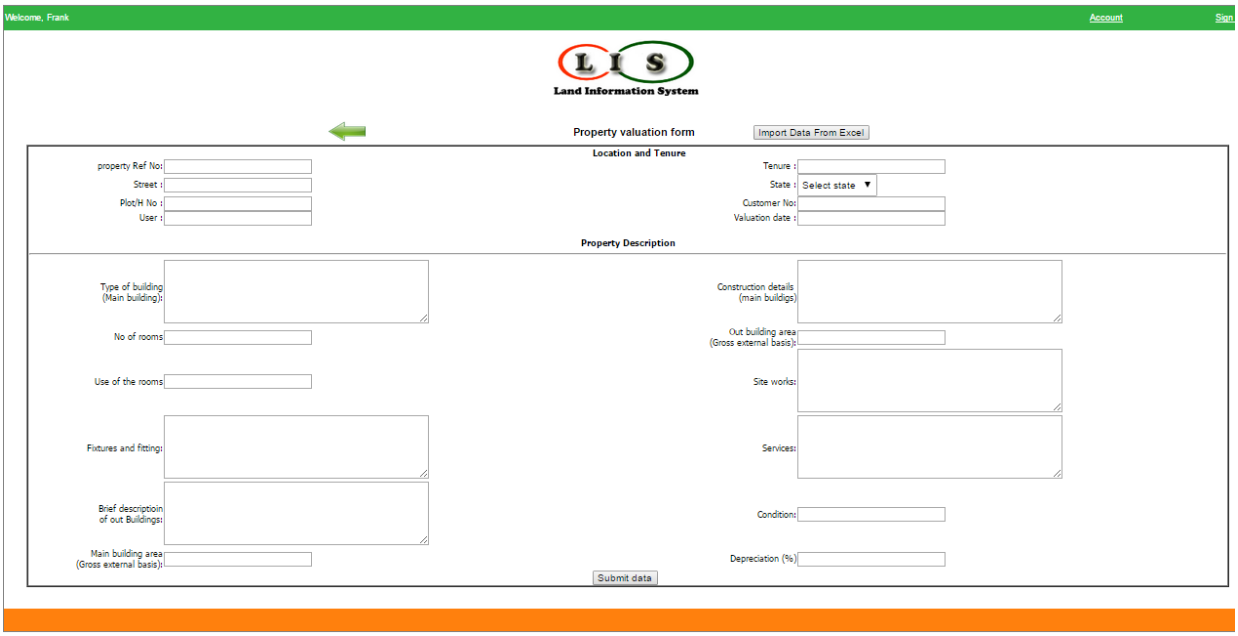
Land use profile interface



Interface for editing allocation of land uses information



Allocation of land uses data entry interface



Valuation data entry interface

Appendix 4: System Valuation forms.

RESEARCH ABOUT LAND INFORMATION SYSTEM FOR ENHANCING LAND USE PLANNING IN TANZANIA.
NELSON MANDELA AFRICANINSTITUTION OFSCIENCE AND TECHNOLOGY

Case study Arumeru and Mvomero districts

4.2.7

EVALUATION FORM FOR LAND OFFICER AND LAND VALUER

Introduction

I am Micky Thambikeni a master's student from NM-AIST Arusha. I am doing a research on development of Land Information System for enhancing land use planning in Tanzania. This evaluation form aims to validate the developed system by valuation participants test the system and provide feedback by filling this form.

5= Strongly agree 4 = Agree 3 = I don't know 2 = Disagree 1 = Strongly disagree

Please indicate the level of agreement with the following statements.					
	5	4	3	2	1
Does the LIS produce expected results?					
Does the system interface look good?					
Does the system easy to use?					
I think technical support is needed to operate the system					
I found that the system is useful					
Overall I am satisfied with this system					

Information about the system

RESEARCH ABOUT LAND INFORMATION SYSTEM FOR ENHANCING LAND USE PLANNING IN TANZANIA.
NELSON MANDELA AFRICANINSTITUTION OF SCIENCE AND TECHNOLOGY

Case study Arumeru and Mvomero districts

EVALUATION FORM FOR SYSTEM ADMIN

Introduction

I am Micky Thambikeni a master's student from NM-AIST Arusha. I am doing a research on development of Land Information System for enhancing land use planning in Tanzania. This evaluation form aims to validate the developed system by valuation participants test the system and provide feedback by filling this form.

5= Strongly agree 4 = Agree 3 = I don't know 2 = Disagree 1 = Strongly disagree

Information about the system

Please indicate the level of agreement with the following statements.					
	5	4	3	2	1
Does the system prevent unauthorized access?					
Can the system backup and recover data in case of failure?					
Can someone learn how to use the system easily?					
Can the system be moved to another environment easily?					
Overall I am satisfied with this system.					

Appendix 5: Permission to conduct research.

THE NELSON MANDELA
AFRICAN INSTITUTION OF SCIENCE AND TECHNOLOGY
(NM-AIST)
School of Computational and Communication Science and Engineering

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E-mail: dean-cocse@nm-aist.ac.tz

Tengeru
P.O. Box 447
Arusha, TANZANIA
Website: www.nm- aist.ac.tz

OUR Ref.No.NM-AIST/M177/T.13/ Date: 8th MAY 2015

To Who it May Concern,

Dear Sir/ Madam,

RE: INTRODUING Mr. MICKY THAMBIKENI FOR ASSISTANCE IN HIS RESEARCH WORK.

Kindly refer to the subject above.

This is to request for assistance to Mr. Micky Thambikeni, a Master's student at the School of Computational and Communication Sciences and Engineering (CoCSE) of Nelson Mandela African Institution of Science and Technology (NM-AIST), and to introduce him to your organization.

Mr. Micky Thambikeni is pursuing Master's degree in Information and Communication Science and Engineering at Nelson Mandela African Institution of Science and Technology.

His research title is "Management Information System for enhancing Land use Planning in Tanzania". On behalf of NM-AIST, I request your organization to accord him with the utmost assistance he might need in undertaking his research work.

Yours Sincerely,

Dr. Martin Kimanya.

Dean of School.