ARDHI UNIVERSITY

ANALYSIS OF 3D CADASTRE IN TANZANIA AND ITS EFFECTS TO THE LAND TENURE SECURITY

A Case Study of Dar Es Salaam City

NDUNGI, PROVIDENCIUS M.

BSc. Geomatics

Dissertation

Ardhi University, Dar Es Salaam

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A Dissertation Submitted to the Department of Geospatial Sciences and Technology in Partially Fulfilment of the Requirements for the Award of Science in Geomatics (BSc. GM) of Ardhi University

CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance by the Ardhi University dissertation titled **"Analysis of 3D cadastre in Tanzania and its effects to the land tenure security"** in partial fulfillment of the requirements for the award of degree of Bachelor of Science in Geomatics at Ardhi University.

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MR. GWALEBA METHOD J.

Supervisor

Date ……

DECLARATION AND COPYRIGHT

I, NDUNGI, PROVIDENCIUS M. hereby declare that, the contents of this dissertation are the results of my own findings through my study and investigation, and to the best of my knowledge they have not been presented anywhere else as a dissertation for diploma, degree or any similar academic award in any institution of higher learning.

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NDUNGI, PROVIDENCIUS M.

22816/T.2019

(candidate)

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DEDICATION

I dedicate this dissertation to my beloved Family; Mr. and Mrs. Ndungi, especially to My Mother MARIA LAZARO NDUNGI for her love, advice, care and financial support she provided to me throughout my 4 years of university studies. Nothing to give back rather than letting her know my sincere love for her.

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ABSTRACT

Tanzania is the one of the highest developing countries in Africa, the population rate in her cities is high, therefore the demand of land use in the cites is high compared to the land capacity, so the trend of using 3D land property system of ownership became more commonly used. But the system of land management in the country is a bit challenge to a such system of land development because it deals only with properties on the surface of the land. The system used is traditionally based (2D cadastre) that means it does not support 3D cadastral data and vertical subdivision of parcel.

The research intends firstly to investigate how does our cadastral system deals with this kind of 3D land development. The research also had to study the satisfaction of our system on the tenure security especially to the 3D land property ownership. Analysis of current/existing cadastral system used in Tanzania was also done as an objective in the study to see how it operates and affect land users in the country in general.

The research was done in Dar Es Salaam within 3 municipals which were Ilala, Kinondoni and Temeke Municipal Councils. The total of 92 people were used as sample size in which 80 were landholders used in questionnaire method (30 from Ilala and Kinondoni and 20 from Temeke municipals) and 12 were land officials used in interviews (5 from Ilala, 2 from Kinondoni and Temeke and 3 from the ministry of lands Dar Es Salaam). Through questionnaire, interview and literature review as the methods of data collection in the research, data were collected, processed and analyzed. This was done using Statistical Package for Social Science (SPSS) and Microsoft Excel Softwares and presented through graphs (Bar Graphs).

The research found that our system of cadastral registration is parcel based and it is 2D in nature. The system lacks Spatial information management models and 3D cadastral database to support 3D mapping so order to facilitate the continued establishment of engineering projects below and above the surface, and particularly to enable the registration of properties that are not on the surface, it is necessary to amend the legislation and define a new spatial and 3D cadastral model where by in a combine is what we call 3D cadastre.

Keywords: 3D cadastre, cadastral system, 3D land use and 3D land property.

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ACRONYMS AND ABBREVIATIONS

MLHHSD	Ministry of Lands, Housing and Human Settlements Development
3D	3 Dimensional
LTS	Land Tenure Security
UTA	Unit Titles Act
MOLIS	Ministry of Land Information System
ILMIS	Integrated Land Management Information System
SOT	Security Of Tenure
SPSS	Statistical Package for the Social Sciences
CS	Cadastral System

CHAPTER ONE

INTRODUCTION

1.1 Background

Cadastral systems have been developed and implemented by governments across the world. These systems are used to assist land and property decision-making across government, businesses, and communities by using land surveying techniques to convey the most complete depiction of land parcel and property boundaries, which is known as cadastral information (Dale & McLaughlin, 1999). Current cadastral systems rely heavily on 2D base maps and survey plans known as traditional cadastral system which fall short of meeting future land development demands and community expectations.

In the beginning of the 20th century, when regular utilization of space above surface started for high-rise constructions and aviation, the question regarding whether such space could be subdivided into separate units for ownership had to be discussed. In recent decades, there has also been an increasing interest in the utilization of property rights in spaces both above and below ground level (Paulsson, 2007).

Several countries have the possibility of using three-dimensional ("3D") property formation, each with its own individual system, but with many similar problems and difficulties (Paulsson, 2007). 3D properties are often considered as being a special kind of property, separate from the traditional two-dimensional ("2D") property, even though many countries have integrated these two types of property within the same legislation. Due to this, and the particularities connected with 3D properties, 3D properties are often studied as a subject of their own. This type of property was recently introduced in Sweden on 1st January 2004, the underlying motive for the research upon which this work is based (Paulsson, 2007).

Due to increase of population and development of the cities together with advancement of technology many countries opted to use this system of cadastre (3D cadastre). This is due to the demand of land for land use and land development (Stoter, 2004). This cadastral system has been developed and implemented by governments across the world such as New Zealand and Australia though there are some difficulties and challenges in implementing this system from 2D cadastre.

When you read on GIM International Article "3D Cadastre in Victoria Australia", The analysis of current practices of 3D representation in Victoria identifies complexities found in different types of plans in terms of 3D and vertical information. These are like vertical information only exists in

cross-sectional diagrams, paper plans do not support 3D analysis some rights, restrictions and responsibilities cannot be spatially represented in the plans and some rights, restrictions and responsibilities cannot be spatially represented in the plans. So overall, improvements are essential if 3D plans of subdivision are to be capable of representing the actual 3D situation. Although this registration method is effective for registering and securing 3D properties in Victoria, the 3D cadastre could improve, represent and manage 3D properties and additionally create 3D visualization possibilities. 3D analysis would also operate on 3D data to perform different applications.

Tanzania as the one of the developing and growing up countries in Africa, the rate of growth of her cities and towns is high, therefore the demand of land and the use in the cites is high compared to the capacity so the trend of using 3D system of ownership (i.e., With vertical dimension) became more commonly used. Example the division of apartments where you find the ground floor is used for commercial space and the upper floor is used for residential space.

Land tenure security is a critical issue in many developing countries, including Tanzania. Land tenure is the one that describes land ownership system in Tanzania.

Tanzania has long struggled with land tenure insecurity, with many citizens unable to establish or verify land ownership. This has led to land disputes, illegal land grabbing, and reduced economic development. In an effort to address these issues, the government of Tanzania has implemented a 3D cadastre system However, it is not clear to what extent this system has been successful in achieving its goals because it's not official cadastral system approved in a country.

1.2 Statement of The Problem.

Population density increase make land use more intense. This trend has caused a growing importance of ownership of land, which has changed the way humans relate to land (Stoter, 2004). Now due to the increase of population and advancement of cities in Tanzania, the 3D land development becomes common, where by the management of 3D land Rights, Restrictions and Responsibilities (3D RRR's) are vital. However, in Tanzania, there is limited data availability on progress made in implementing 3D cadastre, making it difficult to provide some information to landholders. The research therefore aims to link our existing cadastral system towards 3D cadastre.

1.3 Objectives.

1.3.1 Main Objectives

To analyze 3D cadastre in Tanzania and its effects to the land tenure security.

1.3.2 Specific Objectives.

i. To study the existing/current status of cadastral system in Tanzania.
ii. To investigate the satisfaction and challenges of Tanzania cadastral system on 3D land property ownership.
iii. Assessing the demand of 3D cadastral system in Tanzania in relation to LTS.
iv. Propose recommendations for introduction of 3D cadastre in Tanzania for effective LTS.

1.4 Significance of The Research.

1. This research is of great importance for the government of United Republic of Tanzania under the Ministry of Land, Housing and Human Settlements Development to assess this new invention of cadastre (3D cadastre) on their way to official implementation of the system in the country.
2. This research is also of great importance to the land survey profession since it shows the current situation in surveying in our country compared to the new techniques and technologies on how far the world is especially in surveying specifically in 3D property surveying together with mapping of 3D properties.
3. The proposed research is significant because it provides a detailed analysis of the implementation of 3D cadastre in Tanzania and its effects on land tenure security. The findings of the research will be useful for the government of Tanzania, land surveyors and landholders in Tanzania.
4. The research is also of interest to other developing countries that are considering implementing 3D cadastre systems as a way to improve land tenure security.

1.5 Beneficiaries.

The following are the ones going to benefit from the research

1. The government of Tanzania.

The findings of the research are of great importance to the government to identify challenges in our cadastral system towards 3D land property management and how far we have reached to the

3D cadastral information management, hence they can be at good position to formulate some policies basing to the reality situation in the country.

2. Survey industry.

Survey industry under the Ministry of lands can also benefit from this research as a call up for them to know the demand of the community and where now the world is on land use development so they can come up with new techniques on 3D survey.

3. Landholder.

Landholders are the beneficiaries of the research as far as they are the owners and developer of 3d land ownership so they are also in the chain of the 3d cadastral system.

4. Countries planning to implement 3D cadastre and other researchers

This research can be as a reference to the developing countries who are advancing to 3d cadastral to study how Tanzania we are dealing with 3D land ownership.

1.6 Scope and Limitation.

This research covers the definitions of the key concepts in the study and the general concepts concerning cadastral survey and cadastral system specifically 3D cadastre also the concept of land tenure and land tenure security and the impacts towards each other. This research aims at analyzing on how Tanzania system of recording and managing the land information deals specifically in 3D land ownership for effective security of tenure to the land owners against the forcible evictions. This research therefore aims to link our existing cadastral system towards 3D cadastre.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents both theoretical and empirical review on analysis of 3D cadastre in Tanzania and its effects to the land Tenure security. The chapter provides for literature review to explain the research project gap and to obtain the relevance of project topic by providing evidence on how other researchers have said about the same issue. From this chapter we are going to see how the project will come with new findings which are different from others who did investigation on the same issue but did not speak on this project problem.

2.2 The concept of Cadastre (cadastral system).

A cadastre (also known as *cadaster*) is usually defined as a comprehensive register of the real property of a country or a designated area. The figure 2.1 describes the concept of cadastral as it employs the use of a cadastral map or cadastral survey including details of ownership, tenure, precise location sometimes using geographical coordinates, parcel dimensions, area and parcel values which are all stored and managed by the systems in computer. Cadasters are traditionally classified as either juridical or fiscal cadasters.

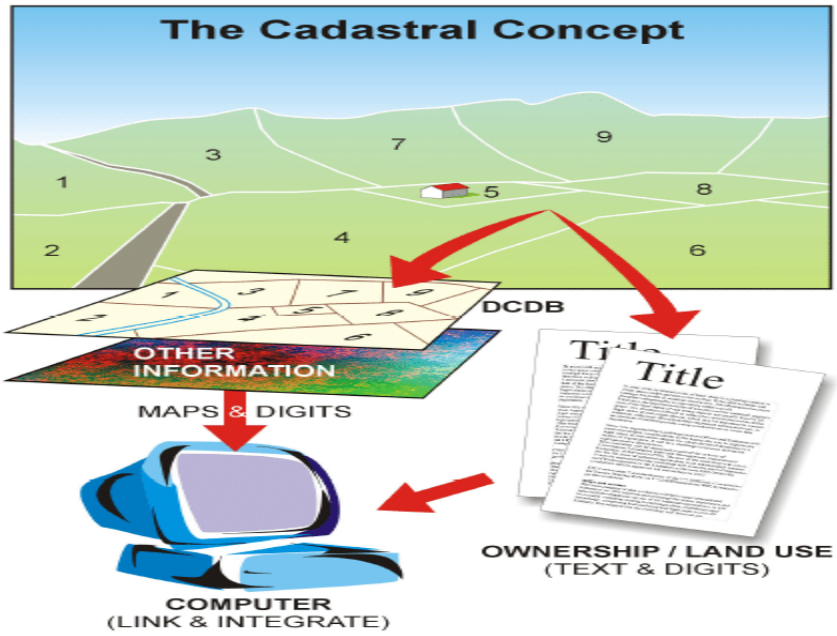

Figure 2.1. The concept of cadastral

Source: Yildiz Technical University Istanbul

Cadastre is the basic source of information for all aspects of land tenure and use, including the resolution of title and boundary disputes. In most countries, including the United States, extensive legal systems have developed around the original administrative systems and the records and information contained within those systems. In addition, cadastre has an important social function in serving as an archive that protects communities.

Cadastral system is purposely used to support land registration such that it can provide information on the use of land and on who is using the land over time, to facilitate efficient and accessible land, to support development of land information systems, to support land regularization and land reform and lastly to support secure land tenure and property rights.

2.2.1 Types of Cadastres.

Depending on their use, type, quality and quantity of data, cadastre can be divided into 3 types;

Fiscal cadastre

This is the record of information necessary for levying property taxes which includes location and value of parcel. A fiscal cadastre must include enough information to calculate a value using certain valuation method.

Legal cadastre.

This is the register identifying the legal owner and precise boundaries of each land parcel. Establishing a legal cadastre requires both fixing parcel boundaries through surveying, mapping and fixing legal rights which may involve negotiation among involved parties and a judicial determination of ownership (adjudication).

Multipurpose cadastre.

This is type of register that is use to assist in the management of land and land use such as planning and administration and enables sustainable development and environmental protection.

2.3 The concept of 3D cadastre;

Various definitions for 3D cadastre have been proposed by (Stoter, Oosterom, & Ploeger, 2004). In this research, the following definition is considered as a reference (Aien, 2013). “3D cadastre is a tool in a land administration system to digitally manage and represent stratified rights, restrictions, and responsibilities (legal objects) and their corresponding physical objects such as buildings, utilities, on, above or under the ground surface in 3D.

3D cadastre has the capability to capture, store, edit, query, analyze and visualize multicomplex properties (Fendel, 2001).

The figure 2.2 describes the concept of 3D cadastre in which land is vertically subdivided to the different owners (co-owners) who have equal rights of occupancy and common area underground shared by all the owners

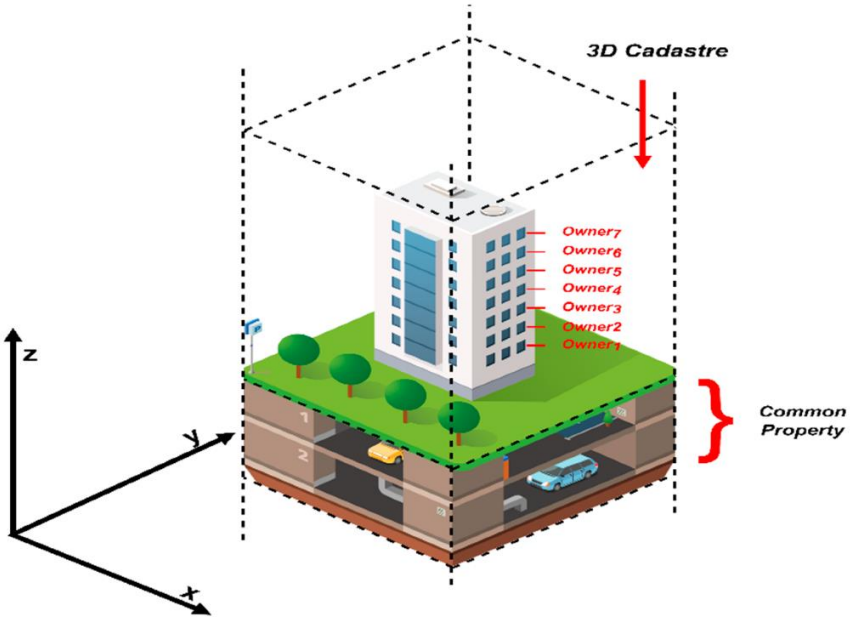

Figure 2.1. The concept of 3D cadastre

Source: Yildiz Technical University Istanbul

In addition to the above definition of 3D cadastre (3D property right) is defined as real property that is legally delimited both vertically and horizontally (Paasch et al., 2011). This definition allows for the inclusion of various types of 3D property in different legal systems. By considering these definitions, moving from a 2D to a 3D cadastre is an important topic that has attracted a lot of attention over the last decade (Grinstein et al., 2001).

3D cadastre also employs the use of a cadastral map or cadastral survey but in a 3D way or 3D views. 3D cadastre involves the use Spatial information management models and 3D cadastral database to support 3D cadastral data for 3D mapping (Benhamu & Doytsher, 2003) A successful cadastre should provide security of tenure, be simple and clear, be accessible and provide current and reliable information at low cost.

NOTE: The term cadastral is an adjective to describe the type of GIS dataset or map that contains property line information. For example, a cadastral map is a map showing the parcels and ownership information for a given area. The term cadastre is a noun that refers to a dataset that

contains the property information such as metes and bounds, dimensions, and property owner details. A cadastre, therefore, is a registry of all property for a given area. The word cadastre stems from the late Greek katastikhon (κατάστιχον) meaning a list or register.

2.4 The concept of cadastral surveying and mapping

Cadastral surveying is the discipline of land surveying that relates to the definition or re-establishment of land parcel boundaries. Land boundaries to survey include land parcel boundaries to obtain surveyed plots (cadastral surveys in urban areas) and land administrative boundaries.
Land administrative boundaries include

- Village boundaries
- District boundaries
- Regional boundaries
- National boundaries
- International boundaries

The surveyed boundaries are permanently marked on the ground using boundary markers called beacons. Cadastral surveying involves interpreting and advising on:

- Boundary locations
- The status of land
- The rights, restrictions and interests in property

This information is recorded for use on plans, maps and other documentation. Accurately recording the information is an important part of the cadastral surveying discipline. Cadastral surveying also involves the physical delineation of property boundaries and determination of dimensions, areas and certain rights associated with properties. This is regardless of whether they are on land, water or defined by natural or artificial features.

Cadastral surveys are generally performed to:

i. Subdivide land into two or more parcels.
ii. Re-establish boundaries of previously surveyed properties to:
    - Determine the physical extent of the land, or
    - Facilitate the transfer of the property.

The law states that cadastral surveys must be performed or supervised by a practicing licensed surveyor. Surveyors are licensed under the Surveying Act 2004, and must comply with the relevant

regulations, practice directives and best practice guidelines when performing the work and preparing the associated plans and survey documents. The government and community entrust licensed surveyors to maintain and protect the integrity of the cadastre, which underpins economic development through confidence in the property market.

Cadastral survey is important as;

- ✓ It provides a solution to land disputes by ascertaining positions of boundaries during demarcation, adjudication and boundary restoration.
- ✓ It Supplies land information needed for land use planning, land development control, land administration, land policy formulation and land reform.

Conclusively as land is a base for development, cadastral surveyors can make land development possible by just surveying land parcel since sustainable developments take place on surveyed lands.

2.4.1 Cadastral Plan

This is a sheet that shows the survey plan deposited when the title was created. Cadastral plan shows property's legal boundaries, area and dimensions, a detailed survey plan or a combination of both. The figure 2.3 is an excellent example cadastral plan, the detailed information relating to points along the boundary of both parcels of the land and two of adjoining roads are noted because 2 parcels of land are shown on one plan.

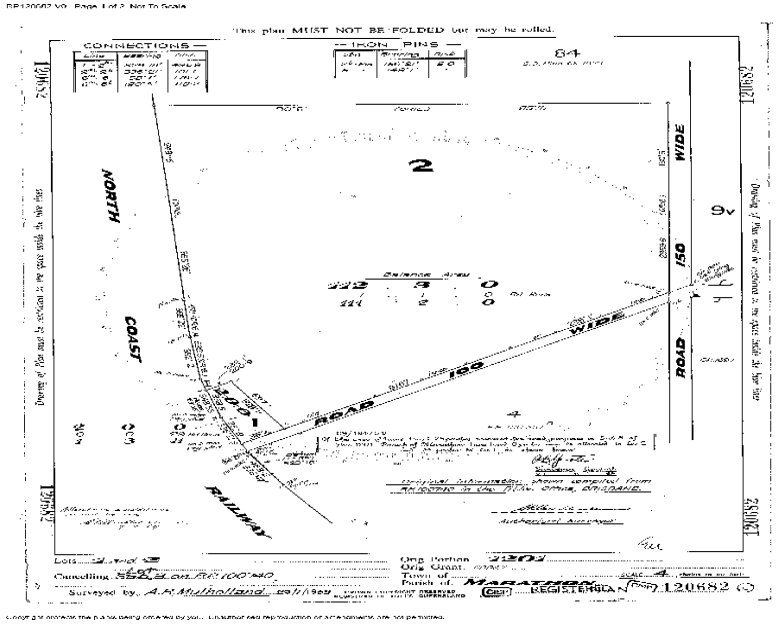

Figure 2.2. Example of cadastral plan

Source: Own illustration

2.4.2 Cadastral Map.

This is a map which provides detailed information about real property within a specific area. This is an essential component of a cadastre. It is a legal and spatial document showing positions of boundaries of cadastral parcel. It is a legal and spatial document showing positions of boundaries of cadastral parcel. Cadastral maps help to determine the location of a property, indicate the size and shape of a land parcel, and reveal geographic relationships that affect property value. Cadastral map is produced when joining together individual cadastral plans.

2.5 The overview of Land Tenure and Land Tenure Security.

The term land tenure is derived from the Latin word, tenure, which means to "hold". Thus, land tenure means a kind of system of land ownership or holding the land. Land Act (revised laws of Tanzania, 2002) under the New Tanzanian Land Law all land belongs to the public but is vested in the president as trustee for and on behalf of all the citizens of Tanzania. In Tanzania, for example, Land Act No. 4 of 1999 and the Village Land Act No. 5 of 1999 provide for two systems of land tenure, Granted Right of Occupancy (GRO) and Customary Right of Occupancy (CRO).

Land tenure defines a relationship between people and land and the types of relationship that are based on consent and agreement within the society, which may be anchored in statutory law, common law and customary traditions.

Now land tenure security or security of tenure is the certainty that a person's right to land will be recognized by others and protected in cases of specific challenges. This refers to the right of individuals or groups of people to effective protection by their government against forcible evictions. Without secure tenure, people are marginalized and vulnerable to being evicted from their land and excluded from society. People with insecure tenure face the risk that their rights to land will be threatened by competing claims and even lost as a result of eviction. Both the term of tenure and the length of the term can contribute to security of tenure (eg. Tanzania, we have the duration of tenure for 33, 66 and 99 years). The right to transfer (ownership rights) land implies greater security of tenure.

2.6 The concept of Unit Titles.

Unit titles are the most widely used form of multi-unit property ownership. They allow owners to privately own an area of land or part of a building and share common property with other unit owners such as lifts, generators etc. This combination of individual and shared ownership of land

and buildings, often in an intensive built environment, means owning a unit title involves a different set of rights and responsibilities than traditional house and land ownership.

Unit title properties in Tanzania are governed by the Unit Titles Act, 2008 and The Unit Titles Regulations, 2009; and are administered by a body corporate known as an Association. Unit Titles Act is the law governing building developments where multiple owners hold a type of property ownership known as a unit title. The Act was created to ensure the diverse and complex range of unit title developments are able to be managed more effectively; and also provide a clear and flexible mechanism for simple and complex developments to be created in the future something of which it has so far managed to achieve. It has managed to provide a modern legal framework for the joint ownership and management of land, buildings and facilities on a socially and economically sustainable basis by communities of individual owners.

2.7 The concept of Land.

Mankind always had a special relationship with the land, and with good reason, since it is a primary key to our existence. As suggested in the previous quote, land serves as the basic platform for life and source of nourishment, shelter, and energy for mankind. It also serves as the basis of income for humans. Reflecting that essential nurturing role, land has often been called "Mother Earth." As a result of the special relationship with and dependence on land, humans for long had a tendency to claim exclusive rights over tracts of land that they occupy, either jointly with other members of a tribe or community or as individuals.

Land can be defined in two broad ways that is; traditionally or non-traditionally (the latter is sometimes called the narrow definition of land). As defined by (Rwegasira, 2012) traditionally the term land involves a wider meaning and application as it includes the surface of the land (soil) and all other things on the soil which are considered to be part of the land by nature; such as rivers, streams, lakes, lagoons, creeks, mines and minerals, trees like palm trees, or by being unnaturally fixed to it like houses, buildings and any other structures. It also includes any estate, interest or any other right over the land for example, the right to collect herbs or to hunt. With this definition, a person without physically owning a piece of land may have a right to claim interest(s) over it.

The non-traditionally definition of land According to the land act of 1999 in the section 2, land is defined as "the inclusion of the surface of the earth and the earth below the surface and all substances other than minerals and petroleum forming the part of or below the surface, things naturally growing on the land, buildings and other structures permanently affixed to land.

In Tanzania, a person can have a legal right to land under a Right of Occupancy from the Government for terms of 33, 66 or 99 years. Nowadays generally only 99 years Rights of Occupancy are issued (Right of Occupancy).

All land in Tanzania is public land and remains vested in the President as trustee for and on behalf of all citizens of Tanzania. The Land Ordinance Act, Cap 113, of 1923 (Revised in 1957), all land, whether occupied or unoccupied, belongs to the Republic of Tanzania. The ability to establish and verify land ownership is crucial for economic development, poverty reduction and social stability.

Public land falls in 3 categories;

1. General land
2. Village land (eg. land occupied by Tanzanians of African descent under customary law)
3. Reserved land (eg. conservation areas and land for public utilities)

2.8 The concept of land administration

Land administration is a process of recording and disseminating info about land rights, value and use of land and its associated resources. Such processes include the determination (adjudication) of rights and other attributes of land, the survey and description of these. Then their detailed documentation and the provision of relevant information.

Core functions of land administration

i. Legal (registry) function: definition of rights (who has what rights); rules and procedures for adjudication, registration, re-registration, etc.
ii. Cadastral function: who has what rights gets spatial expression (i.e., where) in terms of location and this is often realized through surveying.
iii. Dispute resolution function: administrative hearings and rulings often accomplished in quasi-legal capacity and are often subject to appeals in formal judicial organs.
iv. Regulatory function: oversight on certain activities (e.g., land use or land development control) and professional services.
v. Fiscal function: Direct and indirect activities aimed at generating and collecting revenue. Land administration deal with making and implementing decision about the land. It is concerned with stewardship of land both for the present and future generation. Land administration serves various functions in a society as a result it has a political, economic and social dimensions.

2.8.1 Land Administration Process in Tanzania

Both the land Act, no 4 1999 and the Village Land Act, No. 5 1999 defines three categories of land: general land, reserved land, and village land (Sulle, 2015). The occupancy rights can be granted on general and village land in terms of Certificate of Rights of Occupancy (CRO) and Certificate of Customary Rights of Occupancy (CCRO) respectively (Larsson, 2006). All urban areas fall under general land, except the areas stipulated by laws as reserved land, or that considered as hazardous land. The same is governed by The Land Act No. 4 of 1999 and put under the control and jurisdiction of the commissioner for lands (URT (a) 1999). At LGA, the Commissioner for Lands is represented by land officials at various departments such as Land and Natural Resources Department at district level. These professionals include planners, surveyors, valuers and land officers who facilitate planning, surveying and titling activities (land delivery) to provide CROs to land holders. Similarly, the management and administration of village land is vested under the Village Council (VC). Thus, land officials at LGA level oversee land administration activities such as land use planning, farm demarcation and issuing CCROs by the village council and village assembly.

2.8.2 Building Permit Process in the Local Governments Authorities

The process of issuing building permits in local government authorities involves multiple stakeholders. A part from the applicant for building permit, a town planner is consulted in relation to plot use, coverage and building setbacks; a civil engineer is consulted for structural engineering; a geotechnical engineer may be consulted for soil properties; a land officer is consulted for ownership and a health officer advice on the sewage system.

The table 2.1 summarizes the procedures followed to obtain a building permit. These procedures are explained as follows:

- Requesting of build permit form
- Submission of architectural drawings to the land officer for approval of ownership over the plot
- Checking the drawing by town planer by considering the quality and standard of those drawings
- Submission of drawing to the district engineer for approval
- Submission of drawing to the health and environment to take copy of drawing and other copy are remaining to the office for references.

Table 2.1. Processing of building permit

Activity	Responsible person	Considerations
Drawing Scrutinization	- Town Planner	Plot use, Building-plot coverage and ratios and building setbacks
	- Civil Engineer	Structural/ Engineering drawings
	- Land Officer	Ownership
	- Surveyor	Boundaries
	- Health Officer	Sewage systems

Source: (Faustine, 2021)

2.8.3 The benefits of a good land administration system

The modern cadastre is not primarily concerned with generalized data but rather with detailed information at the individual land parcel level. As such it should service the needs both of the individual and of the community at large. Benefits arise through its application to: asset management; conveyance; credit security; demographic analysis;

Although land records are expensive to compile and to keep up to date, a good land administration system should produce benefits, many of which cannot in practice be quantified in cash terms.

These benefits are outlined below:

i. Support for land and property taxation

Good land records will improve efficiency and effectiveness in collecting land and property taxes by identifying landowners and providing better information on the performance of the land market, for example by identifying the current prices being paid for property and the volume of sales. Since the cadastre should provide full cover of the land, all properties can be included and none should be omitted. While not all countries seek to impose taxes on land or property, such fiscal measures are regarded by many as fair and just since they are perceived in effect as taxes upon wealth. They are relatively easy to collect in contrast for example to personal income taxes where earnings can be hidden.

ii. Guarantee of ownership and security of tenure

The compilation of land records and the judicial processes that must be gone through in order to bring land information onto the registers should provide formal identification and, in some systems, legal proof of ownership. The public registers should contain all essential juridical information allowing anyone viewing the system to identify third-party rights as well as the name

of the landowner. In some systems, such as the English registration of title to land, the State then guarantees the details recorded in the register, so that if a mistake were to occur, compensation would be paid. In others, the registers are treated as primary evidence rather than definitive proof. Thus, although there is technically no guarantee of ownership per se, the integrity of the system is sufficiently high for landowners to have full confidence in their rights.

iii. Protect State lands

In many countries the land that is held by the State for the benefit of the community is poorly documented. This is not a problem in countries where the State owns all land, but where there is private land ownership, that which remains in the possession of the State must be properly managed. In all societies the State is a major landowner and its property must be protected for example from encroachment by farmers onto land beside roads or from attempts by squatters to settle on vacant land that is being held for future use. The State needs to manage its property assets and to ensure their efficient use and upkeep every bit as much as does the private citizen. A system of registration of title to land will facilitate this.

iv. Reduce land disputes

In many countries disputes over land and its boundaries give rise to expensive litigation and all too often lead to a breakdown in law and order. Much time is taken up by the courts in resolving these matters, leading to delays in other parts of the judicial system. Land often cannot be put onto the market or put to better use without resolution of the disputes, since no potential investor is likely to wish to be committed to developing land where a lawsuit may be pending. The process of registering rights should prevent such disputes arising in the future, since at the time of first registration formal procedures should be followed that will resolve uncertainties.

v. Improve urban planning and infrastructure development

Urban centers need redevelopment and effective land-use planning and control. In many countries the control of development and the issuing of building permits are the responsibility of the local municipal authority. 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. The availability of up-to date large-scale cadastral plans of urban areas provides the basic framework within which development schemes can be planned and assessed and acceptable designs implemented.

CHAPTER THREE

METHODOLOGY

3.1 Introduction.

This part presents set of methods that are used in gathering and analyzing of the information in the research. This part is mainly focusing on explaining how this study was conducted and the project approaches through describing research design, study area, sampling of the respondents, data collection tools and methods and lastly data processing and analysis.

3.2 Research Design.

According to (Green & Tull, 2004), a research design is specification of methods and procedures for acquiring information needed. Research design clearly indicates the methods of data collection either within a quantitative or qualitative methodology as well as the techniques for data collection. In this research study, both qualitative and quantitative approaches have been used. The main techniques that are used in obtaining the information/data will be questionnaire, interview and focus group discussions.

3.3 Study Area.

The study was conducted in Dar es salaam city council at Ilala, Kinondoni and Temeke Municipal. Dar Es Salaam is a capital city of Tanzania with highest population growth with approximately population of 5.38M people. It is located at 6°48'S, 39°17'E and splitted into 5 districts which are Ilala, Temeke, Kinondoni, Ubungo and Kigamboni. The fact of high population and nature of land use in the city are the main factors made to select it as a study area.

The figure 3.1 highlights the three municipals in Dar es salaam within Tanzania which were used as the case study area. The yellow color in the map highlight municipals used in the study. The map was drawn by using QGIS software.

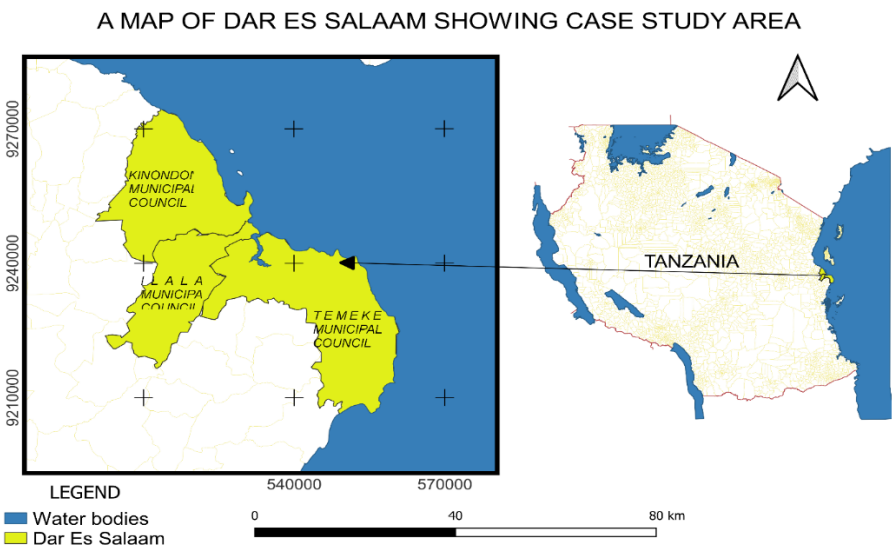

Figure 3.1. A map showing Dar es salaam as a study area

Source: Field source

The figure 3.2 is an example which shows how Dar Es Salaam is a suitable study area for analysis of 3D cadastre due to its unique cadastral characteristics. In particular, the city is characterized by rapid urbanization, high population density and complex land tenure systems which make it an ideal location to explore the challenges, strength and opportunities of implementing 3D cadastral system in relation to the land tenure security. Also, the mixing of land uses and wide range of building heights in Dar Es Salaam make is suitable for the study. Dar es salaam has diverse mix of land uses including residential, commercial, industrial and etc. This presents a significant challenge for traditional 2D cadastral system in terms of managing and maintaining accurate information on property right and interests.

Figure 3.2. Part of Dar Es Salaam with mixing land use

Source: Field source

3.4 Sampling of the respondents

3.4.1 Sample Size and Sampling Techniques.

Sample is a subset of a population used to represent the entire group of a whole population (Bartlett, 2001). Therefore, sample size is the act of choosing the number of observations to include in statistical sample. Thus, the sample size will include people within the city of Dar Es Salaam as a case study area which will involve landholders, land professionals (Municipal land surveyors and land administration officers). Thus, the sample size used was a total of 92 respondents in which 80 people were the landholders (30 from Ilala and Kinondoni Municipal each and 20 from Temeke Municipal), 5 land officials from Ilala Municipal Council, 2 land officials from Kinondoni Municipal Council, 2 land officials from Temeke Municipal Council and 3 land officials from Ministry of Land, Housing and Settlement Development.

3.4.2 Respondents Characteristics

The study explains the characteristics of respondents basing to the education level as summarized in the table 3.1. The table 3.1 shows that most of the respondents participated in answering the questionnaires which is 40% are of secondary education level which is beyond the minimal required education level in the country followed by 28.75% of post-secondary education. So, this proves that the data obtained in this study are valid due to the level of education from the respondents which made them understand the topic and questions which were asked to them.

Table 3.1. Social Demographic (N=92)

No	Variable	Ordinary People		Officials	
		N	%	N	%
1	**Education level**				
	No formal education	3	3.75	0	0.0
	Primary education	22	27.50	0	0.0
	Secondary Education	32	40.00	1	8.3
	Post-secondary Education	23	28.75	11	91.7
	TOTAL	**80**	**100**	**12**	**100**

Source: Field Work.

3.5 Data Collection Tools and Methods

Data collection is a process of preparing and gathering of data for the purpose of obtaining information to keep on record and get reality about a certain matter (Human, 1991). There are several data collection methods include experiments/ clinical trials, observation, administrative survey, documentation, interview and questionnaire. My study adopted questionnaire, interviews and literature review as data collection methods.

1. **Questionnaire**

This is the method of collecting data where series of written question are asked from the respondent by eliciting the feeling, belief, experiences, perception or attitudes of same sample of individual. It can either be structure or unstructured. Questionnaire can contain structure question with blanks to be filled with multiple choice questions or can contain open ended question where by the respondent are encourage to reply at length and choose their own focus to some extent. The study used the mixture of structured questionnaire with few open-ended questions. The main respondents of questions were landholders and residents within the city. About 80 landholders and household were provided with the questionnaires to fill in and 12 land officials were also provided with questionnaires before the interview.

2. Interviews

Interview Is a process consisting of dialogue or verbal responses between one or two people (Hader & Lindman, 1987). This is direct face to face attempt to obtain reliable and valid information in the form of verbal from one or more interviewee. An interview is an interaction process between the interviewer and interviewee in the course of data collection for a particular subject of study or objective. The study used individual face-to-face interview. The interview was done structured basing to the total of 12 officials (4 surveyors and 8 land administration officials) in which some were from the Municipals and Ministry of Lands Dar es salaam. The study applied this method because it is useful for obtaining detailed information about personal feelings, perceptions and opinions about the study and allows more detailed questions to be asked and usually achieve a high response rate including ambiguities which can be clarified and incomplete answers followed up (Fowler, 1996).

3. Focus Group Discussion

A focus group discussion is a qualitative research method and data collection technique in which a selected group of people discusses a given topic or issue in-depth, facilitated by professional,

external moderator. Focus groups are an extremely effective way to engage with potential customers and gather market feedback. The 4 groups of 7 to 9 landholders were used in the study from all municipals in which topics concerning cadastral system in the country and 3D land use technique were presented to the groups where by the members of the groups were allowed to present their ideas and understanding in form of discussion. This enables to acquire information in details.

4. Literature review

The study also employed the use of literature review as a source to obtain information on the study. The study used online study to search information about 3d cadastre as it was introduced and applied in developed countries such like Israel. Also, the study tried to pass on different literatures to see how people wrote on cadastral system of the country and how our land laws say on 3d land property and used. The study tried to pass on Unit Tittle Act of 2008 to search the information on how the government say on 3D land property ownership and development.

3.6 Source Data

Data refers to the facts and statistics collected together for reference and analysis such as values or measurements (Babbie, 1990). Data can be Qualitative data as descriptive information while quantitative data, as numerical information (numbers). The study employed both primary and secondary data as sources of data as described here below.

Primary Data Source.

According to (Rwegeshora, 2006) these are data collected directly from the field from the respondents. Primary data are those, which are collected for the first time, and thus they were original in character (ibid.). In this study, data were collected as primary data direct from the field where by questions were directly asked to different landholders through questionnaires and interviews to the land officials so as to obtain fresh data for the analysis of 3D cadastre in Tanzania and its effect to the land tenure security.

Secondary Data Source.

Secondary data is collected by someone other than the user (American Heritage Dictionary of English Language, 2000). Therefore, secondary data are not original because they are not collected for the first time; they have already been processed and used by others (Barttlet, 2001). Research might use documents like published and unpublished books, reports, papers, articles and journal

as the secondary data sources. The main way this study used to get this kind of data was through literature review. Thus, the study obtained secondary data in documentary materials from online and Ardhi university library. The main documents that research made a study are such like the unit Title Act 2008, National Housing Corporation Act [principal legislation], The Land Act 1999, The Village Land Act 1999, The Constitution of the United Republic of Tanzania. Secondary data help to prove what obtained in primary data so as to increase accuracy of the study (Barttlet, 2001).

3.7 Data processing and analysis

3.7.1 Data processing

when data are collected need to be processed and analyzed in accordance with the context of laid down at a time of developing the research plan (Patrick, 1990). So as to get the meaningful information data are to be processed. Once the data is collected, it then enters the data preparation stage known as data pre-processing. Pre-processing is the stage at which raw data is cleaned up and organized for the following stage of data processing. Data processing is transformation or convention of data into meaningful and usable information. The figure 3.3 below highlights the series of important steps involved in data processing the research.

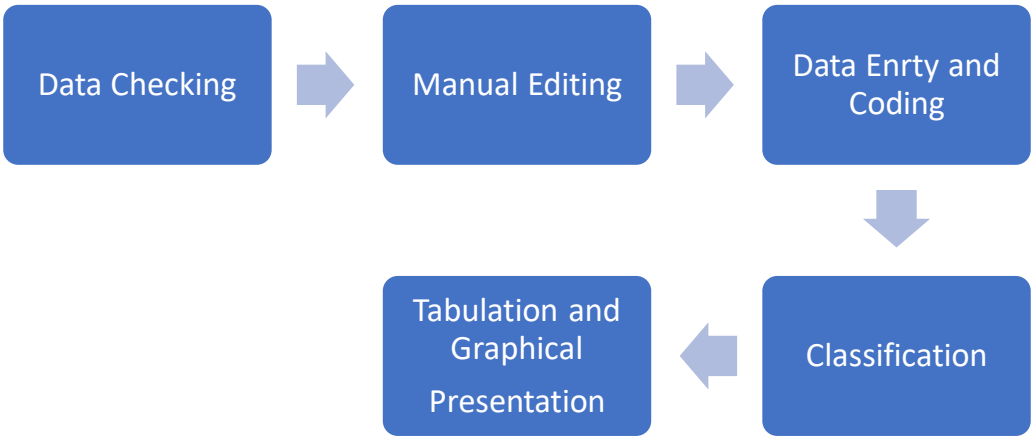

Figure 3.3. Steps involved in data processing

Source: Own illustration

Data checking: The data collected through the questionnaire, the first step of data preparation process was to check the questionnaires if they were answered or not. In research, all questionnaires that were supplied to the respondents were positively responded since most of questions were attempted, therefore the questionnaires were accepted.

Editing: This a process of examining the collected raw data and correcting them when possible. All questionnaires and interview papers underwent a manual cleaning exercise. This involved checking that the questionnaire had a full set of pages, correct identification and good handwriting.

Coding: This refers to the process of assigning numerals or other symbols to the answers so that responses can be put into limited number of categories or classes. In this project, the questions were then coded as 1 – 6.

Classification of data: This the process of arranging data in groups or classes on the basis of common characteristics. All the answers that belong to certain questions were classified and put in the same category and their frequencies derived.

Tabulation: This is the process of summarizing raw data and displaying them in compact or statistical form for further analysis. Tabulation is an orderly arrangement of data in columns and rows. In this research, MICROSOFT EXCEL and SPSS was used to organize the tables.

Graphical representation: this is the use of charts and graphs to analyze or interpret a numerical data. Graphs help to understand the data easily. Most common graphs are bar charts and pie charts. In this project, Microsoft Excel was used to analyze and construct the bar chart to summarize the results.

3.7.2 Data Analysis.

Data analysis is the systematic search for meaning. Research study employes both qualitative data and quantitative data. Both information obtained from questionnaire, interview, focus group discussion and literature review data collection methods were analyzed.

Quantitative Data

(Aliaga & Gunderson, 2000) described quantitative research methods very well as the method explaining phenomena by collecting numerical data that are analyzed using mathematically based methods (in particular statistics). The approach will adopt on answering type of question demanding quantitative answers on questions like ‘how many’ or ‘how much’. This will be done

by collecting quantitative or statistical data form, for example, charts, graphs, diagrams and tables with a specific intention and on a specific subject. In this study basically on quantitative data SPSS and Microsoft Excel were used for analysis. The data were in put into the SPSS software to obtain percentage tables where by the data were then in put into the Microsoft excel for graphical presentation. The data were presented in Bar Graph

Qualitative Data.

Qualitative data is a non-numeric information, such as in-depth interview transcript, diaries, anthropological field notes, answers to open-ended survey questions, audio-visual recordings and images. In this study most of qualitative data were obtained though interview, literature review and focus group discussion. For such kind of data, the research used manual analysis method by means of content analysis. Here data were organized and arranged manually to obtain meaningful information.

CHAPTER FOUR

RESULTS, ANALYSIS AND DISCUSSION

4.1 Introduction.

This chapter presents the results of the findings from the field after being processed and analyzed. This chapter also provides the discussion on the results obtained in the study. The results and discussion are based on research objectives. Thus, this chapter is divided into four sections which are results of specific objectives of the research. These are; The study of the existing/current status of cadastral system in Tanzania, investigation on satisfaction and challenges of Tanzania cadastral system on 3D land property ownership, assessment on the demand of 3D cadastral system in Tanzania in relation to LTS and lastly the recommendations for introduction of 3D cadastre in Tanzania for effective LTS.

4.2 The current status of cadastral system in Tanzania.

To study the existing/current status of cadastral system in Tanzania was among the objectives of the study. Firstly; a survey was conducted to determine the awareness of existing cadastre (cadastral system) among the people in the society. The respondents were asked about their awareness and familiarity on cadastral system and cadastral survey as well. Secondly, a survey was made through interview to determine the systems which are used to store and manage cadastral data and all about cadastral system in the country. Lastly in this objective the research made a study on the impacts of the existing cadastral system in the country.

On the awareness and familiarity on cadastral surveying. The question was asked to landholders (residents) and land officials to state if they are familiar with cadastral survey or not.
The figure 4.1 below represents the summary and analysis of the findings which are plotted in the graphs as shown.

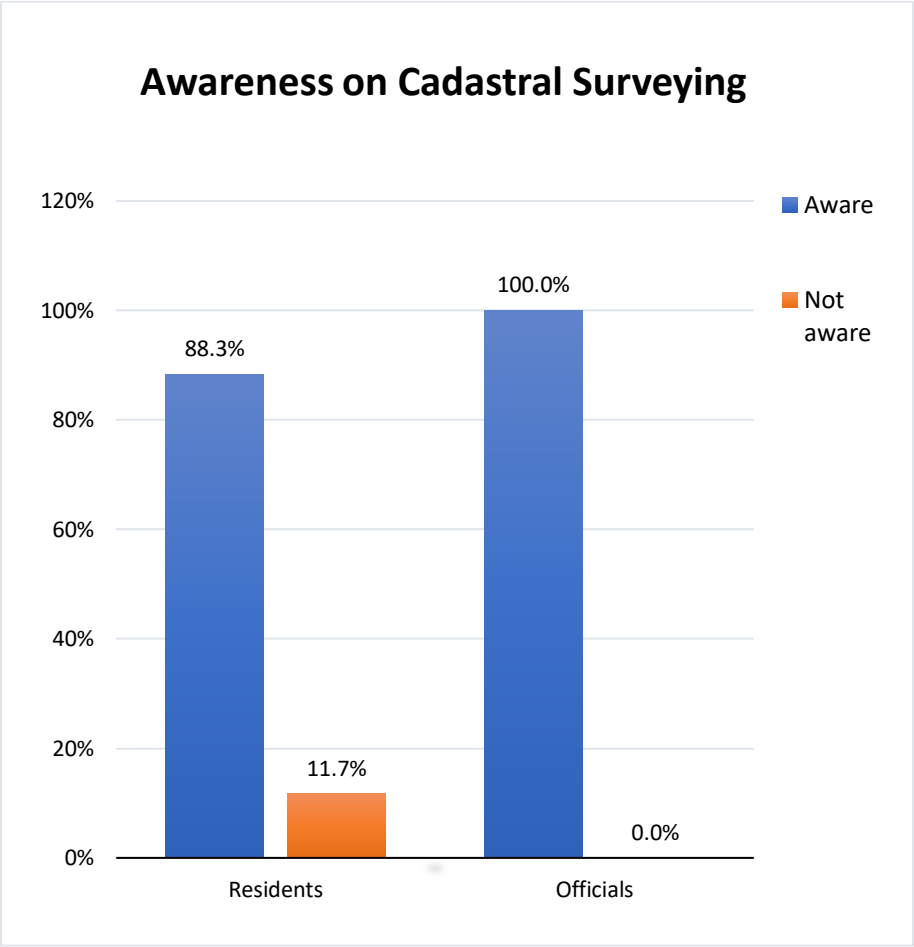

Figure 4.1. A graph showing awareness on cadastral surveying

Source: Field Work

The findings in the figure 4.1 indicates that 88.3% of the residents have an idea and are familiar with cadastral surveying while 11.7% of the residents have no idea and not familiar with cadastral surveying. While 100% of the land officials know what cadastral survey means. This shows people now in the country have advanced in land related activities, know the importance of cadastral surveying and impact of surveying their plots to make their plots formal to increasing the values of their plots and acquire the title of ownership to get all the rights relating to their lands.

Then on awareness and familiarity on cadastre (cadastral system). The question was asked to residents and land officials to say if they ever heard about cadastral system. Then the findings were summarized and analyzed and then plotted in the graphs as shown in the figure 4.2.

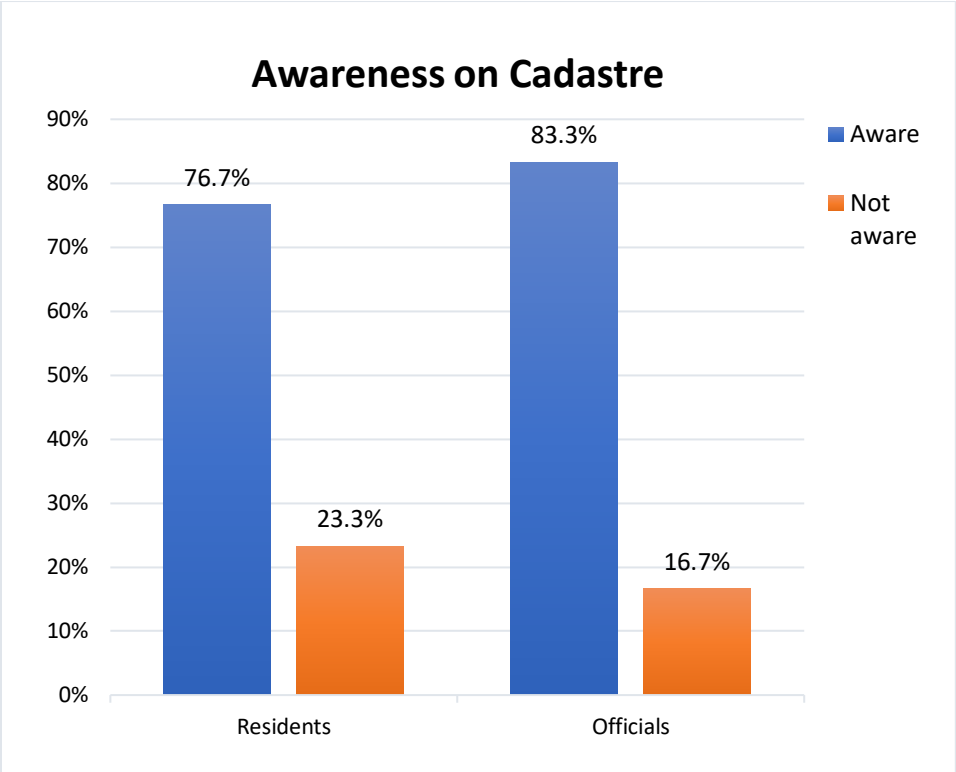

Figure 4.2. A graph showing awareness on cadastre

Source: Field Work

The findings in figure 4.2 above indicates that 76.7% of the residents have an idea and are familiar with cadastre (C.S) existing in Tanzania and the remaining 23.3% of the residents have no idea. This indicates that there is still a big number of residents (landholders) in the country who do not know how and where the information of their lands or parcels are kept which is all about cadastral system of the country. This may be due to illiteracy rate in the country which makes people lazy to make follow-up of their land information. In case of officials, 83.3% are aware of cadastre and 16.7% are not aware. This percent 16.7% is large for land officials being not aware of cadastre. This might be caused by difference in terminologies used between schools and in administration in practice which made the respondents (officials) fail to know what the word cadastre is. For example, in schools we term the system as cadastre or cadastral system while in some of the institutions in practice the system is termed differently such as land registry, cadastral registration, land registry, land registration, land administration, property register and land book. This was truly observed through interviews where by the few officials used to understand and term cadastre as land registration as it is used in their office.

The study went further to determine the systems which are used to store and manage cadastral data and all about cadastral system in the country and came out with the brief background and overview of Tanzania cadastral system. The study found that;

In Tanzania, cadastral system(cadastre) starts with surveying. Cadastral survey in Tanzania is done in both urban and rural areas.

There are some steps taken when conducting cadastral survey in Tanzania. These step groups are

1. Requesting to conduct the survey
2. Executing the survey
3. The submission of the cadastral survey work for the recognition of approval at Survey and Mapping Division.

In the submission of the Cadastral Survey Work, a compiled cadastral file and the draft of the cadastral plan in hardcopy are then checked by a licensed surveyor and when it passes, it will be submitted to the Surveys and Mapping Director (SMD) for further scrutiny and approval.
Complete cadastral survey works then submitted at SMD where a re-check is done and thereafter the process of survey approval and registration begins. Survey Registration System (SRS) is used for approving and registering all surveys in Tanzania.

The research found that, currently in Tanzania there are about two systems used for recording and management of cadastral data. These systems are;

1. **MOLIS** (Ministry of Land Information System)
2. **ILMIS** (Integrated Land Management Information System)

MOLIS: This is a system being used to perform most of the land management function in MLHHSD and the three municipals of Dar Es Salaam city. MOLIS operates only with alphanumeric data. MOLIS helps or used for assessing all payments, taxation and occupancy.

ILMIS. This is a new system introduced on 24th November 2017 in Dar Es Salaam for Dar Es Salaam City Council, Kinondoni and Ubungo municipal councils. This system operates for spatial information.
The main aim of this system was to integrate(connect);

- Land Administration Division (LAD)
- Registration of Titles Units (RTU)
- Survey and Mapping Department (SMD)

And lastly to support the process of transforming land records and maps into digital formats.

ILMIS is used for keeping Information of the land like

- size, location and valuation
- plot number
- land tenure and
- registration and granting land occupancy

The research found that, before this system to be introduced and used there was a manual land information administration system. The manual system was full of challenges and complications like loss of documents and information. Therefore, people didn't trust the manual administration system.

Benefits of ILMIS

- Increased land tenure security
- Improvement of land use
- Provided affordable secure and reliable land administration services

Therefore:
Research found that Tanzania cadastral system has based on registration of land properties and information traditionally. That means our cadastral registration systems are parcel based and it is 2D in nature. Our system does not support the establishment and conveyance of 3D right. Also, the research found that our cadastral system lacks Spatial information management models and 3D cadastral database to support 3D mapping.

Lastly; in this objective the research made a study on the impacts of the existing cadastral system in the country. Respondents were asked to state if the people are secured to their land around their area or not as the impact of cadastral system in a country. From the findings, it was observed that the most of land owners are secured to their land. The summary and analysis of the findings are plotted in the graph in the figure 4.3.

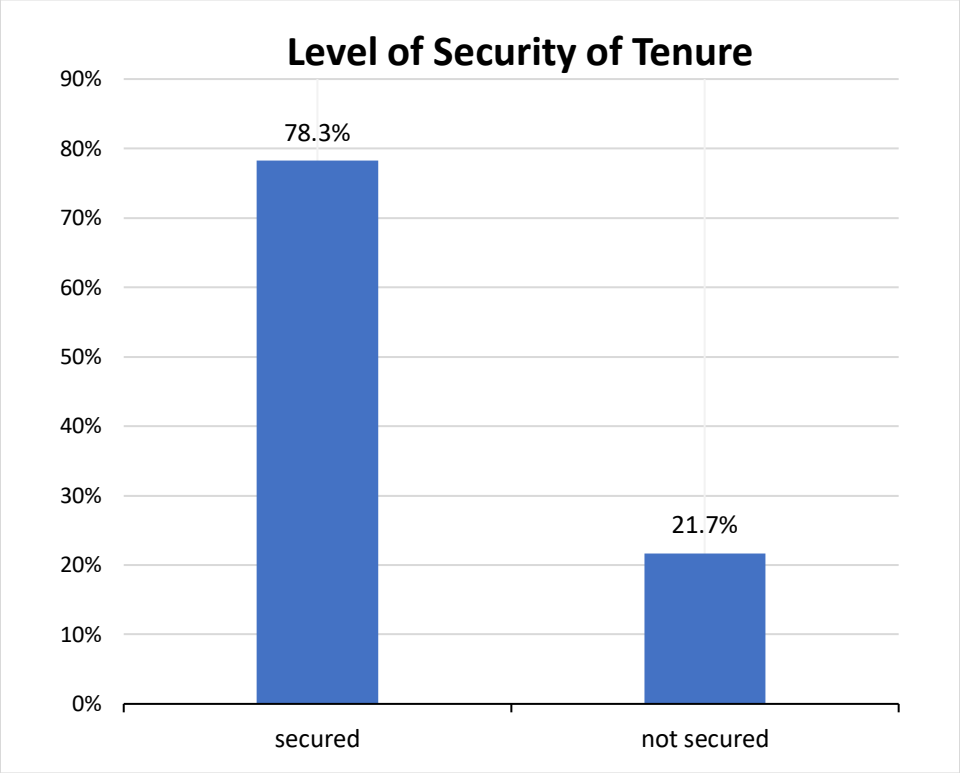

Figure 4.3. A graph showing level of security of tenure

Source: Field Work

The findings in the figure 4.3 above indicates that 78.3% of the respondents said that most of the land owners around their area are safe and secured to their land as a result of proper cadastre in a country and 21.7% of the respondents did not agree with it. This shows that the government play responsibly the role of protecting people to their land against forcible evictions by generating system to manage land information to secure their landholders.

Other impacts were;

Development of the city: Due to the proper management of the cadastral data in digital form in the country through ILMIS and MOLIS systems used in the country, now most of the landholders become confident for their land ownership security hence they tend to develop their land therefore through continuous development of the land now the city become more developed.

Improvement of land taxation: The research found that many of the land administration officers claim that due to proper digital cadastral system from ILMIS and MOLIS systems in the country now the ministry has improved level of tax correction since they can identify the current prices being paid for property and the volume of sales. The system now provided full cover of the land and all properties that are included in a particular piece of the land.

4.3 Satisfaction and challenges of Tanzania cadastral system on 3D land property ownership.

4.3.1 Satisfaction of Tanzania cadastral system on 3D property ownership.

starting with the satisfaction of the Tanzania cadastre, research tried to investigate how the people satisfy with the operating system of cadastre in a country. The respondents were provided with the questionnaire with the question to state whether they are satisfied or not with the cadastre around their area on 3D land ownership. The responses were summarized and analyzed and then plotted in the graph as shown in the figure 4.4.

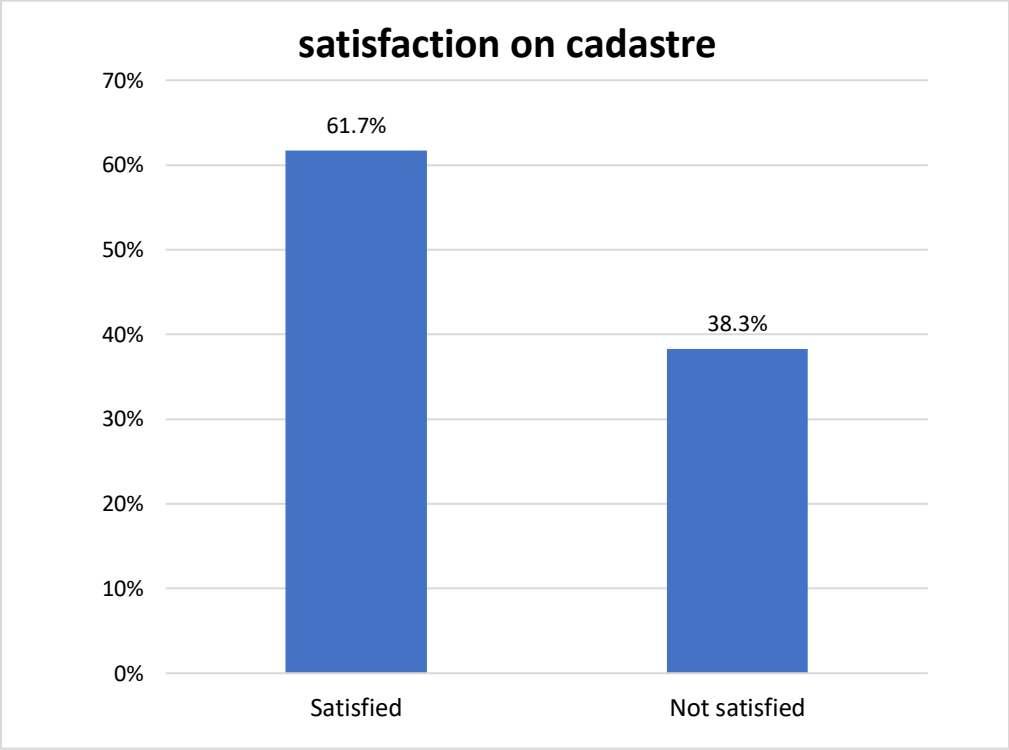

Figure 4.4. A graph showing satisfaction on cadastre

Source: Field Work

The findings in the figure no 4.4 above shows about 61.7% of the respondents are satisfied with the cadastre around their area. Many of the respondents supported this with the reason that the land disputes in the society/community are now minimal hence tenure security is clear than before. The rest of 38.3% of the respondents were not satisfied with the cadastre around their area with some reasons like high cost and expensivity for accessing and high cost for accessing surveying services hence many people fail to access the service. Also, bureaucracy and time consuming from the scratch to title granting was one of the reasons for them not be satisfied.

4.3.2 Challenges of Tanzanian cadastral system on 3D property ownership.

The current cadastre in Tanzania is 2D cadastre. The existing cadastral system is based on Torrens principles (Registration of Title) in 2D dealing only with surface properties. Rely heavily on 2D base map and survey plan which fall short of meeting future land development demands and community expectation;

The main challenge in Tanzania cadastre is that, due to use of space above and below the ground emerging in Tanzania. Common examples are buildings with many stories and multiple uses like shopping mall and residence area around K/Koo. Also, the use of condominium (condo) houses and apartments in which several owners own one building or house. So, to this case of developments, the spatial dimensions of ownership Rights, Restrictions and Responsibilities are often 3D dimension, invisible and multilayered spaces. This makes difficult to keep and manage such information of records in 2D cadastre we use in our country.

The research therefore found that to minimize the dispute in such situation, the government introduced The Unit Title Act as a way to solve dispute by enacting some conditions on how to deal with condominium houses and departments as a way forward to 3D cadastre.

4.4 Demand of 3D Cadastral System in Tanzania in Relation to LTS

Assessing the demand of 3D cadastral system in the country in relation to the land tenure security was one of the goals of the study. The respondents were asked to say if the demand of 3D cadastre in the country is high or law in relation to the land tenure security. That means the respondents had to comment if we real need 3D cadastre according to our 3D land use development in our country or 3D land use development situation in the country can be well managed by our system. The findings were summarized and analyzed and then the results are plotted in the graph as it is shown in the figure 4.5.

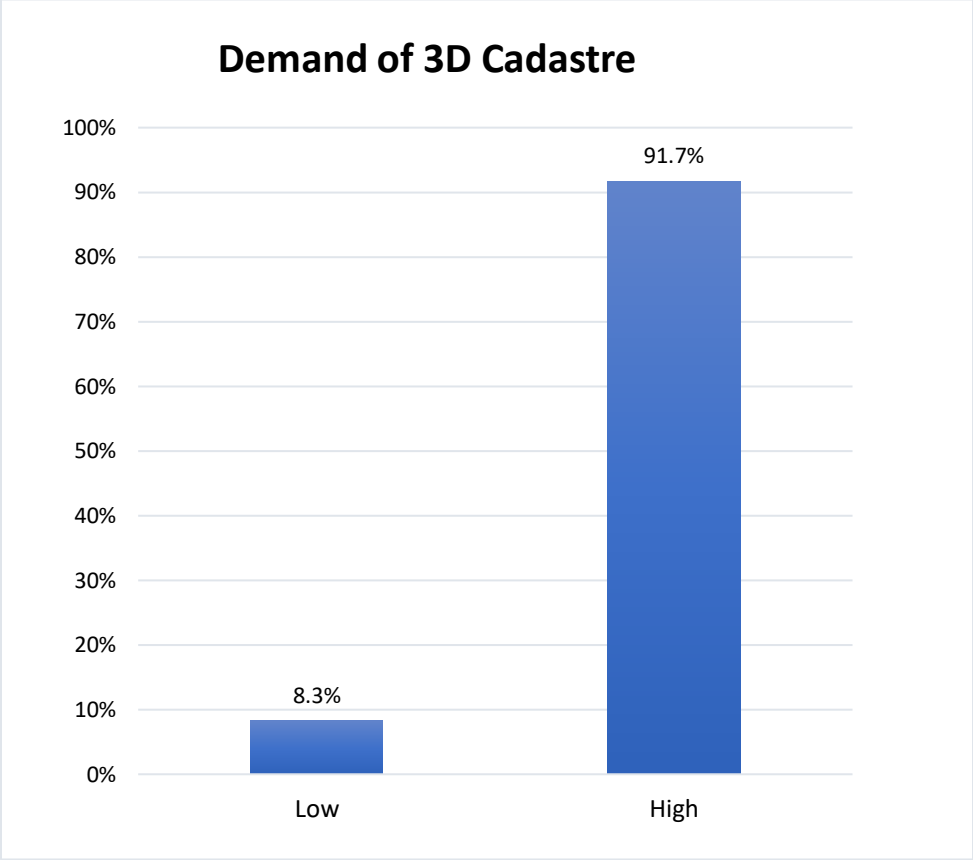

Figure 4.5. A graph showing demand of 3D cadastre

Source: Field Work

The findings in the figure 4.5 above shows that 91.7% of the respondents said the demand of 3D cadastre in the country is high for the lad tenure security for co-owners with the reason that 3D cadastre will help to keep the genuine information of every co-owner therefore in case of any dispute this database can be used to track/trace back all the information and hance can clear conflicts among the co-owners of the same property and hence increase/ensures security of tenure. The rest of 8.3% of the respondents said the demand is low with the reason that Tanzania did not reach that far in 3D land use development instead the level of our 3D land use development our traditional system can manage all the data (information) through registration.

4.5 Recommendations for introduction of 3D cadastre for effective LTS

The study also had an objective to provide recommendation for the introduction of 3D cadastre in Tanzania for effective land tenure security. Firstly, the recommending the study tried to find out the level of awareness and understanding on 3D cadastre within the society. The respondents were asked to state if they are familiar with the concept of 3D cadastre or if they ever heard about 3D cadastre. The respondents were grouped into two that is landholders (residents) and land officers. Figure 4.6 represents the analyzed finding results plotted in the graph.

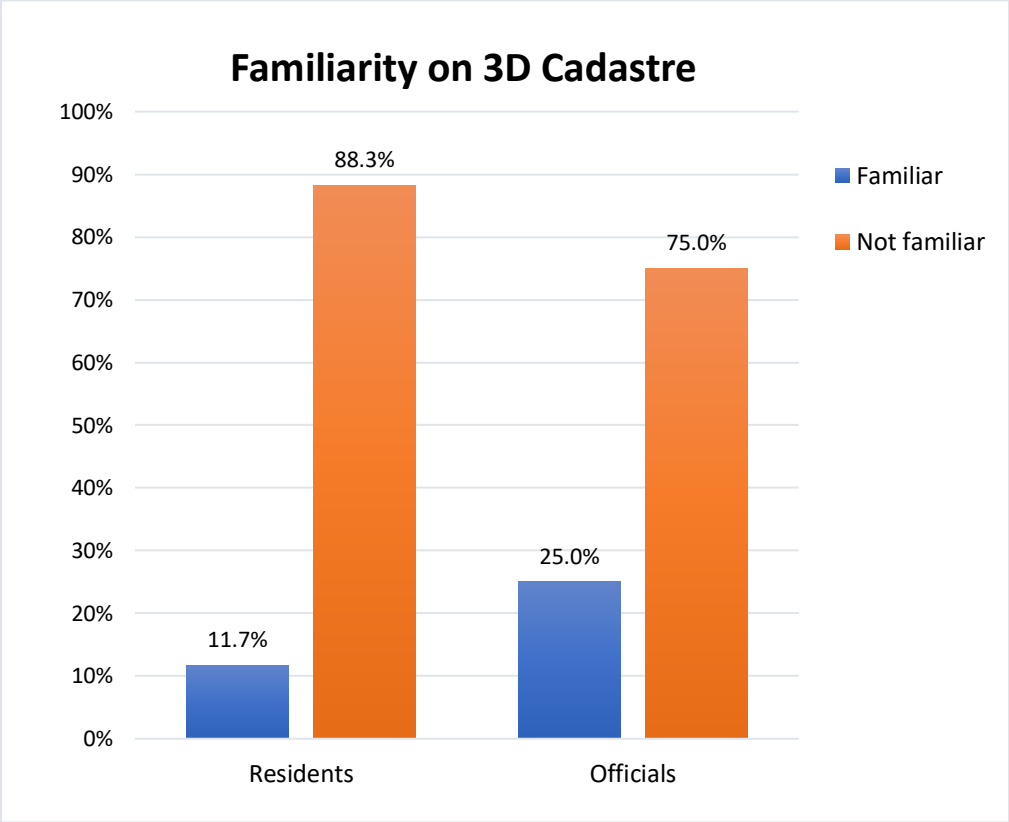

Figure 4.6. A graph showing familiarity on 3D Cadastre

Source: Field Work

The findings in the figure 4.6 above shows that 88.3% of the residents (land owners) and 75% of the land officials are not familiar with the concept of 3D cadastre. Then the rest of 11.7% of the residents (land owners) and 25% of the land officials are the only ones familiar with the concept of 3D cadastre. This indicates that the knowledge concerning 3D cadastre is not common among the people. So, the government and schoolers should try to introduce the concept of 3D Cadastre among the people and stakeholders in the country.

Thereafter; the study passed through different literatures to see how different countries went forwards through introduction of 3D cadastre in their countries. Then came out with the better ways as recommendations that the government of Tanzania under the ministry of lands also should try to follow for introduction of 3D cadastre in the country.

The research used Israel as a study country where by Tanzania may use as reference to establish 3D cadastre for utilization of above and below surface space and for defining the characteristics of the future analytical and spatial cadastre that will replace the existing two-dimensional geographical surface cadastre in Tanzania.

In recent years many researchers like Campbell & Hastie, 1998; Kaufman & Steudler, 1998; Stoter, 2000; have examined the significance of future cadastre and have agreed that future cadastre will be analytical, 3D, spatial and with the current 2D cadastre. it will also be concerned with land, law and people. The 3D cadastre will determine the location of parcels, space and its 3D boundaries and serve the legal and physical objectives while also being utilized for basic mapping, planning land use and spatial environment planning.

The study found about 4 recommendations (steps) that the government should implement for 3D cadastre in a country:

Firstly; Alternatives for registering multilevel and spatial construction by employing existing tools

In order to practice the 3D exploitation potential by different interested parties, it is necessary to define a legal and cadastral solution capable of registering rights in a multilayer cadastral reality.

1. The Amended “Land Law” Alternative:

In the reference to the Israel, the land ownership is defined in the Israeli land law. It says “the ownership spreads over the ground parcel in the depth below and lofty space above it”. So, poses several difficulties, such as: It is not possible to carry out a land transaction and transfer of ownership of a part of the space defined as land ownership, meaning it is not possible to register a house to one person and an underground tunnel to another. Land registration is defined as two-dimensional. (Rachael & Shnaidman, 2018).

Therefore, the law needs to be amended to enable registration of vertical division of the space to various levels and designations.

Now in relation to Tanzania, the government, stakeholders and scholars should try to pass through our land laws and see what the laws say about the ownership of the land in relation to the 3D land property ownership so that the laws can be amended with accordance to the new cadastral system and 3D land ownership in case the law is not clear as how it was done in Israel. Not only that but to suggest 3D Parcel is definition and registration of various ownerships in various levels of the space, provided it complies with the planning map and as such provides a basis for the establishment of 3D cadastre.

2. The Alternative of "Registration of Condominiums":

Since most condominiums consist of several apartments built mostly on top of each other, it is possible to refer to the condominium as a vertical sub-parcellation (Benhamu & Doytsher, 2001). This vertical sub-parcellation is due to coexistence of many different owners in the parcel's space and many different properties on the same parcel. The Registration of Condominiums by the Land Law governs the status of the rights of the several property owners on the same land site, and provides a legal solution of separate ownership on levels.

3. The "Objects Registration" Alternative:

This alternative consists of the establishment of an "objects registry" for spatial objects, totally separated from the existing land registration (Benhamu & Doytsher, 2003). The objects registry will deal only with spatial objects.

4. The "Spatial Sub-Parcel" Alternative:

This alternative provides a solution for the registration of spatial objects, not adjacent immediately to the registered surface parcel, whereas each one of those spatial objects is subject to defined rights and obligations (Shoshani, Benhamu & Denekamp, 2004). The activities in the subterranean space and in the above-terrain space will be made possible through an allotment or expropriation of specific parts of the space included within the vertical boundaries of the surface parcel.

Secondly; Spatial information management model.

The research found that at present, Tanzania database of the land management information system consists of the one and only cadastral layer, two-dimensional, continuous, representing all land registration blocks and parcels. The 3D cadastre will require solutions for managing and organizing 3D and spatial information. This was the same as how it was in Israel. Therefore, four models have to been examined.

I. Single layer data model

Following the current 2D cadastral database structure, the geospatial objects from all three spaces (surface, below surface, above surface) will be grouped together into thematic layers. This data model will be suitable for the future spatial cadastral reality where most activity will still be conducted on land. Including the spatial objects in the surface layer will make it possible for the user to discover the spatial relations between objects. The disadvantage of this alternative lies in its incompatibility with the continuous plane topology characteristic of existing GIS systems and the impossibility of performing spatial analyses using the tools available in the current GIS systems.

II. Multilayer data model.

Information on spatial objects will be organized in three cadastral layers, a layer for each space (surface, below surface, above surface). This solution is appropriate for the existing data model in most GIS systems. Moreover, it permits multilayer analyses with the tools available in the existing 2D GIS systems. The principal advantage of this data model lies in that it preserves the current surface cadastre layer. This alternative suffers from not being able to provide an answer to spatial overlap (two or more objects at the same xy-location), and it is moreover possible that in many areas the spatial layers may be empty.

III. Object oriented data model

Organizing information on the object, rather than by layers, so that the spatial properties would be defined only as objects and the information database would not include single information layers. The objects will be classified into three spaces, with each object being assigned a spatial and chronological identity number. Since most of the currently existing information systems organize the information on the level of layers, rather than objects, the implementation of this model will make it difficult to transit from the surface cadastre to the spatial cadastre.

IV. Integrated data model

The information database is to include only one surface cadastre layer (3D), with geospatial objects defined as objects linked to the surface layer. The surface information will be organized in layers and the spatial information will be organized at the object level. Indicators defined for each surface parcel will point to the spatial objects related (or connected) to the surface parcel

Thirdly; Establishing a 3D cadastral database

One of the first stages in the transition from the traditional cadastre to the analytical and spatial cadastre, is establishing a cadastral database of the current data, at a level that will facilitate reconstruct of boundaries, reparceling, etc. (Jones, Rowe, & Kentish, 1999). Since there is discontinuity in utilizing the above surface space and the below surface space, two alternatives are being considered:

The first possibility is employing a ‘‘mixed’’ system, that involves establishing a continuous 3D land cadastral database with national coverage of all properties located on the surface, and establishing an annexed external database that will refer to the additional existing properties that are not located on the surface.

The second possibility is to employ an ‘‘integrated’’ system, consisting of storing all spatial cadastral information in one single database. Obtaining digital mapping data for establishing the spatial 3D analytical cadastre constitutes the bottleneck in establishing a cadastral information system (Hoinkes & Lange, 1995). A radical solution exists, based entirely on a 3D remeasuring of all land boundaries with advanced instrumentation and analytical calculations. This possibility involves very high costs, for remeasuring and reconstructing the boundaries. An alternative solution is the possibility of using the original measurements in the field books for calculating the location, combined with a new measurement of height. Alternatively, it is possible to digitize the graphic data from the cadastral maps, once again in combination with new measurement of height—this being the least expensive and fastest for obtaining digital information, but also the least accurate, compared with the other possibilities (Doytsher & Shmutter, 1991; Fradkin & Doytsher, 1998). Completion of the height dimension (in all the above-mentioned alternatives for establishing a 3D cadastral database) will be carried out by using one of the existing measuring methods (leveling, GPS and/or photogrammetry), with the possibility of integrating calculations based on a national Digital Terrain Model (DTM).

Lastly; 3D cadastral mapping

In the current land registration method in Tanzania, the registration map (cadastral map) constitutes an integral part of the registration and serves to describe the property. The boundaries of the adjacent parcels, defined on the surface, require a 2D graphic representation of their borders, including the lengths of the boundary lines (fronts) of each parcel. The present block map lacks any altimetric information, the elevation contour lines are not drawn and the altitude of control points and objects is not noted. The block map contains partial planimetric information that assists in locating and reconstructing the parcel boundary and identifying the changes that have taken place in the area of the parcel and its vicinity. There is no detailed information on existing objects and structures in the parcel area, and almost no information regarding the existing infrastructure in the below surface and above surface space of the block. Required within the framework of establishing the 3D cadastre is ability to describe in three-dimensions the location of the horizontal and vertical boundary between the units within the space. The ability to display 3D characteristics of properties will facilitate a better definition of the judicial situation of the properties within the spatial reality. 3D representation corresponds better to reality than 2D representation (Van Driel, 1989). The 3D representation provides better tools for examining and analyzing the information that has thus far been represented by 2D tools only (Smith & Paradis, 1989) and (Pratt, 1998). In any case, the techniques for 3D display are restricted to the 2D environment of the screen or the drafting paper, so that in practice we have to settle for a virtual 3D display, which is a perspective of reality (Hoinkes & Lange, 1995) and (Gisiger, 1998). The spatial 3D cadastral map will be displayed by means of 3D graphic software.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION.

5.1 Conclusion

Research found that Tanzania cadastral system has based on registration of land properties and information traditionally, this is due to the finding results. That means our cadastral registration systems are parcel based and it is 2D in nature. Our system does not support the establishment and conveyance of 3D right. Also, the research found that our cadastral system lacks Spatial information management models and 3D cadastral database to support 3D mapping. It deals only with properties on the surface of the land. So, the existing cadastral systems, due to being surface and 2D, are unsuitable, as is, for the multilayer reality 3D land property development that has evolved in recent decades. In order to facilitate the continued establishment of engineering projects below and above the surface, and particularly to enable the registration of properties that are not on the surface, it is necessary to amend the legislation in our country and define a new multilayer and 3D cadastral model.

5.2 Recommendation.

There are a number of general recommendations which may need to be addressed regarding 3D cadastre analysis in Tanzania to ensure similar projects will be done better in the future: These are

Public awareness and education.

The government should try conducting public awareness campaigns and educational programs to inform citizens about the benefits and functionalities of the 3D cadastre. This will help to create awareness, build trust and encourage public participation in the land administration processes. Not only on 3D cadastre but also still a big number of people lugging behind in understanding of surveying and land relating matters. This has been realized in the research analysis that most of the Tanzania citizens have no concept of 3D cadastre.

Stakeholder engagement

Before the introduction of 3D cadastre in the country it is important the government to involve all relevant stakeholders including local communities, land owners and traditional authorities in the design and implementation of 3D cadastre in the country. This will help in formulation of policies to support 3D land ownership and management. Their input and feedback will help to address concerns, ensure inclusivity and foster a sense of ownership and acceptance of the new system.

Conduction of more research

It is found there are few research studies and documents specifically focused on 3D cadastre in Tanzania. this was one of the challenges faced during researching. Conducting further researches on 3D cadastre can help to expand our understanding and knowledge on what to do to introduce 3D cadastre in the country. Further studies should be done practically under the government through observation from the developed countries to see how this 3D cadastre operate in land management so that we can assure on what we are supposed to doon implementation in our country. The government should try to influence students in schools and other scholars to make more investigations and research on 3D cadastre. Also training skilled personnel who will be expertise on this new 3D technology system.

Frequent updation of the existing cadastral system.

The research found that once the new features are built in the real ground it just ends there. The system does not update new features present on the ground so it is recommended that there should be frequent updation of cadastral data in the system. This is essential to ensure accurate and up to date information about land ownership, boundaries and property attribute.

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APPENDICES

Appendix 1

Questionnaire to be fulfilled by landholders and Residents in Dar Es Salaam City.

This questionnaire aims to gather information for analysis of 3D cadastre in Tanzania and its effects to the land tenure security. Specifically, this questionnaire aims that to assess the understanding on cadastral system and challenges faced by land owners on cadastral system.

A. Respondents' Characteristics.

1. What is your education level (Tick one).

   (a) No formal education.
   (b) Primary education.
   (c) Secondary education.
   (d) Post-secondary education.

2. Do you own a land?

   (a) Yes.
   (b) No.

3. If yes from no.2, is it a 3d property?

   (a) Yes.
   (b) No.

B. Land surveying and cadastral surveying knowledge.

1. Do you know about land surveying or cadastral surveying?

   (a) Yes.
   (b) No.

2. Have you heard about cadastral system (cadastre)?

   (a) Yes.
   (b) No.

3. What is the level of demand of cadastral system in land ownership?

   (a) Low.
   (b) High.
   (c) I don't know.

4. Are you satisfied with the cadastral system in your area?

   (a) Yes.
   (b) No.

5. From no.5 above, either Yes or No, state how.

   ……...
   ……...
   ……...

6. Have you heard about 3D Cadastre?

(a) Yes. (b) No.

If Yes, do you know about it?

(a) Yes. (b) No.

7. Is the system helpful in 3D land ownership in your area (satisfaction)?

(a) Yes.

(b) No. (c) I don't know.

8. From no.8 above, if Yes, to what level of performance?
(a) Satisfactory.

(b) Good. (c) Very good.

9. From no.8 above, if No, to what level of performance?

(a) Not satisfactory.
(b) Bad. (c) Worse.

10. From no.8 above, if No, what do you think are the reasons (challenges)?

(You may tick more than one answer)

(a) It does not provide security of tenure. (d) It is not frequently updated (not up to date).

(b) It has high cost for accessing. (e) It has incomplete information.

(c) It is Not understood (not clear).

(f) Any other ……

11. What is the level of demand of 3D cadastre in a country for land tenure security?

(a) Low.

(b) High. (c) I don't know.

12. Are the people secured to their land /property around your area?

(a) Yes. (b) No.

13. What has 3D cadastre improved in your area? **(You may tick more than one answer)**

(a) Land tenure security. (d) Reduced time for obtaining land/property information.

(b) Development of the city. (e) Forgery on land/property has stopped.

(c) Improved land use. (f) Improved land taxation.

(g) Any other ……

14. What do you think should be done to improve 3D cadastre in Tanzania?

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……..

Appendix 2

Interview Questions for land administration officers in Dar Es Salaam city

This interview aims to gather information for analysis of 3D cadastre in Tanzania and its effects to the land tenure security. Specifically, this questionnaire aims that to assess the challenges facing 3D cadastre in Tanzania and the current status of cadastral system in Tanzania and its impacts towards land tenure security.

1. How long have you been working in the field of land administration and management?

   (a) 1-3 years.

   (b) 4-7 years. (c) More than 7 years.

2. Are you familiar with 3D cadastre?

   (a) Yes. (b) No.

3. What procedures do you follow in recording and managing the information of 3D properties in 3D cadastral system?

   ……...

   ……...

   ……..

   ……...

4. What is your understanding on the current land tenure security situation in Tanzania?

   ……

   ……

5. How familiar are you with the concept of 3D cadastre and its potential impacts on the land tenure security?

   ……...

   ……...

6. How can 3D cadastre help to address land disputes and conflicts?

   ……...

   ……..

7. What do think are the potential benefits /impacts of implementing 3D cadastre in Tanzania?

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8. What are the possible challenges/barriers to implementation of 3D cadastre in Tanzania?

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9. How would you rate the level of awareness and understanding among the people on 3d cadastre?

(a) High (b) Medium (c) Low

10. Have you had any experience with the implementation of 3D cadastre in other countries?

(a) Yes (b) No

If Yes, what can you share basing on your experience

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11. Are there policies for 3D implementation in a country? and what steps should the government take to ensure successful implementation of 3d cadastre in Tanzania.

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……...

THANKS.

Appendix 3

Interview Questions for land surveyors in Dar Es Salaam city

This interview aims to gather information for analysis of 3D cadastre in Tanzania and its effects to the land tenure security. Specifically, this questionnaire aims that to assess the contribution of surveying towards implementation of 3D cadastre in Tanzania.

1. How long have you been working in the field of land surveying as a surveyor?

   (a) 1-3 years.

   (b) 4-7 years. (c) More than 7 years.

2. Are you familiar with the concept of 3D cadastre?

   (a) Yes. (b) No.

3. What are the procedures or how do you survey 3D properties for 3D cadastre?

   ……...

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   ……...

4. What is your understanding on current land tenure security situation in Tanzania?

   ……...

   …...……

5. How can you rate the understanding of surveying especially 3D land surveying among the people in a country …….……

6. What technology/techniques do you use in surveying 3D properties?

   ……...

   …….……..

   ……...

7. What challenges do you face in surveying 3D properties?

   ……...

   ……...

8. What role does technology play in supporting cadastral surveying in 3D cadastral system?

   ……...

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9. How do you map 3D properties as a supporting document in 3D cadastral system?

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10. How 3D cadastre helps to address land disputes and conflicts in the country?

……...

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11. What is the contribution of land surveying (cadastral surveying) in the implementation of 3D cadastre in Tanzania? …….

……...

……...

12, What do you think are the steps should the government take to ensure successful implementation of 3D cadastre in Tanzania.

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THANKS.