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Digital Cadastres Facilitating Land Information Management

Edward Kurwakumire
Department of Geomatics, Tshwane University of Technology, Pretoria, South Africa,
KurwakumireE@tut.ac.za

Abstract

A nation's natural resources form the basis of economic growth in most developing nations. Raw materials required for the manufacturing industry which drives the economy are extracted from the land resource. This renders good governance of land crucial in any country as it is also the basis of sustainable development. However, to achieve betterment in managing land, there is need for accurate, reliable and up to date information about land. Such proper land management policies however remain a challenge to most governments in African nations. Problems with land information differ case by case, but among the most common are the facts that land information is usually not coordinated or it is inadequate. In some cases, land information is available but largely inaccessible. The objective of this paper is to bring out the role of a digital cadastre towards improved land management and land administration. The paper discusses modernization of cadastral systems in municipalities through technological reforms as a facet to improved land governance and at the same time improving access to cadastral information which is public information.

1. Introduction

Cadastral systems have evolved from the allocation of land as grazing land, arable land as well as hunting grounds and often at village level while at the same time, land was acquired and lost through wars. Thus each family possessed arable land with access to common pastures and this sufficed with the population then. This maps the land tenure situation before Zimbabwe was colonised in the 1890s. This description is characteristic of traditional or customary tenure systems according to the Communal Land Act of 1982 and (Cole, 1981; Ollennu, 1962; Rukuni, 1994; Torhonen and Goodwin 1998; Communal land Act of 1982). However, the ever-growing world population and increasing pressure on both natural and manmade resources renders critical the need for land information as a basis for managing and exploiting the land resources in a sustainable manner. This has brought about a transition from communal or customary law based land tenure systems to statutory law based systems such as freehold. However both systems still co-exist in most developing nations such as Namibia, Tanzania, Ghana and Botswana. Zimbabwe utilises the communal tenure system administered through the communal land act and the freehold system based on the Roman Dutch Law that is also utilised in South Africa. Without adequate up-to-date land information it becomes difficult to implement planning, development and exploitation projects of such resources sustainably for the betterment of communities. Land is undoubtedly one of the most valuable resources of any nation (Kurwakumire, 2007) and land information management

forms an integral part of urban development. The value, nature and social characteristics of land and the community is also described in (Alexander, 2007).

Land is at the core of a nation's economy and as such it is essential to device methods for improving its management. In this respect, the implementation of proper management tools and policies with respect to land results in efficient land transactions and land markets. However, this is only possible if the rights pertaining to different land units are well defined and properly documented. The availability of land information improves land valuation, taxation and zoning since all these operations are based on the land unit (Larsson, 1996). It is also important for local planning authorities such as municipalities to be able to identify all land units within their jurisdictions and the rights that attach to them. This information is essential for a more informed zoning process and enhanced spatial planning. Information is the basic resource for any decision making to be done and as such it is the function of a land information system (LIS) to support land management. A land information system needs to be coupled with accurate and complete information if sound decisions are to be made. Dale and McLaughlin (1990) define land management '*as the process whereby land resources are put to good effect'*. This essentially leads to the concept of the cadastre, which is a tool for managing information about land. It is usually an up-to-date public register containing different aspects relating to the land unit such as form of tenure, use and value. Zimbabwe has seen a significant increase in land development projects and land transactions since the end of the hyperinflation period in 2010. The cadastre needs to be secure while offering protection to land right orders. This calls for a digital cadastre that embraces current information and technology, database technology, digital storage media and local and remote access points such as internet portals. The term digital cadastre is used synonymously with automated cadastral or land information systems.

2. Problem Context

Manual systems of managing land information and the resource of land dates back to antiquity with their use still found in developing countries such as Zimbabwe (Kurwakumire, 2007, 2013a, 2013b), Uganda (Kurwakumire, 2009), Ethiopia (Lemmen *et al*., 2009) and Tanzania (Mwabujoko, 2011). In industrialised nations such manual systems have been rendered obsolete and have been superseded by more efficient digital cadastral systems. Furthermore there has been a chain of studies on the development of cadastral models that can be adopted in the development cadastral information systems by different nations. The models provide a conceptual schema that's guides systems development while addressing issues of interoperability and extensibility. These include the cadastre 2014 concept (Kaufmann and Steudler, 1998) the Core Cadastral Domain Model (CCDM) (Lemmen *et al.*, 2003a; Lemmen *et al*., 2003b; Lemmen and van Oosterom, 2006; van Oosterom and Lemmen, 2003; van Oosterom *et al*., 2006), the Social Tenure Domain Model (STDM) (Augustinus *et al*., 2006a; Lemmen, 2010) and currently the Land Administration Domain Model (LADM) (Lemmen, 2012; Tjia and Coetzee, 2012; Tjia and Coetzee, 2013; van Oosterom *et al*., 2013). The LADM was accepted in 2012 as an international standard for land administration. Most developing nations are embarking on automation projects with a notion to develop systems which

are comparable and compatible to those in industrialised nations (Kurwakumire, 2013a; Ali and Shakir, 2012; Li et al., 2012; Tija and Coetzee, 2013). At the same time the hope to bridge the technological gap between the developing and developed nations with respect to land management. However, the building of a computerised land information system takes a considerable amount of time especially in developing countries where map (geometric) data has not been computerised. The need for easy access to cadastral records and efficient land transactions necessitates the need for an automated land management tool, essentially the digital cadastre.

Zimbabwe is one such nation still employing manual and semi-manual techniques based on indices written on card files in surveying departments in municipalities. Automation can greatly assist local authorities in improving the service delivery (Bekkers and Zouridis, 1999). Cadastral data forms the basis of the operations of local authorities as all other activities are in one way or the other associated to land. Local authorities are responsible for the zoning, spatial planning and provision of public services such as housing, educational, recreation and health facilities among other things. A digital cadastre addresses issues such as ease of storage and back up, information sharing by different departments, secure storage and remote access to information while allowing the possibility for performing some but not all land transactions in real time. Extra manual checks and authentications are still necessary particularly in land sales and transfers due to the nature and volatility of the land resource. Field data collection in Zimbabwe is still incomplete (Kurwakumire and Chaminama, 2012; Kurwakumire, 2013b) with most maps outdated. There is no metadata catalogue for the available land information and there exist no standards for the development of cadastral systems.

3. Research Problem

Population growth is directly associated with an increase in pressure on land and the environment. The effect of the pressure on land and other natural resources is that communities develop a need to own land exclusively. This facilitates the emergence of various types of rights to use and develop the land as more permanent holdings. To ensure secure land holdings to the community, there is need to document the land rights in some form of legal register. This essentially brings into light the need for a proper and up-to-date land information system for managing land. This requires the cadastre to evolve so that it can capture and represent all new tenure arrangements that emerge with modernization and sophistication of society. As a result, cadastral models should be dynamic and adaptive rather than static (Zevenbergen, 2002; Barry et al., 2013).

Proper management of land is necessary to good governance and benefits from an adequate and functional cadastral system. Citizens also need to have confidence with the land transaction system which requires good land information (Mwabukojo, 2011). Citizens are now more interested in cadastral information as they seek new property to buy or directions to reach a certain address. The public nowadays wants to be involved even in town planning issues. In this regard, citizens are becoming more spatially enabled. The problem within Zimbabwe's cadastral system is the lack of coordinated efforts in the collection of land information. Several agencies collect land information

for their own use (EIS, 2000; Kurwakumire and Chaminama, 2012) while there is minimum formal sharing of this information. As a result, there is duplication of information as organisations collect similar information. Also, huge amounts of land information are available but inaccessible as there is no metadata catalogue which can specify which organisation has what information. With communal land there is poor land information as only the village and ward boundaries have been demarcated (Kurwakumire and Chaminama, 2012). The systems in use by the Department of the Surveyor General and municipalities are still paper based (Kurwakumire, 2007, 2013a, 2013b) and are largely inefficient. This study puts into perspective the role of a digital cadastre in improving land management and good land governance though improved availability and access to information. This, in turn becomes one way into democratisation of land information (Sawicki and Craig, 1996; Kurwakumire, 2013a) which is primarily public information. This research points out some technical and software specifications that can be employed towards implementation of a digital cadastre and strategies to improve spatial data collection.

4. Research Methodology

This study utilizes the case study approach described in (Yin, 2003) and carried out for prior bachelor theses at Midlands State University in Zimbabwe. Three organisations were investigated namely City of Mutare (CoM), City of Gweru (CoG) and the Department of the Surveyor-General (DSG). CoG and CoM are local government authorities or municipalities and the unit of analysis is the cadastre. The cadastre was also the unit of analysis at the Department of the Surveyor-General. The case study approach was employed to serve the following purposes: (1) to describe the cadastral and town planning processes, (2) to identify the major actors in the land development process, (3) to describe the record keeping mechanisms and (4) to explain the information sharing mechanisms. Data was collected through structured questionnaires coupled by personal interviews. Supplementary data was accessed through collecting reports, policy documents, photographs and participant observation. The data used for the study dates back to fieldwork findings from (Kurwakumire, 2007) that was collected and compiled from CoM and the DSG in 2005. Further field work at the DSG, CoM and CoG was carried out in the period September 2011 to November 2012 in the context of land information systems, digital lodgement of survey records and webGIS to support cadastral and planning applications. Both the 2005 and 2011 surveys examined the status of the cadastral systems and service delivery mechanisms. The 2011 to 2012 survey was used in (Kurwakumire, 2013a) where the line of thought was in introducing a webGIS application to improve access and availability of spatial data at CoG. However, such a webGIS requires a base of either a digital cadastral layer or a digital cadastre where all data sets and other services are built on top which is the essence of this current study.

This study utilizes mostly secondary data used in other related studies and that collected through interactions with stakeholders within planning and cadastral offices. Even though, the secondary data was collected as part of other studies, there was sufficient information to support this current study. The author has a land surveying background in Zimbabwe and has interacted with the DSG, CoG and CoM since 2004 and has in-depth knowledge of the workings of the cadastral system and

land law in Zimbabwe. The author also carried out internships at both CoG and CoM in the period 2002 to 2005 and has continued on research on cadastral systems in Zimbabwe through supervision of bachelor thesis at Midlands State University in the period 2011 to end of 2012. As such, primary data collection was not required for this paper which relies on the personal experience and reflections of the author and available secondary data from other prior studies.

In order to improve the efficiency and effectiveness of the cadastre, there is need to first re-engineer cadastral business processes to modernize the system. Reengineering relates to reforms in individual processes which contribute to the provision of cadastral information or facilitate the fulfillment of a request for a particular land transaction. The motivation behind re-engineering discrete processes is the fact that, the efficiency of the whole cadastral system as a whole is depended on the efficiency of the individual units. Thus discrete units need shorter turn-around times while providing data that is compatible for use by the next units. In this way, there is efficient delivery of the end product to the client who can be a property developer or buyer. Improved land information management and efficient land transactions should result as not only the result of the re-engineering process but of the development of the digital cadastral system. The introduction of the digital cadastre should result in positive impact on the society, economy and land administration.

5. The Status of the Cadastre in Zimbabwe

The cadastral system of Zimbabwe can be traced back to 1897 when the triangulation commenced (Kurwakumire and Chaminama, 2012; Philip *et al*., 1982). The system is based on the Roman-Dutch law as is the case of South Africa (Tjia and Coetzee, 2013) and is comprised of separate cadastral and deeds registry offices even though they are housed in the same building in the capital city, Harare. Land surveys are regulated by the Land Survey Act of 1979 while town planning processes are administered through the Regional Town and Country Planning Act of 1996. Municipalities are mandated to store, manage and maintain records of all land parcels within their jurisdictions but without deeds information. The DSG is the overall custodian of cadastral information in the country. It spearheads and coordinates its collection, maintenance, updating, availability and accessibility to different users. Registered land surveyors are legally permitted to perform cadastral work and sign survey diagrams and general plans produced thereafter. The diagrams need to be signed submitted for approval by the DSG who checks for consistency with the required quality of the surveys and diagrams before the diagrams can be availed for public use. Upon approval, the surveyor general endorses the submitted diagrams otherwise, the submitted portfolio of documents is returned to the surveyor. The cadastral survey is only approved after the required quality of the survey and documents is achieved. The majority of land surveys are carried out using total stations though there is scattered global navigation satellite system (GNSS) technology use (Kurwakumire and Chaminama, 2012). There are no guidelines for GNSS use for performing cadastral work and neither do guidelines for examining the surveys exist. GNSS surveys are based on survey-accuracy GPS techniques which require a base station and a rover operating simultaneously. The products submitted for approval are created in a digital environment using

survey and CAD software but have to be printed and submitted in hardcopy format. The Land Survey Act (1979) Regulations have not been amended regularly since 1979. The regulations are not technology driven, but rather, they restrict the technology for use in surveying and mapping and the lodgement of surveys. Currently, the regulations stipulate that surveys should be carried out by theodolite and electronic distance measurement instruments (EDM).

Land records are kept in hardcopy format in filing cabinets. This is the situation within municipalities, the DSG and at the deeds office. The volume of records has increased since the first records in 1897. With the end of the economic crisis in 2010 and efforts to resuscitate Zimbabwe's economy since then, cadastral record production has accelerated. Municipalities use a card file indexing system to manage storage and access to cadastral information. They keep valuation rolls which record commercial and industrial properties and the market value. However, the valuation roll is seldom updated and more reliable property valuations are available from real estate agencies. Topographical maps within the DSG are out of date as the majorities are based on aerial surveys performed in 1979 (Kurwakumire and Chaminama, 2012).

The manual cadastral systems present major problems including (1) slow access to information, (2) paper documents depreciate due to wear and tear, (3) inefficient backup of documents, (4) loss of documents and (5) inefficient sharing and exchange of land information. Cadastral data can be viewed as a public good as it forms part of public sector information (Bennet *et al*., 2013; Kurwakumire, 2013a). In that regard, it should be widely available and accessible. The conveyancing process is done separately by private conveyancors. It is lengthy (on average 40 days) and expensive as they are too many processes and transaction costs. One of the time consuming aspects is on performing physical searches for cadastral records and deeds information at the DSG and deeds office respectively since both Departments are operating analogue systems.

The fast track land redistribution exercise in 2000 reversed some procedures which were regular prior to this process regarding land resettlement. This was in conflict with the prior Zimbabwe land policy in which there was a legal procedure to be followed from the time a farm is identified for reallocation to the time the new settlers occupy the land. The land was not legally transferred to the State prior to reallocation, and compensation procedures were not followed. The procedure should have been to subdivide the land first through a survey of land and then transfer rights to the recipients identifies for resettlement. The legal requirements for land acquisition for resettlement were later changed by the amended land acquisition act which became the driver of the fast track land redistribution exercise in 2000. Later, the land policy changed such that resettled land holders were granted 99 year leases after a cadastral survey of the land (Paradzayi, 2007). However land surveys for the 99 year leases only gained momentum from 2010 onwards. This has resulted in a backlog of cadastral surveys that are still to be done. This will take considerable time especially using only the technology prescribed in the Land Survey Regulations. There is need to harness the benefits of technology in both the execution of surveys and the lodgement and examination of surveys. A lot of work still needs to be done in converting quantities of analogue data into digital format.

Kurwakumire (2013b) suggests re-engineering of business processes for land administration activities within municipalities. Kurwakumire and Chaminana (2012) recommend the use of new technology in boundary demarcation and the need to revise the Zimbabwean datum. Kurwakumire (2013a) develops a pilot webGIS application to enhance spatial data availability and sharing within and outside municipalities. Modernization of cadastral processes in the context of this paper relates to the adoption of ICT in the automation of the cadastre (see figure 1). The basis of the modernisation is the transition from a manual and now inefficient cadastral system to an automated system which can incorporate new tenure arrangements. This proposed implementation attempts to resolve problems such as security, information management, access, storage, compatibility, interoperability and sharing of cadastral information. The modernized system should be extended to digital lodgement of cadastral data at the Surveyor-General's Department (DSG) as most land survey data is captured in digital form either by total station or global navigation satellite systems equipment (Kurwakumire and Chaminama, 2012) and the processing into information (maps, diagrams etc) is also conducted digitally. In the efforts of managing spatial data, the DSG should identify all providers and data types and compile a metadata catalogue. Metadata should include date of collection, accuracy, scale and resolution. This gives users confidence or certainity when using data collected by other organisations. In future, it is also necessary to think of reforms in the rural areas which are administered through the communal tenure system in order to implement pro-poor land management practices (Lemmen, 2010; van der Molen, 2005) which can in-turn uplift the livelihoods of people on communal land.

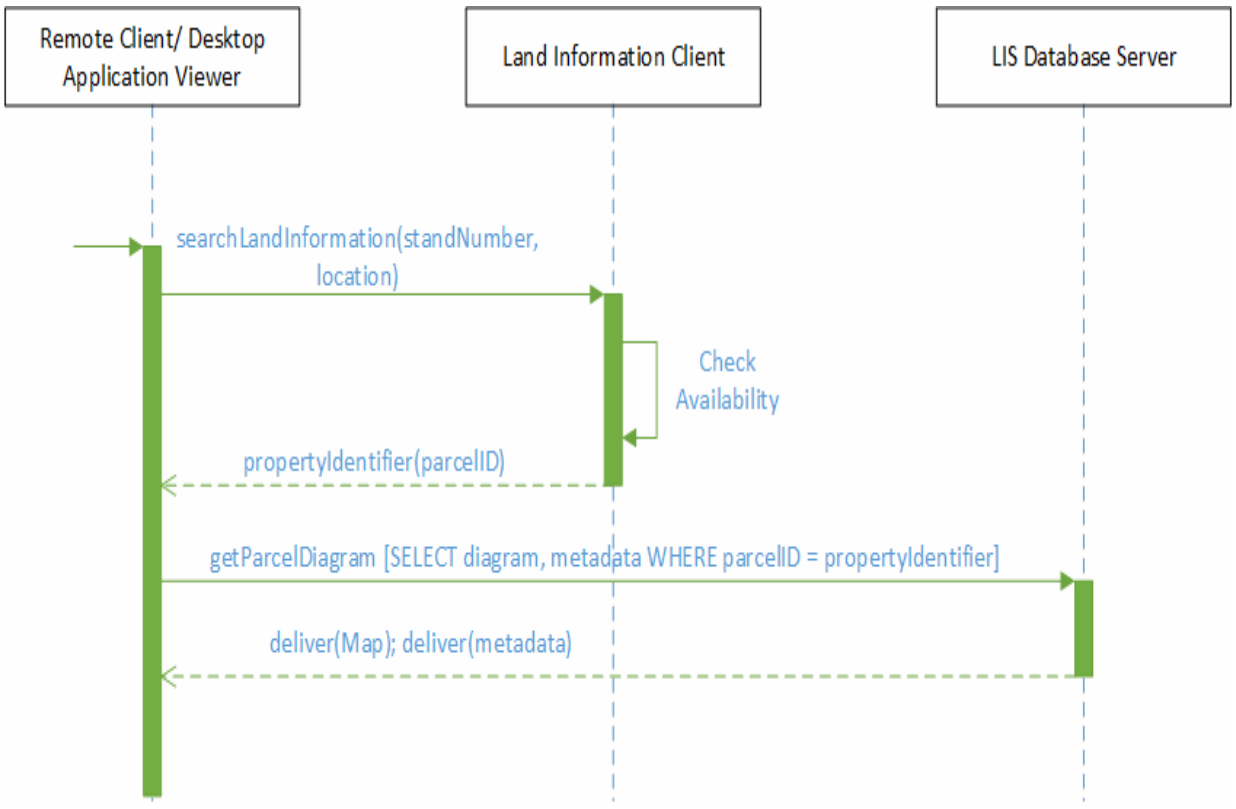

Figure 1: Re-engineering Information Access Protocols (Kurwakumire, 2013b, page 7)

6. Recommendations for Implementation

The transition from a digital to a paper based to a digital land information requires many considerations such as human, technological (hardware, software, peripherals), social and organisational factors including change management. This section emphasises the technological aspects that require consideration to foster a smoother implementation. A concise description of the Zimbabwean cadastral and land transaction system is provided. This is detailed in (Chimhamhiwa, 2002; Kurwakumire, 2013b) including some of the business processes involved. A schema can be developed using these business processes and based on the LADM to ensure similar implementations in different organisations but which are interoperable.

A digital cadastre requires more than just personal computers, but also servers to house the databases. More efficient backup has been made possible through the advent of cloud computing whereby information and servers can be hosted on the cloud. Personal computers are required as the desktop access points to the system within the use of client server technology to enable communication with the database. Several Linux systems are freeware such as Ubuntu and there exist open source database engines such as postgreSGL. There is also open source GIS software such as QGIS and Grass and free spatial data viewers such as UDIG. Pieper-Espada (2010) discusses the use of open sources alternatives in developing digital cadastres. The open source alternative is suggested in this study as financial constraints are among the major impediments to automating cadastral systems in developing nations. On the other hand open source software continues to develop and there is increased use and possibilities to migrate to commercial database systems in future. Similar work can be done with commercial software and database engines such as ArcGIS and Oracle Spatial as they are more established than open source. Municipalities need smaller systems which feed information into the digital cadastre maintained by the DSG who is the custodian of basic information relating to land (Kurwakumire and Chaminama, 2012) to enable real time changes and updates. This makes possible real time sharing of spatial information from various cities by other government departments, industry, non-governmental organisations and the public. The cadastre is a public listing, in which all land parcels of a country of a defined area are stored (Dale and McLaughlin, 1990) so it is a matter of public policy as to whether access to information will be freely available or whether there will be a cost and the nature of the information that different users can access.

Several processes are required for full implementation including those shown in Table 1. The processed depicted are not exhaustive but give an insight of the work that needs to be done from a technical point of view ignoring organisational, social and human resource constraints.

Table 1. LIS/ Digital Cadastre Process Elements

LIS DESIGN*	**DATA COLLECTION**				
	Field Survey: GPS, Total Station	High Resolution Satellite Imagery	Inter-agency data Searches	Photogrammetry	
	DATA PROCESSING				
	Digitizing	Transformations	Format Changes		Data Integration
			Rasterization	Vectorisation	
	POPULATING DATABASE	**INTEGRITY CHECKS**	**QUALITY CONTROL**	**INTEGRATION WITH ADMINISTRATIVE DATABASES**	
	LAND INFORMATION SYSTEM DEPLOYMENT				
	Pilot Implementation	Design Modifications	Retesting	Full Deployment	

*Creating Relations, Users, Access Rights, Security Protocols, Desktop Application, Remote Application Interface

Meta data needs be catalogued so that users know where to find the data and the characteristics of the data. Storing all spatial data in a global reference system such as WGS84 would solve many data integration issues. However, older data sets will have to be transformed. The cadastral authority should consider using low-cost land survey data collection techniques suggested in Kurwakumire and Chaminama (2012). Special consideration should be made for the parcel numbering system for the database as similar stand numbers exist in different suburbs within a municipality. The parcel identifier (parcel_ID) is normally the primary key or unique identifier for the parcel relation. The parcel is the base unit of the digital cadastre and therefore the parcel_ID is linked to rights holders and the nature of the rights held. The parcel_ID can be a combination of the stand number and abbreviations of the suburb and municipality name for example 201RSGWR to represent stand number 201 in a suburb called River Side and in Gweru municipality. Alternatively, considering the adoption of a postcode system in Zimbabwe may be necessary as it aids in the creation of an effective and unique parcel identifier. The DSG should have central control of the national land database since they are the custodian of basic information relating to land (Kurwakumire and Chaminama, 2012) that is also required by other entities or organisations. Linking the DSG system to the deeds registry should also be considered so that minimum time is lost in searching for records as these systems are housed by two different organisations.

There is a need to learn from countries such as the Netherlands and Germany. Netherlands has a complete digital cadastral layer available at her cadastral office. It is imperative to avoid their implementation problems but rather adopt best practices in land administration (Williamson, 2000) as per the land administration guidelines and international standards for land administration (ISO/TC-211, 2012).

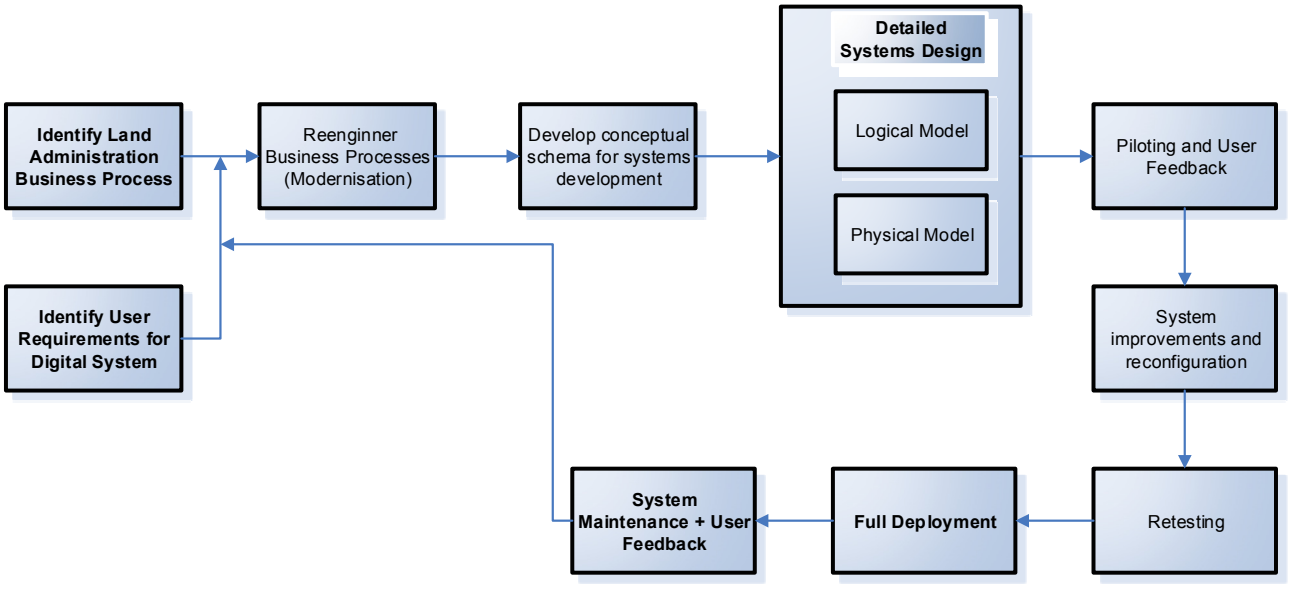

Figure 2. System development conceptual framework

The detailed system design is illustrated in Figure 2 above. There is need to identify the land administration business processes (Kurwakumire, 2013b) and the user requirements. The results are used to modernize the business processes. At this stage there is a need to develop a conceptual schema for the proposed digital cadastre which is used as the basis for developing the logical and physical model. The conceptual schema shows the different entities and the relationships that exist between them. The system boundaries are defined at this stage. In the logical stage, key attributes are identified including the primary keys for each entity or class and foreign keys where required. This stage is still software independent. Operations to be performed by each entity such as calculating the area from the parcel geometry or calculating the time a particular person held title to a parcel of land are devised at the stage. With the information provided from the conceptual and logical modelling it is then possible to design a prototype which is software specific before a full scale system can be deployed. The prototype application should be tested within and outside the DSG to obtain initial user feedback for use in improving the design. Upon improvement, the prototype goes through many cycles of retesting and improvement until it is ready for full deployment. Thereafter, the system should be maintained and modified through use of user feedback.

7. Design Issues

Several issues are crucial to systems development as detailed in (Kurwakumire, 2013a) and in section 6 of this article. Digital cadastres, like any other information system, are implemented in a society or organisation. As a result, the implemented technology becomes part of the social system in which it is implemented. The social construction of technology is discussed in Pinch and Bijker (1987). To ensure successful implementation of a system, there is need to take the social interactionist role in order to: (1) explain, understand and analyse similar implementations, (2) identify problems and setbacks (organisational, technological, capacity) as well as good practices

and (3) develop a set of best practice procedures and strategies to foster a better and informed implementation. Among problematic implementation issues is failure to take cognizance of change management as it is crucial to the success of systems adoption.

Organisations are shaped by their own cultures, values and institutions. To foster change, organisational learning, which is also a process rather than a once-off activity, is crucial to the success of a digital cadastral implementation. The workers within the cadastral offices should understand and appreciate the need and benefits of transition to a digital cadastral information system. This should be coupled with staff development and training which should be done in a piecewise manner as the system is introduced. The introduction of the digital cadastre can result in organisational structure changes in which some departments and or sections can be eliminated while new ones may also be created. For a smoother implementation, there should be a mechanism to migrate and retain all employees within the new structures otherwise the implementation will face intensive resistance. However, with the initial implementation, it is likely that some processes need to be outsourced since conversion of analogue spatial data to a digital form takes considerable time and effort. Systems must be user centered and interactive (Kurwakumire, 2013a). This transforms users from passive to active users as demonstrated in the web 2.0 concept described in (De Longueville, 2010).

8. Future Work

This study proposes a conceptual framework for developing land information systems as well as some technical and software requirements. It brings into light information access through desktop and internet portals. This may, in the long run, reduce transaction time hence making land transactions faster and improving the efficiency of the cadastre. There is, however, a need to conceptualize the proposed framework in figure 2. In particular, the relations and different modules required for the application and their respective architecture within the system needs to be explored. Modelling the architecture of the digital cadastre can be done using unified modeling language (UML) while at the same time based LADM (ISO/TC-211, 2012) which is a standard framework for developing land administration systems. The result should be a common architecture that is interoperable and extendable and which can be used by different cadastral offices without major changes. There are some organisational and social reforms that ensure a smoother and more successful implementation that need to be detailed such as staff development, organisational culture and resistance to change. Successful implementation can benefit from an understanding of prior GIS, SDI and e-government implementation projects such as those by Nedovic-Budic and Pinto (1999), Sheppard (1995) and by Reeve and Petch (1999). There is still a need to understand and detail the custodianship, sharing mechanisms (Chaminama, 2009), licensing and copyright issues with respect of information in the digital cadastre, bearing in mind that the cadastre contains public information. Also, the cadastre is a component of the land administration system which is a public good infrastructure (Bennett *et al*., 2013). A nationwide digital cadastre provides the base data for the development of a national spatial data infrastructure

9. Conclusions

Land is undoubtedly the most important resource in any country hence the need to manage it in a sustainable manner. Land is a major resource for economic activity in third world countries. Good land governance is a pre-requisite to sustainable development which ensures proper resource utilization and a land heritage for future generations. A digital cadastre can aid in achieving this goal through improving the efficiency and effectiveness of the cadastre and the execution of land transactions. However, there is need to modernize other related processes such as the land survey (modernizing the Regulations) and the deeds generation process to reduce the time required for a land transaction. There is a need to embrace information technology within all cadastral and registration processes. Customary land tenure should be integrated into this modernization process as motivated in the Social Tenure Domain Model in order that an inclusive and complete digital cadastral system is developed for Zimbabwe. Issues such as licensing and copyright still need to be considered as they have a bearing on the LIS and information access. The framework presented in this study is conceptual but highlights the most important aspects that need to be considered for the system development.

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