EVALUATION OF LARGIS APPLICATION IN PLANNING, ACQUISITION AND MAINTENANCE OF UTILITY SERVITUDES: AN ESKOM CASE STUDY

by

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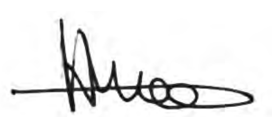

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ABSTRACT

GIS has been used for quite some time by utility organisations while the demands for their services by the public have also increased exponentially. This has prompted many utility organisations to constantly review their systems in operation for any potential problems associated with their use in order to propose possible and suitable improvements necessary to maximize their production.

This study evaluates the performance of Land and Rights Geographic Information System (LARGIS), a GIS based information management system employed by Eskom to manage its servitudes' land rights information. LARGIS has been analysed in terms of its application to planning, acquisition, registration and maintenance of servitudes land rights information.

Information on LARGIS was collected using a questionnaire administered to Eskom personnel that work with the system while interviews were used to obtain more information not obtainable from the questionnaire. Obtained information was analysed using a relational matrix of data sets and processes in order to identify subsystems making up LARGIS. Information flows and processes in each of the subsystems were then analysed using Data Flow Diagrams (DFD) supported by associated Data Dictionary (DD) so as to identify possible shortcomings in information flows and information processing. The information collected was also used to identify institutional, legal, economic and additional technical shortcomings.

The study revealed that LARGIS had made a positive impact on the way Eskom previously managed its servitudes by using a single system to plan, acquire, register and maintain land rights associated with servitudes. However, the study also identified shortcomings for which recommendation have been proposed so as to make LARGIS much more responsive to Eskom`s demands for servitudes land rights information management.

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LIST OF ACRONYMS AND ABBREVIATIONS

ALS	Airborne Laser Solutions
CASE	Computer Aided System Engineering
DD	Data Dictionary
DFD	Data Flow Diagrams
DOT	Department of Transport
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
FM	Facility Management
GIS	Geographic Information System
GMP	GIS - Based Mapping Program

GPS	Global Positioning System
IT	Information Technology
KV	Kilo Volts
LARGIS	Land And Rights Geographic Information System
LCMP	Life Cycle Management Plan
LES	Line Engineering Services
NGI	National Geo-spatial Information
OPM	Organisational Process Modelling
QGIS	Quantum GIS
RAD	Rapid Application Development
ROW	Right Of Way
SANSA	South African National Space Agency
SDI	Spatial Development Infrastructure
SDLC	System Development Life Cycle
SDW	System Development Workstation
SGO	Surveyor General`s Office
SSADM	Structured System Analysis and Design Method
SSM	Soft Systems Method
UML	Unified Modelling Language
4G	Fourth Generation

CHAPTER 1
INTRODUCTION

1.1 Research background

Geographic Information System (GIS) is intrinsic to every company and has progressively become a dynamic tool used for different purposes. It is used for various reasons within utility companies, ranging from depicting line routes and sites, helping Land Survey entities in supplying maps efficiently and effectively as well as aiding in handling statutory applications to build infrastructure (Rey, 2010). There are many benefits that can be derived from GIS. This is coupled with the fact that digital methods of storing and manipulating information are now commonplace. GIS provides a common platform for planning and visualisation of what is on the ground thus showing where changes will happen and how it will happen.

The increasing needs for new infrastructure and a high demand for power supply pose a challenge for the acquisition of land for development or expansions of utility infrastructures (Oxford Business Group, 2008; Kessides, 2004). In response to these issues, various information systems have been introduced. One such system is the Land and Rights Geoinformation Systems (LARGIS) which handles the spatial management of land rights within a single repository (Murata, 1995). This system is used by Eskom South Africa for Land Development and management of Land Rights.

GIS provides the opportunity for spatially identifying the location of network asset and the corresponding land rights assets at the same time; which has always been a challenge in the past. This system makes the management of land rights possible and easily accessible to all different users involved in all different phases of servitudes management from the planning phase to the last phase of maintenance of land rights. Nevertheless, there are certain factors that also affect the effective implementation and application of this system.

Utility organisations such as Eskom, Transnet and municipalities have used GIS for quite some time while the demand for their services by the public have increased exponentially. It is therefore important that the response of GIS to the increasing demands is evaluated in order to ensure that the system is able to meet the demand and if necessary identify the shortcomings and propose possible improvement so as to address them. This research therefore, seeks to establish whether the adoption of GIS at utility organisations has yielded time and cost effective, accessible information for decision making and planning purposes. It thus evaluates in retrospect the appropriateness of output information for planning for proposed developments, economic and institutional problems that maybe associated within this system if necessary.

These organisations mainly deal with utility servitudes which are legal rights that a person has over an immovable property of another. The planning and acquisition of these servitudes such as power management and electricity (power lines` servitudes), gas pipe lines, telecommunications, water and wastewater through GIS is essential. Not only are the servitudes captured but all other land related rights such as leases, wayleave agreements and option plans (which are legal documents stating the long or short term right to use specific property or a portion of a property) which are also part of the land rights database. The servitudes for these utilities sometimes traverse across the entire part of southern Africa, for example the power lines servitudes; hence the reason these parastatal companies are engaged in the management plans for servitude life cycle for their right of ways. The servitude life cycle management addresses also issues of planning through environmental impact assessment, economic, social as well as environment issues of this management task (Mahoney et al. 2008).

A lot has been written about the application of GIS in various aspects (Clay & Shanahan, 2010, Shamsi, 2005, Hiet et al. 1996, Godin, 2001, Waytt & Ralphs, 2003). However, little has been researched on the ways of increasing the optimal use of GIS in utility servitudes management. Therefore, this study seeks to fill that gap by evaluating the manner in which planning for utility servitudes is done with the aid of LARGIS in Eskom, and to further assess how the acquisition and maintenance of servitudes are achieved through the application of LARGIS. Finally to suggest ways to improve this system if necessary.

1.2 Problem statement

Utility organisations have been using GIS for quite some time. In the meantime the demands for services have increased. It is therefore imperative to review this system`s performance periodically, in relation to this increasing demand in order to establish its response to the increased demand and to identify shortcomings, so as to and propose improvements necessary to address the increasing consumer demands for services. Furthermore, the competition is very high in today`s world, successful utility organisations have to take supreme advantage of its resources, inclusive of people, equipment and information by using GIS to integrate spatial data with other corporate data (Esri, 2010a). Lack of a system that could provide a direct link between companies main database with other departments poses a challenge to a viable planning and delivery of services.

1.3 The aim and objectives of the research

The aim of this research is to evaluate the effectiveness of LARGIS application, in the planning, acquisition, registration and management of utility servitudes in order to establish its response to the increasing demand for services and to identify any possible shortcomings, so as to propose improvements to enable the system meet the increasing consumer demands for services using Eskom as a case study.

In pursuance of this aim, the following objectives and associated summarized methodology of achieving them are proposed:

Objective 1

To undertake an analysis of how LARGIS is currently applied in planning, acquisition and maintenance of servitudes.

This will be achieved by investigating the system using review of relevant organizational documents concerning LARGIS applications in servitude management, interviews and questionnaires with LARGIS users and finally by on-site observations of the LARGIS in operation.

Objective 2

To identify possible shortcomings which hinder the optimal use of LARGIS.

This will be achievable through analysis of information collected and processes observed during analysis of the LARGIS operations.

Objective 3

To propose possible improvements to the LARGIS in order to overcome the identified shortcomings.

This will be done by suggesting changes to technical, economic and institutional aspects of the LARGIS based on the identified shortcomings.

1.4 Research questions

(a) How is GIS currently applied in planning, acquisition and maintenance of servitudes?

(b) What are the possible shortcomings hindering the use of LARGIS as a servitude management tool at the Eastern Region Land Development department of Eskom?

(c) What changes should be introduced to improve the performance of LARGIS as a servitude management tool at the Eastern Region Land Development department of Eskom?

1.5 Study area

Eskom, the case study for this research is a South African electricity public utility entity. The designated study area for this research is the Eastern Region Land Development department of Eskom situated in New Germany, KwaZulu Natal (29.48.19 S, 30.53.04 E) as shown in Figure 1.1. One of the biggest in the generation of electricity in the continent and it is rated among the top seven in terms of production capacity in the world (Eskom Holdings Limited, 2011). This entity is mainly involved in generation, distribution, and transmission of electrical power and controls a transmission system that covers about 28,000km of high voltage transmission lines between 132kv to 765kv (Mahoney et al. 2008).

Eskom requires servitudes for its power line transmission. The planning and acquisition of these servitudes through LARGIS is the major focus of this study, Figure 1.2 denotes a simplified model of major functions within LARGIS. Not only are the servitudes, captured but all other land related rights such as wayleaves agreements and option plans (which are legal documents stating the long or short term right to use specific property or a portion of a property) are also part of the Eskom land rights database. This system also addresses issues of planning through environmental impact assessment, economic, social as well as environment issues of this management task (Mahoney et al. 2008).

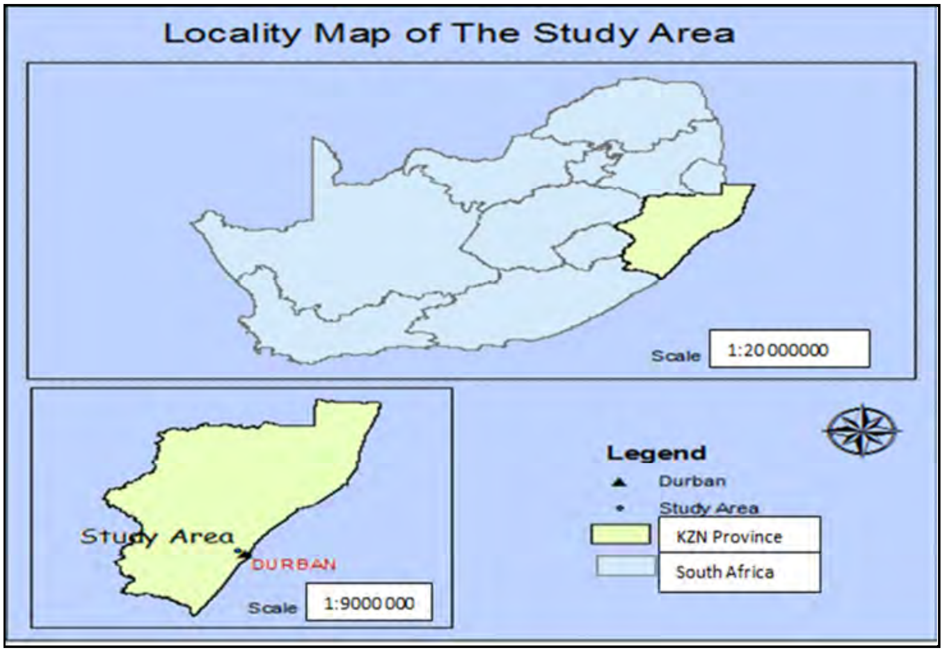

Figure 1.1: Locality map of New Germany, KwaZulu Natal

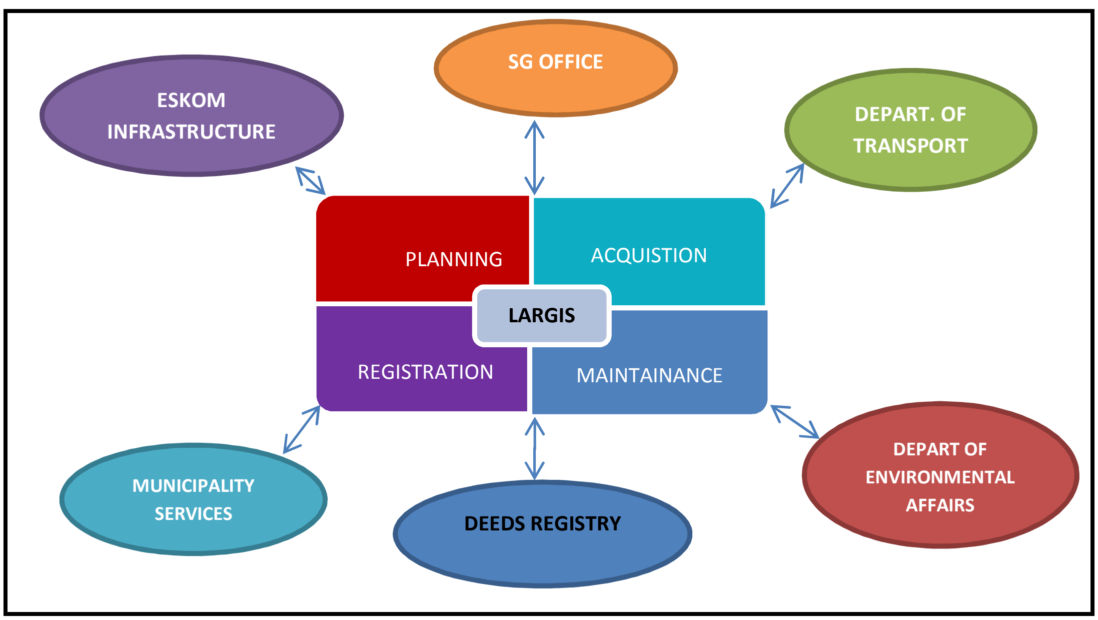

Figure 1.2: Model of LARGIS

1.6 Thesis organisation

Chapter 1 has set the basis and context of this study by outlining clearly amongst others the targeted aim and the objectives.

Chapter 2 gives an overview of information system as well as different methods of system analysis and development. This chapter also covers the review of the theory information and different criteria used in evaluating information system performance. It briefly discusses information system development methodologies with particular reference to information system life cycle.

Chapter 3 provides an overview of the concepts and theories in GIS development and its applications in different aspects in utility organisations.

Chapter 4 gives an overview of LARGIS as a form of GIS and its application in Eskom in all phases of management of land rights. It also discusses the security considerations in LARGIS.

Chapter 5 outlines the research approach followed in the collection of data and the model followed in the analysis in this research. It further describes the methods of data collection, the sampling techniques as well as data analysis techniques used in this study.

Chapter 6 presents the results collected by primary methods of data collections. It also offers an analysis and interpretation of these results and review of the applicable literature.

Chapter 7 gives a general discussion of the findings and analysis reached in chapter 6.

Chapter 8 is the final chapter that discusses the conclusions reached from the findings and analysis of the aim and objectives of this study. It also provides the recommendations to the challenges encountered with the application of LARGIS as a servitude management in a utility organisation.

CHAPTER 2
EVALUATION OF SYSTEM ANALYSIS METHODS

2.1 Information system overview

In any organisation, huge amounts of money get invested in information system in order to enhance performance. It is therefore essential to monitor and evaluate any system that is in operation. However, the process of evaluation can be costly; as a result, there are a couple of models that have been developed on how to evaluate information systems effectively and efficiently.

The evaluation of information system assists in determining whether the system is being utilised proficiently and defines how successfully the system meets its objectives and the organisation`s goals. Apart from these, it increases the organisation`s competitive advantage and makes it more productive. It is therefore critical to have a good monitoring and evaluation model that can ascertain whether the system is efficient, easy to use and appropriate for intended use. The results of the evaluation assist in identifying any limitations with the system being evaluated.

Various studies have been done in the past to evaluate the impact of information systems and analyse the influence they can pose on the end user`s performance. Numerous methods of assessing information system`s effectiveness, success and failures were explored. These led to some development of models that integrated variables such as system efficiency and information accuracy with the user satisfaction model. Whilst other models basically measured the impact of information system on individual user`s performance by concentrating mainly on the user acceptance and satisfaction.

Similarly, GIS as a form of information system also has gained widespread attention and use over the past decades. This technology can provide many benefits for a variety of spatial data activities to the organisations which utilise it. The outcomes that match users' needs can be accomplished if an effective structured process is followed in the implementation. This structured process is usually referred to as system development process and it comprises five basic phases as explained in the succeeding sections (Somers, 2008).

An information system is a system that consists of the network of all communication channels used within an organisation. It links all the various systems in an organisation in such a way that they are able to work effectively and efficiently towards the same goal (Chilufya, 1997). Therefore, Information System Development is a range of actions used to form information systems.

These actions are arranged into stages named System Development Life Cycle (SDLC). Rouse (2009) states that during the process of system development, the current system is assessed in order to identify the faults. This occurs during the first phase of preliminary investigation of system development as shown in Figure 2.1. This can be done by primary methods of finding information such as interviews. Belle et al. (2003) demonstrate that during this stage, the following major areas should be considered when doing a feasibility study:

- “Economic feasibility to measure the costs and benefits of the new system.”
- “Technical feasibility to ensure that the organisation has sufficient hardware, software and personnel resources to develop and support the proposed system.”
- “Operational feasibility, the willingness and ability of management, users and Information Systems staff in the organisation to build and use the proposed system. ”

Rouse (2009) articulates that the needs for a new system should be clearly defined and shortcomings in the current system well addressed so as to propose precise proposals for improvement. Development of a new system follows the design phase of a system. Intensive training of the user and testing of the system performance then proceed. Changes are done where needs arise in this stage. The system can then be put into applications in different ways as discussed in section 2.5. Once the system has rolled–out, consumers are informed of any changes or upgrades of the system. Constant evaluation on the running system is crucial.

2.2 Review of the methods of system analysis and development

The academic interest for the system development models has increased greatly over time; this has resulted in the creation of completely new ways of organizing business processes using information systems. There are various methods used in developing information system appropriate for a particular type of application.
According to Patel (2005), information system methodology clearly defines information system problem and affords a phased process for development of information system. A simple principle is that by following the specified phases the problem area system

requirements can be defined. There are several methodology approaches. However, the substantial formal part of it is that, they all follow a systematic, chronological and phased plan and each phase provides detailed documents for the subsequent stage and the complete effective development of a new information system.

Amongst others, are simple methods which model the system processes by detecting the interactions among representatives that perform some process in order to accomplish their aims of modelling the organisational goals, this method is referred to as the Organisational Process Modelling (OPM) (Belle et al. 2003)..

Besides this, there is a comprehensive method that engages with all aspect of the hard system matters. It is based on waterfall life cycle model discussed in section 2.4. This method is known for its intensive user involvement in the requirements analysis stage. It uses logical data modelling, data flow modelling and entity behaviour modelling techniques. It makes diagrammatic representation and divides projects into small modules with well-defined objectives as stated by Hawryszkiewycz, (1994). This model is called the Structured System Analysis and Design Method (SSADM), however, this has been widely criticised for inability to incorporate changing organisational goals and needs indicative to large organisations.

The other modelling method is the Unified Modelling Language (UML). It is a modelling language designed to provide standardised way for visualising the design of the system as described by Baar, (2004). This method is most suited to implementation in an object – oriented environment unlike the SSADM (Al-Humaidan and Rossiter, 2001). The developers can model resources by using the stereotype feature because this model does not have any mechanisms to prototype the resources (Baar, 2004).

Apart from this model, there is the Soft Systems Methodology (SSM) which checks the quality by outlining processes for events in an abstract model of the anticipated system, although this model does not have provision for other features of the hard system method such as activities, designing interface and data (Al-Humaidan and Rossiter, 2001). The soft systems methods focus on what to do with the organisational concerns and model systems to account for human activity and surrounding environmental influences. This enables a participative approach to form debate about potential improvements to complex organisational problems (Patching, 1991). SSM offers a good base for detecting stakeholders and cultural challenges (Palmius, 2007).

To add more, there is the workflow management system approach, which mainly uses a value chain by combining people, organisation and processes together to improve the quality of service (Al-Humaidan and Rossiter, 2001). The advantage of workflow system is that it manages the flow of work between the users and system applicants with the suitable information which is accessible by the system in order to accomplish the set goals. Al-Humaidan and Rossiter (2001) further indicate that it saves labour and paper and also reduces dead time in processes and improves their quality. In this model, the tasks are passed from each participant in the right structure to ensure that all fulfil their expected contribution.

Depending on the dimension used for modelling, Wang and kumar (2005) articulate that workflow management system can be viewed either from the process based perspective, information based architecture or organisational perspective. Al-Humaidan and Rossiter (2001) emphasise that the combination of workflow and UML is seen as a best way to success. In view of Reinwald (1994), workflow management system manages the flow of business processes done through different individuals and gets correct information to the right people using the correct channels.

In an attempt to address the problems of slow development cycles, Rapid Application Development (RAD) model was developed. RAD methodology came up with the use of advance development tools which enhance the process of development and creates codes of high quality such as code generators and the visual fourth-generation (4G). This model therefore was developed to respond to the need to deliver systems very fast hence it is grounded on the notion that higher- quality products can be developed quicker through more practical processes (Brady, 2014). This model encourages consumer response and commends and reduces development period. However, the setback is that it is dependent on team work and individual performances for recognising business needs.

Contrary to the SSADM, RAD does not build each step on the work that was prescribed without any deviation and conducts steps in parallel.

According to Al-Humaidan and Rossiter (2001), besides the resources, analysis of the system involves numerous fundamentals such as problem identification, organizational structure, employee`s opinions and goal realisation. However, the shortcomings identified with these models were that the quality of the system and its usefulness needed to be evaluated before the system could deliver performance impact (Al-adaileh, 2009). In some cases, insufficient systems could be evaluated by its users based on accessibility and personal characteristics.

2.3 Theory on evaluation of the performance of an information system

There are a lot of views as to how to evaluate information system. Evaluation of an information system detects whether the system performs as expected and the extent to which it compares to the previous system. Various approaches have been discussed by different authors. Approaches such as interpretative evaluation have not been used extensively possibly due to lack of applied method that is set for evaluators and assigners of evaluations. However, interpretative approach according to Lagsten (2011), theoretically provides conceivable benefits such as stakeholders commitment and learning opportunities as compared to traditional cost-benefits approach. Some approaches focus on the economic criteria whilst others on the user oriented criteria. Walsham (1993) alludes that system evaluation is essentially a qualitative process of determining the possible cost or benefit based on a defined criteria. He cautions that these approaches often contain measures that are both economically and technically challenging as they are developed from a managerial perspective.

On the other hand, Palmius (2007) pronounces the criterion model for evaluating information system as based on five criteria namely, the organization, individual, information, technology and systemics. He states that the organization criterion describes how well the information system supports the organization`s performance while the individual criterion is related to the production and approval of individuals within the information system. Palmius (2007) further indicates that the quality and access of information are related to the information criterion. Technology criterion defines the security, usability, software and hardware whereas the systemics criteria are related to model conformance, system properties and cybernetics (Palmius, 2007). In his view, these criteria must be measurable and comparable in practice.

Hitt and Brrynjolfsson (1996) however, have a different view from Palmius (2007) regarding the assessment of the quality of information system. They outline the three basic criteria as productivity, business profitability, and consumer surplus for evaluating whether information technology is useful. Whilst Remenyi et al. (1999) believe that evaluation can either be formative or summative. A formative evaluation is whereby the organisation evaluates so as to increase the performance while in summative, evaluation is performed to observe the quality of the past performance (Remenyi et al. 1999).

Petter et al. (2008) identified the following; system and information quality, system use and the net benefit as variables to define information system success. Nevertheless, they state that these variables are interdependent and are not independent as measures of success. Petter et al. (2008) describes information quality in terms of the completeness, accuracy, friendliness and understandability. While system use was defined by measuring the frequency of use, purpose of use, the extent and the way in which staff utilise the capabilities of an information system. Another factor which was considered important was the quality of the support system received by the system users. This is assessed by prompt response to the user`s needs and the reliability. Whereas the net benefit of the individual and organisation at large are classified as user satisfaction, improved decision making, increased cost reductions and improved productivity (Petter et al. 2008).

Alternatively, Hinton et al. (2000) emphasise that evaluation should reflect both the outcome-based and process-based approaches. The outcome-based approach focuses on the measures of the information system effectiveness whereas the process based approach focuses on the view that certain conditions have to be met. In comparison to Hilton et al. (2000) sentiments, Jokela et al. (2003) believe in a theory based evaluation with a universal approach. Their approach establishes goals at the beginning and maintains that action is taken at the end to make changes in the organization based on the evaluation outcomes. This approach involves the interaction between the participants and valuator. Vasilecas et al. (2006) complement that goal – driven and task driven evaluation approaches are the most common as they allow evaluation criteria to be set logically and to receive well founded results.

In addition to Vasilecas et al. (2006) views, there are other strategies for evaluating a system such as the goal–based evaluation and the Goal–free evaluation. In goal–based evaluation, analysis is based on the desired business goals. On the other hand, goal–free evaluation offers more understanding of the system, part in the business and its social and organizational implications (Cronholm and Goldkuhl, 2003). There are no goals used, it is more interpretative and situation based. Another strategy is criteria based whereby evaluation is based on predefined qualities and desired criteria that are important to evaluate from different perspectives.

DeLone and McLean (2003) developed their model of information system success highlighting the importance of an improved and steady success metric. The eminent D & M model of information system success was aimed at addressing the fact that an information system can affect different levels besides organisational and individual levels. This is because information system success affects businesses and people as well (Pitt et al. 1995). DeLone and McLean (2003) emphasise that the D&M model is depends largely upon the administrative perspective. Therefore a clear knowledge of the information system and organisation is essential. This will control the types of methods used for each success measurement which depends on the nature and purpose of the system(s) being evaluated (DeLone and McLean, 2003). Abugabah et al. (2010) and Al-adaileh (2009) evaluated the impact of information system from the end user perspective and focused on the development of models to investigate information system and user`s system performance.

2.4 Information system development life cycle

Information systems must be integrated into the processes of the organization in order to attain competitive advantage. However there is a communication gap between the “user” and the “programmer”. The user knows his needs but lacks the practical skill, likewise the programmer apprehends the computing environment but not the user setting. This communication breach between the two involved individuals should be translated according to the needs of the user into comprehensive stipulations to be implemented by an intermediary, the system analyst (Belle et al. 2003). Furthermore, an organisation may see a need to improve operations or to cope with increased volumes of expansions operations, or perhaps customers may demand a better level of service. For this reasons, systems go through a creative design process called the systems development life cycle. Lewis (2009) explains system development life cycle as “the overall process of developing, implementing and maintaining information systems through a multistep process from initiation, analysis, design, implementation, and maintenance to disposal”. Thus the concept of a life cycle in relation with Information System Development arises because the development of an information system has a specific beginning and ending after which a post implementation review is conducted to assess whether the system requires improvement thereby repeating the cycle (Chilufya, 1997).

Information System Development Life Cycle follows sequential processes in which developments flow progressively downwards as shown in Figure 2.1 and the processes are recursive.

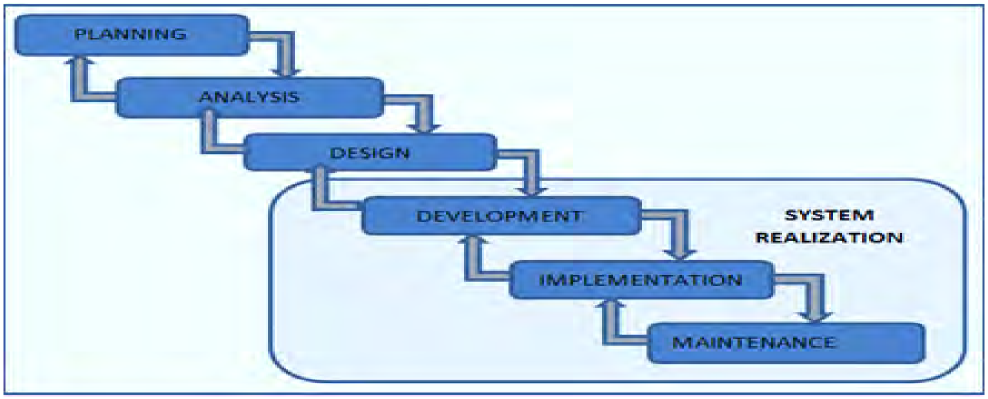

Figure 2.1. Systems Development Process: Waterfall Model. *(Adapted from Guptas, 2005)*

2.4.1 Phase I: System planning

It is important that any GIS application development also meets the desires of its users, in terms of the cost, quality and time efficiency and effectiveness. This starts with the establishment of user requirements also known as the feasibility study to see whether the problem is resolvable or if it is worth solving by examining technical feasibility, cost and benefit analysis. This is the most crucial phase of application development. Gupta (2005) augments that this phase involves initial investigation and survey, and should lead to clear statement of the scope and objectives of the system. He further adds that this phase involves evaluation of the existing system and produces an analysis of alternate system that maybe developed. Cummings & Haag (2006) complement that this involves formulating a plan for the intended system which begins with defining the intentions for the system and how it will support the strategic goals of the organization. However, this phase may result in a decision of not proceeding to the subsequent phases if the decision is found to be not feasible.

2.4.2 Phase II: System analysis

System analysis is the process of exploring a system in order to diagnose problems, and to recommend improvements to the system using the information. During this phase, an analyst studies how the existing system works in order to determining the user`s requirements using contextual interviews intended to users (Benyon et al. 2005). This includes collection of data from different sources using various tools such as questionnaires, interviews, review of present documents and other methods (Guptas, 2005). System analysis helps the organisation to understand the geographic context of their data thus allowing for easy decision making and enhancing the process of solving problems. It further allows for new improved development of software. The analysis phase requires discourse between system designers, Information Technology (IT) specialists, and the system's future users. In this phase, the system's requirements begin to be defined.

2.4.3 Phase III: System design

The design phase starts with identification of alternate technical solution thereby selecting the most suitable solution and detailing it out (Guptas, 2005). It thus involves the physical construction of the system and the design of the network and both system and user interfaces. The design should be tested to ensure that the anticipated design is verified for performance, and to ensure that framed requirements are met. The cost – benefit may again be performed at this stage. This is to say the aim of this phase is to change the requirements that were defined earlier into comprehensive specifications that can be used in the succeeding phase. Usually a pilot study with procedures guidelines and database adjustments is done during this phase.

2.4.4 Phase IV: System realisation

This phase has three sub-phases. The first one is system development which is composed of coding and testing the design. This stage is followed by the implementation stage which generally occurs before the users finally sign off. It is the final stage that acknowledges testing and bug fixing. In this stage, the system is implemented into the organization's processes. User documentations are created to communicate to users how the system operates.

The last stage under system realisation is the application and maintenance and operation. This entails a phase of training the operators and improving the system augmentation (Rumbaugh et al. 1991). This stage involves monitoring the system to be sure it is operating in accordance with the firm's objectives. Users familiarize themselves with the system and additional new features are introduced. Support is also given as a continuous activity so as to fix any problems encountered.

The processes are or can be repeated depending on the outcomes of each phase as shown in Figure 2.1.

2.5 System conversion methods

There are different methods of converting from an old system to a new one. The choice depends entirely on an individual organization. The following provides a discussion of different methods of converting from an old system to a new system.

2.5.1 Parallel conversion

Parallel conversion as described by Wang & Wang (2012), occurs when the old and the new system are run alongside for a certain period until there is an agreement between management and the project development team to completely change over to the new system (Figure 2.2).

The problem with this method is that it is costly to the organization to run two systems simultaneously. This method minimises the dangers caused by conversion failure. This type of conversion was adopted with the introduction of LARGIS at Eskom.

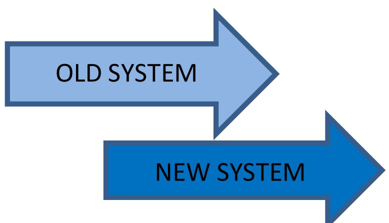

Figure 2. 2. Parallel system conversion method

2.5.2 Direct conversion

This method of system conversion adopts a new system instantly and replaces the old system (Figure 2.3). This is easy but very unsafe in case the conversion fails as there is no backup system.

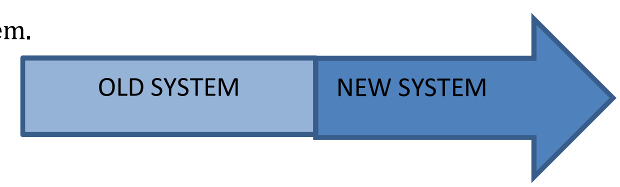

Figure 2.3. Direct system conversion method

2.5.3 Pilot conversion

A pilot conversion encompasses using the new system in only a small division of the company as a test site. This method is safer because it allows any bugs to be found without the whole company being affected.

2.5.4 Phased conversion

This method allows gradual implementation of the new system in phases within an organization (Figure 2.4). This allows only a few departments to be converted to a new system at a time.

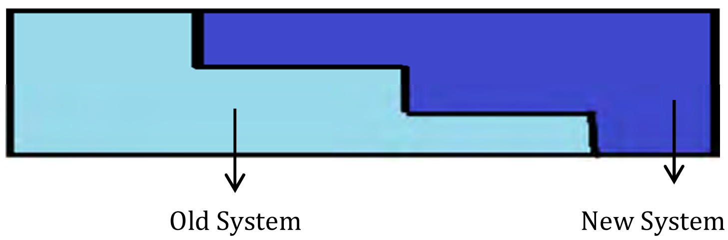

Figure 2.4. Phased system conversion method

The phases can either be physical location or functional areas. This phased in method minimises the risks of failure even though it takes a long time for the complete roll- over of the new system.

CHAPTER 3
OVERVIEW OF GIS APPLICATIONS IN UTILITY ORGANISATIONS

3.1 Introduction

This chapter makes an overview of the concepts and theories in GIS development and its applications in utility organisations. It further outlines the findings of other previous researchers on the scope of GIS. It also defines servitude management life cycle and the key drivers of servitude management in terms of economical, environmental and social cost and benefits and.

3.2 GIS applications in various utility organisations

The benefits of GIS have been widely acknowledged and data sharing is one of the commonly known advantages. As stated by Johnson et al. (1992), GIS allows for the integration of data sharing across programs, regions, agencies and levels of government. Johnson et al. (1992) emphasise the importance of data sharing initiative partnership between the Agency and local governments in order to achieve the environmental protection goals of the future. Whilst Meehan et al. (2007), also substantiate that, like any other enterprises, GIS is used as a central unit that feeds all other departments within an organisation with information. There is an interchange of information from planning, design, surveying, engineering, construction up until the as build documentation phase (Meehan et al. 2007).

Wyatt and Ralphs (2003) support the fact that the information about facilities in GIS is used to support a number of business processes such as maintenance and operations and property management (acquisition, disposal, refurbishment and redevelopment). However, they also highlight the challenges associated with the implementation of GIS in any department at general. Wyatt & Ralphs (2003) further, state that the problems that were experienced in a case study done in London with the implementation of General GIS in transport property and network rail pilot plan of compiling asset register and assisting with planning, designing and information sharing on major infrastructure projects were largely of a technical nature. For example the legacy data was not easily transferable to the new system and the GIS database adopted was not relational.

It is important for organisations to be able to integrate a network based system with that of a polygon-based system in a network route. This is always the case where there is a need to manage a linear asset crossing onto a polygon system. This scenario relates to organisations which deal with line based assets that cross a polygon based system such as a private property (Douglas, 2008).

System development constantly occurs due to the market pressure. In other parts of the world such as Denmark, Land acquisition GIS was created in order to understand the impacts of route selections, to determine and manage cadastral information of the affected land parcels more proactively (Bentley Systems Corporation, 2012). In Eskom (South Africa), the increasing electricity demands have caused the organisation to adopt LARGIS and other tools to handle approximately 7000km of power lines added each year to its infrastructure with the coupled new generated spatial datasets (i.e. power line routes to large electrification areas) (Rey, 2010).

According to Johnson and Pettersson (1992), the ability to access, manipulate and display vast amounts of information from relational database on to map in real time provides municipalities and other governmental entities with a powerful tool for planning, design, operation and management of complex resource infrastructure systems. Municipalities and public agencies use GIS in various management activities. Private industries such as gas companies use it to manage alterations in lease maps and to determine best locations for gas stations in developing areas.

GIS software, in the profit-making environment is driven mostly by needs and suitability. Software developers will frequently usually engage the latest research on algorithms to ensure that the quality is improved and efficiency is enhanced for all their products. (Smith et al. 2007). He emphasizes that the choice and application of suitable tools in a way that is beneficial to the intended aim is essential. Therefore, this study will attempt to justify this fact by evaluating the impact that use of LARGIS has in a utility organization.

There are constant developments in GIS utility management services. According to Shamsi (2005), a GIS - Based Mapping Program (GMP) is an inclusive development in GIS which allows one to get up to date and precise information faster about new sewer infrastructure. This technology includes extensive information about a sewer infrastructure collected from interviews. Thousands of companies use GIS to improve processes or service delivery. System just changes, this implies that it begins with a basic program to which more features may be included. It is therefore essential to carefully plan and monitor the development information for businesses. Hence this study also evaluates the current LARGIS applications for maintenance of land rights. This process goes in phases; it starts with the planning analysis, design, implementation and lastly system evaluation of the system (Namalomba, 2001).

The advantages of GIS are acknowledged by many utility companies. Bernard (2007) supports this statement maintaining that GIS is progressively being utilized in the management of both simple planning models and detailed information management systems. It can as well be used to identify best locations of new substations and to detect networks that are overloaded. She indicates that there has been a steady increase in the usage of GIS and information sharing with other departments and local communities. However she emphasises that it is strongly advised that some of these projects are researched in order to be able to make a decision as to what type of system will be perfect to use.

GIS technology is beneficial to many areas. The growing and active GIS market drive costs down and lead to constant improvements for hardware and software components of GIS. Pervaiz (2007) illustrates some of the benefits of using GIS in power transmission line sighting, where GIS is used to analyse options for appropriate areas and to locate the best route. However he emphasises that in the past, the power transmission systems were established in order to keep up with the ever increasing demands for power. Alternatively, mounting interest over environmental issues and rural areas development has been limiting this process.

Most surface infrastructures such as road transport and electricity facilities, including underground infrastructures such as natural gas pipelines, sewer pipelines are widely geo-referenced using GIS.

3.3 GIS applications in planning, acquisition and maintenance in utility organisations

Over the years GIS has made outstanding developments in different areas such as disaster prediction, land management, public facility management, urban planning, water supply, electricity facilities and many others. Organizations have come to realize that GIS, not only helps manage the existing utility infrastructure, but can also aid in the design for future expansions (Shamsi, 2002). The utility industry is a major consumer of GIS because of the fact that almost all utilities can be spatially referenced. Hughes (2006), maintains that GIS gives utility users the opportunity to determine both the location of their assets and to analyse the attributes about them.

A similar application of LARGIS is a GIS system used in California utility. According to Skurzynski (2007) this system allows records pertaining to the status of land acquisition for right of ways to be kept, traced and accessed within a company`s system. This enables a full record of all the interactions with property owners during the process of land acquisition.

GIS, is crucial in planning and monitoring of power generation resources. It assists in determination of optimum generation and prime route selection. (Esri, 2010b)

3.4 GIS in Network analysis

GIS has wide applications in network analysis and allows easy and quick identification of problems. This is an important factor in cost reductions and high performance. Utility organisations use network analysis to managing their infrastructure: water, sewer, power. They also use it to monitor and analyse their distribution systems and meter-reading routes. While municipals use GIS in network analysis for various uses such as analyzing bus and truck routes, determining best possible plans and leverage costs. Therefore, GIS is widely used to plan network expansions, model possible changes, and schedule repairs and maintenance because it enables easy visualisation and analysis of utility network. Esri (2012) argues that with the support of GIS, assets can be managed in real time and schematic diagrams of utility networks can be created and viewed.

GIS also allows for planning of transmission networks, maintaining and managing of transmission asset data such as substations, lines and other structures. It also aids in the analysis of network congestion, as well as determination of site feasibilities (Esri, 2012).

There is pressure for water distribution companies to distribute and supply water efficiently. GIS is then employed in network analysis to support numerous tasks such as leakage detection, pump scheduling, maintenance scheduling and failure management.

In addition, other applications of GIS in network analysis include routing which entails path computation in transport network, the financial cost to traverse a network and the restrictions on travel such as one way streets and lastly temporal information. It is further applied in network tracing whereby a particular path is determined through a network in water or utility networks. GIS provides information on service area coverage for points of interest. Therefore it is essential in resource allocation for decision – making and customer relationship management applications.

3.5 GIS in asset and facility management

Facility Management (FM) refers to the integration of people, place, and infrastructure. One of the principal applications of GIS has been in facility management. Throughout the facility life cycle, GIS supports the organization with a mission, from site selection to space planning and maintenance, lease management and usage, safety issues, and continuity planning (Esri, 2010).

In consistence with Rich & Davis (2010) the entire life cycle of a facility can be monitored through GIS. However, they caution that the main challenge lies with the management of every process in a way that reduces both the short- and long-term impacts on the natural environment, at the same time making sure that benefits of the facility to the public are increased.

It is used in this field mostly across the world for emergency, disaster planning and response, also in space and asset management and site selection. Some utility organisations apply GIS in asset and facility management for various reasons. Some utilise it in location of underground pipes and cables while others for balancing loads in electrical networks or even for tracking energy use and planning facility maintenance.

3.6 GIS in Spatial analysis and planning

A spatial information system consists of a number of components. These include software and hardware, data, people, procedure as well as communications. Spatial information system allows various databases that maybe be dispersed in the organisation to be linked and accessed through open database connectivity standards that are being adopted. Spatial information systems that are well integrated with other systems in an organisation can provide information quickly and in the desired form to managers and key professionals. This provides efficient and effective decision support.

Haining (2003) describes spatial analysis as a representation of a group of systems and methods that use the spatial referencing connected with each object that is specified within the system under study. The three main elements of spatial analysis are the cartographic modelling, the mathematical modelling and the spatial data analysis. The spatial data analysis uses spatial referencing in the data by incorporating the development and use of statistical methods for appropriate analysis of spatial data.

Spatial planning involves making suitable decisions concerning the distribution and position of land use activities. Quality spatial planning depends entirely on effective management of information and manual management can be very difficult. Aksoylu and Uyguçgil (2005) demonstrated that GIS supports numerous elementary operations for effective management of geo-information. These include all the primary factors related to the collection of information up to the maintenance and analysis of spatial information. However, they point out that easy access to digital data may result into abuse and misuse and data security is critical as discussed in section 4.2.

3.7 Servitude management plan and key drivers to servitude management plan

In a study conducted by Volsoo (2003), it was discovered that the management of servitudes involves several concerns. The plan covers several issues related to the complete life cycle of a servitude. This management plan also takes into pespective the economic, social and environmental prospect of the servitude. (Eskom Holdings Ltd, 2007).

For example the economic, the social costs and benefits of the current and proposed activities are important to be acknowledged even though costs are difficult to quantify. It is therefore vital to manage servitudes for minimum bio-physical and social environmental impact for optimal system performance and costs. Problems such as negotiations faced with stakeholders, interested and affected parties in one phase leads to problems during the next phase.

Servitude life cycle phases

In 2002 Eskom`s transmission technology department started engaging in life cycle management plans (LCMP) for different equipment based on Mahoney et al. (2008) cited by Volsoo (2004). Despite the fact that servitudes cannot be classified as equipment, they were also included in the plan to ensure that they are managed effectively and efficiently. Servitude life cycle constitutes of the following phases:

Planning phase

This phase takes about four to eight years. The following activities are expected to occur during this phase; monitoring, predicting load growth and determining and justification of the need by the expansion planning department. The Environmental management Plan (EMP) and the Environmental Impact Assessment (EIA) are undertaken by the department of Land and Rights.

Acquisition Phase

Once the need and justification process has been approved, the acquisition phase follows immediately. It enrols by EIA process and once the record of decision is issued by the environmentalists, the negotiations for the acquisition of the servitude process start. Land and rights department and Line Engineering services (LES) are heavily involved in survey, design, negotiations and registration of servitudes

Construction Phase

This phase usually takes one to two years. Even though it is more involved with the construction part such as line setting out and tower foundations, there is still landowner liaising and monitoring of EMP done by the land and Rights department.

Maintenance Phase

This is the longest phase of all phases taking about twenty five to hundred years. Several issues are managed. The review performance, report, audits, mitigation measures and assurance reports are done in this phases.

Decommissioning phase

This is the last phase whereby it can be decided that the equipment is been removed or restore its environment, monitor and audit it.

CHAPTER 4
LAND AND RIGHTS GIS (LARGIS)

4.1 Overview of Land And Rights GIS (LARGIS)

This chapter gives an explanation of LARGIS as a system adopted by Eskom and its role in the administration and management of land and rights. It also provides an overall picture of LARGIS and discusses how Eskom employs LARGIS manage and maintain its servitudes at different stages.

Utility industries around the world are using new business strategies to manage and improve services. As discussed previously, GIS offers most suitable solutions to efficiently and effectively manage land information. There are various geo-information systems used to manage land assets such as LandWorks GIS. This is GIS software that maps and analyses all land assets and is used with any land records system. To mention a few, others include an open source GIS, Quantum GIS (QGIS), which can be used for mapping of land and rights. There is also Quorum GIS which integrates digital maps, satellite imagery, document management and workflow processes. Quorum GIS can be used for multiple applications such as land management system, right of way management and many other applications.

Like any other utility organisations, Eskom has invested a lot of money in a system called LARGIS. LARGIS is the geo-information system for management of a property portfolio with associated land rights for different industries. It supports the acquisition of land rights and tracks progress with a comprehensive management reporting.

Data in LARGIS is stored centrally in a data store and can be accessed by other people in the organisation in critical decision making, strategic asset planning and development. This system is particularly used for the planning, acquisition, registration and maintenance of Eskom's land and rights. It consists of different datasets displaying data such as roads, cadastral, power lines, cables, transformers, substations etc. Eskom follows the servitude management plan using this system.

LARGIS is linked to several data sets and the main ones are the cadastre dataset, deeds registry dataset, property valuation dataset, aerial and satellite imagery dataset and the national road network dataset. The cadastre dataset entails land parcel boundaries and the deeds register dataset defines land ownership, land transfer and mortgages for boundary administration. The property valuation dataset provides information for assessing property and land value for the purpose of land acquisition compensation, rates calculations and billing. For imagery, there is 0.35 - 0.50m aerial imagery from National Geo-spatial Information (NGI) and satellite imagery provided by South African National Space agency (SANSA). Road networks dataset assists with national, secondary, main and other roads which is critical for powerline route selection.

There is a provision in LARGIS to superimpose other service datasets such as water, sewage and telecommunication necessary for planning and management of utility servitudes. However, this provision is not fully being utilised because LARGIS at Eskom is still at its inception stage therefore it has not yet reached that milestone.

4.1.1 Application of LARGIS in planning of rights:

The planning stage is the initial stage of the rights work flow life cycle, this implies that the management of all rights begin at this stage before moving on to other stages namely; acquisition, registration and maintenance. LARGIS provides the user with all the tools to plan the rights affected by a particular linear object, in this case a power line in a single GIS package. This then eliminates the effort of using different software systems to plan, archive and obtain that information.

During the planning phase using LARGIS, a new proposed power line route is selected and the line route file is imported onto the system (LARGIS). This system displays the route against all other datasets (cadastral, roads, other power lines etc.), which enables the identification of the cadastral properties affected by the proposed route.

When the properties affected are identified, it is possible to attain land ownership details related to the affected properties as the system is linked directly to the deeds office server. This information can then be used to plan for the rights to be acquired as the necessary details about the land (bonded, deceased estate or liquidated etc.) and land ownership (individual, trust, company, undivided shares etc.) will be available. This tool therefore enables all necessary data to be fed into the system and hence a smooth process of planning.

4.1.2 Application of LARGIS in acquisition of rights

The acquisition of land rights follows the planning phase in LARGIS. The system creates a sub database whereby all the information related to the planning of rights is stored. Information such as an agreement signature, date when a right was created, enables the LARGIS to detect whether the agreement between Eskom and the land owner had been concluded or not. A right with an agreement signature date filled-in will automatically move to the acquisition stage (sub database) as the implication is that Eskom is in process of acquiring that right, the system will no longer list and categorise it as in planning phase because the interactions have commenced with the land owner.

For a system like LARGIS to be useful, the activities on the ground need to be aligned and updated on the system so that the system can analyse that information and present it in a convenient way for ease of understanding and interpretation. It is therefore common that rights within the same project reach their workflow stages at different times. For example, some could still be in planning stage while others are in acquisition stage, registration or already in maintenance stage.

Rights under the acquisition stage are like an asset still under construction in LARGIS terms, its unfinished business until such time when the deeds registration of the right is initiated. In this system, a right under the acquisition stage will have information such as; land owner agreement, land owner banking and identity details. These details are crucial for monetary compensations, value for the right and valuation report for the right. It will however not have for instance; the deeds registry number as it is yet to go through the registration process. The system stores all this information pertaining to each right separately and categorically depending on the stage the right is.

4.1.3 Application of LARGIS in registration of rights

Land or land rights registration is the process that provides a safe and certain foundation for, enjoyment and disposal in land. LARGIS records and stores juridical, fiscal and land use cadastre. These records about land could be information depicting area by ownership, taxable land or the extent of certain activities on the land.

An acquired right in LARGIS is a right in which an agreement has been reached with an owner and an agreement signed for the transfer of servitude rights. However a right under the registration stage is a step further and different in such a way that a legal process to register the real right is initiated thus falling under registration. Technically on LARGIS, a right under the acquisition stage will move to the registration stage once the data fields pertaining to the legal formalisation of such rights are populated and filled-in. Information such as, conveyancer instruction`s date, prompts the system that the right is now being registered and automatically it is ceded to the registration stage. Rights being registered are basically rights that are in the process of registration with the deeds registration office. When the process is completed, a deed of servitude is scanned and stored in the LARGIS. The LARGIS system has specific data fields for the house keeping of rights under registration, once a right has been allocated with a number from the deeds office and that unique number is entered in LARGIS, the system will automatically pick up that the deed is now registered and it will transfer the right over to the maintenance stage of the work flow.

4.1.4 Application of LARGIS in maintenance of rights

At the maintenance stage, LARGIS stores land rights which are registered or fully owned by Eskom. These rights are similar to assets within an asset register; LARGIS at this stage enables each right to be independently amended, annexed or revised in order to update any changes or amendments on each individual right. Some rights belonging to Eskom get co-used by other service providers. For instance Umgeni Water shares underground water pipeline servitudes with Eskom's over- head power line servitudes and such agreements pertaining to the co-use get stored against that particular right's data fields.

Maintained rights have data fields to allow for the input of any other conditions that Eskom as a right holder may need to comply with under the servitude terms. In this way LARGIS offers the user, for analytical purposes, the ability to identify and differentiate maintained rights against the actual number of land parcels crossed by Eskom power lines. This enables the segregation of already attained rights from those still under planning, acquisition and registration within a project. This therefore provides a picture of how well or bad an entity is in the formalisation of its land rights. LARGIS for Institutions such as Eskom is thus used as a tool to measure, identify and correct such informalities in its rights management efforts.

4.2 Security considerations regarding data in LARGIS

In many parts of the world, citizens have the right to access information but also the right to privacy, hence the data used is protected for the purpose for which it was intended. Access to land related data may be politically or socially sensitive and may need to be controlled by the appropriate legislation as well as by access restriction controls (Dale and McLaren,1988).

LARGIS, as discussed in section 4.1, is an information system that essentially uses data from various sources, and information is also accessed from this system by numerous users for different purposes. Data security is therefore a critical issue. This is to protect information from any form of misuse, disruption, modification or unauthorized access.

The assessment of the operational environment is vital in order to identify the basic security controls that would protect the system. This includes the protection of the integrity, confidentiality and availability of system information. The assessment of risk to detect the vulnerabilities and threats in the system and the possible effect or the extent of damage that could result from loss of integrity, confidentiality and availability of system information on the operations and assets of the organization is essential (Conti, 2007). The idea of information assurance as discussed later in this section in terms of the four layers of data security ensures that information is protected against physical theft, natural disasters or server breakdown.

The risk assessment should be undertaken to assess the level of risk that the introduction of a new system might have to the existing system and also to assess the already prevailing controls and their effectiveness. Therefore every organisation needs a security plan and security certification which embrace all functional, legal and other security requirements stipulated in the regulations and relevant laws. These should ensure that information security products meet the defined security claims as prescribed by the data security laws and regulations.

The organisation`s assets and resources are to be archived when the information systems are transferred, disposed of, or are obsolete to allow for use in a follow – on system. The same applies to LARGIS, the data is backed–up at national level against server breakdowns. Future technology changes might make the system`s data retrieval methods obsolete therefore information should be retained in a manner that takes into account the mentioned changes.

There are measures of data security that have been implemented to protect data in terms of the four layers of security control measures. The first layer basically tackles the physical theft of the computer hardware and software. This is controlled by means of restricted access controls whereby a personal disk has to be scanned to gain entry recording times, dates and individual access point. This goes hand in hand with deployment of security guards patrolling the premises.

The second layer implemented is the intrusion detection systems such as alarms, locks on doors and fire precautions, the use of strong room for protection against natural disasters, and identification such as video cameras, photo identity badges used together with access cards.

In LARGIS, access is strictly controlled for information security purposes. The activities of data processing staff is strictly regulated and monitored. This is contained in the third layer which deals with administrative controls.

In the outer layer of data security in LARGIS, login credentials are granted only to those that need and use LARGIS to do edits and updates. LARGIS keeps record of every single user that is logged on at that particular time for information security purposes. There is however a viewing rights for all other employees who are involved in decision making.

CHAPTER 5
METHODOLOGY, METHODS OF DATA COLLECTION AND ANALYSIS

5.1 Methodology approach

There are numerous research methods approach in system analysis and development. However this study opted for the work flow management system approach because it essentially uses user friendly and satisfactory parameters (variables) for system evaluation.

Data work flow management approach was used because it controls the organization`s processes by combination of human and information resources to support the quality of the processes performed. It also enables the management of work flow and information to be stored in a database. This approach was used in conjunction with SDW CASE tools because SDW CASE tools allows consistency checks to be run in order to validate the integrity of the work.

The following methods of investigation were used during the process of system evaluation through work flow approach. Initially the objectives of the system and of the organisation were determined in order to assess system effectiveness. The measures to assess how well these objectives have been achieved were developed by establishing the indicators that were used to observe and measure the performance of the existing system using interviews, questionnaires and by reviewing organisational documents. A list of the problems identified was drawn up and a framework of how to tackle each problem was designed in order to respond to the last research question.

The key participants were the four staff members who had the insight of LARGIS and were directly involved in a day to day running of LARGIS. Amongst these four members, one was on a managerial position involved in decision making and could give information regarding business processes and goals. The other three were system users who were directly interacting with the system, who processed data to obtain information, collected and maintained data. These provided a basis for user requirements analysis. Their viewpoints were crucial in the assessment of the factors that gave a measure of success and failures of the system.

A good information system depends largely upon the purpose of the system and perspectives of the stakeholders. This study thus bases its discussion on the latter, that is, exploring from the participants of information system`s point of view.

The data sources for this process were derived from the organisational documentation, by observation of the interaction between the system and its users and lastly from the interviews and questionnaires. All these gave the user`s insights and perceptions on the quality of the system. An extensive review of the system was done through site visits. The questionnaire was divided onto three sections namely; the first part contained the participants' details and positions in order to know the role they played while the second section was intended to acquire information about the application of LARGIS in Planning, Acquisition, Registration and Maintenance of servitudes. The last part of the questionnaire explored the challenges, if any with regards to the application of LARGIS in managing land rights.

Interview and documentation reviews were used to identify the work flow related to spatial data. The understanding of what information is being used, who is using it and how the source data are being collected, processed, stored and maintained are the basis for evaluation process (Clarke, 1997). Qualitative approach to data gathering and analysis was done by starting with the review of existing literature. This was followed by a detail case based data collection among LARGIS users.

5.2 Methodology Concluding Remarks

This study looks at the evaluation of implemented system to determine its actual benefits and draw-backs with the interest of getting information on possible system improvements. This is done by using the approach that uses the success assessor's indicators suggested by Platisa and Balaban (2008) as the time taken to respond, reliability of output information and information security. It also attempts to get the managerial participation and user satisfaction.

It therefore contributes to an evaluation framework built by Clarke (1997) which assesses the existing information, processes, data and potential GIS users. It does however incorporate the theory Wang and Kumar, (2005) of workflow management system model which views workflow as an interaction of processes, information and resources. This is presented from the information based architecture perspective in this study. Systemic Hirschheim & Smithson (1988) criticise most models for focusing mainly on the systematic aspects of the system such as the technical and economic aspects while overlooking the social and human aspects. Therefore, a different approach is followed in this study, which incorporates the user`s perceptions in the evaluation as substantiated by Hirschheim & Smithson (1988), that excluding the social issues could have a negative impact on the system value and user satisfaction . This does not only assist in giving the understanding of how the system works but also provides the users` perceptions on how the system supports their work. This was done by the methods described in section 5.2.1

In view of some of these gaps in system analysis models, this study attempts to take a different route of evaluating a system in operation based on its performance and its end users opinions. This also incorporates the analysis of the interaction of the system with its user. In this case, further data sources come from the interviews of the users, their perceptions and understanding of the system.

This way, based on the outcome of the evaluation, essential aspects of the system could be identified and more practical solutions be developed in order to enhance the system and provide recommendations on the shortcomings identified.

5.3 Methods of collecting data and analysis

Data collection is the most crucial stage of the research methodology and is the phase that determines whether the research question will be answered adequately. This section provides an overview of various methods that were used to collect and analyse data to evaluate the effectiveness of LARGIS applications in planning, acquisition and management of servitudes. It also gives details of the concepts and procedures that form the essential analytical methods used in this study. Specific sections detail the research approaches and sampling techniques applied. The assumptions and limitations to the methods applied are also presented in this chapter.

In order to achieve the set objectives, it must be taken into account that not a single approach fits every problem hence a choice must be made as to what methods to be used. Therefore, this study applies both the Qualitative and Quantitative methods of data collection and analysis. Rocco et al. (2003) interprets qualitative methods of research as methods that pursue to explain the meaning, circumstances and occasions using peoples` perspectives and understandings around them. It makes theory by inferring the evidence. It is therefore inductive in its approach rather than deductive (Rocco et al. 2003). Smith (2000) adds that qualitative approach methodologies are concerned with how individuals or social groups perceive and understand the world. Smith (2000) further asserts that they are channels for understanding and accounting for how places, people, and events are created and characterised.

While quantitative approach as explained by Burns (2000), deals with the gathering and analysis of data in numeric form, Burns (2000) emphasizes that it does not take into consideration the ability of people to interpret their experiences and construct their own meanings. This results into the belief that facts are always correct and similar for all people.

This mixed methods according to Bogdan & Biklen (1982) involve organizing data, breaking it into controllable components and searching for patterns to discover essential issues to be ascertained at the same time ensuring that the procedures followed are relevant, appropriate and justified complements (Kumar, 2005).

5.3.1 System analysis

The initial phase of data collection applied in this study was qualitative methods in order to get the subjective assessment of attitude, opinions and users` behavior towards the system in place. Having established a general impression of how the system operates, the succeeding phase was more focused and consisted of more closed questions that required direct answers.

To achieve the established objectives, the following activities were carried out.

(a) **Interviews**

Interviews are research instruments used to collect data. They can either be structured or unstructured. Structured interviews are set to record information of qualitative nature so as to explain behaviour within a pre-determined group. Unstructured on the other hand try to comprehend the complex attitudes of members of society without imposing any preconceived category that may limit the field of investigation (Sapsford & Jupp, 2000)

Both structured and unstructured interview methods were used; an interview whereby the questions were defined but also left open for any possibility of discussions and explanations of certain possible terms.

The interviewee's were asked a sequence of questions without limiting them with pre-determined set of answers. As highlighted by Fontana and Frey (1994), this method allowed flexibility in questions and disparity in responses. The method attempted to answer several questions relating to the pre-established research objectives. A top- down approach was used, whereby the personnel to be interviewed would start from higher levels of management to get the overall picture hence identifying the major components of the system and tasks within these components. Once this was completed, the next step was to interview the system users at various operational levels. The objective here was to find the major business processes and functions of the system (LARGIS).

A questionnaire was emailed a week prior to the interview sessions so as to allow the participants a reasonable time to familiarize themselves with the questions as shown in appendix E of the questionnaire. This included both closed and open questions. A series of closed–ended (structured) questions had only two response categories such as “Yes” or “No”, or questions with boxes to tick or scales to rank. Face to face interviews were conducted to build empathy and also to clarify ambiguous answers where possible with the participants.

A follow up telephone interview was also done to enquire about information that was initially not recorded.

(b) **Direct observation**

Observation is defined as "the systematic description of events, behaviors, and artifacts in the social setting chosen for study" (Marshall and Rossman, 1989). The information obtained using this approach narrates to what is presently occurring and is not influenced by either the previous conduct or forthcoming desires or approaches of the respondents (Myers, 2009).

This is done by observation of relevant behaviour, absorbing and noting details and actions of the environmental conditions at work. It involved the actual observation of how an individual organisation uses the system (GIS); this included the uploading of data and the actual usage of spatial data. The relevant information gathered was written down and questions were asked to the respondents where clarification was necessary. This method was coupled with the first stage of interviewing.

The information collected was limited but not subject to behavioural patterns and attitudes of respondents and there was an allowance of actually seeing what people do rather than relying on what they say they do. In addition, this method does not depend on people`s inclination to provide information.

(c) **Questionnaires**

Questionnaires, unlike interviews, have the advantage of addressing a larger part of targeted people. They seek some kind of information from a number of users especially if it is of quantitative nature. Nonetheless, questionnaires also have a disadvantage of not being possible to customise to individuals as it is with other methods of data collection. Furthermore, they are mostly suited to closed questions and are not effective for open questions (Hawryszkiewycz, 1994).

Interview guiding questions were prepared with both open and closed questions. The questions were grouped into specific topic to make it easier to understand and follow. The aim was to get opinions about the use of GIS application as a servitude management tool among selected users in the organization. These were emailed and hand distributed to relevant targeted users.

(d) **Documentation/organizational review**

This is a review of relevant documents pertaining to how the organisation conducts the activities related to servitude management. It involved a review of written documents, archived data and organizational reports and articles. This provided a basis for comparison of data collected by primary methods. It therefore enabled the researcher to identify gaps and shortages of knowledge in the area concerned. And therefore it provides a basis of what additional information is needed.

5.3.2 Information analysis

Quantitative and qualitative methods of research were used to analyse the information collected. All the responses were recorded in charts, data flow diagrams and tabular format with the aid of CASE tools and Microsoft Visio to allow for smooth analysis of data.

5.3.3 Sampling techniques

According to Kumar (2005) a sample is a segment of the population selected to represent the population as a Whole. In this study no sampling techniques were used. The entire population, that is all the officials who were directly involved in the application of LARGIS were interviewed. For the purpose of this study, a total of 4 people were interviewed. Even though it is more reliable to use large models rather than small models, due to the amount of time available, the study was based only on one regional office in KwaZulu Natal.

5.4 Data analysis techniques

Data analysis is a process of using rational techniques to define; scrutunise and evaluate data; it involves interpretation and translation of the collected data into meaningful and logical information (Mason, 2002). Various data analysis techniques have been used in this study, one such technique is Quantizing. A process whereby qualitative data is deduced into quantitative data by reducing verbal data such as interviews, observations or documents into variables that can be represented numerically. Qualitizing technique for analysing data was also used; this is a method whereby data was acquired using scores and ratings. Quantitative data was then translated into qualitative data in order to summarise the patterns of the findings. Creswell (1998) cautions that qualitative approach is subject to be influenced by biases by the investigator however measures have been taken in this study to minimise biases as much as possible. One such measure was to make a comparison of the findings from both the interviews and questionnaires with those that were jotted down during an observational study.

This study engages system analysis as discussed in section 5.3.1 using data flow modeling technique with the aid of System Development Workbench (SDW 5™) Computer-Aided System Engineering (CASE) tool to model Data Flow Diagrams (DFD). This is done, firstly in order to identify possible bottlenecks and shortcomings. Secondly, to propose the suggestions for an improved system by identifying the system`s data stores, data flows and processes from the data obtained during interviews and questionnaires conducted.

5.5 Software packages

Every organization aims at using productivity aid to reduce time and to develop systems. An organization`s goal is to produce a dynamic and maintainable software system that meets the user`s requirements. Whichever method is used in system analysis, there always has to be automated tools to support the quality and the speed of system development. CASE (Computer- Aided Software Engineering) is a computer based program, as the name implies, that can be used for the same purpose. Rapid prototyping and development tools such as Case technology allow for quick exploration and testing of applications Roger (2003). CASE tools provide graphical facilities for modeling and design. They integrate the development done during each phase of a system life cycle. They can be used with structured, object – oriented or agile development methods. Amongst all, one of the benefits is its ability to check the consistency, contradictions and completeness whist at the same time it speeds up development process. System Development Workbench (SDW)

Version 5 was used as Case Tools. The other software packages used included Microsoft Visio, Microsoft Excel and ArcGIS 9.0.

5.6 Limitations and assumptions

- The interviews were limited to only four personnel who were actively involved in the application of LARGIS.
- Most of the data collected was of qualitative nature and this method of data collection is subject to personal biases.
- The study was only conducted in Eskom, Land and Rights department in KwaZulu Natal only.

CHAPTER 6

DATA PRESENTATION, RESULTS AND ANALYSIS

6.1 Introduction

This chapter presents the results collected through the direct observations, interviews, questionnaires and organizational documentation review. It also offers an analysis and interpretation of these results.

6.2 Results and analysis

6.2.1 Information architecture development

Information system architecture is a term used to describe a set of ideas that determine the way information is assembled, the steering methods and the terms used within the system. It aids in the identification of essential information systems with their principal relationships and associated infrastructure. The whole information system flow is determined by data relationships between subsystems (Batley, 2007).

To define the information architecture, processes and data classes identified from the analysis were organised in a form of a relational matrix given in Table 6.1. This relational matrix was developed manually by mapping processes with data classes using Microsoft Excel. The three unique action codes were used "U", "C", and "CU" in this matrix table, whereby "U" means use, this implies that a corresponding process uses a corresponding data class. Action code "C" means create, in a similar way, "C" is used if a corresponding process is created using the corresponding data class. For instance, in Table 6.1, a layout plan (data class) is created to present or display a selected route (process) diagrammatically.

Finally, "CU" means create and use. This action code is used if a corresponding data class is used to create a corresponding process. For example in the process of land application administration, a servitude progress report is created at the beginning of the application and simultaneously used to administer and update the progress of the application.

The action codes 'U' for use, 'C' for create and 'CU' for create and use were used at the intersections of every process and data class based on whether a corresponding process 'uses', 'creates' or 'creates and uses' a matching data class respectively.

Where a corresponding data class was used in a process then a "U" was put at the intersection whereas where a corresponding data class was used to create a process then a symbol "C" was used. Similarly, in a case whereby a corresponding data class could be created and be used by the corresponding process, a symbol "CU" was used but left blank if the data class was neither created, used nor created and used by the corresponding process.

Table 6.1: Matrix Table for Processes and Data Classes

	DATA CLASSES																																	
PROCESS	LAYOUT PLAN	PLANNING REPORT	EIA REPORTS	LAND ADVERTISEMENTS	STATE CONSENT	PUBLIC NOTICE	LAND APP. DATA FILES	TRADITIONAL CONSENTS	OPTION AGREEMENTS	SERV.ACQUISITION	PROGRESS REPORTS	LAND VALUE	VALUATION CERTIFICATES	FIELD SURVEY RECORDS	SURVEY CONTROL(X,Y,Z)	WAYLEAVE AGREEMENTS	SERV DIAGRAMS	VERIFIED DOCS.	TITLE DEEDS COPIES	DEED OF SALE	ORIGINAL TITLE DEEDS	PROPETY TRANSFER RECEIPT	CERTIFIED TITLE DEEDS	PAYMENTS RECEIPTS	QUERY RESULTS	ENCROACHEMENTS PLANS	LAND USE MAPS	ROUTE SKETCH PLANS	MUNIC. RATES	LAWS & REGULATIONS	CAD PLANS	AERIAL PHOTOS	TOPO MAPS	EXPROPRIATION PLANS
SELECT ROUTE	C																		U								U					U	U	
INVESTIGATE SITE	U	C	U																U								U	U			U	U	U	U
EIA PROCESS	U		C																								U	U				U	U	
LAND APPLICATIONS ADMINISTRATION	U	U	U	C	C	C	C	C		CU									U								U	U			U	U	U	U
NEGOTIATE FOR LAND	U							U	U	CU		U	U			U			U								U	U			U			
VALUATE LAND	U		U									U	C						U								U	U	U		U			
ACQUIRE SERV.	U				U		U	U		C				C	C	C	C		U								U	U			U			
VERIFY DOCUMENTS									U							U	U	C	U	U			U											
REGISTER DOCUMENTS									U							U	U		C	C	U		U							U				
CERTIFY REGISTERED DOCS.									U							U	U		U	U	C	C	C							U	U			
QUERRY CHECK																U			U					C	-	-	U	U	U			U	U	
RATES CALCULATION												U	U			U			U					-	C	C	U	U	-					
MAKE PAYMENTS												U												CU				U						

The matrix depicted in Table 6.1 presents development of information architecture within LARGIS as a main system. This matrix forms a basis for the development of information architecture by detailing out all the processes and data classes involved in LARGIS.

The colour coded information provided in the rows represents the processes associated with management of servitudes in LARGIS. Whereas, the information in columns represents data classes used or created by different processes. The processes in the matrix can then be assembled into four identified major processes /phases as illustrated in Appendix A1. These process groups represent the following four major stages in the life cycle of a servitude namely:

(a) Planning
(b) Acquisition
(c) Registration
(d) Maintenance

Subsequent to the assembling of the major processes in Appendix A1, which identified the subsystems within the main system, data flow exchanges were shown by arrows to indicate how information flows to and from different processes within the main system as illustrated in Appendix A2. The information subsystems were then shown with process names and action codes removed as depicted in Table 6.2. The rectangular boxes in Table 6.2 represent the four sub-processes. These sub processes are interconnected but they do not overlap.

Table 6.2: Information architecture

PROCESS	DATA CLASSES																																	
	LAYOUT PLAN	PLANNING REPORT	EIA REPORTS	LAND ADVERTISEMENTS	STATE CONSENT	PUBLIC NOTICE	LAND APP. DATA FILES	TRADITIONAL CONSENTS	OPTION AGREEMENTS	SERV.ACQUISITION	PROGRESS REPORTS	LAND VALUE	VALUATION CERTIFICATES	FIELD SURVEY RECORDS	SURVEY CONTROL(X,Y,Z)	WAYLEAVE AGREEMENTS	SERV DIAGRAMS	VERIFIED DOCS.	TITLE DEEDS COPIES	DEED OF SALE	ORIGINAL TITLE DEEDS	PROPEITY TRANSFER RECEIPTS	CERTIFIED TITLE DEEDS	PAYMENTS RECEIPTS	QUERRY RESULTS	ENCROACHEMENTS PLANS	LAND USE MAPS	ROUTE SKETCH PLANS	MUNIC. RATES	LAWS & REGULATIONS	CAD PLANS	ARERIAL PHOTOS	TOPO MAPS	EXPROPRIATION PLANS
SELECT ROUTE	PLANNING																																	
INVESTIGATE SITE																																		
EIA PROCESS																																		
LAND APPLICATIONS ADMINISTRATION																																		
NEGOTIATE FOR LAND										ACQUISITION																								
VALUATE LAND																																		
ACQUIRE SERV.																																		
VERIFY DOCUMENTS																		REGISTRATION																
REGISTER DOCUMENTS																																		
CERTIFY REGISTERED DOCS.																																		
QUERRY CHECK																								MAINTENANCE										
RATES CALCULATION																																		
MAKE PAYMENTS																																		

6.2.2 Impact of LARGIS on management of land rights

Figure 6.1 mainly portrays the opinions of the four respondents interviewed about the impact of LARGIS in the management of land and rights. The answers were either Yes or No for the three selected measuring tool for services.

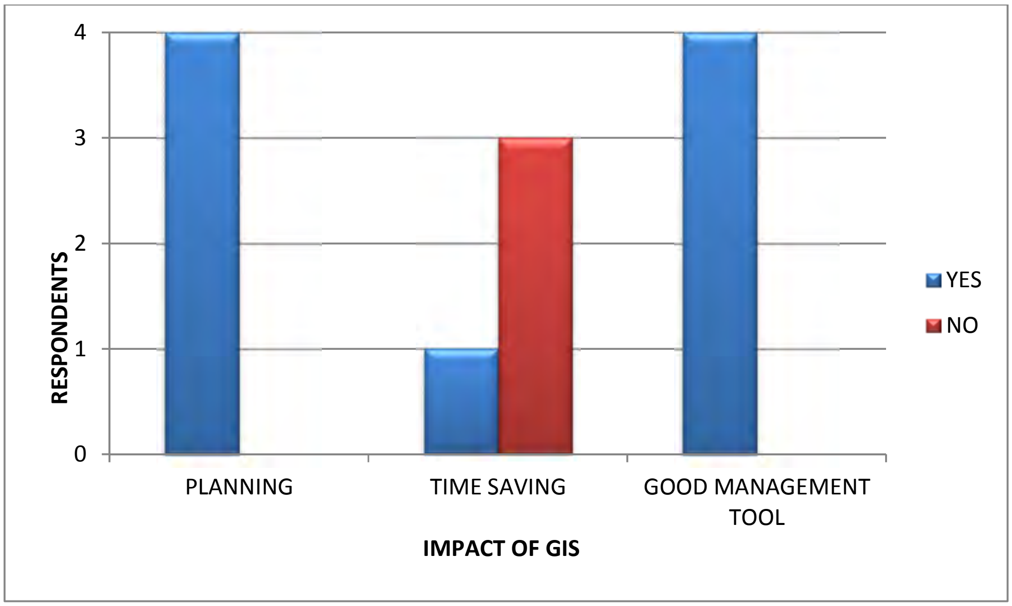

Figure 6.1. The Impact of LARGIS in the management of land and rights

All four respondents agreed that LARGIS has improved or enhanced performance for the management of land rights in their organization for planning and as a good management tool as shown on the bar chart in Figure 6.1. While on the issue of time saving, three out of four interviewees agreed that LARGIS has significantly reduced the time spend on a job.

6.2.3 Analysis of LARGIS in the management of land and rights

As reflected in Figure 6.1 of the results, most respondents indicated that they strongly agree that LARGIS has indeed improved the way they manage land rights based on two factors, namely planning and as a good management tool. However, it was shown that at this stage, it cannot be regarded as saving production time because the operators are still not very familiar with most of its functions. Hence only one person agreed that it saves time in a way that it allows for management of land right in a single system.

Hence the introduction of LARGIS in this organisation has enhanced the planning of route selection for powerlines which implies the procurement of land rights (servitudes) is also improved. It has also proven to be a useful tool for keeping and managing land rights projects in one system within the organisation. It may be concluded therefore, that LARGIS has brought about a positive impact in the management of land rights.

6.2.4 Impact of LARGIS on the work environment

Figure 6.2 demonstrates the responses based on the impact of LARGIS in a work environment at large. A total of four respondents were asked whether LARGIS was efficient, in a manner that it achieves maximum productivity with minimum wasted effort or expense. Furthermore, to explore whether LARGIS was favoured compared to the old system. The question also seeks clarity whether there were any frustrations encountered when working with LARGIS and if there were other aspects of the system that still needed to be learnt.

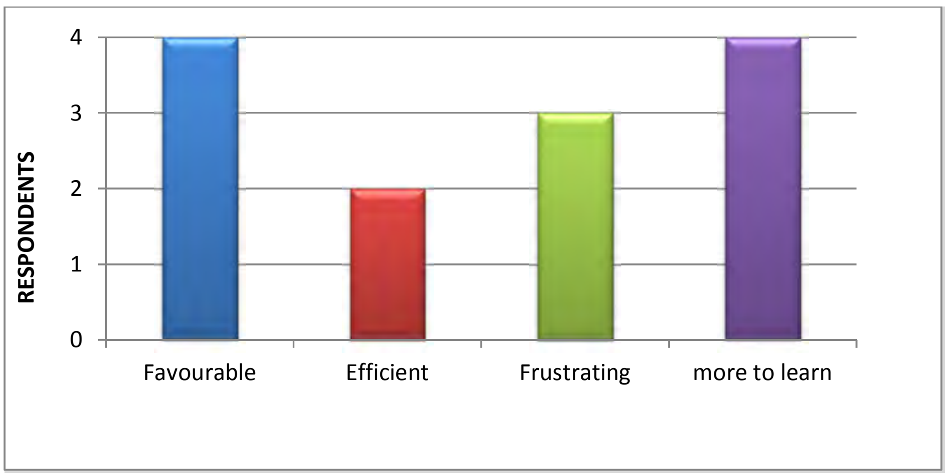

Figure 6.2. Impact of LARGIS in a work environment

All four interviewees agreed that LARGIS is favourable, but felt that there was still more to learn. Half of the respondents stated that it was efficient, while the other three found the use of the system frustrating.

6.2.5 Analysis of LARGIS on the work environment

The production rate at work environment can be affected either positively or negatively by the introduction of any new technology or a new application. In the interviews carried out to assess the impact of LARGIS at work environment, the findings presented by Figure 6.2 show that this new system is preferred to the old way of managing land rights. In spite of that, the users are quite frustrated trying to make the best use of this system. Perhaps this is because there is so much to learn. Another reason could be adapting to the new ways of working which could be stressful and straining at times. The other half found it to be efficient because unlike the previous system, LARGIS allows all process of servitude management to be managed in one single system.

6.2.6 Factors/Challenges faced during the transition from old system to LARGIS

Figure 6.3 presents the views of the interviewees regarding the challenges they encountered during the transition from the old system of managing land and rights at Eskom into LARGIS. The question was whether the conversion process from the old system to the new one was a smooth transition in a way that there were no or fewer problems encountered with this change of systems. The responses were based on a scale of 1 – 5, (1 = strongly agree, 2 = agree, 3 = fair, 4 = disagree, 5 = strongly disagree).

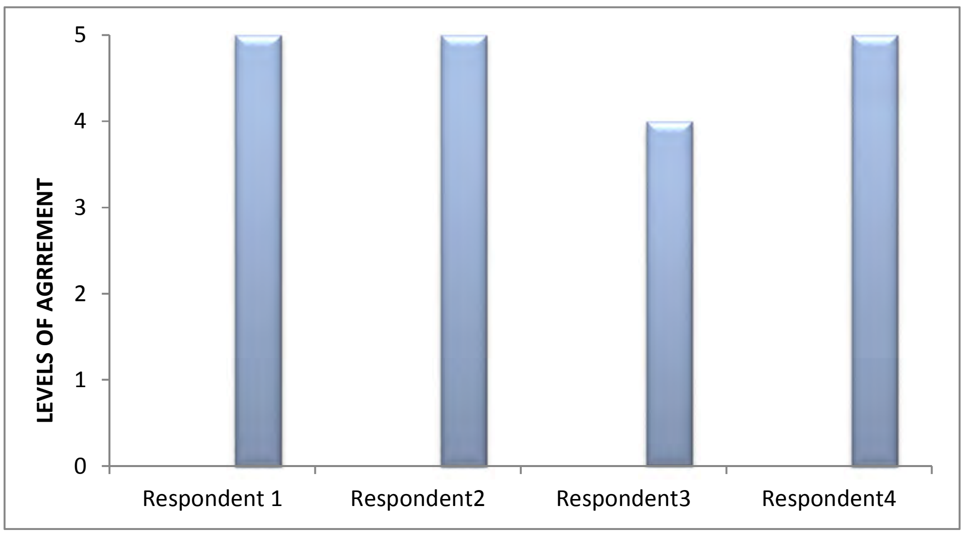

Figure 6.3. Challenges faced during historic data conversion

Figure 6.3 denotes that respondent 1, respondent 2, and respondent 4 strongly disagree that the transition was not a smooth transition. The parallel method of conversion from the old system to the new system was used. That has been proved to minimize the dangers caused by conversion failure, however, the users of the system felt there were some challenges encountered (section 2.5.4 pp17).

6.2.7 Analysis of challenges faced during the transition from old system to LARGIS

There can be several factors that contribute to the challenges faced during the transition from the old system to LARGIS. It was established that data on the hard copies were too old and therefore not legible. Also, some property designations had changed but not updated in the old deeds of servitudes. More to this, there was some mismatch of the servitude geometries with the attributes data identified during the checking/verification process. Hence these posed challenges in the transition from the old system to LARGIS.

6.3 Information and process analysis

In order to form a basis for the proposal of an improved land and right geographic information system; information and process analysis was carried out so as to identify the information oriented shortcomings and challenges. The approach engaged was that of modelling data flows using data flow diagrams (DFD) with the aid of the Data Dictionary (DD). The data dictionary which explicitly explains all the data input and output flows and the processes involved is attached in Appendix D.

As reflected in Table 6.2, all subsystems have at least three processes. However, information can flow from one to a single or more processes, as revealed in Appendix A2. For instance, data can flow from the acquisition phase to both registration and maintenance phases. A typical scenario is that of acquiring a "wayleave agreement" right. Since these are done for small lines, there is no need for registration of a servitude, the right is planned, acquired, skips registration phase and goes straight to the maintenance stage. At Eskom, there are different types of rights created depending on the size of the assets, for instance "11Kilovolts -33 Kilovolts" power lines follow the above procedure, and the 88 Kilovolts upwards follow the normal full life cycle work flow involving planning, acquisition, registration and maintenance.

A Matrix of processes and data classes, shown in Table 6.1 was translated into a context diagram reflected in Figure 6.4 using SDW CASE tools. The data flow decomposition process which uses a top–down method to rationally create processes as a network of smaller processes, input and output data flows was employed.

(a) Context diagram

The context diagram shown in Figure 6.4 is a model for the investigation of an existing system reflecting on how information flows in and out of LARGIS as a servitude management tool. This shows a system at a highest level, its boundary and external influence (Choubey, 2012).

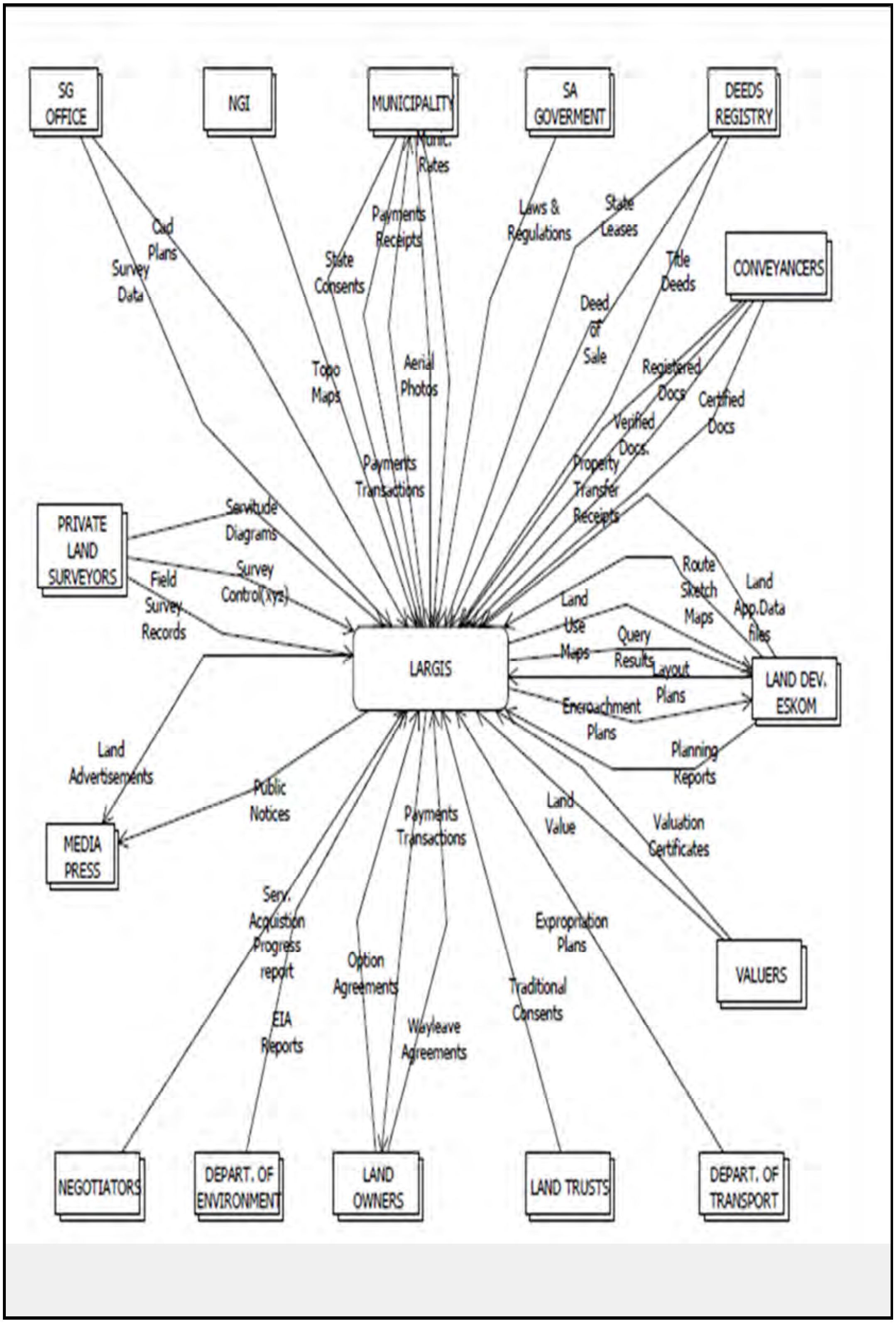

Figure 6.4. Context diagram-LARGIS

On the context diagram (Figure 6.4), the external entities are denoted by the squares. These are the sources or destinations for data outside the system. The arrows denote the direction of flow of data sets in and out of the system while the label against each data flow depicts the data class flowing in and out of (LARGIS).

(b) Top level diagram

The context diagram was decomposed into a top level diagram (Figure 6.5) based on the four subsystems identified in the information architecture development provided in Table 6.2, namely; planning, acquisition, Registration and Maintenance.

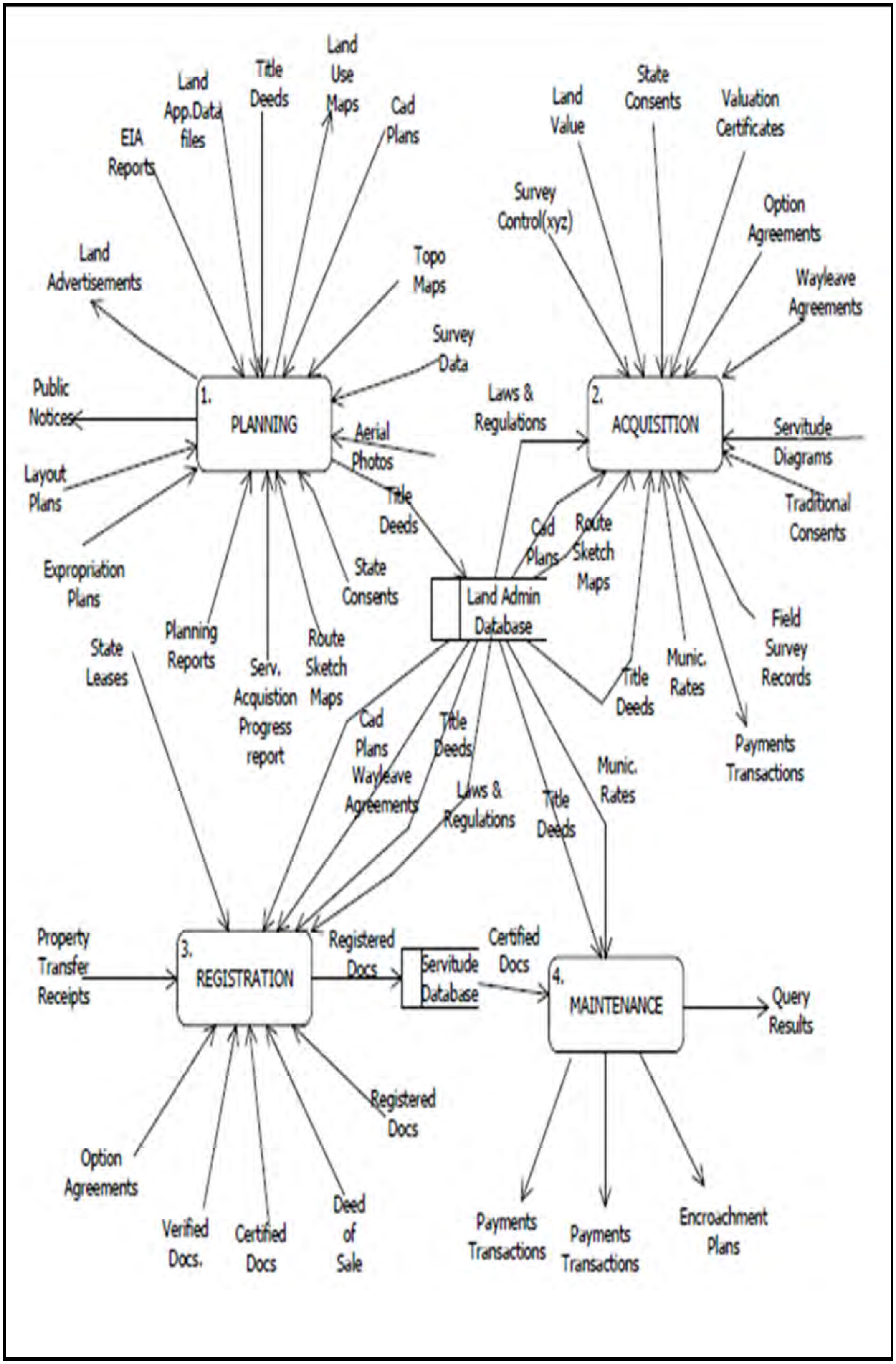

Figure 6.5. Top level diagram

Each of these subsystems consists of a number of processes which, depending on their complexity, can be broken down into further processes (sub processes). At this level data flows among the concerned subsystems are indicated. Repositories (data stores) that hold data which more than on subsystem create and/or use may also appear at this stage. These repositories may be manual storage facilities such as map cabinets, but may also be digital data bases. Figure 6.5 shows that two data stores shared by the subsystems within LARGIS exist at this stage. These are the 'Land Administration' and 'Servitude Data' data stores.

(c) First level diagrams

Each of the subsystems identified at the top level diagram (Figure 6.5) was further decomposed into processes as discussed below.

Planning

It can be attested in Figure 6.6, that during the planning phase, several datasets in LARGIS are used to facilitate both selection of route and investigation of site processes by showing all the cadastral boundaries and land information and hence the properties affected by the proposed development. The environmental impact assessment process also helps to determine the best optimum route in order for applications and administrations for option plans and other land agreements can be done. Most information is loaded into LARGIS to allow and enhance easy planning procedures. This is the stage where data is drawn externally from different entities and departments.

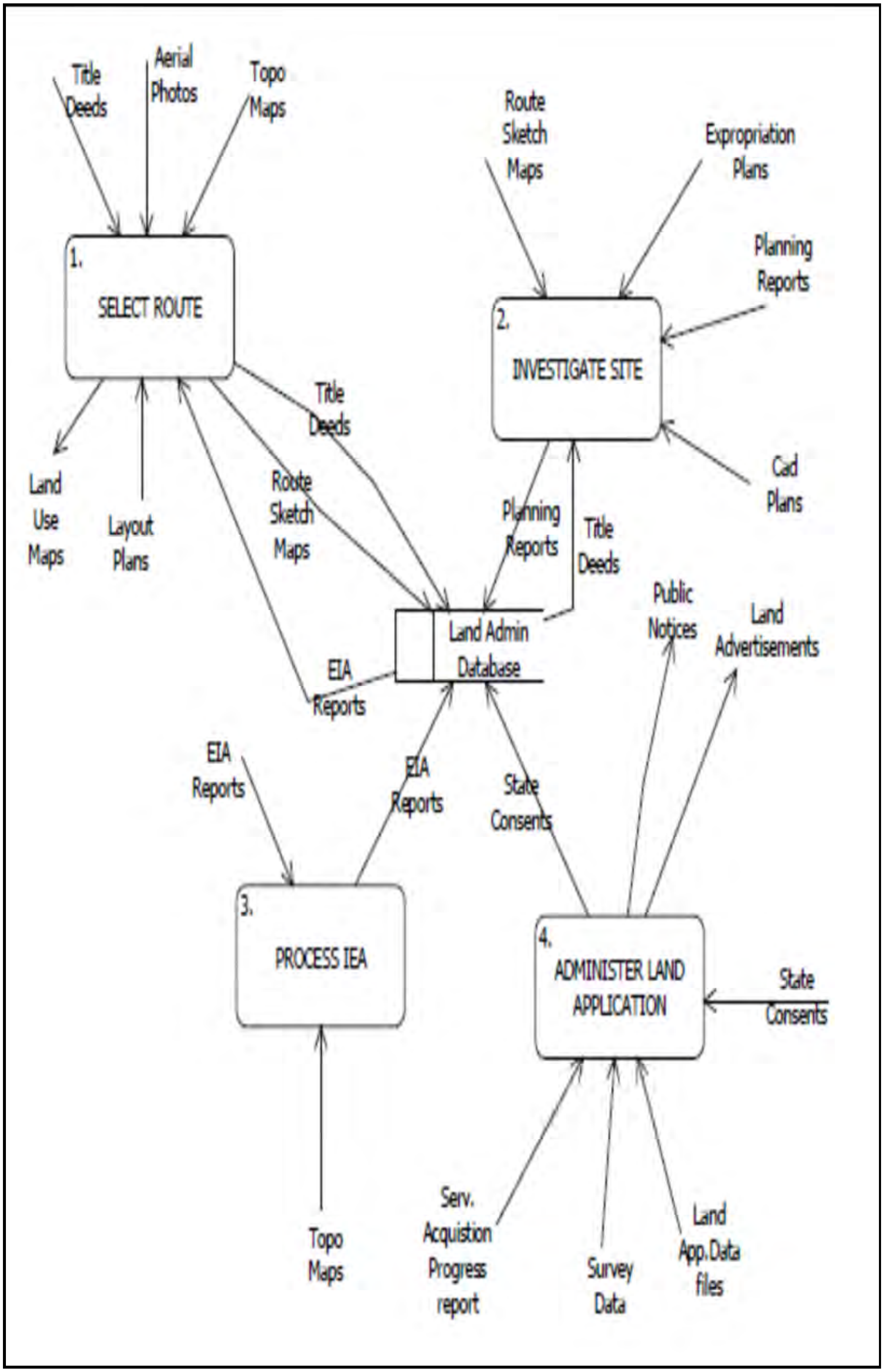

Figure 6.6. First level diagram-planning

Acquisition

The process of land acquisition immediately follows the planning phase. During the acquisition stage, three sub processes are involved. These are the negotiation, land valuation and acquisition of servitudes processes carried out by different individuals but accessing and storing information from one database as reflected in Figure 6.7.

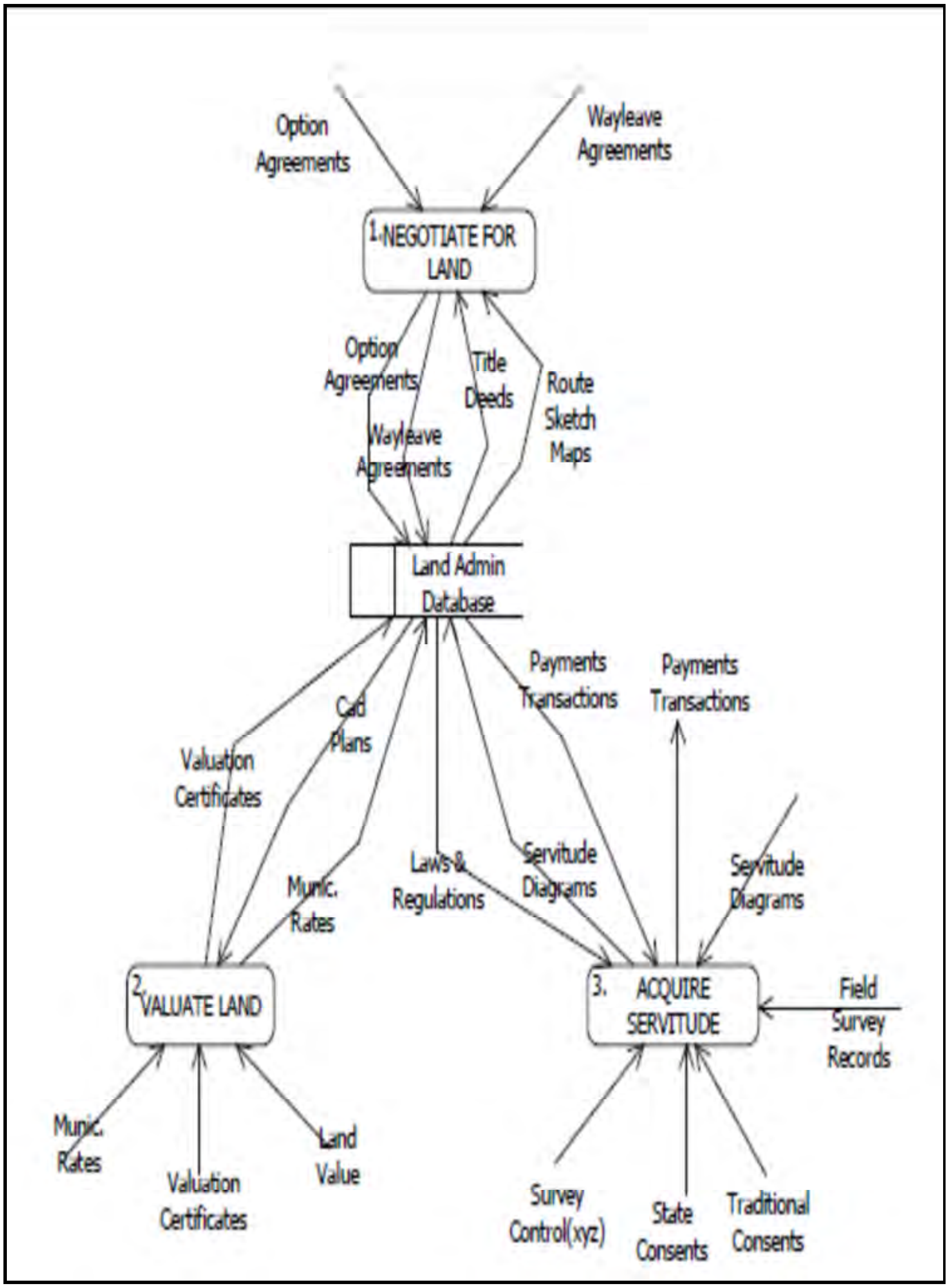

Figure 6.7. First level diagram- acquisition

Registration

At registration stage, documents necessary for registration of servitudes are verified and then a draft title deed is prepared (Figure 6.8). The documents are then registered and certified. These legal documents are stored in the servitude Database.

However, Figure 6.8 reveals a shortcoming of the current system that data cannot be accessed from one central point. For instance, it flows in a chain from “verification” to “registering” and then finally to “certifying”. This therefore portrays that one process is dependent on the other and consequently a hindrance on one process will ultimately affect the whole stage/phase.

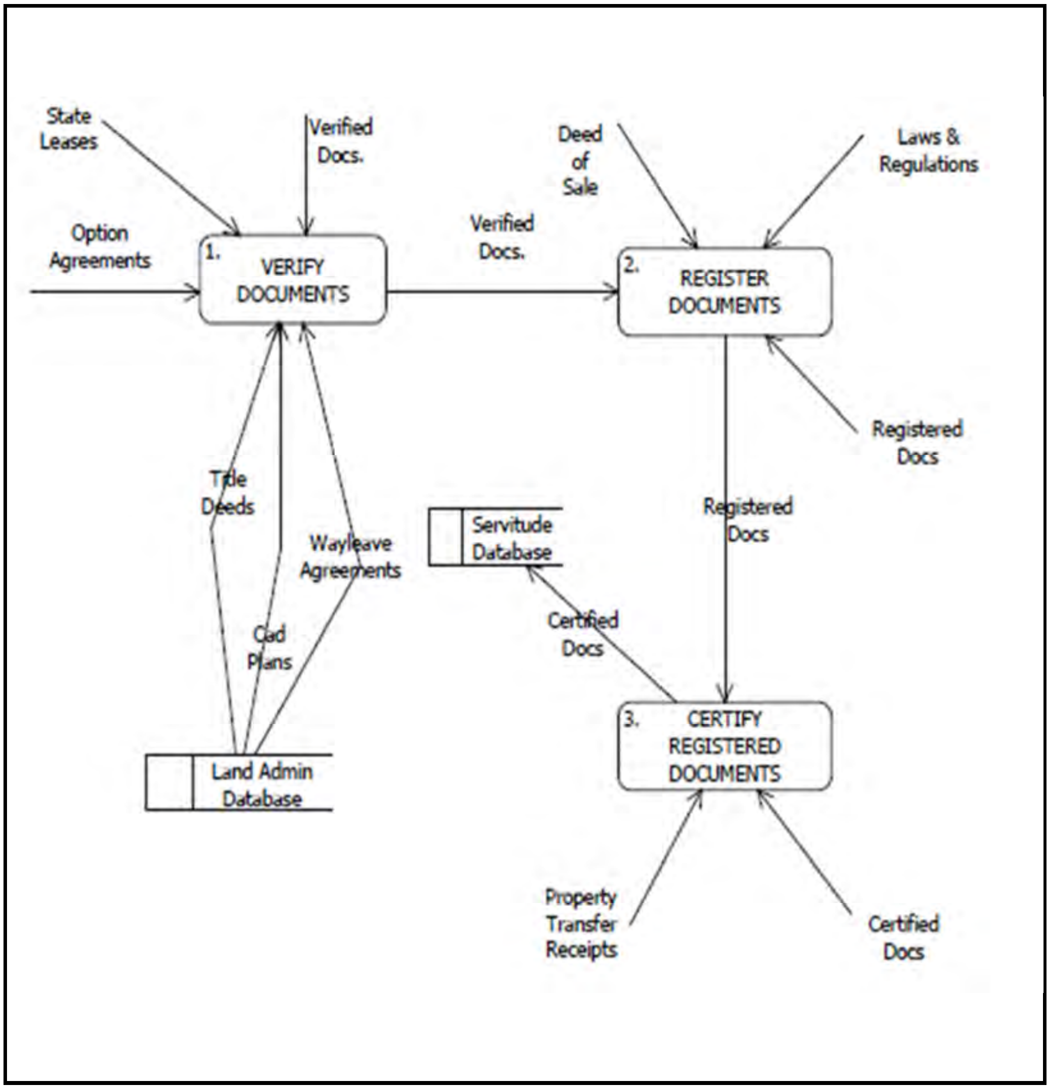

Figure 6.8. First level diagram- registration

Maintenance

The final stage of maintenance as shown in Figure 6.9 is basically the management of acquired servitudes. Municipal rates can be calculated and managed within the system. Encroachments on the Eskom servitudes also can be investigated with the aid of spot 5 imagery together with aerial photographs as part of the LARGIS dataset.

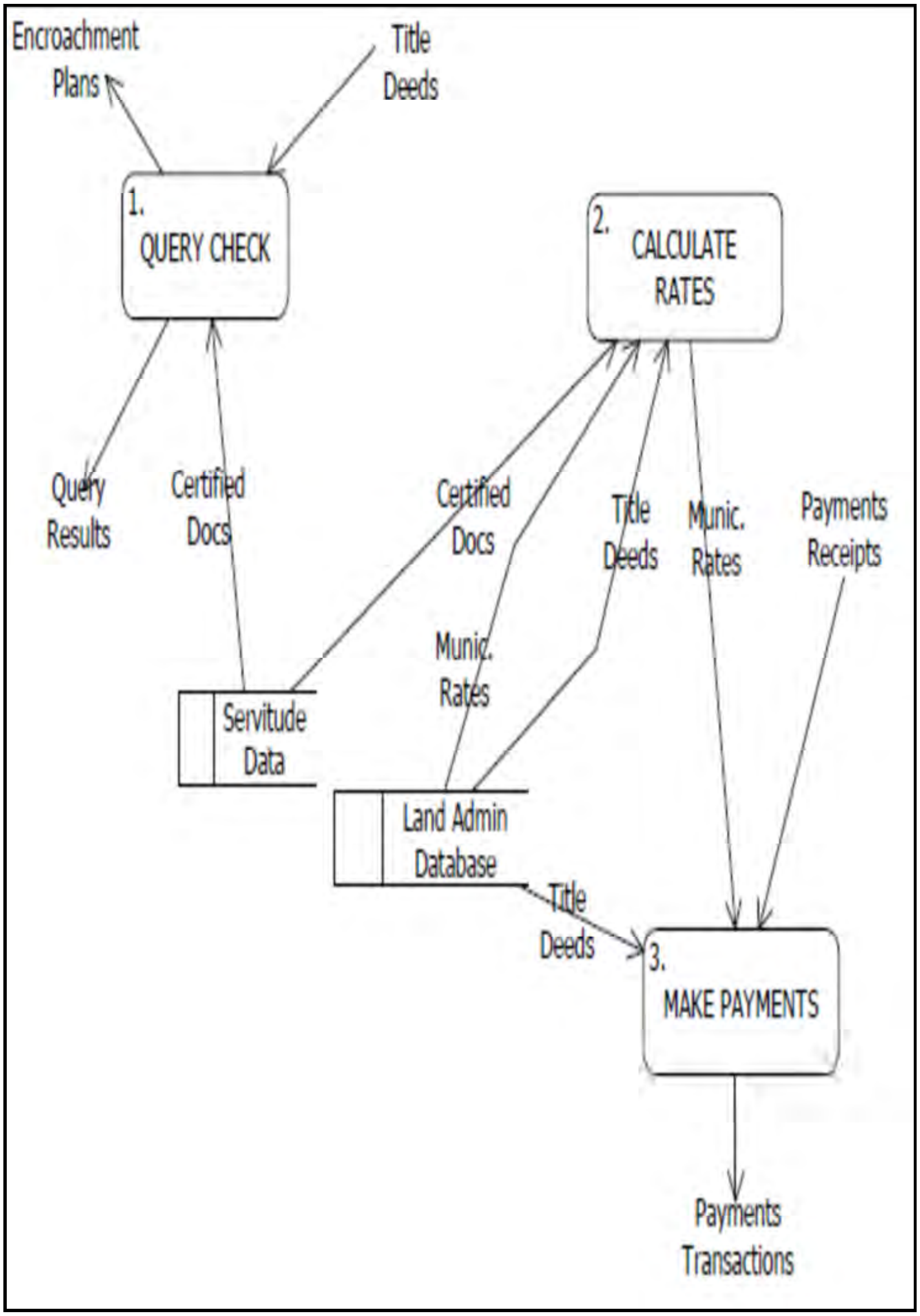

Figure 6.9. First Level Diagram-Maintenance

6.4 Systems constraints and problems

The system analysis enables identification of the bottlenecks that can affect the performance of the overall system. The identified challenges assist in determining how the improved system could be designed. The classification Table 6.3 provides a comprehensive problem classification so that relevant measures of solutions can be ascertained. Some identified problems associated with the application of LARGIS were of organisational, technical, economic, social, legal and of political nature as illustrated in Table 6.3.

Table 6.3. Classification of system constraints

CLASSIFICATION	CONSTRAINT
ORGANISATIONAL	Skill shortage
	poor data quality due to illegible & old hard copies
TECHNICAL	Network problems
	Inadequate scanning facilities/resources
	Un-updated data
	Access to Datasets
	Incompatibility of data
ECONOMIC	insufficient funding
	Prohibitive land prices
SOCIAL	Difficulty in land negotiations with the legal land owners
	Natural heritage sites, paleontological sites
	Work culture
LEGAL/POLITICAL	Encroachments
	Backlog of unexamined & Approved cadastral survey records resulting in process delays
	Misunderstanding of new planning legislations

From Table 6.3 it can be seen that the system experiences a mix of problems and bottlenecks. The challenges need to be addressed if the system has to perform optimally. The following is a brief explanation of each class of problems and bottlenecks highlighted in Table 6.3.

6.4.1 Organisational

These have been identified to be mostly influenced by shortage of skill with regards to this new application. Also the other challenge which is difficult to deal with is the nature of data which in most cases is too old and therefore illegible.

6.4.2 Technical

With regards to technical problems, network problems seemed to be one of the dominating challenges. The storage system "hyper-wave system" is used by all the branches in the province and therefore it gets so overloaded that it is sometimes difficult to access information.

All the data sets need to be updated on regular basis to ensure that the system has the most updated information. Moreover, access to datasets from other departments is difficult and in most cases data is not compatible with the system.

Over and above, there is still a lot of data which has not been fully digitized hence it cannot be accessed in LARGIS this is due to large amounts of work that cannot be scanned by the available scanning resources. This backlog of documents that were not yet scanned hindered a smooth delivery of the new system.

6.4.3 Economic

Economic issues such as staff training also played a major role in the challenges that were hindering optimum utilization of this new system. In addition to this, funds were needed to manage system bugs. Furthermore, excessive high land prices charged by the legal land owners make it difficult to for the organization to acquire more land for its servitudes.

6.4.4 Social

A lot of social issues were discovered in the study. These included the working culture whereby people were so much used to the old way of doing things and a change was a bit stressing and uncomfortable. Besides this, the process of land negotiations with the legal land owners was a tedious operation which affected the whole work flow.

Other social concerns are the cultural, historical and heritage resource, as well as the paleontological sites which must not be threatened, but be conserved as stated by the National Heritage Resources Act (Act No. 25 of 1999) according to their level of significance. These issues hold back the projects because they require the archaeological and paleontological impact assessments to be done prior to permission being granted for their use for servitudes.

6.4.5 Legal/Political

New planning legislations are still not fully understood and had a lot of red tapes which delayed the process of land acquisitions. Furthermore, backlog of unexamined cadastral survey records also often contributes to the delays in the whole process. Land encroachments onto the land to be acquired also have to be rectified prior to land being used as servitudes. This becomes a challenge if illegal squatters are involved in the process.

6.5 Factors affecting the planning and acquisition of servitudes

During system analysis it was also revealed that there are other issues that contribute as hindering factors to the planning and acquisition of servitudes. These include environmental issues, heritage sites, existing servitudes, road networks, ownership state of land, existing powerlines and disputes over land negotiations as presented in Figure 6.10. The units of measurement are derived as a proportion in relation to the chances of likelihood that a certain factor affects the planning or acquisition of powerline servitudes per hundred.

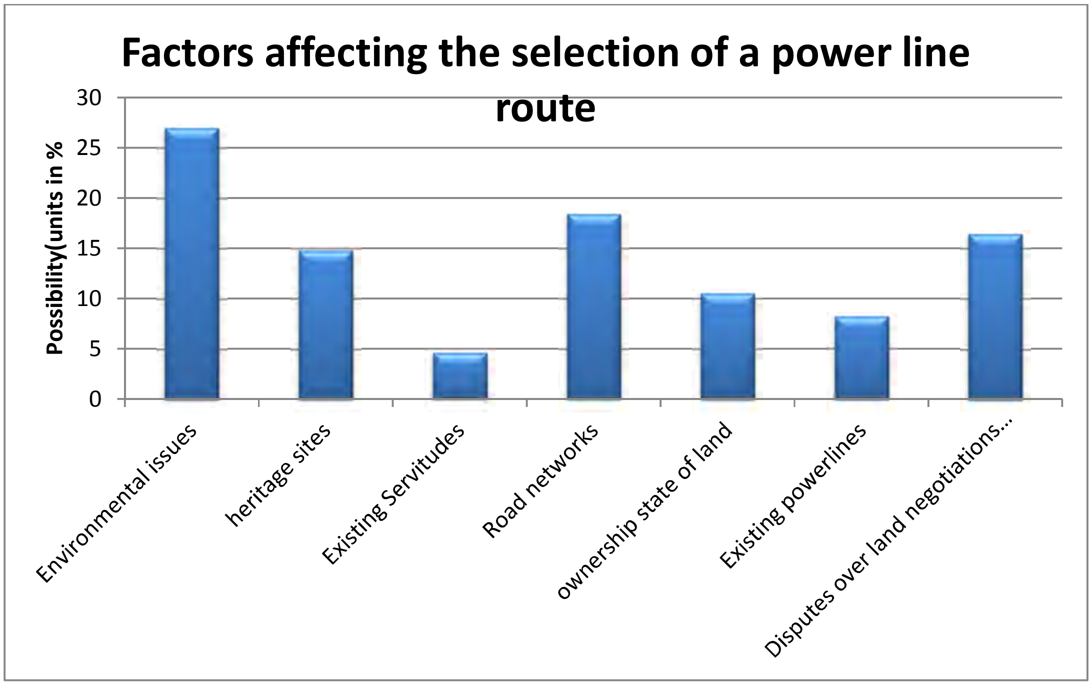

Figure 6.10. Factors affecting route selection of a power line route

Amongst the identified factors, it was found that environmental issues such as a belt of sensitive vegetation or the wetlands seemed to be a dominant factor that can affect the re-routing of a power line path in 26% of the cases. Road networks also contributed significantly in the re-routing of a selected power line course. The reason behind this could be that in most cases these power lines traverse across linear infrastructures such as roads or railway lines. There are therefore set minimum clearance for all infrastructures affecting the power line routes as revealed in table in appendix B. Consequently, there are minimum design safety requirements that have to be taken into consideration.

Figure 6.10 further, illustrates that there are still some cases (16%), whereby the negotiation costs of land could be exorbitant due to aspects such as a power line crossing over a commercial farming land or forestry and therefore this could lead to budget strain for that project. In this case, other alternative ways could then be explored. This relates to the state of land ownership (10% of the cases) which could as well delay or even hinder the process of either acquisition or registration of land (servitudes) as the conveyancing of servitudes rights could not be achieved without proper land ownership documents and ultimately lead to re- routing of that particular line.

CHAPTER 7
DISCUSSION

7.1 Introduction

This chapter explores the outcomes of the findings of this study by critical and intensive evaluation and interpretation of the results collected and presented in Chapter 6 based on the objectives set in Chapter 1.

As mentioned in Section 1.2, in today`s competitive world, the demands for services are high and hence the quality performance has to be kept at optimum level. It is therefore essential to constantly review any system in operation for any potential problems associated with its use in order to maximize its production.

The aim of the study therefore, was to evaluate the effectiveness of LARGIS application, in the planning, acquisition and management of utility servitudes in order to establish its response to the increasing demand for services and to identify possible shortcomings, so as to propose improvements to enable the system meet the increasing consumer demands for services. This was done by first understanding how the system works by interviewing users, visits to the organisation and observing people at work. Supporting documents and manuals were also read for additional information. As reflected in Chapter 6, data flow diagrams and data dictionary were used to record and graphically present the information and processes involved.

The problem areas discovered were defined in Table 6.3 and suggestions for the new improved system have been done by developing a conceptual solution to the shortcomings as outlined in Section 8.3. This has not included the development or physical design of specifications of how the new system should run.

7.2 Discussion of the findings

Objective 1: To undertake an analysis of how LARGIS is currently applied in planning, acquisition and maintenance of servitudes.

In order to assess the effectiveness of LARGIS in Eskom, an analysis was undertaken using various tools that included interviews with the system users, visits to Eskom, observing people at work and review of organizational documents. The acquired information from the analysis was then used to develop a relational matrix given in Table 7.1 by mapping the processes with data classes in order to determine the relationship between the processes and data classes, and subsequently helping in identifying the sub-systems making up LARGIS. The relational matrix Table 6.1 denotes that, more than one process can use or share one data class. This therefore implies that, the system allows both internal and external sharing of data, which is a vital aspect of a good GIS system as acknowledged by Johnson et al. (1992).

However, this reveals some constraints with regards to the exchange of data with external organisations. This is due to the fact that some organisations have strict policies regarding privacy and sharing of data. Table 6.3 indicates that, one of the challenges still faced with application of LARGIS in utility organisations is access to external datasets. Data sharing affects the performance of LARGIS. LARGIS gets some of its data externally and this makes the exchange of data not a smooth process. The constraints with regards to this include data incompatibility and restricted access to data as mentioned earlier.

With regards to the management of land rights in LARGIS, introduction of any new system is usually expected to enhance performance and be able to fulfil the requirements of its users but not exceeding the budgeted costs and planned time frame for each project undertaken (Eccles et al. 2003). The results presented in Figure 6.1 show a generally positive impact of LARGIS on management of servitudes whereby almost all the respondents highlight that LARGIS is a useful tool in the planning of servitudes management.

It was further added that it is a good management tool which increases production time as reflected in Figure 6.1. In assessing the effectiveness if this system, it proves to be effective in the general management of land rights. In a work environment, LARGIS appears to be a most favoured system. Figure 6.2 indicates 50% efficiency since this is a new system which has never been used before at Eskom, there seems to be a lot to be learned regarding its operations and this tends to be frustrating at times to the users. This is influenced by several factors such as work culture; a situation whereby people are used to a certain way of doing things and a sudden change and having to adapt to new ways can be stressful. This is substantiated in Figure 6.2, whereby three people in four found it very frustrating, however it still takes preference over the old system of managing land rights in terms of time management and other factors. The shortcoming identified was lack of regular training.

Objective 2: To identify possible shortcomings which hinder the optimal use of LARGIS.

Even though it was highlighted in section 2.5.1 that the parallel conversion method was employed in the introduction of LARGIS, the results show that this conversion method does not prove to make the conversion process from the old system to the new system a smooth conversion. The challenges that were encountered were mainly technical and organisational. For instance, there was a vigorous digitising exercise that needed to be performed before it could become usable in a LARGIS setup. This is because most organisations or departments still store their data in paper format.

The analysis in section 6.4 revealed three major areas of concern in system constraints among others. These are the technical, operational and economic constraints. The technical challenges as illustrated in Table 6.3 amongst others include issues of network problems and data incompatibility. As mentioned in Section 3.2, Wyatt & Ralphs (2003) highlighted the challenge of data incompatibility by the legacy data that was not transferable to the new system and the database adopted was not compatible with the new GIS model that was being introduced in a study conducted in London. This therefore suggests that data incompatibility of the existing datasets is an issue that needs to be considered. The other issue of importance is technical support which should be readily available.

Even though training of staff is a skill issue but the costs or funding for staff training have also been identified to be amongst the causes of economic strain to the organisation. However it is likely that during the initial stages of implementation of any new system, costs may exceed the benefits. Therefore, there is a need for performing cost- benefit analysis in order to be certain that for the entire life cycle of a system the benefits would surpass the costs. Lastly, the operational bottlenecks depend entirely on human resources; corporate culture, the willingness of the users to adapt to and support the new system based on certain factors such as increased productive time.

In the study of Murata (1995), servitude management involves several concerns such as social, political and environmental issues; Figure 6.10 stands to substantiate that besides technical, economic and operational problems, there are other problems that affect a smooth operation of LARGIS during the land acquisition stage. Some identified factors are inevitable such as environmental issues, inclusive of heritage sites.

It becomes quite difficult for a smooth work flow between different phases in the management of servitudes in LARGIS if one phase is on hold. As reflected in Figure 6.10

disputes over land negotiations is one of the main social challenges. Sometimes land owners ask for prohibitive high prices for their land. This could be due to the fact that, in some cases the owners are not willing to give out their land because they believe that powerlines devalue their land. In the study of Butler (1982) cited by Ramaphosa (2012), the refusal also is based on several factors such as loss of ploughing land, effects on eco-tourism, visual impacts and the electrical safety risk to live stock. These issues, even though are administrative or social, they have a negative impact in the work flow of data in LARGIS and ultimately affects the output or expected turn around.

Other problems of social nature are as suggested by Ramaphosa (2012) that negotiation problems are usually a consequence of lack of knowledge, poor communication and ultimately low levels of public participation which result into poor relations between land owners and developers and may hinder the process of servitude acquisition.

In addition, ownership uncertainty, which can be a case whereby it is not clearly stipulated as to who is the legal owner or beneficiary of land. There is usually a delay in the process of land acquisition hence the entire work flow. Changes in one part of the system have both anticipated and unanticipated consequences in other parts of the system (Wamicha, ND). Positive anticipated results could be quality information that is accurate and optimal as well as improved performance while the unanticipated consequences could be the operational challenges as discussed above.

Another factor that stands out is the road networks as shown in Figure 6.10. These are primarily important due to height clearance issues. For instance road designing engineers are concerned mainly about ensuring that the powerline height is at utmost clearance to prevent vehicular movement interactions below such as abnormal load trucks. Just as road networks are designed based on the need and the use of that location (be it for residential, industrial etc.); the clearances applicable or used vary based on the amount of voltage that particular powerline carries. For example, in a residential road roughly 10m wide – the clearance of a 33kv line above ground is 5.5 m, that of an 88kv is 5.9 m, while a 132kv is 6.3m as shown in the Eskom Clearance Chart in Appendix B.

Similarly, existing powerlines also have a significant impact in the selection of powerline routes. These contain live electricity and some conductors are not insulated. While choosing route selection, it must be ensured by powerline designers that new powerlines crossing above existing ones don't cause electrical magnetic conflict. It is therefore essential to allow for adequate clearances between lines and this is controlled by means of set standard clearances based on the sizes of powerlines (See Minimum clearance chart in

Appendix B). In a route selection thereof; provided that the above cannot for some reason be achieved, the route will need to be altered until the inter line clearances are compliant with the above. The Eskom chart used for the above and other standards are compiled from the Occupational Health & Safety Act 85 of 1993 – Electrical Machinery Reg. 15-20

Besides all the constraints that may affect a powerline route negatively, existing servitudes in the vicinity of a proposed route can sometimes be reused in other sections of the route where it is possible to share servitude widths i.e. one servitude width being used to accommodate two powerlines. This saves money and time for Eskom since negotiations, compensations, valuations processes etc. are skipped, Eskom utilises the right that is already being maintained.

Objective 3: To propose possible improvements to the LARGIS in order to overcome the identified shortcomings.

The shortcomings that were discovered with this study on LARGIS, were not only technical but inclusive of other aspects such as social, organizational, cultural, legal, economic, political and all others that had impact on the its performance.

The frustrations of learning to work with a totally different new system can be an organisational challenge. It is therefore proposed that this gets minimised by adequate training prior the implementation of any new system. Furthermore, digitising of socio-cultural information is essential in order to avoid poor planning which leads to conflicts on the ground and a backlog of processes on LARGIS.

A need for smooth flow of data both internally and externally is crucial. As a result, a system that is able to exchange data in a format that is compatible with all other systems would add more benefits and value to the organisation at large. Additionally, it is suggested that perhaps a service agreement is completed between Eskom and other departments that provide information that would be vital and affect the planning, acquisition , registration or maintenance of Eskom`s servitudes.

CHAPTER 8
CONCLUSIONS AND RECOMMENDATIONS

8.1 Introduction

This chapter presents the conclusions reached from the findings and analysis based on the established aim and objectives for this study. It also provides the recommendations to overcoming challenges encountered with the application of LARGIS in management of utility servitudes.

8.2 Conclusions

The aim of this study as defined in Chapter 1 was to evaluate the effectiveness of LARGIS application, in the planning, acquisition, registration and management of utility servitudes in order to establish its response to the increasing demand for services and to identify possible shortcomings, so as to propose improvements to enable the system meet the increasing consumer demands for services. To achieve this aim, research methodologies that enabled the analysis of the system were developed. These included structured and unstructured interviews, direct observations, questionnaires and documentation review as discussed in Chapter 5.

Through system and information analysis, the first objective of how LARGIS is currently applied in planning, acquisition, registration and maintenance of servitudes was achieved. This study has revealed that LARGIS has provided for the management of land rights using one single system to plan, acquire, register and maintain servitudes even though it was also discovered that the current application of LARGIS still needs some improvements. This is because LARGIS does not incorporate in its database enough information on other network services such as water pipelines, telecommunication lines and others that may affect a better informed planning of Eskom power lines.

The study further confirmed that the issue of data protection, security and accessibility to the main database was dealt with a high level of sensitivity in LARGIS as every user is given a unique password for login into the system (LARGIS) in Section 4.2 on page 28. This provides the opportunity of identifying the changes and updates done by every user and also makes every employee accountable for their work or updates on the system.

It was shown in Section 4.2 that the system also has a backup system at the national control office server for protection against server breakdowns. Other assets such as the deeds of servitudes, diagrams and other legal documents, true certified original copies are still stored both digitally and manually in the strong room for protection against physical damage in case of fire at every regional department.

The reviewed documents showed that in my area of study (Eskom, the eastern region) LARGIS has not yet reached that optimum utilization level of the management of rights at the maintenance stage. It has also shown that due to its recent implementation, even though the system is fully operational, it is being partially utilized for its capabilities.

The second objective of the study was to explore the challenges faced with the application of LARGIS as a servitude management tool in a utility organisation. Through information analysis, the research has revealed that there are various challenges with regards to LARGIS application. These ranged from organisational, technical, economic, social and legal problems.

The organisational challenge is the need for continual training of technical staff in order to meet up with the rapidly evolving software technology systems needed in the utility organization in order to manage its servitudes efficiently.

On the aspect of technical shortcomings, conversion of historic information or data, the checking and verification for this process for the Eskom officials was a tedious exercise and time consuming as well.

It is also acknowledged that economic issues such as insufficient funding and prohibitive land prices posed a challenge to enable full functioning of the system. Likewise, the study has shown that if social matters such as negotiations with land owners in the early phases of a servitude life cycle have been poorly conducted, these tend to have a negative impact on the later stages of maintenance and management. This is because LARGIS has been treated as a broad system incorporating not only technical issues, but inclusive of social, organizational, cultural, legal, economic, political and all others that may impact on its performance.

Based on this analysis, the use of LARGIS for servitude management is a complex process. However, the study revealed that LARGIS is a useful tool in servitude management by the positive impact it has made on the way Eskom manages its servitudes by using a single system to plan, acquire, register and maintain land rights associated with servitudes.

The last objective of proposing improvements to the identified shortcomings, is addressed by a set of recommendations outlined in the following section.

8.3 Recommendations

This study has acknowledged that the inefficiencies of most technological developments are largely accredited to the failure to recognize various aspects that influence the system as well as its development. Therefore, for a better and improved system it is recommended that the following factors be taken into consideration:

Organisational issues:

In view of the identified shortage of skills, regular training of staff on any developments that are introduced in an organization is essential. Even though it is recommended that the training is done prior to the system roll-out in order to avoid unnecessary frustrations caused by lengthy learning curve to the users, it is equally important that the training is maintained throughout, following system implementation and that reviews are done to ensure that the system complies with the ever changing user demands. Modern technologies like LARGIS are highly depended on capital therefore a substantial investment should be made in skilled labour for maximum production.

In addition, research and development plan should be put in place in order to ensure that the system is keeping up with the demand and continuous development or to check for a need to improve the existing system with market and development expansions.

Technical Issues

One of the technical related problems identified was that of cadastral datasets that were not up-to-date. It is recommended that arrangements be made with the surveyor general`s office to provide updated datasets on a monthly basis.

Currently the system has a configuration which requires regional offices to connect to a single server at the national office resulting in dependency for all regional offices on single server. It is recommended that a decentralized system of databases be implemented in place of a centralized database which serves all regions. This will resolve the problem of all the regional offices relying on one single server and subsequently avoid network congestion problems.

Problems of data inaccuracy and lack of credibility mainly triggered by illegible and old hard copies and massive needs for scanning can be resolved by scanning which can either be out-sourced to a professional contractor or by acquisition of high quality scanners. Equally important, to the future development of LARGIS, is the problems of digitalizing historical data. This must be dealt with and verified completely prior to rolling-out of the new system.

Cultural and Socio-Economic Issues:

In view of the user`s frustrations in learning how LARGIS functions and trying to make the best use of it at the same time. It is recommended that the staff is informed of the prospective benefits of introducing a new system prior to its implementation.

Some of the delays in land development which also affect the smooth running of the system are caused by the social problems. This should be handled with high level of sensitivity in order to avoid conflict which might lead to delays in Eskom acquisition of rights in land. Furthermore, these negotiations problems should be set at levels that do not offer much of a net loss to the owner whilst simultaneously offering opportunities for Eskom to be able to invest in that piece of land.

Additionally, another challenge is that of unmarked sensitive areas, heritage sites or conservations areas. To avoid the negative impact of the development upon these areas, it is essential that both the environmentalists and the communities work together from the initial stage of planning until the end of the project to identify and exclude these areas. All information about these sensitive areas because should be recorded digitally and made available to the system for good planning purposes.

Legal/Political Issues:

Problems of data sharing and security can be resolved by maintaining data exchange procedures and standards. A review of the extent to which private and confidential information is kept within the system and made available to the public is essential. Rigid legislations also must be reviewed as these sometimes hamper development and delay the processes of land acquisition.

More openness integration is essential even though this is seen as a threat rather than an opportunity is more of a technical issue. For any system of land administration to be effective, cooperation with various government agencies and private sector agencies is required. However as mentioned earlier security measures have to be more complex and the adoption of common standards of storing data has to be universal so that that can be compatible. This may necessitate internal changes that maybe costly to implement and of no direct benefit to work of the individual agency.

However, if more datasets such as hydrology data about water courses, streams and rivers as well as conservation data designating protected areas, and conservation areas could be incorporated in LARGIS, better and informed planning would be enhanced.

With regards to the issues of encroachments onto Eskom servitudes, strict rules and prosecution of offenders should be done as this is very hazardous to the occupants of the illegal settlements underneath overhead power line servitudes.

Based on the objectives pursued, the findings achieved for each objective point out that despite the challenges, when fully implemented LARGIS would inevitably improve the management of land and rights. The scale of this study was limited to one region due to time constraints. There is a need for similar studies to be conducted at a broader scale to allow further assessment of how other regions are coping.

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Appendices:

Appendix A1 Data Clustering and Subsystems Definitions

PROCESS	DATA CLASSES: LAYOUT PLAN	PLANNING REPORT	EIA REPORTS	LAND ADVERTISEMENTS	STATE CONSENT	PUBLIC NOTICE	LAND APP. DATA FILES	TRADITIONAL CONSENTS	OPTION AGREEMENTS	SERV./ACQUISITION PROGRESS REPORTS	LAND VALUE	VALUATION CERTIFICATES	FIELD SURVEY RECORDS	SURVEY CONTROL(X,Y,Z)	WAYLEAVE AGREEMENTS	SERV DIAGRAMS	VERIFIED DOCS.	TITLE DEEDS COPIES	DEED OF SALE	ORIGINAL TITLE DEEDS	PROPETY TRANSFER RECEIPTS	CERTIFIED TITLE DEEDS	PAYMENTS RECEIPTS	QUERRY RESULTS	ENCROACHEMENTS PLANS	LAND USE MAPS	ROUTE SKETCH PLANS	MUNIC. RATES	LAWS & REGULATIONS	CAD PLANS	ARERIAL PHOTOS	TOPO MAPS	EXPROPRIATION PLANS
SELECT ROUTE	C																	U								U					U	U	
INVESTIGATE SITE	U	C	U															U								U	U			U	U	U	U
EIA PROCESS	U		C																							U	U				U	U	
LAND APPLICATIONS ADMINISTRATION	U	U	U	C	C	C	C	C		CU								U								U	U			U	U	U	U
NEGOTIATE FOR LAND	U							U	C	CU	U	U			U			U								U	U			U			
VALUATE LAND	U		U								C	C						U								U	U	U		U			
ACQUIRE SERV.	U				U		U	U	U	C			C	C	C	C		U								U	U			U			
VERIFY DOCUMENTS									U						U	U	C	U	U			U											
REGISTER DOCUMENTS									U						U	U		C	C	U		U							U				
CERTIFY REGISTERED DOCS.									U						U	U		U	U	C	C	C							U	U			
QUERRY CHECK															U			U					C			U	U	U			U	U	
RATES CALCULATION											U	U			U			U						C	C	U	U						
MAKE PAYMENTS											U												CU				U						

Appendix A2 Subsystems data exchange flows

DATA CLASSES

PROCESS	LAYOUT PLAN	PLANNING REPORT	EIA REPORTS	LAND ADVERTISEMENTS	STATE CONSENT	PUBLIC NOTICE	LAND APP. DATA FILES	TRADITIONAL CONSENTS	OPTION AGREEMENTS	SERV./ACQUISITION	PROGRESS REPORTS	LAND VALUE	VALUATION CERTIFICATES	FIELD SURVEY RECORDS	SURVEY CONTROL(X,Y,Z)	WAYLEAVE AGREEMENTS	SERV/DIAGRAMS	VERIFIED DOCS.	TITLE DEEDS COPIES	DEED OF SALE	ORIGINAL TITLE DEEDS	PROPETY TRANSFER	RECEIPTS	CERTIFIED TITLE DEEDS	PAYMENTS RECEIPTS	QUERRY RESULTS	ENCROACHMENTS PLANS	LAND USE MAPS	ROUTE SKETCH PLANS	MUNIC. RATES	LAWS & REGULATIONS	CAD PLANS	AERIAL PHOTOS	TOPO MAPS	EXPROPRIATION PLANS
SELECT ROUTE	C																		U									U					U	U	
INVESTIGATE SITE	U	C	U																U									U	U			U	U	U	
IEA PROCESS	U		C																									U	U				U	U	
LAND APPLICATIONS ADMINISTRATION	U	U	U	C	C	C	C	C		CU									U									U	U			U	U	U	U
NEGOTIATE FOR LAND	U								C	CU		U	U			U			U									U	U			U			
VALUATE LAND	U											C	C						U									U	U	U					
ACQUIRE SERV.	U						U	U	U	C				C	C	C	C		U									U	U			U			
VERIFY DOCUMENTS									U							U	U	C	U	U				U											
REGISTER DOCUMENTS									U							U	U		C	U	C			U							U				
CERTIFY REGISTERED DOCS.									U							U	U		U	U	U	C		C							U	U			
QUERRY CHECK												U	U			U			U						C			U	U	U					
RATES CALCULATION																U			U							C	C	U	U				U	U	
MAKE PAYMENTS												U													CU				U						

Appendix B Minimum clearance chart

Eskom — EASTERN REGION KWA-ZULU NATAL

MINIMUM CLEARANCE CHART

At maximum sag & or swing as applicable. O.H. & S. Act based on 50°C & 500 Pa wind.

Nominal Voltage -kV	ABC LV & HV	1.1 or less	7.2	12	24	36	48	72	100	145	245	300	362	420	800	533 d.c. (note 12)
Min safety clearance (outdoor earth)	-	-	0.15	0.2	0.32	0.43	0.54	0.77	1.00	1.45	2.10	2.5	2.9	3.2	5.5	3.7
Above ground outside townships (note 1 & 2)	4.5	4.9	5.0	5.1	5.2	5.3	5.4	5.7	5.9	6.3	7.0	7.4	7.8	8.1	10.4	8.6
Above ground in townships (note 1)	4.5(note3)	5.5	5.5	5.5	5.5	5.5	5.5	5.7	5.9	6.3	7.0	7.4	7.8	8.1	10.4	8.6
Above roads in townships & proclaimed roads outside townships (note 4) Mpumulanga roads (note 5)	5.5	6.5	6.5	6.5	6.5	6.5	6.6	6.9	7.1	7.5	8.2	8.6	9.0	9.3	11.6	9.8
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]					[illegible]									
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
Transnet Rail Freight railway non-electrified (note 10)		11.0	11.2	11.3	11.4	11.5	11.6	11.8	12.0	12.4	13.0	13.3	13.9	14.2		14.7
Transnet Rail Freight telephone lines (note 11)		1.2	1.4	1.4	1.5	1.7	1.8	2.0	2.2	2.7	3.2	3.6		4.5		
Transnet RF track electrification & earth wires (on track structures)		1.8	2.0	2.1	2.2	2.3	2.4	2.6	2.8	3.3	3.7	4.2	4.7	5.0		5.5
Inter Line spacing		≤ 1.1 kV	6.6kV	11kV	22kV	33kV	44kV	66kV	88kV	132kV	220kV	275kV	330kV	400kV	765kV	533kV
Class A (major inter connector 275-400kV)				18	22	24			28	30		34		36		
Class B (minor inter connector 88-132kV)				14	18	20			22	24		30		34		
Class C (major radial feeder customer groups & municipalities)				10	12	14			18	18		28		30		
[illegible]				[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		[illegible]		[illegible]		
[illegible]				[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		[illegible]		[illegible]		
[illegible]				[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		[illegible]		[illegible]		

Notes:

[illegible]

Tree plantation cut width 2 x 24m for retic & 2 x 28m for Sub Tx lines
Tansnet Pipelines: structures to be > 15m from CL of pipeline servitude, 88kV & over = EW within 800m to be insulated & aviation spheres @ x/ing
FM Towers - structures to be > 500m away

[illegible]

2 Permits required for local legislation from KZN Wildlife
1 Permits required for national legislation from DWAF
Max height of indigenous bush under a line is 3m

Spans	Clearance
under30m	15.2m
30-167m	21.3m
over167m	30.5m

[illegible]

Roads - Reticulation Lines:
National : any part of structure 20m from road reserve boundary (<40kV)
KZN Main : (any part of structure) greater of 35m from CL or 15m from fence
KZN District : (any part of structure) 20m from CL.

[illegible]

REV 14

Appendix C **Dictionary for processes**

PROCESS NAME	PROCESS No.	PROCESS DESCRIPTIONS	INPUT FLOWS	OUTPUT FLOWS	BOTTLENECKS
Planning	1[1]	Undertaking the planning of all the servitudes to be acquired by the organization.	-Layout Plans -Planning Reports -EIA Reports -Land Advertisements -State consents -Public notices -land applications data files -Traditional consents -Option agreements -Land Use maps -Route sketch Plans -Aerial Photos -Topo maps -Expropriation plans	-Land application data files -Plans and maps -Searched data	-Rigid legal requirements
	1.1[2]	Selecting the best route With minimum side effect to the environment & community at large	-Layout Plans -Land Use maps -Topo maps -Aerial Photos	-Alternative routes	

[1] Planning of Servitudes lines
[2] Process of selecting a servitude route

Appendix C (Continued) **Dictionary for processes**

PROCESS NAME	PROCESS No.	PROCESS DESCRIPTIONS	INPUT FLOWS	OUTPUT FLOWS	BOTTLENECKS
Investigate a site	1.2[3]	Investing any possible harm or danger of the selected route to the environment and society.	-Layout Plans -EIA Reports -Aerial Photos -Topo maps -Expropriation plans		
EIA process	1.3[4]	A process of doing environmental impact assessment.	-Layout Plans -EIA Reports -Aerial Photos -Topo maps -Expropriation plans	-EIA Reports	
Land applications administration	1.4[5]	A process of administering all the land applications with different departments	-Layout Plans -EIA Reports -Aerial Photos -Topo maps -Expropriation plans -Laws and regulations -Public notices -Topo maps	-land applications reports/consents -State consents	-Delays in responding to the requests

[3] Process of doing feasibility study
[4] A process of doing environmental impact assessment.
[5] Administration of all the land applications with different departments

Appendix C (Continued) Dictionary for processes

PROCESS NAME	PROCESS No.	PROCESS DESCRIPTIONS	INPUT FLOWS	OUTPUT FLOWS	BOTTLENECKS
Acquisition	2[6]	A process of acquiring land legally from the rightful owners for various development purposes.	-Option agreements -Serv. Acquisition progress reports. -Valuation Certificates -Field survey records -Survey control(x,y,z) -Wayleave agreements -Servitude diagrams	-Servitude diagrams -Approved consents	- Backlog of unexamined survey records which causes delays -Insufficient funds -Inconsistent cadastral numbering -Process can be slow and frustrating due to negotiations delays
Negotiate for Land	2.1[7]	A process of establishing a common agreement between the stakeholder and the land owners.	-Aerial Photos -Layout Plans -Land Use maps -Route sketch Plans -State consents -Topo maps	-Serv. Acquisition progress reports	
Valuate land	2.2[8]	Valuation of property for compensation based on the land use and other factors	-Land Use maps -Land value -Municipal rates	-Valuation certificates -Land value	-Sometimes prices are not based on market value of the property.

[6] Acquisition of land legally from the rightful owners for done in three steps
[7] First step under the process of land acquisition
[8] Second step in land acquisition

Appendix C (Continued) **Dictionary for processes**

PROCESS NAME	PROCESS No.	PROCESS DESCRIPTIONS	INPUT FLOWS	OUTPUT FLOWS	BOTTLENECKS
Acquire servitude	2.3[9]	A process of legally acquiring land from the land owners for proposed development	- Servitude acquisition progress reports -Field Survey records -Survey control -Wayleave agreement	-Servitude diagrams	
Registration	3[10]	Registration of land and all rights in land and all other legal documents	-Verified Docs -Title Deeds copies -Property transfer receipts -Payments transactions Certified Title deeds -Deed of sale	-New title deeds -Registered miscellaneous documents	-Land without title deeds -Prolonged processes by the land owner. -Estates whose legal owners are not up to date -Informal land transactions
Verify documents	3.1 [11]	Checking that all the documents meet the requirement for registration	-Mortgage -Option plans/agreements -Servitude diagrams -Title Deeds	-Verified Title Deeds -Verified documents	-Takes times to ensure all documents are in order

[9] A process of legally acquiring land from the land owners
[10] Registration of land and land all rights
[11] Process of checking that all the documents meet the requirement for registration

Appendix C (Continued) **Dictionary for processes**

PROCESS NAME	PROCESS No.	PROCESS DESCRIPTIONS	INPUT FLOWS	OUTPUT FLOWS	BOTTLENECKS
Certify registered documents	3.3[12]	Checking, signing and endorsement of registered documents	-Registered documents -Registration laws and regulations	-Certified Title deeds -Certified miscellaneous documents	Certify registered documents
Maintenance	4[13]	Maintenance of all inventory of all records of land rights offered or leased to Eskom	-payments receipts -Encroachment plans -Municipality rates -Land use maps - Route sketch Plans -Deed of sale	-Land recordings	
Enquiry Check	4.1[14]	Overlaying the newly designed layout plan with the existing plans to ensure that there is no overlap	-Site plans -Layout plans -Aerial photos - Servitude diagrams -Wayleave Agreements	-Checked layout plans -Encroachment plans	Duplication of work; it is done both internally and by external land surveyors
Rates calculation	4.2[15]	Calculation of the amount of rates payable depending on individual municipality	-Municipality Rates	-Municipal rates bills	
Make payments	4.3[16]	Monitoring of all land transactions	-Payments transactions	-Payments Receipts	

[12] Process of certify registered documents
[13] Process of maintenance of all inventory of all records of land rights in Eskom
[14] Process of cross checking for duplication and encroachments
[15] Process of calculating the costs of rates
[16] Process of monitoring of all land transactions

Appendix D **Dictionary for data flows**

DATA FLOW NAME	DESCRIPTION	SOURCE	USED BY PROCESSES IN APPENDIX C	DATA STRUCTURE
Layout plans	Proposed development plan showing the proposed boundaries prepared in line with the planned land use for the proposed developments	Planning of land rights section	1,1.1,1.2,1.3	Layout plans
Planning reports	Reports prepared on how the proposed land is to be developed	Planning of land rights section	1,1.4	Reports
EIA Reports	Reports outlining restrictions towards environmentally sensitive areas	Environmental consultants	1,1.3	EIA Authorisation
Land advertisements	Advertisement to the public for the Allocation of land for development	Press / Public notice boards	1,1.4	Advertisement notice
State consents	These are written consents issued by different departments affected by the development.	Different state departments	1	Planning consents
Public notices	Notices to warn the public of any upcoming development	Eskom	1	Notice
Land Applications data files	Formal requests in writing to different Gov. departments to develop land	Eskom	1,1.4	Applications forms
Traditional consent	Permission from a traditional leader to make developments on land	Chief/Tribal representative	1,1.4	Chief`s consent letter
Option agreements	Formal & detailed agreement with standard clauses defining the right being registered/acquired. Defines the right(s) /responsibilities of both the owner & Eskom (Developer)	Eskom	1	Option sketches/plans

Appendix D (Continued) Dictionary for data flows

DATA FLOW NAME	DESCRIPTION	SOURCE	USED BY	DATA STRUCTURE
Servitude acquisition progress reports	Reports uploaded in LARGIS on updates On the progress of each project.	Eskom	2,2.1,2.2,2.3	Reports
Land value	The value of land as evaluated by land valuators	Land valuators	2,2.2	Land valuation report
Valuation certificates	Certificates issued by land valuators indicating the value of that particular land	Land valuators	2,2.2	Valuation certificates
Field survey records	Records detailing how a particular survey was performed.	Land surveyors	2,2.3	Field Survey records
Survey control (x,y,z)	Data required for cadastral survey as a reference points	Private surveyors	2,2.3	Control points(Y,X,Z)
Wayleave agreement	An agreement and a sketch for small line between the owner and Eskom	Eskom	2,2.3	Wayleave
Servitude diagrams	A diagram for registering a servitude over a property	Private surveyors	2,2.3	Servitude diagrams
Verified Documents	Checked documents for registration purposes	Conveyancers/ Registration officers	3,3.1	Verified documents
Title deeds	documents evidencing a person`s legal right in property.	Deed registry	3,3.1	Title deeds
Deed of sale	An agreement of sale and Transfer of ownership of property in favour of the buyer from the seller	Eskom & land owners	3	Deed of sale
Property transfer receipts	Receipts received/ given when a property is registered	Deed registry	3.3.2	Receipts
Certified title deeds	documents evidencing a person`s legal right in property.	Deed registry	3,3.3	Newly created title deeds

Appendix D (Continued) **Dictionary for data flows**

DATA FLOW NAME	DESCRIPTION	SOURCE	USED BY	DATA STRUCTURE
Payments receipts	Receipts from payments made	Eskom	4,4.3	Payments Receipts
Query results	Overlaying the newly designed layout plan with the existing plans to ensure that there is no overlap	External institutions or public	4,4.1	Checked layout plans
Encroachment plans	Plans showing a situation whereby a Property owner violates the property rights of the other legal owner by either infringing or taking illegal occupation of land	Encroachment checks, Examined cadastral plans	4,4.1	Encroachment data
Land use maps	Maps showing the exactly what the land is zoned for.	Municipalities	1,2	Land use map
Route sketch maps	Sketches depicting the route of a proposed servitude line	Eskom	4	Route sketch maps
Municipal rates	This is the money payable to the Municipality base on the location , Land use and the extent of the land in question.	Municipalities	4,4.2	Rates payments

Appendix D (Continued) **Dictionary for data flows**

DATA FLOW NAME	DESCRIPTION	SOURCE	USED BY	DATA STRUCTURE
Laws and regulations	Laws and regulations guiding development planning, survey and approval of survey diagrams & registration of land	Government	1,4	Statute Documents
Cadastral plans	Plans showing cadastral boundaries	Land surveyors	1;2;3;4	
Aerial Photos	photographs Captured from the space using aircrafts.	air surveys		aerial photos
Topo maps	Maps showing detailed, accurate graphic representations of features that appear on the Earth's surface	NGI	1;2;3	Topo maps
Expropriation plans	Plans depicting portions of land acquired for road purposes	Department of transport	1	Expropriation plans

Appendix E

QUESTIONNAIRE

Questionnaire

This questionnaire is part of the research study being carried out by a Masters student at UKZN. It is aimed at acquiring information on the application of LARGIS in Planning, Acquisition and Maintenance of Land Rights at Eskom.

All the collected information will be used to compile a report for Master`s Thesis based on the findings and views of LARGIS` users.

SECTION A

Name	
Position	
Department	
Contact Details	
Date the Questionnaire is filled in	

DESCLAIMER:
The information collected is solely for academic purpose and participation should be purely on voluntary basis.

PLEASE ANSWER THE FOLLOWING QUESTIONS BY CROSSING (X) ON THE RELEVANT BLOCK OR WRITING DOWN YOUR ANSWER IN THE SPACE PROVIDED BELOW.

SECTION B

This section of the questionnaire is intended to acquire information about the application of LARGIS in Planning, Acquisition and Maintenance of servitudes.

1. What positive impact has the introduction of LARGIS made in the management of land rights?

___

___

___

2. Land rights (Servitudes) in Eskom undergo the four life cycle stages namely planning, acquisition, registration and Maintenance:

a) What information gets loaded into LARGIS during the planning phase

___

___

___

b) What are the inputs or documents required to move a right into the second phase of acquisition.

___

___

___

c) What information is required during the registration of Eskom`s servitudes stage and how does LARGIS facilities this process?

___

___

___

d) How does LARGIS assist in the management or maintenance stage of servitudes?

___

___

___

3. Briefly explain how LARGIS is currently applied in planning, acquisition and maintenance of servitudes (Land rights)

   a) PLANNING:

   ____

   ____

   ____

   b) ACQUISITION:

   ____

   ____

   ____

   c) MAINTENANCE:

   ____

   ____

   ____

4. How are investigations/queries pertaining to Eskom rights carried out within your office using LARGIS?

   ____

   ____

   ____

5. At the maintenance stage of a right within a municipal demarcation, how does LARGIS manage/handle payments the municipal rates?

   ____

   ____

   ____

SECTION C

This section of the questionnaire explores the challenges, if any with regards to the application of LARGIS in managing land rights.

6. Please outline the challenges faced during the following stages:

   <u>Planning Phase:</u>

   a) During a route selection, what factors hinder or cause any line deviations from the originally planned line/route?

      ____

      ____

b) Does LARGIS aid in identifying environmental issues such as natural resources, unique and sensitive areas, and biodiversity?

Yes ☐

No ☐

c) If your answer to (b) is No, how are the above issues dealt with during the planning phase in LARGIS?

Acquisition Phase:

Briefly explain the role or the inputs of the following into LARGIS

a) Valuator

b) Negotiator

c) Do the valuations reports for servitudes compensations get challenged during the negotiations between Eskom and Land owners?

d) What problems could stop a right from leaving the acquisition stage to the registration phase?

Registration Phase:

a) What are the common problems faced during Eskom registration of Rights?

Maintenance Phase:

a) During the maintenance stage, how are issues such as encroachments onto Eskom servitudes dealt with using LARGIS?

b) Why is it difficult to get all the rights in the maintenance stage (full assets of Eskom)

c) What are the technical challenges that you face on the daily use of LARGIS?

d) Are there any organizational challenges that might hinder the maximum use of LARGIS in managing Land and Rights?

e) What challenges did you experience during the Historical Data (Deeds of servitudes, wayleaves , option plans etc.)Conversion for the purpose of uploading into LARGIS?

f) Would you say the historical data conversion into the LARGIS System was a success?

g) What problems did you encounter during the approval process of geometry and attribute data batches?

h) Are there any other issues not mentioned above that hinder the optimal and effective use of LARGIS in your department?

11. Is there a back-up plan to prevent the system breakdown in the event of loss of key personnel or equipment failure?

Yes ☐

No ☐

12 (a) If yes to 11, what is it?

(b) If No, to 11, why?

SECTION D

This section of the questionnaire seeks possible improvements that could be suggested, if any with regards to the application of LARGIS in managing land rights.

12. Are you satisfied with the performance level of LARGIS?

Yes ☐

No ☐

13. If your answer to 12 is NO, are there future plans of enhancing or improving the System?

Yes ☐

No ☐

14. If your answer to 13 is YES, what future plans of enhancing or improving the system are in place?

____

____

____

15. If No to 13, what improvements would you suggest be made on the system?

____

____

____

On a scale of 1 - 5, Rate (1= Excellent, 2 = Good, 3 = Fair, 4 = poor, 5 = worse)

16. Has LARGIS improved the way that you manage your land rights as a Right`s Practitioner?

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

17. How has LARGIS enhanced your performance in terms of time efficiency?

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

18. Within your current land rights database, what percentage of rights would you say have successfully been planned, acquired, registered and maintained?

____

19. Does LARGIS as a servitude management tool enable you to plan for prospective rights?

20. Indicate your personal preference of managing land rights

Old System ☐ New System ☐

21. Do you have any training session on the use /application of LARGIS?

Yes ☐

No ☐

22. If yes, how often?

23. What special tools, equipment, software, etc were purchased to effectively implement LARGIS?

*** Thank you for your co-operation and assistance ***