GEOGRAPHIC INFORMATION SYSTEM AND THE IMPLEMENTATION OF KENYAN VISION 2030

State Department of Lands

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DECLARATION

I, the undersigned, declare that this project is my original effort, and that neither the whole nor a part of it has been, is being, or is to be submitted for an academic degree in this or any other University.

Signature: ______________________Date: ________________________

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D61/65650/2013

This research project report has been submitted for examination with my approval as the University supervisor.

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DEDICATION

To Ruth for her unceasing love and confidence in me over the years.

To Kayla, a source of inspiration to me.

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LIST OF ABBREVIATIONS

GIS	Geographic Information Systems
ANOVA	Analysis of Variance
DSS	Decision Support Systems
GDP	Gross Domestic Product
GoK	Government of Kenya
ICT	Information Communications and Technology
IPR	Intellectual Property Rights
LIS	Land Information Systems
LSTS	Location Strategy Three Stage
MDG	Millennium Development Goals
MPVC	Michael Porter's Value Chain
PASW	Predictive Analytics Software
PoP	Points of Presence
Q-Q	Quantile-Quantile
SDG	Sustainable Development Goals
SPSS	Statistical Package for Social Sciences
STI	Science Technology and Innovation
TTF	Technology Task Fit

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ABSTRACT

In the private and public sectors, organizations have invested in information systems as a strategic infrastructure in management decision making. These tools have been identified as paramount and vital in driving management efficiencies. Geographic Information Systems (GIS) is one type of such specialized information systems and business infrastructure which can be leveraged upon to efficiently support space based strategic decision making. Though such attempts have been noble in developed economies, few and of limited system functionalities have focused on developing economies as Kenya. Considering land as a critical resource as spelt out in Kenyan Vision 2030, there does not exist an efficient exploitation of GIS and a strategic decision support system for its administration in Kenya. Therefore as computing power rises, big data emerges and efficient data management becomes central in organizations strategies, there is an increased need for policy makers to expand their knowledge of GIS to aid decision making through an effective management of such increasingly complex land related data. Therefore, this research delves into uses and challenges of leveraging upon GIS using Technology-Task Fit Model, Michael Porter's Value Chain Model and Location Strategy Three Stage Model as theoretical lenses to understand the implication of GIS in management theory and strategic decision making. Using a survey approach, this research examined the State Department of Land. Based on the factors identified, a conceptual framework was hypothesized and tested on data collected through a survey of staff based at the Lands offices in Ruaraka, Nairobi. The analysis resulted in a well-fitted model. The results present a suitable frame of reference to guide the formulation of strategic information systems policies in the State Department of Lands in Kenya and beyond.

CHAPTER ONE: INTRODUCTION

1.1 Background of the Research

In the last two decades, government agencies and ministries have been investing in information systems to improve efficiency in service delivery, strategy and decision making (Coltman, Tallon, Sharma, & Queiroz, 2015). In 2006, Kenya launched a multi-sector strategy dubbed *Vision 2030*. Decision making is central to the success of this strategy. Singh's (2012) crux is that approximately 80 per cent of decision making data is 'location based'. Since Geographic Information System (GIS) is a specialized type of information system and business infrastructure with an ability to integrate the 'location' and 'textual' components (Alharbi, 2015) and decision making is a set of management practices (Stefanovic, 2014), this study aimed at extending the theory and the practice of management by presenting GIS as a vital decision making and support system infrastructure or tool in achieving the goals and guiding the implementation of Kenyan *Vision 2030* in the State Department of Lands in Kenya.

1.1.1 Geographic Information System

Geographic Information System (GIS) is an information based system or business tool with an increasing use in a multiple number of sectors (Douglas, 2008). It enables the capture, the storage, the sharing, the manipulation, the analysis, the management and the presentation of both textual and geo-referenced data (Worboys & Duckham, 2004). GIS comprises a set of hardware, which is the platform upon which data management is supported, software which forms a set of programs or applications for data manipulation, organizational structure which constitutes skilled human capital that operates the system infrastructure, and the methods which form the business rules or models that inform the data operations (Longley, Goodchild, Maguire, & Rhind, 2011) as supported by the hardware.

To put the above in context, in 2008 Starbucks Corporation, an international retailer headquartered in the US with almost 17000 global points of presence (PoP) engaged in strategic location based decisions with a resounding success. The retailer ceased operations at over 700 under performing locations in the United States (US) (Glover, Schulz, Wyeth, & Wiles, 2010). The scenario presented the implications of GIS on how *space* and *place* conspire to impact management strategy and decision making (Heywood, Corneliues, & Carver, 2011).

The basis of planning surrounds a management decision in any situation, thus strategy enables the union between the organization and the surrounding environment (Balogun, Okeke, & Chukwukere, 2014). GIS aids in bringing the management parameters of the environment into organizational decision making. Therefore, a good approach is to accommodate the ever changing environment of an organization leveraging upon a marketing mix, that is, product, place or geography, promotion and price. These refer to the main areas of decision making (Mihalič, Garbin-Praničević, & Arneri, 2015).

Despite the benefits of GIS, there exist challenges towards the effective utilization of GIS (Eldrandaly, Naguib, & Hassan, 2015). Firstly, data which is an important component of GIS, but is seriously lacking in developing nations (Masoodi & Rahimzadeh, 2015). For instance, census data in Kenya is collected only after 10 years, and so it could also be out of date data. Also, secondary data is equally expensive. Secondly, hardware is very costly in Kenya (Mulaku, 2014). This is because better part of the hardware components are still imported from developed nations. Thirdly, there is shortage of technical GIS related skills (Kimenyi & Kibe, 2014). GIS is a newer filed and so human capital is still at its nascent stage of development in the developing world. Fourthly, in developing countries, software is expensive (Balogun, Okeke, & Chukwukere, 2014). Like hardware, this is imported from the developed nations. In addition, the human capital in existence is still not competent enough to develop or customize for the local situations. Fifthly, commitment of developing countries in investment in modern technologies is relatively low (Balogun, Okeke, & Chukwukere, 2014). In addition, lack of adequate energy and unreliable internet connectivity present a challenge regarding real time information sharing (Alharbi, 2015). These form some critical support infrastructure for data management.

Finally, Abdel-Fadeel *et al* (2013) found that inadequate regulations to organize intellectual property rights for business or organizational gain make the intangible GIS assets vulnerable to insecure practices.

1.1.2 Vision 2030 of Kenya

United Nations in its agenda 2030 adopted a framework of making Sustainable Development Goals (SDGs) part of national development plans (NDGs) (Omulando, 2015). In East Africa, Uganda coined Vision 2040, Tanzania has Vision 2025, Rwanda has Vision 2020, and Burundi has Vision 2025 while Kenya has Vision 2030. As forward looking statements, these visions focus on the future. These inspire and attempt to provide a clear decision-making criterion based on the overall goal to achieve a unified global agenda. Using such visions, people's expectations are stretched in line with the performance and aspirations to increase their output in anticipation of improved standards of living across the globe.

Kenya's Vision 2030 has a mission to create a competitive nation at a global level by 2030 (GoK, 2006). It is anchored on three critical and key pillars. These are the

Economic, the Social and the Political pillars (GoK, 2006). It envisages that Kenya shall remain committed to governance reforms and eradication of population marginalization. Specifically, the Vision postulates an intensive application, use and deployment of Science, Technology and Innovation (STI) to increase throughput in production and drive management efficiencies in strategy formulation and decision making. This is intended to optimize the cost of conducting business as well as to drive cost efficiency in public service delivery across a multiple number of sectors in Kenya.

1.1.3 State Department of Lands

In this research, Kenya's State Department of Lands is used as an empirical setting to understand the context in which Geographic Information Systems (GIS) is anchored in the extant literature. Though Vision 2030 Secretariat is the policy organ that drives the strategic goals, State Departments remain the implementing agencies across the entire bureaucracy of government.

The State Department of Lands is domiciled under The Ministry of Land, Housing and Urban Development. The Ministry was created in 2014, through the second Presidential Order of 2014. This was in accordance with Constitution of Kenya (2010) as promulgated in 2010.

In the new arrangements, the ministries that previously existed were merged to form super ministries with increased scopes and roles. Thus, the five erstwhile and one time fully fledged ministries of Housing, Land and Urban Development and Nairobi Metropolitan Development, were merged to form the current Ministry of Land, Housing and Urban Development.

The Ministry provides policy direction and coordination of land, housing and urban development related matters. Specifically, the State Department of Lands' vision is

'Excellence in Land Management for Sustainable Development of Kenya' while the mission is '*To Facilitate Improvement of Livelihood of Kenyans through efficient Administration, Equitable Access, Secure Tenure and Sustainable Management of the Land Resources.'*

In the State Department of Lands in Kenya, GIS can be leveraged upon to inform decision making and strategy formulation. Specifically, the department is charged with the responsibility to ensure that there is efficient administration of the land as a critical resource. It formulates and implements land policy, registers transactions, and undertake land surveys. This ensures an efficient planning of physical infrastructure to inform the national development (GoK, 2016). However, the efficient and operational administration of an information system platform is contingent upon the availability of adequate information. In lands sector, many countries are computerizing their cadastral records and creating large, national databases (Kneebone & Holmes, 2015). Geographic data can be integrated, analyzed, and distributed in ways that until recently were not possible (Agrawal, Catalini, & Goldfarb, 2015).

1.2 The Statement of the Problem

In private and public national or international organization, two critical issues are evident: a lot of geographically based information, big data and so the more data one has, the more challenging it is to manage and infer meaning (Auroop & Gupta, 2014). It is a fact that up to 80% of all data handled has a common parameter: geography (Singh R. , 2012). In this case, GIS is important in aiding the strategic management decisions based upon this parameter of place and space. Unlike any other type of information handling system, GIS adequately understands the concept of location and place (Alharbi, 2015).

Indeed, there is intense competition for the finite space in the planning of infrastructure (Mulaku, 2014). Governments spend heavily to deal with space disputes (Kairu & Wahome, 2015). Yoders (2012) opines that GIS visualization tools such as Google Earth can be leveraged upon to efficiently support strategic space based decisions.

Though the above attempts have been noble in developed economies, few and of limited system functionalities have focused on developing economies. Considering land as a critical resource as spelt out in *Vision 2030* (White, Saturnino, Ruth, Ian, & Wendy, 2013), there does not exist an efficient decision support system for its administration in Kenya. This has presented bureaucratic challenges compounded with administrative inefficiencies (Kuria, Ngigi, Gikwa, Mundia, & Macharia, 2016). Therefore as computing power increases and the big data emerges, there is an increased need for policy decision makers to expand their knowledge of information systems to aid decision making more especially in managing more complex land data with a focus on the goals of *Vision 2030*.

1.3 Research Questions

Thus the research questions for this study were as follows:

1) What is the extent to which GIS is used in the State Department of Lands in Kenya?
2) What are the challenges encountered while using GIS as a decision support system for the implementation of Vision 2030 in the State Department of Lands in Kenya?
3) What is the relationship between the uses of GIS and Vision 2030 goals in the State Department of Lands in Kenya?

1.4 Research Objectives

Focusing on Kenya's State Department of Lands, research objectives were as follows:

1) To determine the extent to which GIS is used.
2) To determine the challenges encountered while using GIS as a decision support system for the implementation of Vision 2030.
3) To establish the relationship between the uses of GIS as a decision support system and Vision 2030 goals.

1.5 Value of the study

It is envisaged that the research findings may invoke policy changes on the strategy and policy of investments in information systems infrastructure to support decisions in the State Department of Lands. Since management benefits of location intelligence are strongly reflected in the business processes, they inevitably have implications on the management policy positions. Land agencies need to manage their land related data assets more efficiently and effectively. This is possible by transiting from legacy 'silo' workflows to enterprise wide information systems solution. This would enable the putting up of the geo-database at the center of a land assets enterprise transactional workflow. In addition, better understanding of this interface may provide a frame of reference for more robust decisions that may influence the policy articulation of Kenya's Vision 2030 in regards to the potential of geographic information system (GIS) as a decision support tool.

Finally, the theoretical literature developed can be exploited for management value. This may extend the management science theory by presenting GIS as a critical decision support system in other organizations in the private and public sector across the developing and emerging economies.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

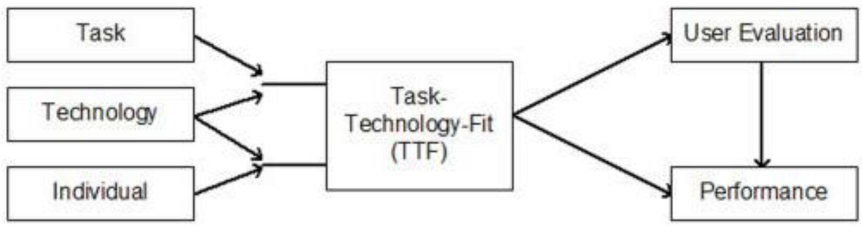
This chapter presents the theoretical models, the extant literature and their appropriateness to the research objectives. In addition, a conceptual model is presented.

2.2 Theoretical Models

There are a number of models that may be used to explain the value of Geographic Information Systems (GIS) in management science theory, three of which are Technology Task Fit (TTF), Michael Porter's Value Chain (MPVC) and Location Strategy Three Stage (LSTS) models.

2.2.1 Technology Task Fit (TTF) Model

Proposed by Goodhue & Thompson (1995), TTF model asserts that using technology as an enabler a positive performance impact is possible in the task carried out. However this is only probable if the technology characteristics match the task requirements and the user's abilities.



(Goodhue & Thompson, 1995)

Figure 1: Technology Task Fit Model

In this respect, any misalignment between the capabilities of GIS and user's skills in accomplishing the goals of Vision 2030 result in a reduced fit or match, limiting envisaged performance goals of the State Department of Lands.

In fact, Goodhue & Thompson (1995) define task-technology fit (TTF) as the extent to which a set of technology enables a user to conduct a specific task. It is the fit among the requirements of the task, the user abilities and the potential of the technology (Goodhue & Thompson, 1995).

In the context of GIS, the potential of the technology is contingent upon its hardware as well as the users' potential. The users' potential is measured in terms of the relevant trainings undertaken and the education level of the users. The tasks enable the process of the conversion of inputs into outputs' (Goodhue & Thompson, 1995).

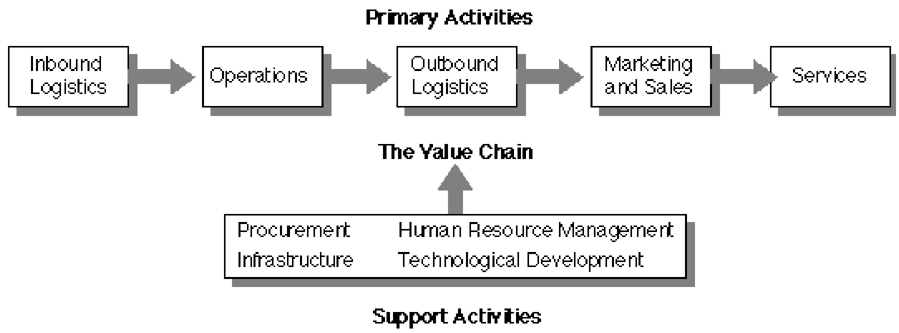
2.2.2 Michael Porter's Value Chain (MPVC) Model

Today, organizations operate in a dynamic environment (Mihalič, Garbin-Praničević, & Arneri, 2015), where competition prompts for modern technologies to be leveraged upon (Berisha-Shaqiri, 2015). Porter (1998) advances a model that identifies five principal roles: (1) inward bound logistics, (2) operations, (3) outward bound logistics, as well as (4) marketing and (5) service.

Logistics (1 &3) has an inherent spatial or geographic dimension. This is because goods or services offered have to move or be transitioned from one geographic location to another for an operation or operations (2) to happen. On the other hand, demographic, which is a GIS based data, is of particular importance in addressing a given target market (4) (Sekhar & Padmaja, 2013). Thus, there is an increasing interest in the service dimension (5) (Ramseook-Munhurrun, Lukea-Bhiwajee, & Naidoo, 2010). 'Knowing Your Customer' is a central element in customer relationship management. In this respect, geographic location informs such service customization (Alharbi, 2015).

Indeed, there are numerous opportunities to exploit in the geographical characters of data in the organizational value chain in an attempt to support different levels of logistics decision-making.

Thus, the greatest use of information system with a location based component is at an operational level, for instance, routing or tracking and tracing. GIS may thus appear in two areas: companies with a large base of clients, across a large spatial or geographical spread e.g. parcel distribution companies. Given the geographical nature of the data analysis that supports such logistics related decision-making; it is likely that the deployment of GIS grows in decision support organization systems.



Source: (Porter, 1998)

Figure 2: Porter's Value Chain Model

In this respect, GIS can be leveraged upon to address the 'location' component. Indeed, this may intensify through the use or intense deployment of Science, Technology and Innovation (STI) to raise efficiency levels as envisaged in Vision 2030 to address the goals of State Department of Lands.

2.2.3 Location Strategy Three Stage (LS3S) Model

The theory is founded on 'location' as a vital element in organizational competitiveness. Ghosh & McLafferty (1987) propose an approach to determine best location to address the competition. At market selection, an organization decides which service area to enter. This considers market demographics or transportation networks. At areal analysis, selected service area is segmented into subareas. This is evaluated for the physical and socioeconomic indicators. Then an organization performs a detailed site evaluation to forecast service targets.

Indeed, GIS is able to integrate both geographic and textual data. This can be used to better understand competition, physical and socio-economic indicators upon which a strategic decision can be based. These desperate aspects sum up Kenya's Vision 2030 aimed at creating a competitive economy by 2030.

2.3 Goals of Vision 2030

The government of Kenya launched of a long term strategy dubbed 'Vision2030'. It is expected that various economic sectors act as a cog for its implementation (GoK, 2006). It has three pillars. The economic pillar purposes to progress the prosperity of the population. It aims to achieve approximately 10% per annum in GDP growth rate starting 2012. The social pillar aims to advance the social equity. This is because no civilization is able to attain the cohesion levels as projected by Vision 2030 if significant parts of the population live in abject levels of poverty (GoK, 2006). The political pillar envisions a country that responds to the needs of the population, whose participation in the public issues is appreciated and facilitated.

Specific to Lands sector, the vision recognizes the centrality of land to the achievement of Vision 2030. It states that *'land is a critical and key resource for the development in the social, economic and political sphere'* (GoK, 2006). Indeed, sustainable land administration is central for the optimal use of land as a critical resource (Kairu & Wahome, 2015).

Thus, the elementary building block in any Land – based Information System (LIS) is the land parcel. This is identified in the cadaster database and is linked to records or attributes labeling the stakes of interest, the ownership and less often the valuation.

These can aid in fiscal purposes' decisions as valuation or taxation, legal purposes' decisions as conveyancing, or land use purposes' as administration or environmental protection. Therefore, in Kenya, land constitutes an imperative dimension of life. It is a factor of production, hence sustains the livelihoods of the majority. Thus, land should be managed in a manner that recognizes the attributes associated with it. It is indeed the Kenyans' ultimate heritage (Pellis, Lamers, & Van der Duim, 2015).

2.4 Strategic GIS and Vision 2030

Geographic information system (GIS) as a decision support system supports two main data types, spatial data and non-spatial data (Douglas, 2008). This means it is capable of spatial and non-spatial data analytics for management decision making. Spatial data are dots or lines or symbols, while non-spatial or textual data define characteristics of spatial objects. For example, 'name' of a client of the State Department of Lands residing at a specific address is an 'attribute or non-spatial data', whereas the 'address' is a 'spatial data' (Douglas, 2008).

For a comprehensive GIS there is need to have (1) a means of input for the data (2) storage, retrieval or query of data, (3) transformation or analysis of data and, (4) reporting of data, such as maps or reports. This forms a geographic database, which is the most important component of a GIS infrastructure (Auroop & Gupta, 2014). This database ensures that data is logically associated. Therefore, organizations must have a consistent and a significantly logical data on their areas of service. These data should be compatible with other information used in the value chain. In this regard, GIS creates a knowledge base for the entire organizational strategy (Berisha-Shaqiri, 2015).

For Kenya, the absence of a national land management decision support system (DSS) has led to the proliferation of haphazard expansion of infrastructure as well as space conflicts. Since GIS can integrate database operations in land related decision modeling (Akomolafe & Afeni, 2014), this can minimize risks and maximize opportunities (Berisha-Shaqiri, 2015). GIS can be leveraged upon considering its location savvy, analytical and forecasting powers in decision making (Douglas, 2008). For instance, GIS can visualize economic data with a component of geography (Thompson, 2015). United States (US) has managed to integrate population census tracts with employment data (Kneebone & Holmes, 2015). Gibbons & Machin (2005) used GIS to estimate the proximity or closeness of a property to other infrastructure. Chhetri *et al* (2014) used GIS to present the variations in land development patterns across cities by integrating data on density of employment and wages. In fact, through understanding geographies and social relationship to location, informed decisions can be made (Agrawal, Catalini, & Goldfarb, 2015). Social analysts have used the base maps of the state of Oregon and selected datasets from the census bureau of the US to show residents' education levels, ages and employment status (Esri, 2007).

In Kenya, government conducts a census, which informs the redrawing of electoral areas to maintain appropriate representation that reflects changes in the population (Brashier, 2012). Redistricting is a geographic problem and GIS is the associated geographic solution (Lehr, 2015).

Further, site selection is one of the main principles of land use planning and plays a critical role in the design of infrastructure (Cheng, Li, & Yu, 2007). The relation of a site to its surroundings influences the decisions of infrastructure planners. However, this decision is based on the available information on the geographic variables (Molenaar & Songer, 1998). The review of GIS-based multi-criteria decision analysis approaches indicate that GIS-based spatial decisions aim to comprehensively determine the most suitable locations that meet the needs of infrastructure facilities (Malczewski, 2004).

In Kenya's Vision 2030, land is a key pillar for development in varied spheres including the socio-political and economic developments. The transformation under Vision 2030 is contingent upon the land use policy in place. The policy is envisaged to facilitate land administration, computerization of land registries, creation of National Spatial Data Infrastructure and the development of an enhanced legal framework to address land disputes (GoK, 2006; GoK, 2016).

Since most of the cited areas in literature are in developed nations, this study attempted to explore the potential uses and attendant challenges of GIS as a decision support system in the State Department of Lands in Kenya.

2.5 Challenges of GIS

Despite the benefits of GIS, there exist challenges towards its effective utilization (Eldrandaly, Naguib, & Hassan, 2015). Though data is one of the most important components of GIS, it is seriously lacking in developing nations (Masoodi & Rahimzadeh, 2015). Even the population census data is not regularly updated. In Kenya, this is done every ten years. In fact, many utility service areas are not geo-referenced in relation to location and socio-economic data (Auroop & Gupta, 2014). In addition, the availability and affordability of computer hardware is not very promising in Kenya (Mulaku, 2014). Additionally, a number of Kenyans are still illiterate in the use of such technologies and even the educated ones are indifferent to the use of GIS.

Further, in developing nations, GIS based software is still very expensive (Balogun, Okeke, & Chukwukere, 2014). However, training in the use of GIS is not quite novel in developing countries (Agrawal, Catalini, & Goldfarb, 2015). This is due to insufficient number of professionals in such technologies. In these respects, in many parts of the world including in Kenya, commitment of governments in investment in modern technologies to improve operational efficiencies in public sector is relatively low compared to advanced nations (Balogun, Okeke, & Chukwukere, 2014). This implies a low degree of implementation and adoption of the modern technologies.

It is also evident that lack of efficient power supply across government offices to run the hardware as well as unreliable internet connectivity counters the real time data sharing which is much needed in management decision making (Alharbi, 2015). Finally, Abdel-Fadeel *et al* (2013) thrust is that there is lack of suitable laws to administer the intellectual property rights (IPR). This makes GIS based intangible assets susceptible to insecure practices. Hence, organizations may lose attendant and contingent financial privileges.

2.6 Conceptual Framework

Flowing from the extant literature, relationships between concepts were used to form a conceptual framework. This model consists of four constructs. This includes spatial and non-spatial analytical capabilities of GIS as forming a set of the independent variables, user-characteristics as control variables and Vision 2030 performance goals as dependent variables. These analytical capabilities or task complexity are key antecedents of decision-performance as suggested by Goodhue & Thompson (1995) in the TTF model. In addition, user-characteristics have also been shown to impact on decisions made hence were controlled for in this study. The relationships between the constructs are presented in a conceptual model:-

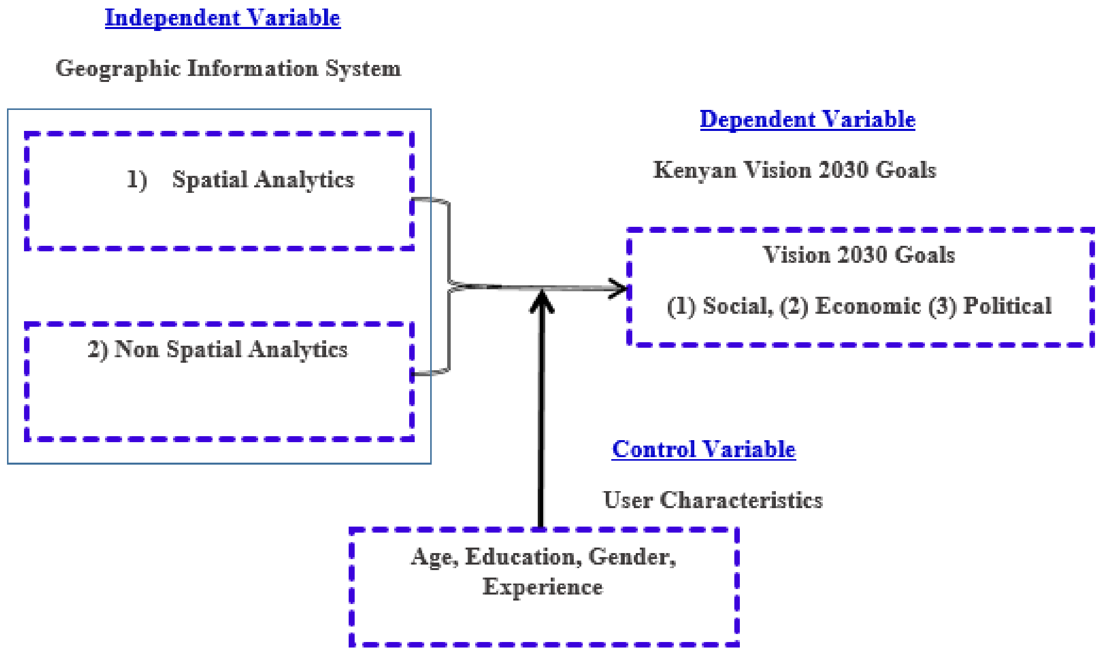


Figure 3: Conceptual Framework

Therefore, spatial and non-spatial analytical capabilities of GIS can be seen as informing the Vision 2030 goals of State Department of Lands. However, this relationship is controlled by the characteristics of the user, which include Education and Experience Levels of the officers at the State Department of Lands in Kenya.

CHAPTER THREE: RESEARCH METHODOLOGY

This chapter presents the research design, the population sampling, as well as the data collection and analyses procedures used to address the research questions in the study.

3.1 Research Design

The research design is a blueprint describing the methods and rules employed in data collection, measurement and analysis (Kirshenblatt-Gimblett, 2006). The study used a cross-sectional research design. At the State Department of Lands, this provided a 'snapshot' of the outcome and associated characteristics of a phenomenon under study, at a specific point in time (Olsen & Diane Marie, 2004).

3.2 Population Sampling

This study employed census as a sampling technique. Thus, data was collected through complete enumeration of the entire population at the State Department of Lands in Ruaraka, Nairobi. This is where the sample size and the population size are equal (Singh & Masuku, 2014). This addresses the accuracy and the reliability of data collected because the census approach eliminates or reduces the error of sampling and provides data about all the units in the population under the study.

To put this particular sampling procedure into context, the target population was 46 officers and the choice of conducting census at Ruaraka was informed by a possibility to generate large amount of data from the staff working at Ruaraka. This is where the GIS section which mainly deals in land databases and support systems is based. The sampling design was thus optimized to ensure accuracy of the survey estimates at both - managerial and operational - levels.

3.3 Data Treatment Procedures

3.3.1 Collection of Data

The questionnaire adopted a Likert scale. In addition, the respondents had a chance to express additional opinions by responding to *'other specify'* on issues that the instrument may not have adequately covered. The questionnaire was divided into four sections (A to D).

In the questionnaire, Section A presented 'General Information' pertaining to the respondent. This enquired on the background and demographics of the respondents. Section B measured the extents to which the Department uses Geographic Information System. While Section C measured the challenges that the Department encounters while using GIS in the implementation of Vision 2030, Section D measured the goals of Vision 2030. Further, for the closed ended questions, a 5-point intensity Likert scale was used with meanings as follows: Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4) and Strongly Agree (5).

3.3.2 Analyses of Data

The quantitative data was captured and analyzed using Predictive Analytics Software (PASW) or Statistical Package for Social Sciences (SPSS) version 17. The following regression model guided the analysis:

Equation 1: Regression Model

$$Y = a_o+b_1x_1+b_2x_2+\ldots+b_mx_m$$

Where x_1, x_2,..., x_m are independent variables (as spatial and non-spatial analytics capabilities of GIS as independent variables and user characteristics of respondents as control variables), Y was the dependent variable representing the Vision 2030 decision outcomes, which could be in the Economic, Social or Political pillar. The parameters b_1, b_2... b_m were the estimated coefficients of regression.

CHAPTER FOUR: DATA ANALYSIS, RESULTS AND DISCUSSIONS

This chapter presents the results of data analyses as underpinned by the theories, research methodology and the methods applied. To start with, the chapter highlights the results of data preparation procedures as well as the descriptive statistics. The chapter is organized in the order of research objectives as presented in Chapter One.

4.1 Data Preparation

In this phase, data was checked for accuracy, missing values were analyzed so that the informational meaning of the data is best represented (Gandomi & Haider, 2015). The data was collected through the administration of the structured questionnaire to forty six (46) officers at Ruaraka Offices, Nairobi.

Prior to data analyses, some diagnostic tests were conducted on data that was collected.

4.1.1 Reliability and Validity

In this research, a reliability test was conducted on the items used to measure the users' perceptions of GIS at the State Department of Lands. The reliability test measured how constructs were used or may be used in replicating the research in a similar manner.

Thus, in the study, the test of internal consistency established that the constructs could, to a large extent, be used to construct a more similar outcome. The reliability results are as presented in Table 1:

Table 1: Cronbach's Alpha Test

Cronbach's Alpha	Cronbach's Alpha based on Standardized Items	No. of Items
0.753	0.754	14

The overall score of Cronbach Alpha (α) for the variables was found to be reliable. Hair *et al* (2010) opine that any construct with a score value exceeding 0.7 presents an adequate and an acceptable reliability level. The need to define better scores for the Cronbach Alpha was not necessary as the scores on each construct showed a good indication of reliability.

4.1.2 Normality Test

Following the administration of the survey questionnaire, normality test was also conducted to ascertain whether the data had a normal distribution characteristic (George & Mallery, 2011).

In the survey data, this was achieved using Quantile-Quantile (Q-Q) Plots on Predictive Analytics Software (PASW) 17, earlier called SPSS, to estimate the distribution parameters. It is observed that all measures were normally distributed on the Q-Q plots. The results are presented in *Appendix D*.

4.1.3 Missing Data Analysis

This was conducted because a significant effect on data analysis may arise due to missing or incomplete data. This may adversely impact on the results and subsequently on the resulting interpretations. A rule of thumb is that an upper threshold should be 10% of missing data in any analysis column. However, a less restrictive rule puts the threshold at 20% (Hair *et al.*, 2010). Table 2 shows the results of missing data analysis.

Table 2: Missing data percentages (N=46)

	N	Mean	Std. Deviation	Missing	
				Count	Percent
Gender	46	1.4348	.50121	0	.0
Age	46	2.4783	1.06956	0	.0
Education	46	3.8696	.93354	0	.0
Cadre	46	1.6522	.48154	0	.0
Experience	46	3.2391	1.46340	0	.0
Matching_ID_Parcel	46	4.4348	.74988	0	.0
Infrastructure_Planning	46	4.1087	.94817	0	.0
Land registration	46	4.3696	.74113	0	.0
Resolution of conflicts	46	4.2609	.77272	0	.0
Verification of Land Rates	46	3.0652	1.21842	0	.0
Calculating of Subsidies	46	1.8043	.95730	0	.0
Expensive hardware	46	4.3043	.69505	0	.0
Expensive Software	46	4.3261	.51873	0	.0
Lack of up to Date Data	46	3.5652	.86029	0	.0
Limited Training	46	2.9565	.78758	0	.0
Government Policy	46	2.5435	.88711	0	.0
Data Unavailability	46	2.9348	.90436	0	.0
Unreliable Internet	46	1.8261	.79734	0	.0
Unrealiable_Power_Supply	46	1.5870	.71728	0	.0
Use of GIS in Location based data	46	1.0217	.14744	0	.0
Major use of GIS	46	1.8261	.70881	0	.0
Any other use	46			0	.0
Any other challenge	46			0	.0

From the foregoing, all variables did not exceed the thresholds. Therefore, there was no justifiable and permissible need to explore a method of treating missing data.

4.2 Descriptive Statistics

4.2.1 Data Overview

The data was collected through a survey using a set of structured questionnaires. In total, 46 respondents participated under the two strata - manager level and operations level staff, all at the State Department of Lands in Ruaraka, Nairobi. An acceptable response rate was achieved since majority of the questionnaires administered were received back. The researcher employed the *'drop-&-pick'* tactic (Ibeh, Brock, & Zhou, 2004). Indeed, higher response rates present a higher statistical power (Baruch & Holtom, 2008).

Using PASW 17 *(or SPSS),* demographics was analyzed along age, level of management, education level, experience level and gender.

Table 3: Age and Gender

		Gender		Total
		Male	Female	
Age	21-30	7	3	10
	31-40	6	8	14
	41-50	5	7	12
	51-60	8	2	10
Total		26	20	46

Out of the 46 respondents, 56 per cent were male. In addition, majority were in the age bracket of 31 and 50, with equal percentages in the age bracket of 21-30 and 51-60.

Table 4: Age and Level of Management

		Level		Total
		Managerial	Operations	
Age	21-30	0	10	10
	31-40	7	7	14
	41-50	3	9	12
	51-60	6	4	10
Total		16	30	46

Out of the 46 respondents, 65 per cent were at operations level. In addition, majority of operation level staff were in the age bracket of 21 and 30. Further majority of the managers were in the age bracket above 31 years.

Table 5: Age and Education Level

		Education					Total
		Secondary	Diploma	Bachelor	Master	PhD	
Age	21-30	1	5	4	0	0	10
	31-40	0	4	5	5	0	14
	41-50	0	7	3	1	1	12
	51-60	0	2	3	4	1	10
Total		1	18	15	10	2	46

Out of the 46 respondents, 39 per cent had a Diploma, 32 per cent had a Bachelor degree and 21 per cent had a Master degree while 4 per cent had a PhD. Majority of the staff interviewed had at least a Diploma level of education.

Table 6: Age and Experience Level

		Experience						Total
		Under 5	6-10	11-15	16-20	21-25	Over 25	
Age	21-30	4	6	0	0	0	0	10
	31-40	0	8	4	1	1	0	14
	41-50	0	0	3	9	0	0	12
	51-60	0	0	1	2	2	5	10
Total		4	14	8	12	3	5	46

Out of the 46 respondents, majority had work experience in GIS and land database related matters in the range of 6 to 20 years. Majority of these were in the age bracket of 31-50.

4.3 Extent of Usage of GIS

Following the descriptive analysis, extents of usage of GIS was established to generalize the resulting information to the population of interest. To be noted is that the research question (I) was formulated in confirmatory manner and was addressed using survey data. The study adopted six indicator dimensions. These include: *"matching owners' ID with land parcel," "infrastructure planning," "land registration," "resolution of land conflicts," "verification of land valuation rates,"* and *"calculation of rate subsidies"*.

Table 7: Extent of Use of GIS

	N	Minimum	Maximum	Mean
Calculating Subsidies	46	1.00	5.00	1.8043
Verification of Land Rates	46	1.00	5.00	3.0652
Infrastructure Planning	46	2.00	5.00	4.1087
Resolution of Conflicts	46	2.00	5.00	4.2609
Land registration	46	2.00	5.00	4.3696
Matching of ID with Parcel	46	3.00	5.00	4.4348
Valid N	46			

It is evident that most users majorly use GIS for *'matching owner's IDs to the parcel'* compared to *'calculating land rates subsidies'*. Indeed, GIS is evident as capable and preferable in land registration, resolution of conflicts, infrastructure planning and verification of land rates in that order. Indeed, this supports the extant literature that land information system (LIS) is the specialized type of Information System (IS). It captures, processes, stores, analyzes, disseminates and shares land information (Kuria, Ngigi, Gikwa, Mundia, & Macharia, 2016). Indeed, the International Federation of Surveyors (FIG) defined a GIS based specialized information system as a decision support tool for administrative, legal, political and economic purposes. It aids in the planning and development (Balogun, Okeke, & Chukwukere, 2014). In fact, a cadaster or land parcel is the primary component of the land information system (GoK, 2016). Therefore the systems aids in quick, reliable and easy land transaction. It supports in urban and infrastructure planning, land reform and reduce land disputes (Mulaku, 2014).

It is therefore evident that broadly, the advantages of GIS based land information systems can be discussed in terms of cost efficiency, competitive advantage and effectiveness. These reduce the labor costs, saves space for storing the analog records, as the digital or automatic processes of control aid in data sharing. This happens at a better quality services level at the optimal cost. Thus, to be able to empirically confirm the extents of specific uses of GIS in the management of location based data, results are presented in Table 8:

Table 8: GIS in Managing Location Based Data

	Frequency	Per cent	Valid Per cent	Cumulative Per cent
Yes	45	97.8	97.8	97.8
No	1	2.2	2.2	100.0
Total	46	100.0	100.0	

Indeed, majority (97.8 per cent) of the respondents use GIS in managing location based data. This is referred to as Spatial Analysis in the conceptual model hypothesised in Chapter Two. Thus, it can be argued that spatial analytics capability is a critical function for service delivery in the State Department of Lands in Kenya.

4.4 Challenges of Usage of GIS as a Decision Support System

The second objective of the research set out to determine the challenges that results following investment in GIS. This is summarised in Table 9 in terms of the weight of each challenge as evident from the respondents:

Table 9: Challenges of Use of GIS

Challenges of use of GIS	N	Mean
Expensive hardware	46	4.3043
Expensive software	46	4.3261
Lack of up to date data	46	3.5652
Limited training	46	2.9565
Government Policy	46	2.5435
Data Unavailability	46	2.9348
Unreliable Internet	46	1.8261
Unreliable power supply	46	1.5870
Valid N (listwise)	46	

It is evident from the analysis that the most serious challenge is the cost of the hardware and software of GIS. Indeed, this could impede data collection and GIS database construction. Due to the challenge of data integration with exiting systems of the department, the cost could even be much higher. Further, every regional office in Kenya may need to have a database server which would further exert much more pressure on the operation and maintenance costs of GIS.

In all, these support the extant literature. Hardware and software cost is prohibitive for emerging economies to afford (Balogun, Okeke, & Chukwukere, 2014). Kenya is one such example of emerging economies.

4.5 GIS and Vision 2030

To confirm the hypothesized model of GIS in management science at the State Department of Lands in the background of the goals of Vision 2030, a regression analyses was conducted. This estimated the relationship between the dependent variable (Vision 2030 goals) and predictor variables (GIS analytical capabilities) as moderated by the user characteristics as control variables.

4.5.1 Vision 2030 Goals in State Department of Lands

Considering the pillars of Vision 2030, GIS seems to address cost efficiency (Economic Pillar) more than the Dispute Resolution (Social Pillar) and Legal Framework (Political Pillar) of Vision 2030 at the State Department of Lands. The results are presented in Table 10:

Table 10: GIS and Vision 2030

	Frequency	Per cent
Land Administration Towards Dispute Resolution	16	34.8
Computerisation of Registries Towards Cost Efficiencies	22	47.8
Enhanced Legal Framework	8	17.4
Total	46	100.0

From the results, it's evident that using Geographic Information Systems (GIS) as a Decision Support System (DSS) at the State Department of Lands contributes approximately 47.8 per cent towards the Economic Pillar, 34.8 per cent towards the Social Pillar and approximately 17.4 per cent towards the Legal Pillar of Vision 2030.

Indeed, while there is minimal revenue, aside from the retained fees, there are many benefits of use of GIS due to increased efficiency. First, the officers of the State Department of Lands have the accurate and current or updated information available. These enable the tasks to be performed faster in terms of data sharing and processing of organizational information, both spatial and tabular.

Further, the tedious search for information in different departments and locations can be avoided. The automatic transfer of data to the GIS allows for easy updating of data available to the public which provides transparency and cost efficiency (Akomolafe & Afeni, 2014). Though dispute resolution (Social Pillar) and legal framework (Political Pillar) in land management is enhanced, the cost efficiencies (Economic Pillar) that result due to the use of GIS is more pronounced at the State Department of Lands.

4.5.2 Regression Analyses

In this research, regression modeling offered a suitable approach to put the hypothesized model to test. The model was expressed using a set of variables, with the relationships amongst them hypothesized. Thus, a fitness test against the sampled data was conducted to answer research question III based on the level of significance of 0.05. For this work, this model is built on the basis of the conceptualized framework in Chapter Two.

Table 11: The Model of GIS Use and Vision 2030

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.630[a]	.688	.461	.52057

a. Predictors: Use of GIS in Managing Location based Data, Gender, Cadre, Age, Education, Experience; F statistic = 3.935; P value = 0.004

Thus, incorporating the coefficients of the predictor variables, the regression model is presented in Table 12:

Table 12: The Model of GIS Use and Vision 2030

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.460	1.456		1.689	.103
	Gender	.129	.169	.091	.765	.451
	Age	-.025	.174	-.037	-.143	.888
	Education	-.091	.146	-.120	-.622	.539
	Cadre	-.442	.293	-.300	-1.511	.143
	Experience	.135	.121	.280	1.122	.272
	Matching_ID_Parcel	.214	.172	.227	1.248	.223
	Infrastructure_Planning	.126	.116	.169	1.092	.285
	Land_registration	-.223	.173	-.233	-1.288	.209
	Resolution_Conflicts	-.358	.155	-.391	-2.318	.029
	Verification_Land_Rates	.153	.106	.263	1.449	.159
	Calculating_Subsidies	.226	.122	.305	1.856	.075
	Expensive_hardware	-.004	.184	-.004	-.023	.982
	Expensive_Software	-.030	.222	-.022	-.136	.893
	Lack_Date	-.255	.130	-.309	-1.963	.060
	Limited Training	-.056	.153	-.062	-.367	.717
	Government Policy	.091	.117	.114	.775	.445
	Data Unavailability	.298	.131	.381	2.277	.031
	Unreliable Internet	.085	.128	.096	.669	.510
	Unrealiable_Power_Supply	.000	.142	.000	-.004	.997

a. Dependent Variable: Vision 2030 consolidated goals

The overall sample model was found to fit the data with Goodness of Fit (GoF) indices as P<0.05 (0.004) with F statistic of 3.023. The ANOVA results are presented in Table 13:

Table 13: Analysis of Variance

ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	15.563	19	.819	3.023	.005[a]
	Residual	7.046	26	.271		
	Total	22.609	45			

The results support the existing literature. With a significance level at 0.005, the null hypothesis ‘that the model has no predictive value was rejected. Overall, the regression model presents a statistically significantly prediction of the outcome (i.e., it is a good fit for the data).

Indeed, information systems aid the users conduct their information management tasks in a more effective and efficient manner. Ministries spend millions of shillings invested in information systems infrastructure to develop organizational or individual competencies. Thus, a more critical concern in information systems research has been to understand in a better way the linkage between the systems infrastructure and the user performance. Task-technology fit model, Location Strategy Three Stage model and Porter's Value Chain model appeared adequate to model the impact of GIS as a specialized form of information systems and user characteristics on Vision 2030 goals. More specifically, it is the match among the requirements of the task, the user abilities, and the functionalities and potential of the technology (Goodhue & Thompson, 1995).

Further, given the Vision 2030 has three strategic pillars (Economic, Social and Political); the influence of the predictor variables was also tested on each of the pillars. In the State Department of Lands in Kenya, the specific goal of Vision 2030 under the economic, social and political pillar is to ensure computerization of registries to drive cost efficiencies, solve land disputes and enhance legal framework as envisaged in the Constitution. GIS as a decision support system was tested to determine these influences and the results are as presented in the Table below:-

Table 14: Effects of Predictors on the Pillars of Vision 2030

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.625	1.318		1.233	.227
	Matching_ID_Parcel	.208	.168	.220	1.239	.225
	Infrastructure_Planning	.225	.097	.301	2.312	.028
	Land_registration	-.253	.173	-.265	-1.466	.153
	Resolution_Conflicts	-.334	.152	-.364	-2.197	.036
	Verification_Land_Rates	.191	.100	.328	1.905	.066
	Calculating_Subsidies	.264	.122	.356	2.169	.038
	Expensive_hardware	.127	.181	.124	.700	.489
	Expensive_Software	-.160	.202	-.117	-.791	.435
	Lack_Date	-.301	.132	-.366	-2.282	.029
	Limited Training	-.060	.146	-.067	-.414	.682
	Government Policy	.145	.118	.181	1.225	.230
	Data Unavailability	.319	.134	.407	2.373	.024
	Unreliable Internet	-.062	.121	-.070	-.511	.613
	Unrealiable_Power_Supply	.018	.138	.018	.127	.900

a. Dependent Variable: Vision 2030

Notice that at a significance level of $< .05$, *'data unavailability', 'lack of up to date data', 'calculation of subsidies' 'resolution of conflicts'* and *'infrastructure planning'* are the significant predictors influencing the Pillars of Vision 2030. Further, controlling for the user characteristics, the results are as presented in Table 15:

Table 15: Controlled Predictors of GIS on Vision 2030 Pillars

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.460	1.456		1.689	.103
	Matching_ID_Parcel	.214	.172	.227	1.248	.223
	Infrastructure_Planning	.126	.116	.169	1.092	.285
	Land_registration	-.223	.173	-.233	-1.288	.209
	Resolution_Conflicts	-.358	.155	-.391	-2.318	.029
	Verification_Land_Rates	.153	.106	.263	1.449	.159
	Calculating_Subsidies	.226	.122	.305	1.856	.075
	Expensive_hardware	-.004	.184	-.004	-.023	.982
	Expensive_Software	-.030	.222	-.022	-.136	.893
	Lack_Date	-.255	.130	-.309	-1.963	.060
	Limited Training	-.056	.153	-.062	-.367	.717
	Government Policy	.091	.117	.114	.775	.445
	Data Unavailability	.298	.131	.381	2.277	.031
	Unreliable Internet	.085	.128	.096	.669	.510
	Unrealiable_Power_Supply	.000	.142	.000	-.004	.997
	Gender	.129	.169	.091	.765	.451
	Age	-.025	.174	-.037	-.143	.888
	Education	-.091	.146	-.120	-.622	.539
	Cadre	-.442	.293	-.300	-1.511	.143
	Experience	.135	.121	.280	1.122	.272

Even with the user characteristics controlled for, the use of GIS as a decision support tool in achieving the pillar goals of Vision 2030 is still significant influenced by the same predictors. Over all, the model still has a predictive value as evident in ANOVA results in Table 16:

Table 16: Analysis of Variance

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	15.563	19	.819	3.023	.005[a]
	Residual	7.046	26	.271		
	Total	22.609	45			

Therefore, it can be concluded that , *'data unavailability', 'lack of up to date data', 'calculation of subsidies' 'resolution of conflicts'* and *'infrastructure planning'* are the significant predictors influencing the achievement of each of the pillars of Vision 2030 using geographic information system (GIS) as a decision support system (DSS) in the State Department of Lands in Kenya.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

The previous chapter has presented data analysis, discussions and the results. This chapter introduces the summary, conclusions and recommendations by revisiting the problem of the research.

5.1 Summary of the Research

Although a range of extant literature presents management value of GIS, much of this has focused largely on developed economies. Further, the focus has been less extensive in public sector as compared to the private sector (Basamh, Qudaih, & Suhaimi, 2014). With this in consideration, the study set out to mainly identify the uses, challenges and influence of GIS on the achievement of Vision 2030 in the State Department of Lands in Kenya with a specific focus on Ruaraka, Nairobi where the GIS section is based. This was achieved through the use of survey approach, informed by theories drawn upon information systems and marketing disciplines. The study attempted to examine how various levels of management at the State Department perceive and identify with the management value of GIS. Analyses were conducted using 46 respondents.

Indeed, the research results demonstrated the existence of management value of GIS. It further confirmed the hypothesized conceptual framework and tested on the collected data to obtain a validated and well-fitted value model. Indeed, this supports extant literature that through investment in GIS by State Department of Lands, governments not only try to drive cost efficiency but also support pertinent management decisions.

Further, *'data unavailability', 'lack of up to date data', 'calculation of subsidies' 'resolution of conflicts'* and *'infrastructure planning'* appeared in the model as the significant predictors influencing the achievement of each of the pillars of Vision 2030 using geographic information system (GIS) as a decision support system (DSS).

5.2 Conclusions of the Research

The study attempted to bridge some theoretical and practical gaps that had been identified in the review of literature. Thus, theoretical and practical implications are briefly discussed.

5.2.1 Theoretical

This research contributes to GIS value theory in management science theory by linking the concept of location based data or systems with investment in specialized types of information systems as GIS. This is due to the need of a specialized decision support system to drive Vision 2030 agenda in Kenya. The theoretical model expands the scope of studies on value researches on information systems and more especially in the management of 'location based' data in strategic decision making.

5.2.2 Practical

This research provides a frame of reference that may be useful to public sector decision makers concerning investments in information systems infrastructure. One strategic finding that may have an important implication in practice is that level of management or cadre of the officer using GIS is associated with increased value of GIS use. In addition, governments need to re-consider their needs to leverage upon information systems infrastructure as a tool to drive efficiency, even more during the times of fiscal crises.

Further, to achieve the envisaged goals of Vision 2030, a special focus need to be directed on *'data unavailability', 'lack of up to date data', 'calculation of subsidies'* *‘resolution of conflicts’* and *‘infrastructure planning’*. This is because they appear as significant predictors influencing the achievement of each of the pillars of Vision 2030 while using geographic information system (GIS) as a specialized type of decision support system (DSS).

5.3 Recommendations and Limitations of the Research

In any given scholarship effort such as this, there may be underlying limitations (Creswell, 2013). These form a critical component in evaluating the viability of the research results.

Firstly, the primary data collected from the civil servants was cross-sectional. However, the effects of the modern technologies undergo a constant change over time. This means that the findings as a result of survey data may change over time, and so a need exists for a review. This can probably be conducted using time series data or modeling using structural equations to take care of the limitations. Secondly, though the research is placed within the State Department of Lands in Kenya, the choice of Ruaraka GIS unit might have not been representative of the entire State Department of Lands. In this research, attempts were made to capture the general role of the sector and the mother Ministry as appears to reach consensus among proponents of Vision 2030. In future, a research can be conducted that covers the entire ministry or ministries in Kenya.

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APPENDICES

Appendix A: Letter of Introduction

UNIVERSITY OF NAIROBI
SCHOOL OF BUSINESS

Telephone: 020-2059162
Telegrams: "Varsity", Nairobi
Telex: 22095 Varsity

P.O. Box 30197
Nairobi, Kenya

DATE 6/10/2016

TO WHOM IT MAY CONCERN

The bearer of this letter KENNEDY OKONG'O

Registration No. D61/65650/2013

is a bona fide continuing student in the Master of Business Administration (MBA) degree program in this University.

He/she is required to submit as part of his/her coursework assessment a research project report on a management problem. We would like the students to do their projects on real problems affecting firms in Kenya. We would, therefore, appreciate your assistance to enable him/her collect data in your organization.

The results of the report will be used solely for academic purposes and a copy of the same will be availed to the interviewed organizations on request.

Thank you.

UNIVERSITY OF NAIROBI
SCHOOL OF BUSINESS
06 OCT 2016
P.O. Box 30197 – 00100, NAIROBI

PATRICK NYABUTO
SENIOR ADMINISTRATIVE ASSISTANT
SCHOOL OF BUSINESS

Appendix B: Letter to Participants

Dear **Sir, Madam,**

This is an invitation to participate in the MBA research project titled **Geographical Information System and the Implementation of Kenyan Vision 2030: State Department of Lands.** This research has been approved by University of Nairobi's Business School and aim of the research is to present a management value of GIS as a decision support system at the State Department of Lands in Kenya.

Your participation is voluntary and the data collected is considered confidential. The data will be used purely for academic study and no individual names will be published.

Thank you for your time and participation.

Yours sincerely,

KENNEDY OKONG'O

University of Nairobi, School of Business

Appendix C: Questionnaire

Section A: GENERAL INFORMATION

Gender: Male ☐ Female ☐

Age: 21-30 ☐ 31-40 ☐41-50 ☐51-60 ☐

Level of Education: Primary ☐ Secondary ☐ Diploma ☐ Bachelor ☐

Masters ☐ PhD ☐

Others...

Managerial Level ☐ or Operations Level ☐

Experience in Years: Under 5 ☐ 6-10 ☐11-15 ☐ 16-20 ☐ 21-25 ☐

Over 25 ☐

SECTION B: Indicate the Extents of usage of GIS

TICK (√) as appropriate the answers using the scale given below: Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4), Strongly Agree (5)

No	Extent of use of GIS	1	2	3	4	5
1	Matching of owners' ID with land parcel					
2	Infrastructure planning					
3	Land registration					
4	Resolution of land conflicts and disputes					
5	Verification of land valuation rates					
6	Calculating subsidies					
7	Any other use?					

SECTION C: Indicate the Challenges of usage of GIS

TICK (√) as appropriate the answers using the scale given below: Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4), Strongly Agree (5)

	Challenges of Usage of GIS	1	2	3	4	5
8	Expensive hardware					
9	Expensive software					
10	Lack of up-to-date data					
11	Limited training					
12	Government policy e.g. Intellectual property Issues					
13	Data unavailability					
14	Unreliable internet connectivity					
15	Unreliable power supply					
16	Any other challenge?					

TICK (√) one as appropriate:

SECTION D: Indicate Spatial and non-Spatial Usage of GIS

17. Do you use GIS to manage location based data?

YES ☐ NO ☐

SECTION E: Indicate GIS usage in Vision 2030

18. Of the following Vision 2030 goals (Social, Economic and Political Pillar), which one does GIS help in most?

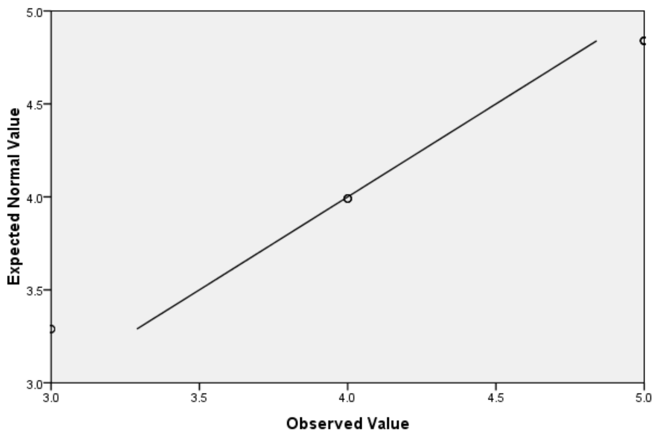
a) General land administration towards solving disputes { }

b) Computerization of land registries towards cost efficiency { }

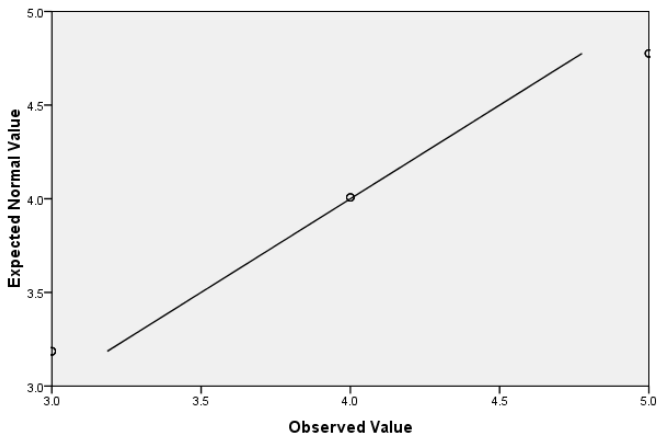
c) Enhance legal framework { }

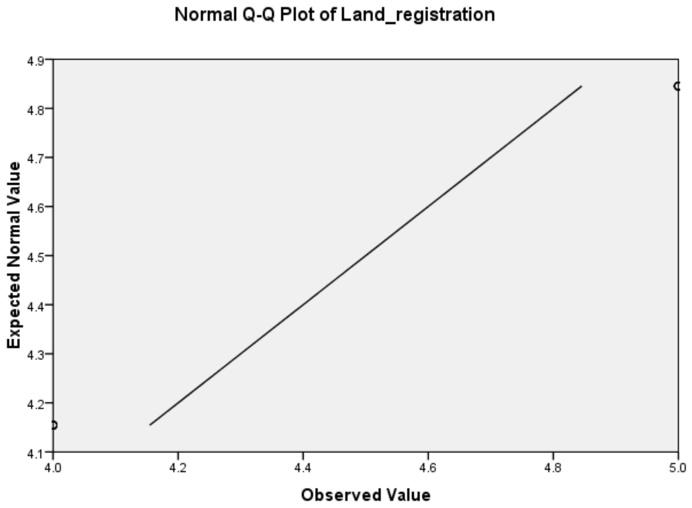
Appendix D: Normal Distribution

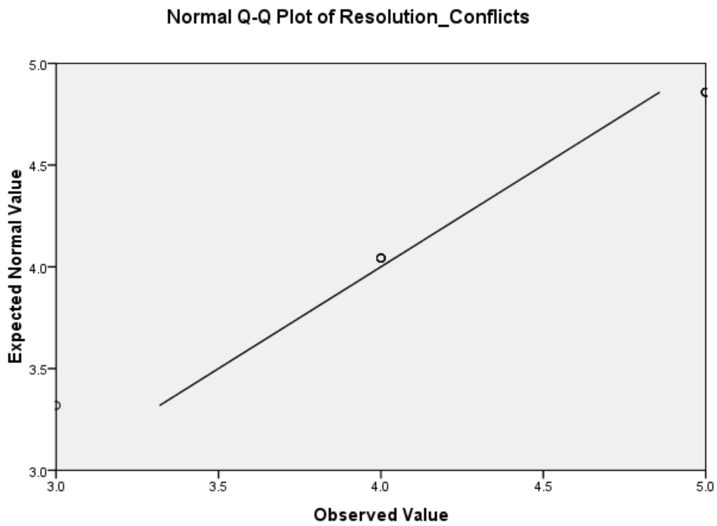
Normal Q-Q Plot of Matching_ID_Parcel

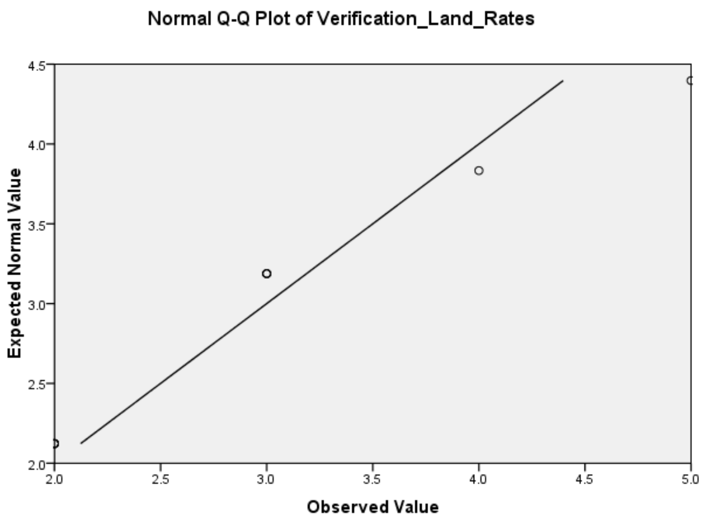


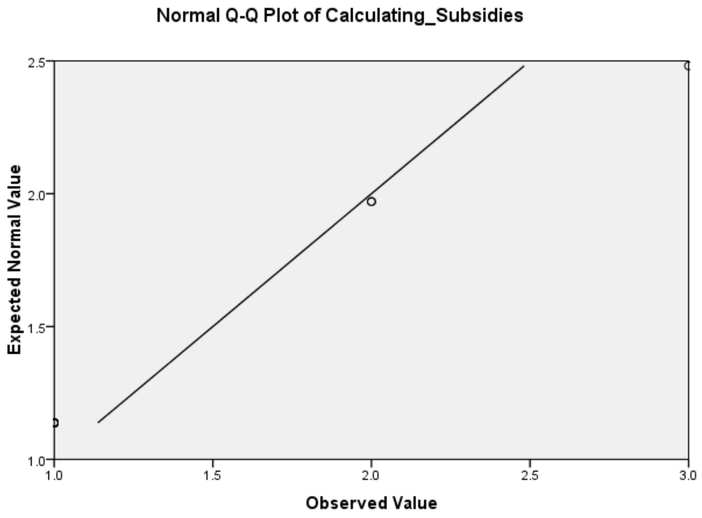
Normal Q-Q Plot of Infrastructure_Planning

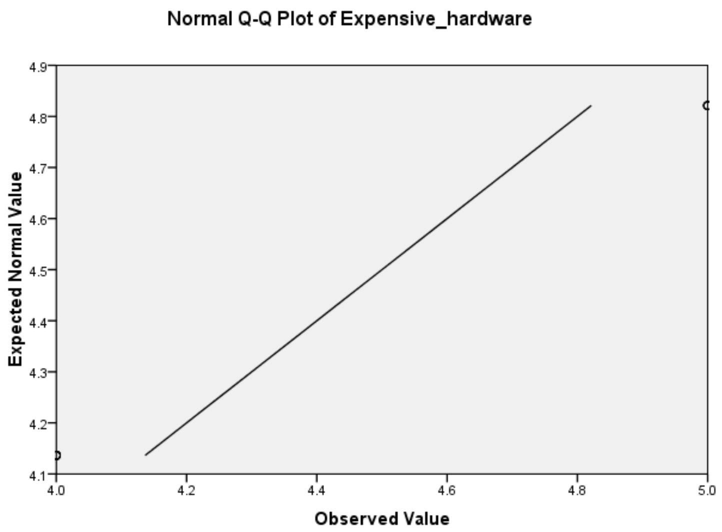


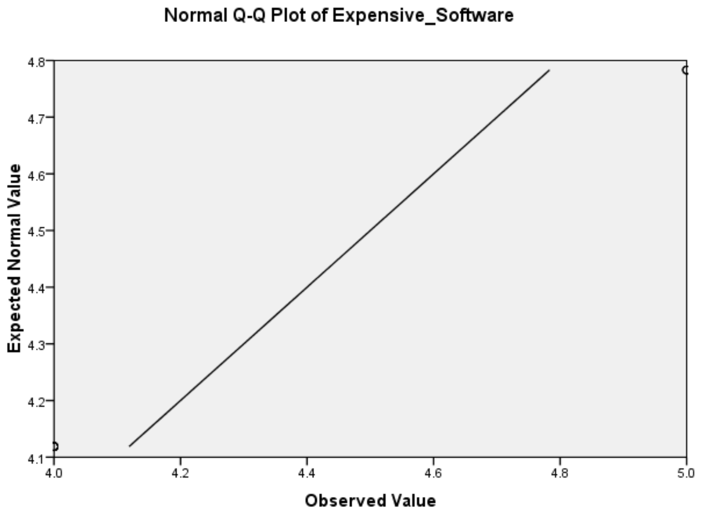

Normal Q-Q Plot of Land_registration
Expected Normal Value
Observed Value
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4.0
4.2
4.4
4.6
4.8
5.0

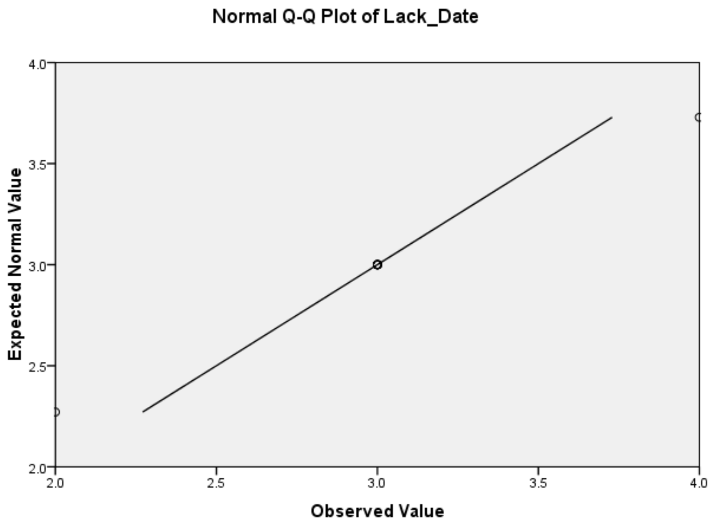

Normal Q-Q Plot of Resolution_Conflicts
Expected Normal Value
Observed Value
5.0
4.5
4.0
3.5
3.0
3.0
3.5
4.0
4.5
5.0

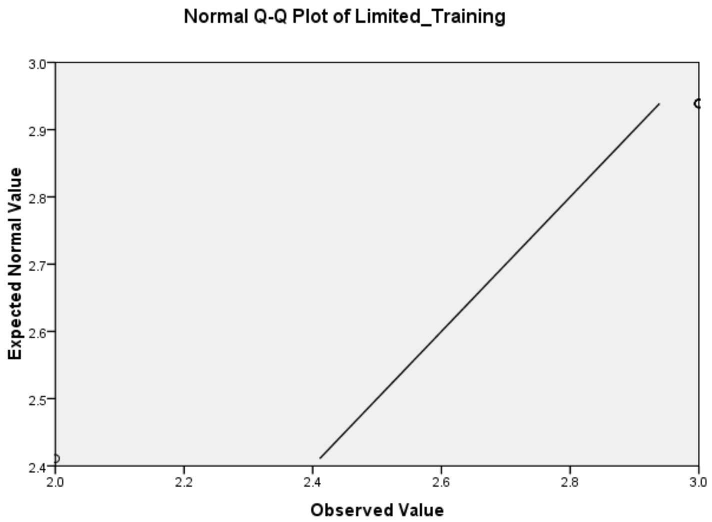

Normal Q-Q Plot of Verification_Land_Rates
Expected Normal Value
Observed Value
4.5
4.0
3.5
3.0
2.5
2.0
2.0
2.5
3.0
3.5
4.0
4.5
5.0

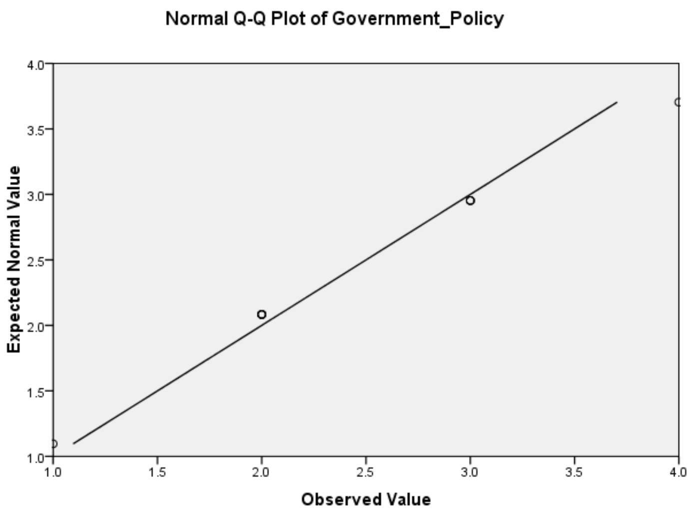

Normal Q-Q Plot of Calculating_Subsidies
Expected Normal Value
Observed Value
2.5
2.0
1.5
1.0
1.0
1.5
2.0
2.5
3.0

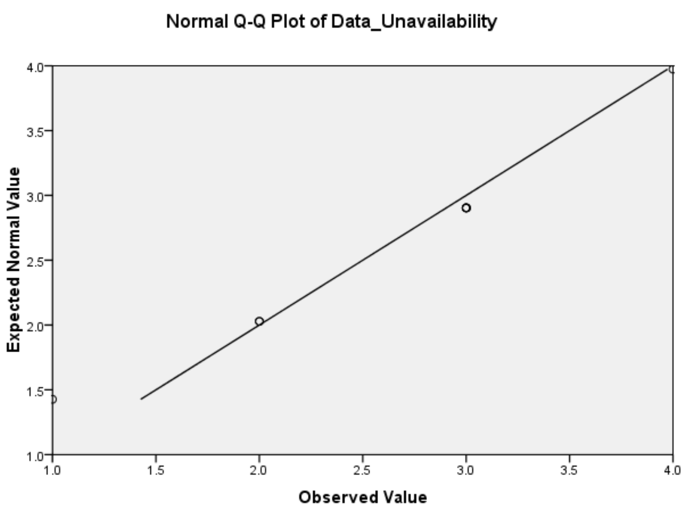

Normal Q-Q Plot of Expensive_hardware
Expected Normal Value
Observed Value
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4.0
4.2
4.4
4.6
4.8
5.0


Normal Q-Q Plot of Expensive_Software
Expected Normal Value
Observed Value
4.1
4.2
4.3
4.4
4.5
4.6
4.7
4.8
4.0
4.2
4.4
4.6
4.8
5.0


Normal Q-Q Plot of Lack_Date
Expected Normal Value
Observed Value
2.0
2.5
3.0
3.5
4.0
2.0
2.5
3.0
3.5
4.0


Normal Q-Q Plot of Limited_Training
Expected Normal Value
Observed Value
3.0
2.9
2.8
2.7
2.6
2.5
2.4
2.0
2.2
2.4
2.6
2.8
3.0


Normal Q-Q Plot of Government_Policy
Expected Normal Value
Observed Value
4.0
3.5
3.0
2.5
2.0
1.5
1.0
1.0
1.5
2.0
2.5
3.0
3.5
4.0


Normal Q-Q Plot of Data_Unavailability
Expected Normal Value
Observed Value
4.0
3.5
3.0
2.5
2.0
1.5
1.0
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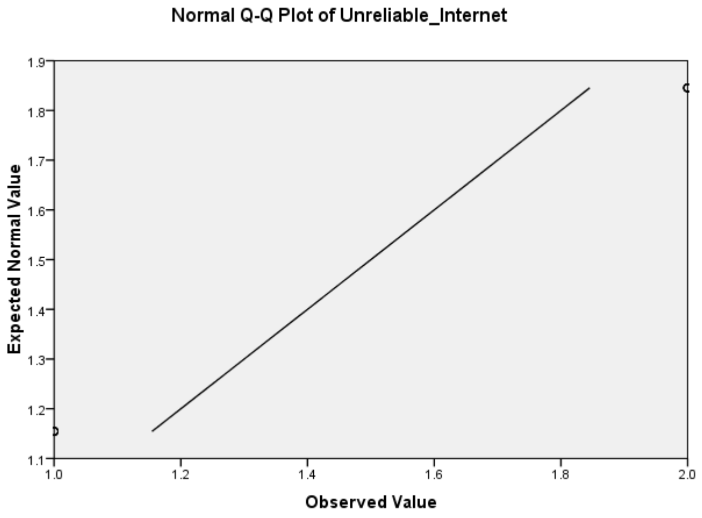
2.0
2.5
3.0
3.5
4.0



Normal Q-Q Plot of Unreliable_Internet
Expected Normal Value
Observed Value
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
1.2
1.4
1.6
1.8
2.0