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Abstract

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Keywords: Geographic Information Systems (GIS), implementation, Namibia, organisation, innovation, Actor Network Theory (ANT)

This thesis presents an in-depth empirically informed investigation of the implementation process of Geographical Information Systems (GIS) in Namibia. The aim of the thesis is to contribute to a deeper understanding of the process of GIS implementation in developing countries. I argue that this aim could be realised from a social construction of technology perspective. In so doing, I adopted an interpretive stance, informed by innovation translation of actor-network theory (ANT) as a framework for understanding the complexities of interplays between social and technological entities. Empirical materials were gathered through exploratory survey questionnaires and descriptive case studies. In addition, participation at conferences with themes related to GIS implementation in developing countries and more particularly in Africa provided a wider understanding of perceptions of GIS users in Africa, regarding the implementation aspects of GIS technology on the continent. A literature survey and the author's accumulated experience provided a valuable contribution to the research and guided the empirical research undertaking.

The exploratory survey questionnaires was undertaken to investigate the perception of the Namibian GIS community regarding the implementation aspects and effectiveness of GIS technology in their respective organisations. The survey questionnaires were circulated to a total of 183 people, 73% of which have responded. The survey findings offered insight into the general characteristic of the human actors in the implementation process of GIS, the perceptions of the systems end users regarding the impacts of GIS, and the main challenges hampering the effective use of GIS technology. The need to study a complex topic within its organisational context led me to adopt a case study methodology. The purpose of the case studies was to pursue more fully issues raised in the survey questionnaire by discussion them at length with key persons, and to observe firsthand GIS implementaion. Using ANT framework, the case studies addressed the aim of the thesis by tracing the actors, associations, formation of alliances and delineating actor-networks involved in the implementation process of GIS, in three different organisational settings. ANT helped unpack the complexity inherent in the implementation process of GIS technology.

The adoption and implementation of GIS involves the interplay of social and technological entities, as they negotiate, accept and reject translations, as well as they influence and impact one another. I argue that GIS implementation is an ongoing organisational process, in which the social and the technological entities cannot be easily divorced from each other, and requires them to be considered in relation to each other.

Table of Contents

List of Tables and Figures

Tables

Figures

Boxes

Chapter 1: Introduction

1.1. Description of Research Problem and Motivations

Like everything in human affairs, the current study is a product of a particular history - of a particular someone in a particular context of time, place and ideas. The history and the compilation of this study are closely linked to the development of the author's preceding professional career. Specifically, the study emerges from own exposure to the constraints and problems embedded in the implementation process of Geographic Information Systems (GIS). My first exposure to GIS was in November of 1998 at the Desert Research Foundation of Namibia (DRFN)[1], where I participated on a Summer Desertification Programme (SDP)[2]. The aim of the 1998 SDP was to evaluate the potential value of land and water resources in northeast Namibia. The study had a GIS element planned onto it, run by a "YES man" (Young Expert Swede), who introduced us (SDP group) to the thrills and wonders that GIS can do. Instantly, I feel head over heel in love with the magic ideas of GIS. In the following year I got a part-time job with a GIS-consulting company InterConsult Namibia[3] where I developed a full passion for GIS. During my period at InterConsult, the company was very much in a transitional phase, from an analogy centred approach to a digital approach. Hence my work involved a lot of digitising and data processing; it was a labour-intensive process. While receiving on-job technical training, I also read books and magazines about GIS to learn more about the software I was using and the field of information systems generally. Towards the end of the same year, I got full-time employment with DRFN working on a National Programme to Combat Desertification (Napcod). My time at Napcod was spent mostly in company of computers, working on GIS aspects of the programme, among other activities.

Soon, I changed my career direction from natural science to information systems, sparked largely by a fascination with computing and graphics. From the outset, GIS was more than a business for me. It was an academic venture, a professional challenge, and a technological edge. I attended various short trainings in the field of information systems and spatial data management. In 2000, I enrolled for an MSc programme in Geographical Information for Development at the University of Durham, UK, where I was technically well equipped and introduced to the hot debates in the field. However, it remains hard to pronounce if I was equipped to work in the conditions back home or to work in a UK standard condition. I returned to Namibia after completing the MSc programme, where I immediately joined the Ministry of Environment and Tourism (MET) working on spatial information management as well as regularly getting involved with numerous GIS-projects. Within the scope of these activities, I compiled numerous smaller studies (most of which were related to short-term missions of various projects), and organised various GIS workshops and short courses. Within the SADC region (Southern Africa Development Community)[4], I have been involved in the planning of GIS-projects, and organising of various regional GIS workshops for regional studies. At a continental level, I have been actively involved in AfricaGIS activities such as contributing to the "SDI handbook for Africa", and periodically

[1] DRFN is an independent, non-governmental organization dedicated to sustainable use of Namibia's environment.

[2] SDP was a training programme for university and polytechnic students arranged by the DRFN and funded by the Swedish International Development Agency (SIDA).

[3] InterConsult Namibia is a local company providing consultancy services within groundwater development and information systems.

[4] SADC member countries are: Angola, Botswana, the DRC, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe

making contributions to SDI-Africa and EIS-Africa discussion forums and monthly newsletters. My realisation with many of these GIS activities is that most of what is being done is worse than worthless. From the planning to the actual implementation phase, resources are used for emergencies that should never have happened in the first place, and little goes to implementaion that could sustain. Some projects never even accomplish the purposes, which they were intended for. It is agreeable that GIS is interesting and the potential uses are enormous, but the challenges are enormous too.

With time, I have come to realise that what I thought was going to be fun, the fascinating GIS was becoming problematic in many ways. I realised that the dream is that GIS can do anything, the reality is that it isn't that easy. There are many problems to solve; most of these problems are not technical, but organisational; i.e. resistance to change, lack of political support, and insufficient funding. Although it seemed easy to implement computer information systems, I realised that we lack the full understanding of their nature and their potential. In addition, there tend to be confusion about how processes like decision-making might be improved by a computer technology like GIS. When information systems do fail, often than not, our immediate, almost instinctive reaction is to look for technical explanations. We ask what went wrong with the software, is the network infrastructure or protocols inadequate. It shows how we regard information systems as technical projects, thus looking for technical reasons for failure. We appear to create one technical innovation after another as we move farther away from questions regarding implementation aspects and implications of these innovations.

A reflection to my previous experience with GIS projects drastically changed my approach to information systems, particularly to GIS. Instead of appreciating them from a technological point of view, I changed my view to a more open perspective. I have come to realise that the scope of information systems adoption and implementation must be enlarged to incorporate organisational environment and structures. Many researchers have also realised this important point in their studies, unfortunately, from a practical point of view, this is typically done using a naïve perception of organisational structures and processes. In this study, I am prompted to question the implementation process of GIS in Namibia, and in developing countries generally.

The current research investigates the process of GIS implementation in Namibia, while putting the research in the context of a developing country. The term implementation is understood as the process through which communities of users within an organisational setting become aware of, adopt, and use GIS (Obermeyer and Pinto 1994, Ramasubramanian 1999a). In this study, the process of GIS implementation is concerned with why, how and by whom GIS is implemented. The goal of the research is to contribute to a better understanding of GIS implementation. The research does not intend to give a comprehensive description of the technical GIS building elements and databases, nor does it seek to advice how to organise and improve these technological aspects of GIS implementation. Instead, it focuses on three stages of GIS implementation process: initiation, execution and stabilisation, by examining in detail the actions and perceptions of GIS users and the organisational context within which these actions take place. It explores a range of factors – social, political, economic, cultural, and technological which pattern the process of GIS implementation. The study is influenced by the literature on the social construction of technology, which assumes that technologies are not independent of the environments in which they are located, but rather only gain meaning from their context (Bijker 1987, Latour 1987, Campbell and Masser 1995, Obermeyer and Pinto 1994). Studies of social construction of technology emerged through a critique of "technology determinism"[5]. Proponents

[5] See chapter two

of this perspective argue that each stage in the generation and implementation of new technologies involves a set of choices between different technical options. Alongside narrowly technical considerations, a range of social factors affect which options are selected – thus influencing the content of technologies and their social implications (Williams and Edge 1996). Analytically, the study draws on Actor Network Theory (ANT).

1.2. Research Objectives and Questions

The general objective for the current research is to study the implementation process of GIS technology in Namibia, in a context of a developing country. Under this umbrella, three specific objectives are drawn:

1) Studying the historical development, present situation and challenges associated with GIS implementation in developing countries, particularly in Africa.
2) Examining in detail the actions and perceptions of Namibian GIS users and the organisational context within which these actions take place.
3) Studying the motivation and implementation processes of GIS in Namibia.

The general research problem breaks into a set of five specific questions that will structure the investigation of the above stated objectives.

1) Through which processes is GIS implementation in developing countries, particularly Africa constructed?
2) What are the driving forces for GIS implementation in Namibia?
3) How is GIS technology transferred to the receiving organisations?
4) What are the strategies that organisations adopt in the implementation process of GIS?
5) Who are the actors and what are their roles in the deployment of these strategies?

1.3. The term Implementation

Although the term "implementation" of GIS is used extensively in the literature, it holds different meanings for individuals. This thesis can be better understood if there is a shared understanding about the use of the term. As a working definition, implementation of GIS can be regarded as the process through which communities of users within an organisational setting become aware of, adopt, and use GIS (Obermeyer and Pinto 1994, Ramasubramanian 1999a). The term implementation is similar to Rogers' (1983) term "diffusion", which he defined as the process which an innovation is communicated and adopted through certain channels over time among members of a social system.

To guide understanding of GIS implementation in this research, the implementation process is divided in three stages: initiation, execution and stabilisation stage. The initiation stage is composed of agenda setting in which GIS technology is not yet acquired but ideas to acquire it are being discussed. The execution stage follows a successful initiation when the actual GIS technology is then acquired and put to operation. In the stabilisation stage, GIS technology is becoming an ongoing element in the organisation's activities.

1.4. Overview of Namibia

1.4.1 The Country

Population

Namibia has a small population in relation to its land area, making it one of the most sparsely inhabited areas in the world and supporting only about 0.2 % of the continents human population (Erkkila and Siiskonen 1992). According to the official Population and Housing Census conducted in 2001, Namibia has a total population of 1.8 million (NPC 2003). Of the 1.8 million people, 67% are in rural areas and 33% in urban centres. The population is growing at an annual rate of 2.1% per annum, down from 3.2% experienced in the period 1981-1991. The average population density of Namibia is 2.1 persons per km^2. Some historians explain the current low population density primarily by the German genocide wars against the Herero, Nama and Damara[6] population (see also under history below).

History

Namibia obtained independence on March 21, 1990, after a century of colonial rule, first by Germany (1884 - 1914) and then the apartheid administration of South Africa (1920 - 1989) (Katjavivi 1988, Mendelsohn *et al*. 2002). At independence, the country opted for a multi-party Presidential system of government with general elections held every-after five years. Since independence, the ruling party has been the South West Africa People's Organisation (SWAPO), and there are about five opposition parties.

Administration

Administratively, Namibia is divided into 13 regions, with Windhoek as the capital city of the country. The regions vary widely in terms of geographical expanse as well as in population size (Mendelsohn *et al*. 2002, NPC 2003). Each region is divided into constituencies. Altogether there are 107 constituencies (Devinso 2000, NPC 2003, Rydén 2004). The regions are administered through local authorities and locally elected regional councils.

Economy

The Namibian economy is largely dependent on the extraction and export of mineral, fishing resources, and the tourism industry. Namibia is the fourth-largest exporter of non-fuel minerals in Africa and the world's fifth-largest producer of uranium (Esterhuysen 1998, Commonwealth 2005). Namibia is a primary producer of gem-quality diamonds and large quantities of lead, zinc, silver and tungsten (Esterhuysen 1998). Namibia is member of the fourteen-nation SADC established in 1980 to promote regional cooperation in economic development among member countries of the sub-region. It is also a member of the five-nation Southern Africa Customs Unions (SACU[7]) (Leistner and Cornwell 1996). International agencies classify Namibia as a lower middle-income country. Namibia's social and economic life is characterised by a striking dualism. There exist certain areas inhabited mainly by whites (and only a few other Namibians) and there are areas inhabited by the remainder of the population. This dualism is also reflected in

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[6] In 1904, the Herero started a war against the German settlers. The Nama and Damara jointed the war later. During the war, the Germans pursued a genocidal campaign against the Herero, Nama and Damara. The Germans poisoned waterholes, machine-gunned refugees and forced survivors into prison labour camps. The Herero population was reduced from 60 - 80 000 to 16 000, while the Namas were reduced from 15 – 20 000 to 9 800, and a third of the Damara were killed (Katjavivi 1988).

[7] SACU was formed in 1969 with the signature of the Customs Union Agreement between South Africa, Botswana, Lesotho, Namibia and Swaziland. It entered in force in 1970 thereby replacing the Customs Union Agreement. Its aim is to maintain free exchange of goods between member countries. It provides a common external tariff and a common exercise tariff to this custom area.

the unequal distribution of per income and assets between whites and the remainder of the population, as well it shows up in the distribution of social services too (UNDP 2002).

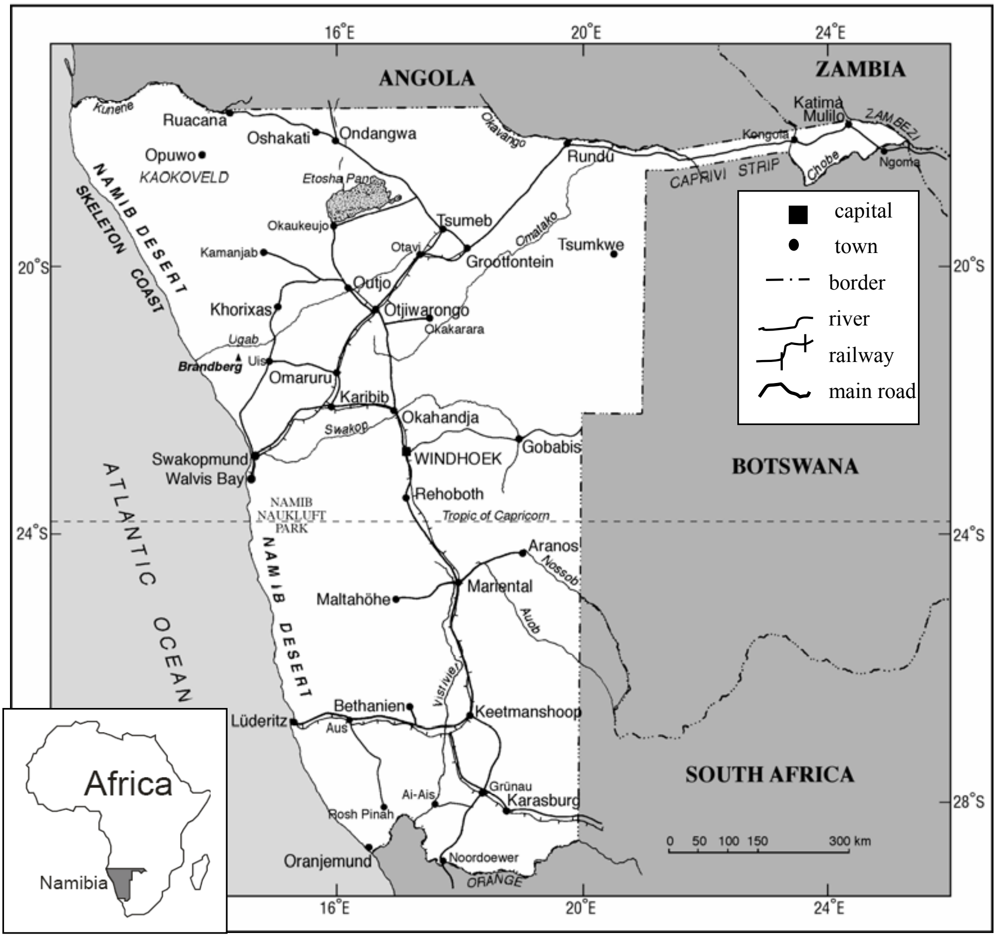

Figure 1.1: Map of Namibia

Infrastructure

Namibia possesses, compared to other African countries and seen in relation to the small population and the large the size of the country, an exceptionally well developed but unbalanced physical infrastructure (i.e. telecommunications, roads, water, electricity and sanitation). Such excellent but unbalance infrastructure maybe seen in the mirror of the country's colonial heritage. Before independence, the development and distribution of most infrastructures followed the interest of the colonial powers and not in the interest of the indigenous people of Namibia. Although this unbalance was consequently addressed after independence, for visible change a lot remain to be achieved.

1.4.2. Major National Development Challenges

Like many other developing countries, Namibia is faced with a number of development challenges. At independence, the country inherited large social disparities as a result of the skewed development objectives of the past. This disparity has been well evidenced by rural and urban poverty, huge disparities in income distribution, unequal access to land and natural resources, poor education, health and housing, and many other more subtle issues. Even more is the vast environmental debt[8] that Namibia inherited. The marine fisheries sector had partly collapsed in the 1970s by over-fishing, the productivity of the agricultural rangeland had shown a steady decline, as had biological diversity in large areas of the country (UNDP 2002). Hence, deforestation, overgrazing, soil erosion, declining water and wetland quality and other environmental problems became issues of major concern in an independent Namibia (Van der Merwe 1999, Nakanuku *et al*. 2001, Noongo *et al*. 2002). In response to these problems, Namibia became one of the first countries worldwide to incorporate an environmental and sustainable development clause within its National Constitution (Articles 95(l)). As a developing country located in an arid region where drought and high climatic variability are endemic, and where great demands are placed on natural resources, Namibia is considered particularly vulnerable to the effects of environmental change (Heyns *et al*. 1998, Wardell-Johnson 2000, Seely *et al*. 1998, Blaikie *et al*. 1994).

The National Planning Commission (NPC) is responsible for the country's development plans[9]. The present main challenges facing the nation and the government in particular were identified in the Second National Development Plan (NDP2) as:

- Poverty reduction
- Land reform
- Employment creation
- Diversification of economic opportunities and in particular encouragement of cottage industry production, small and medium scale enterprises
- Equitable distribution of resources, and
- Combating HIV/AIDS

In order to address the above challenges in a rational and synergic manner, the government has in place a number of mechanisms (development frameworks, policies and programmes). Line ministries together with local NGOs and parastatals are responsible for implementing the various mechanisms. Responsible ministries mainly deal with national activities while the community scale activities are dealt with by specific (often donor funded) programmes/projects which have greater potential for community participation and development of more integrated approaches. The direction adopted by the government through the Green Plan, the National Development Plan (NDP), and Vision 2030[10] underlines intersectoral nature of development challenges in Namibian.

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[8] Environmental dept refer to the accumulation of past environmental impacts of natural resource depletion and environmental degradation (Sachs *et al*. 1998, Jones 2003).

[9] NPC formulated the first National Development Plan (NDPI) in 1994. The purpose of NDPI is to guide the overall direction of development in the country. NDPI covered the period 1995/1996 – 1999/2000. NDP2 was formulated in 2000, and is currently being implemented (2001/02 – 2005/06). NDP2 has sustainable development and environmental considerations at its heart. This purpose was formulated by combining Namibia's Green Plan and NDP1 approaches into one process so as to mainstream issues of sustainable development, together with a far more integrated approach to development. Line ministries participated in the development of the guidelines and objectives set out for each sector.

[10] Vision 2030 is a compilation of wishes of Namibian people for the future. It states: "The national Vision for 2030 is that the people of Namibia are well developed, prosperous, healthy and confident in an atmosphere of interpersonal harmony, peace and political stability; and as a sovereign nation, Namibia is to be reckoned as high achiever in the

At current, line ministries are in the process of developing specific criteria for rigorously monitoring progress towards meeting environment and development objectives. Up till now, irregular monitoring, missing and/or poorly documented data in addition to poorly defined indicators present difficulties in reviews of the impacts of policies and programmes. Overall, contemporary development planning in Namibia can be described as people-centred, democratic approach with a strong emphasis on community involvement, which had previously been lacking. Most of government initiatives are run from central government, although a few have been decentralised to grassroots scales. At the time of writing, there are debates about how to combine decentralisation and coordination of various policies.

Namibia is widely applauded as an example of a good democracy. The country is also generally praised for its fiscal regime and package of incentives that have been put together with a view of attracting investments. But there is one factor that militates against this sought, and this is the underdevelopment of the country's workforce. Generally, Namibia can be described as having a large, but under-productive civil service. This under-productivity is attributed to inadequate human capacity. Development requires that labour not only be available, but it must also be skilled. Consequently, the country relies highly on foreign expatriates and consultants who at times lack sufficient knowledge about the country. There is also a high trend for better-qualified managers and technical experts to move from government to the private sector, where better working conditions, better remuneration packages and wide opportunities are offered. Bureaucracy in Namibia enjoys a large measure of discretion. Technical standards, guidelines and several other less prominent factors are also used in day-to-day office life.

1.4.3. Why GIS in Namibia

Information systems and technologies, including GIS have been advocated as mediums through which many of the objectives of the new development mechanisms could be achieved (Tötemeyer *et al*. 1993, Mendelsohn 1996, Klintenberg *et al*. 2001, Nakanuku *et al*. 2001). Moreover, the use of these technologies and the adoption of new management practices provide developing countries like Namibia with the promise of actively participating in the global processes which could contribute to national development plans (Avgerou 2001, Mendelsohn 1996). A number of examples can be seen in Namibia where organisations are engaged in the development and implementation of GIS technology. For instance the Ministry of Education are implementing the national education information system, and the Ministry of Health are implementing a health information system. GIS and related technologies have also been embedded in the national assessment policies and development frameworks. For example, the use of GIS and remote sensing is emphasised in the national Vision 2030 (GRN 2004) and the national biodiversity strategy (MET 2001). Furthermore, these technologies have a potential to play major roles in planning, implementation, and monitoring of many of the Agenda 21 action items, which Namibia is a signatory of[11].

comity of nations. This Vision will be achieved through full mobilization of the nation's human and natural resources in vigorous pursuit of sustainable development, peace, liberty and justice in the interest of our people, our neighbours and the international community."

[11] Namibia is a signatory to the UN Convention to Combat Desertification, UN Convention on Biodiversity, the Framework Convention on Climate Change and the Ramsar Convention. These Conventions share some common principles, so that action done under one convention benefits another.

Justification for the use of GIS rests on the premises that they (1) capture, store, manage, and integrate large volumes of spatial data[12], (2) provide methods and operations for analysis and synthesis of data, (3) allow events of different types and information from various sources to be linked, (4) allow manipulation of information to give new insight, and (5) have the ability to map, monitor and update disparate information which enables visual identification of potential developmental problems (Klintenberg *et al*. 2000, Mendelsohn 1996). Researchers at the Polytechnic of Namibia (Joubert *et al*. 2002) advocate that GIS can help to put researchers close to decision-makers by providing a key to rational decision-making about spatially related questions. Spatial data are particularly valuable for planning and development efforts because they describe the spatial distribution of economic resources, population and other relevant factors that would contribute to mitigate problems of uneven development in a society like Namibia[13]. Spatial data of interest for planning and development can generally fall into three categories: physical, political and socio-economic[14] (Mennecke and West 2001, Schwabe 2001). The three are difficult to collect, manage and worse is to integrate them, given that they are usually collected from different sources. It is deemed that planning, be at local or national scale, requires the availability of accurate aggregated information pertinent to a wide range of objectives coupled with tools to support analysis and decision making. Thus, many workshops, working groups and seminars have deliberated and expressed themselves on concerns to the facilitation of production and access of spatial data in the country (Tötemeyer *et al*. 1993, Nakanuku et *al*. 2001, Noongo *et al*. 2003). Recently, GIS capabilities have included Internet-enabled applications delivering information in database and map forms. As such, GIS has proven to be an attractive method for making information available to stakeholders, including the general public.

1.4.4. National arrangements pertinent to spatial data

The Government is the sole producer of fundamental datasets[15] (Tötemeyer *et al*. 1993, Nakanuku *et al*. 2001, Noongo *et al*. 2003). It is thus, its responsibility to ensure that the country's information infrastructures are developed in an orderly, coordinated framework. The place of other sectors in the production and maintenance of information should not however be underestimated. For example, the most important sources on pre-colonial historical information available in Namibia are held by the church museums and archives of Evangelical Lutheran Church in Namibia (ELCIN) and Evangelical Lutheran Church in the Republic of Namibia (ELCRN), maps and photographs have over the years been collected by individual scientific researchers, and oral sources of attribute data have been collected by various NGOs.

In 1999 the Cabinet called for the establishment of a National GIS Committee with the following reference:

- Develop policies and strategies for the creation of a GIS based on a user-cooperative approach within the framework of a whole of government approach which sets minimum standards.

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[12] Spatial data are described in chapter two.

[13] See a section on "GIS and Society" in chapter four.

[14] Physical data is about features of the ground, bodies of water, roads, mountains etc. Political data is about artificial designations that define an area as being part of a political entity. Socio-economic data is about populations, economics, and social patterns. Socio-economic data are usually the most difficult to obtain, as result, require a significant financial investment by an organization seeking to use GIS for socio-economic applications.

15 A dataset with national coverage needed consistently by a great variety of users from inside and outside the government agency in order to achieve their objectives.

- Coordinate the acquisition of digital spatial data, aerial photography and satellite imagery throughout the country and more particularly in the government sector to reduce wastage of funds.
- Evaluate and approve all requests for creation of digital geographic data in the whole of government.
- Develop guidelines relating to specifications, standard, data exchange and technology acquisition for GIS.
- Ensure that spatial data and GIS of national significance are identified and that GIS to be developed are compatible and sustainable.
- Develop an amendment bill to the existing copyright law to cover government digital geographic data.
- Ensure that government agencies enter into proper agreements with firms who create digital geographic data for them so that re-selling of the data is controlled thereby enabling the government to collect appropriate royalties.
- Re-negotiate with private firms presently holding government digital data on the terms for selling the data in order to ensure that government gets its dues.

The legal mandate to spearhead the establishment of the National GIS Committee was placed under the Directorate of Surveys and Mapping (DSM). The membership of the Committee was approved by the government and consisted of Heads of Divisions charged with creating and/or using geographic data in the following agencies:

- Lands, Resettlement and Rehabilitation
- Works, Transport and Communication
- Mines and Energy
- Regional and Local Government and Housing
- Directorate of Information Technology
- Telecom
- Agriculture, Water and Rural Development
- Environment and Tourism
- Central Statistics Office
- Directorate of Elections
- Nampower

Since its establishment, the Committee met about four times at irregular intervals and has made little progress before it faced a "natural death" (M. Coetzee 2003, *pers. comm.*). A GIS user group, NamGIS was also formed. The group lasted for two years and boasted 20 - 30 members (O. Mwanza 2005, *pers. comm*). Despite fierce criticism from some GIS users in the country, this research would venture to state that both the National GIS Committee and NamGIS did pave the way for some positive developments. Current activities related to spatial data infrastructure (SDI)[16] are based on principles propagated by the preceding initiatives.

In 2002 at the second national workshop on "Environmental Monitoring and Indicator Network[17] (EMIN II)", participants assigned the Environmental Information Systems (EIS) Unit of the MET to facilitate the reformation of the National GIS Committee. The primary task of the new Committee was to offer advice on the development of spatial data standards and information sharing guidelines for the Namibian GIS community. Interestingly, instead of promoting an information market in the country, EMIN II called for a form of legal regulation of data exchange and the involvement of all sectors in the collaboration and formulation of an information sharing

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[16] An SDI is an umbrella of policies, standards, and procedures under which organisations and technologies interact to foster more efficient use, management and production of geographic data (FGDC 1996).

[17] EMIN is a formal network of resource managers, researchers and technical staff from line ministries, NGOs, parastatals and the private sectors. Since its inception in 2001, a series of EMIN workshops have been held each year. The overall objective of EMIN is to bring institutions and individuals together to deliberate issues and concerns pertinent to Government policies on environment, planning and sustainable development. EMIN is spearheaded by the Ministry of Environment and Tourism.

policy[18]. While the process was slow, the Committee was later re-established in 2003, and adopted the 1999 National GIS Committee's reference with minor amendments[19]. This Committee came to be known as the National Spatial Data Infrastructure (NSDI) Committee and it has membership from the following offices:

- National Remote Sensing Centre
- Central bureau of Statistics
- Directorate of Geological Survey
- Trade and Industry
- Department of Water Affairs
- Directorate of Environmental Affairs

The NSDI Committee managed to draft a spatial data sharing policy which was reviewed by EMIN III workshop participants (Noongo *et al*. 2003). The Committee has also drafted a strategic plan for the development of the NSDI with particular view on the planning of SDI activities and organisational arrangement including funding and capacity strengthening (see Appendix one). By the time of writing this thesis, the strategies presented in Appendix one are being scrutinized.

1.5. Study Structure

In chapter one I have presented my pre-understanding of the problem situation, which is the concern of this research. My pre-understanding has emerged largely from own personal experience, and from the review of other people's experience. In the same chapter I have also introduced Namibia, the context within which this research is based. The section has set the scene for subsequent chapters, by providing some background information about Namibia in general. It then briefly described the major development challenges of the country. It ends by highlighting the needs for GIS, and some developments of spatial data infrastructures in the country.

Chapter two is a review of the literature. It provides background information and explores the debates on the topics relevant to this research. It also looks at the theoretical frameworks underpinning the research on information systems with a view to identify the framework best suitable for this research.

Chapter three presents the philosophical perspectives underpinning this research, and describes the methodologies undertaken to guide the collection and interpretation of the data.

Chapter four provides a review of GIS development in developing countries. Special attention is drawn to continental Africa, and highlights on temporal aspects and the present status of GIS development on the continent.

Chapter five presents the findings of a survey questionnaire circulated among GIS users in Namibia, to assert their perception of the implementation and impacts of GIS. While the chapter only provide a broad sweep of issues that aroused, it also provides an indication of the thematic areas, and sets a scene for the case studies.

Chapters six and seven present the description of the case studies and the synthesis thereof respectively. The case studies were carried out in three organisations, to provide an indepth assessment of the implementation process of GIS.

Chapter eight ends the thesis with an assessment of how the research has addressed the research questions defined in chapter one. It also outlines the limitations and opportunities for further research as well as the main contributions and implications of this study.

[18] ECA-CODI (1999) subcommittee on Geo-Information advises governments to develop policies which follow cost-recovery principle including the commercialisation of geo-information products.

[19] The author has been at the forefront of the re-establishment of the Committee.

Chapter 2: Literature Review

2.1. Introduction

In this chapter, the aim is to review the literature on topics and debates relevant to this research. In the next section (2.2), the concept of GIS and its various definitions are explored to provide an understanding of the technology in question and to seek a useable definition in the context of this research. Section (2.3) will explore the field of Information Systems to discover the development of the field in which GIS technology rests. In section 2.4, the chapter will review the research and debates forming the basis on how GIS and society interact and influence each other. Emphasis is placed on how GIS technology affects society and vice versa, because such debates points towards research directions that contribute to our understanding of the benefits and detriments of GIS. Section (2.5) will discuss the theoretical frameworks behind the research on GIS implementation, and assess the practicability of these frameworks to address the purpose of this research. Actor-Network Theory (ANT) is introduced in section (2.6) as a research framework to delineate and investigate the social and technical interactions involved in GIS implementation and use. Discussion on ANT is continued in section (2.7) where emphasis is placed on innovation translation, an import aspect of ANT that allows the trace of actors and their interests in actor-networks. A section (2.8) on GIS and organisation is considered important because it explains the nature of the working environment in which GIS is implemented, and how GIS and the organisation may influence or impact each other. The final section (2.9) provides the chapter's summary and conclusion.

2.2. An Overview of GIS: Definitions and Concepts

The literature is filled with many approaches of defining GIS, with each approach reflecting a person's current perception of the technology. As the person's experience changes, their perception of GIS and as a result the definition of GIS also changes. Looking at dozens of definitions for GIS it becomes clear that each definition is developed from a different perspective or disciplinary origin. Some definitions regard GIS in terms of a list of its elements (e.g. system components, hardware/software aspects), others see GIS in an even narrower sense as a marriage of computer assisted cartography and database technology, and still others are somewhat vague that they allow every computer graphics and drafting software package capable of displaying a map to be labelled as GIS. While some definitions suggests GIS to be a merely technical pursuit, as if solely existing for the purpose of creating maps and analysing spatial data, a "black box"[20] that we can feed data and in turn receive an unbiased and accurate assessment, others consider that GIS is more than just a "black box"; they realise that there is interaction between the user, the data and the machine environment in which the data are stored and processed. To illustrate the various approaches of defining GIS, Table 2.1 lists some definitions. Each type of user will prefer a different definition (e.g. Table 2.2).

[20] The concept of "black box" is developed by Latuor (1987); see later in section 2.6 in this chapter.

Table 2.1: Definitions of GIS

AUTHORS	**DEFINITIONS**
Dangermond (1988)	GIS consist of five basic elements: data, hardware, software, procedure and people.
Cowen (1988)	A decision support involving the integration of spatially referenced data in a problem-solving environment.
Carter (1989)	An institutional entity, reflecting an organisational structure that integrates technology with a database, expertise and continuing financial support over time.
Aronoff (1989)	Information system with geographical data aspects.
Dueker and Kjerne (1989)	A system of hardware, software, data, people, organisations and institutional arrangements for collecting, storing, analysing and disseminating information about areas of the earth.
Tomlin (1990)	A technology for storing, combining, analysing and retrieving large amounts of spatial data.
Maguire (1991)	A facility for preparing, presenting, and interpreting facts that pertain to the surface of the earth.
Burrough (1992)	A standardised definition of GIS runs as follows: computerised information storage, processing and retrieval systems that have hardware and software specifically designed to cope with geographically referenced spatial data and the corresponding attribute information (tables, charts, and statistics).
Bernhardsen (1992)	A powerful tool that is used for storing, retrieving, transforming and displaying spatial data of any kinds.
Simonett (1993)	Although there is no universal definition for computer systems manipulating geographic data, GIS is the collective term commonly accepted for them.
Huxhold and Levinsohn (1995)	A collection of information technology, data and procedures for collecting, storing, manipulating, analysing, and presenting maps and descriptive information about features that can be represented on maps.
ESRI (1997)	A computer-based tool for the inventory, analysis and visualisation of spatial information. Through their interdisciplinary nature, institutional networking is also facilitated.
DeMers (1997)	A working GIS integrates five key components: hardware, software, data, people and methods.
Burrough and McDonnell (1998)	A powerful set of tools for collecting, storing, retrieval at will, transformation and displaying spatial data from the real world for a particular set of purposes.
Christiansen (1998)	A tool that allow for the processing of spatial data into information, generally information tied explicitly to, and used to make decisions about, some portion of the earth.
Lang (2000)	A system, consisting of hardware, software, data, procedures and a proper organisational context, which compiles, stores, manipulates, analyses, models and visualise geographical data, to solve planning and management problems.
Longley, Goodchild, Maguire and Rhind (2001)	A computer system for analysing and mapping just about anything moving or stationary.
Gavin & Gyamfi-Aidoo (2001)	Database management software, that includes specialised extensions required to handle and analyse geo-referenced information.

Table 2.2: Groups who find different GIS definitions useful (after Longley et al. 2001)

Scope of GIS definition	**Group who find them useful**
A container of maps in digital form	The general public
A computerised tool for solving geographic problems	Decision makers, community groups, researchers
A mechanised inventory of geographically distributed features and facilities	Utility managers, transportation officials, resource managers
A tool for revealing what is otherwise invisible in geographic information	Scientists, investors
A tool for performing operations on geographic data that are too tedious or expensive or inaccurate if performed by hand	Resources managers, planner, cartographers

Maguire (1991) identifies three perspectives of describing GIS, namely, *identification*, *technological* and *organisational* perspective. The *identification perspective* describes the unique features of GIS that distinguish GIS from other types of information systems, giving GIS its special identity to justify separate attention needed during its implementation. The *technological perspect*ive tends to gravitate towards four different approaches. The first of these is a process or function oriented approach. This approach emphasise the information handling capabilities of GIS. A second approach is an application approach, with focus on the applications of GIS and the problems they attempt to solve. The third approach, which is probably the most widely used is, the toolbox approach. This approach emphasises the generic aspects of GIS as a toolbox to manipulate spatial data (Burrough and McDonnell (1998), Table 2.1). The fourth approach is the database-oriented approach, which regards GIS as a database system, reflecting the influence of database theory and practice on GIS.

GIS data can be divided into two data elements: spatial and non-spatial or attribute data. Spatial data are the spatial tangible elements in the landscape such as roads, rivers, administrative boundaries etc. They can be defined as points, lines and polygons. Spatial data act as reference points for the attribute data elements. Attribute data contain further information about the spatial elements. In GIS spatial elements are seen as more important than the attribute elements, and it is this fact that goes some miles to separating GIS from other information systems (Maguire 1991, Burrough 1990). This does not however imply that the attributes of a spatial element are ignored; they are often used in the analysis of spatial data. Regarding the *organisational perspective* of describing GIS, Maguire does not describe what the term or what he means. Burrough (1990) describes organisational context in terms of business operations, staff and organisational units that manage GIS, reliable funding and proper legal and political support.

In defining GIS, practitioners (Table 2.1) focus on three functional aspects of GIS. These aspects have all been suggested as being the defining components of GIS (Maguire 1991). They are: mapping, database and spatial analysis. The mapping aspect provides inventory functions such as data querying. The database aspect is concerned with simple analysis such as overlaying and buffering. The spatial analysis focuses on more complex analytical functions such as modelling.

This research favours the descriptions of GIS as defined by Carter (1989) and by Dueker and Kjerne (1989) (see Table 2.1). Carter's definition is more appropriate in a developing world context for three reasons: 1) it defines GIS in generic terms, 2) it includes an organisational perspective, and 3) it takes into account the critical component of sustained financial support that is especially relevant to developing countries. Carter's definition takes a holistic view, incorporating information technology, elements of spatial data and standards, and people with GIS expertise and the inexorable organisational setting. The inclusion of people and the social interactions in this definition is important because people and their social and cultural realm play an important role in interactions with GIS technology. Carter's definition is therefore seen appropriate for understanding GIS implementation in a developing country.

Dueker and Kjerne's definition on the other hand, may not seem comprehensive enough; yet, it encompasses all the characteristics, as long as the terms are expanded to their intended meaning. A system implies a group of several interrelated and linked components with different functions to serve some particular purposes. For example, the purpose could be planning or management problems (Christiansen 1998), or could involve a complex decision-making (Cowen 1988). It also emphasises the role of people and organisations in collecting, defining and using information. This broad view establishes a fundamental premise for this research, the premise that GIS cannot usefully be adopted and implemented and thence studied and evaluated in isolation from its context, upon which its success or failure depends.

Dueker and Kjerne carefully distinguish between the data in the system and the information that results from the system. Unfortunately, there is no agreement in the literature on what "data" and "information" really means, although there is a clustering of ideas concerning the terms. Tables 2.3 and 2.4 collect some definitions of data and of information respectively. The most common element in Table 2.3 is that data refers to raw facts or raw materials. More thoughtfully, Hirschheim *et al*. (1995) referred to data as "invariances". Checkland and Holwell (1998) have argued that to someone who sees something as a fact, that something is to them invariant, and that there are myriads invariances about which no one would bother to argue. In the views of Hirschheim *et al*, such invariances have a potential meaning to someone who can interpret them. Thus, generally, data refers to something taken to be invariant which can be, but has not been processed (Checkland and Holwell 1998). In Table 2.4, most definitions of information include words like meaning, value, useful, relevant, and processed. Nearly, all definitions of information use data to describe the starting material out of which information is created. In the GIS arena, these terms (data and information) are frequently used interchangeably, although the differences between them can still be significant.

Commonly, GIS is emphasised as a tool. Chrisman (2001) has argued from a social interactionism perspective that tools are developed within a social historical context to serve changing needs, but tools are also intended to change their social contexts. In this view, GIS can also be designed to be applicable and effective for a certain purpose.

For many years GIS has only mainly been described as a tool (as seen in the definitions presented above). Over a decade ago, however, the field of GIS has seen progress with views that define GIS as a science (GIScience). These views are now a major part of themes of several research journals (e.g. Computers and Geosciences, GeoInformatica, Cartography and Geographic Information Sciences (formerly American Cartographer and Geography and Geographic Information Systems), International Journal of Geographic Information Science (formerly International Journal of geographic Information Systems).

GIScience was coined by Goodchild (1992) in a paper where he argued that GIS is a science concerning the fundamental issues arising from the use of GIS. Goodchild defined GIScience as a science that studies …

> "the generic issues that surround the use of GIS technology, impede its successful implementation, or emerge from an understanding of its potential capabilities."

In agreement with Goodchild, Longley *et al*. (2001), have argued that other terms used interchangeable with GIS (such as geomatics, geoinformatics, geocomputing and spatial information science) have much the same meaning as they all suggest a scientific approach to the fundamental issues raised by the use of geographic information systems and related technologies. Goodchild (1992) proposed that GIScience consisting of GIS and its related fields of learning such as remote sensing, cartography and surveying should be fostered to ensure a more permanent future for the discipline.

Goodchild's definition (which is widely acknowledged in the literature), suggests that people using GIS will inevitably ask questions about topics as scale, accuracy, and relationship between humans and computers. These kinds of questions can only be answered through systematic scientific inquiry and access to major branches of knowledge like cognitive science, particularly the scientific understanding of how people think about their geographic surroundings (Longley *et al*. 2001). Another part of GIScience consists of its role as the experimental apparatus that is passively exploited or actively extended and modified in support of the testing of earth science hypotheses (Clarke 2001). According to Zietsman (2002), the knowledge base for GIScience is primarily located in the discipline of geography and its sub-disciplines, as well as in computer science, but it also draws from disciplines such as surveying, geodesy, physics, mathematics, statistics and applied sciences such as geology, forestry and planning[21].

Table 2.3: Definitions of data

Author	**Definition**
Clare and Loucopoulos (1987)	Facts collected from observations or recoding about events, objects, or people.
Maddison (1989)[a]	Natural language: facts given, from which others may be deduced, inferred.
Knight and Silk (1990)	Numbers representing an observable object to create information.
Martin and Powell (1992)	The raw material of organisational life, it consists of disconnected numbers, words, symbols, and syllables relating to the events and processes of the business.
Avison and Fitzgerald (1995)	Data represent unstructured facts.
Hirschheim *et al*. 1995	Invariances with potential meaning to someone who can interpret them.
Hicks (1993)	A representation of facts, concepts or instructions in a formalised manner suitable for communication, interpretation, or processing by humans or by automatic means.
Laudon and Laudon (1991)	Streams of raw facts that can be shaped and formed to create information.
Longley *et al.* (2001)	Data consist of numbers, text or symbols, which are in some sense neutral and almost context-free.
Gavin & Gyamfi-Aidoo (2001)	A recording of facts, concepts or instructions on a storage, medium, for communication, retrieval and processing by automatic means and for presentation as information that is understandable by human beings.

[a]Cited in Checkland and Holwell (1998)

[21] See also a discussion in section 2.3 of this chapter.

Table 2.4: Definitions of information

Author	Definition
Galland (1982)	Information is that which results when some human mental activity (observation, analysis) is successfully applied to data to reveal its meaning or significance.
Clare and Loucopoulos (1987)	A pre-requisite for a decision to be taken. Information is the product of the meaningful processing of data.
Knight and Silk (1990)	Human significance associated with an observable object or event.
Laudon and Laudon (1991)	Data that have been shaped or formed by humans into a meaningful and useful form.
Martin and Powell (1992)	Information comes from data that has been processed to make it useful in management decision-making.
Longley *et al.* (2001)	Information is different from data by implying some degree of selection, organisation and preparation for particular purpose. Information is data serving some purposes or data that has been given some degree of interpretation.
Hicks (1993)	Data that has been processed so that it is meaningful to a decision maker to use in a particular decision.
Avison and Fitzgerald (1995)	Information has a meaning…. (it) comes from selecting data, summarising it and presenting it in such a way that it is useful to the recipient.
Gavin & Gyamfi-Aidoo (2001)	Data that human beings assimilate and evaluate to solve a problem or make a decision.
Worboys and Duckham (2004)	Data plus context.

2.3. The Field of Information Systems

The field of Information Systems (IS) is relatively new, emerging only in the late 1940s with the introduction of the first computers based on vacuum tubes (Checkland and Holwell 1998). At that time, and until recently, practitioners and researchers approached the field from the prevailing perspectives, i.e. technology, computer sciences, and software programming. This was so until revolutionary changes in business environments came posing new challenges to IS specialists. Nonetheless, its rapid development is often attributed to the introduction of integrated circuits in the mid-1960s (Large 1980, Haraway 1991, Checkland and Holwell 1998). Smith and Medly (1987), Earl (1989), Checkland and Holwell (1998) provide an overview of the history of development of the field of IS. Although the authors' accounts have a broad-brush picture in common, from simple data processing to more sophisticated technology and operations, the differences between them are also striking.

Information systems can be regarded as agents of change (Latour 1987, Checkland and Holwell 1998) as they enable organisations to do things, which would not otherwise be possible, often conquering both time and space (Checkland and Holwell 1998). It is however not possible to introduce IS into a human situation without changing that situation significantly. As such, it is not surprising to see the field of IS emerging as an important area of study because we need to understand these potent sources of social change. The field of IS is generally described as an overlap of different disciplines, each contributing in their own views. These different views can be argued to be evidence that field of IS is in deed at best only an emerging field, that has grown at fast pace. It has been defined as an integral of six fields (Davis 1980, cited by Checkland and Holwell 1998), as an intersection of three domains (Cooper 1988, Ahituv and Neumann 1990), and as a combination of two fields: computer science and management, with a host of supporting disciplines e.g. psychology, sociology statistics, political science, economics, philosophy and mathematic (Hirschheim and Boland 1990). While these different approaches have contributed to enrich the field, they have also brought some confusion. This confusion is even demonstrated within universities, where departments of computing or computer science are set up, while interests in information systems are pursued in management departments. Individuals whose interests are in IS often find themselves in departments of computer science, management or other disciplines where they feel beleaguered. In the case of GIS though, as a discipline, geography appears to be one of the logical homes for it. Hence, the extent to which GIS has established a foothold in geography departments and the role that geographers have played in its development. Well, geographers have the longest and strongest tradition of map-based relations (Borchert 1987), and have been accustomed to handling spatially referenced data.

Traditionally, an IS has been defined in terms of two perspectives: one relating to its function, and the other to its structure. From a functional perspective (Goldkuhl and Lyytinen 1982), an IS is a technologically implemented medium for the purpose of recording, storing, and disseminating linguistic expression as well as for the supporting of inference making. Through these functions, IS facilitates the creation and exchange of meanings that serve socially defined purposes such as sense-making and argumentation (Langefors 1973). From a structural perspective (Davis and Olson 1985), an IS consists of a collection of people, processes, data, models, technology, and partly formulated language, forming a cohesive structure which serves some organisational purpose or function. Both two perspectives include social elements as actors (see section 2.6 in this chapter), which can be interpreted that the service provided by an IS in part depend upon social contributions.

Like in the case of GIS, the literature is filled with other numerous definitions of IS. Their differences generate dissimilar conceptualisations of the field. Three definitions coincide with the author’s awareness of technical computational processes and her interest in social factors in organisations. They outline the perspective followed in this research that, IS is concerned not only with the development of new information technologies but also with questions concerning how they can best be applied, how they should be managed, and what their wider implications are. First, a technical definition of IS is provided by Laudon and Laudon. This definition brings out the computer software which represents the technical element of IS.

> “A set of interrelated components that collect (or retrieve), process, store, and distribute information to support decision making in an organisation.” Laudon and Laudon (1998)

Second, Buckingham *et al*’s elaborate definition takes into account the participation of society and its objectives.

> “A system which assembles, stores, processes and deliver information relevant to an organisation (or to society), in such a way that the information is accessible and useful to those who wish to use it, including managers, staff, clients, and citizens.” Buckingham *et al*. (1987)

Third, Handy’s and, Checkland and Holwell’s definition sets the function of IS within an organisation as that of serving people and support organisations taking action in the real world. Noteworthy, Checkland and Holwell do not even suggest the use of computers.

> “The nerves of the organisation without which none of the systems would function; serves the three (adaptive, operating and maintenance systems), running through them and around them.” Handy (1985)

> “The nature of IS is that it is a function supporting people taking powerful actions.” Checkland and Holwell (1998)

Elsewhere Checkland (1981) has argued that it is a fundamental proposition that in order to conceptualise, and so to create a system which serves, it is first necessary to conceptualise that which is served, since the latter will sort of dictate what would be necessary to serve or support it.

2.3.1. GIS in the context of other Information Systems

Although GIS can be both manual and digital, the use of computers in the handling of GIS has been allowed to advance as computer technology itself advances. Distinguishing GIS from other computer related IS has become problematic, as evidenced in some of the GIS definitions in Table 2.1. Considerable confusion remains about the identity and claims of GIS. One area of such confusion is "what is the relationship between GIS and other information systems". Thus GIS is often taken to be synonymous with one other IS. For a better understanding, this section will review the position of GIS within the general context of IS, indicating its different strands and the relationships with other information systems.

Maguire (1991) argues that if IS could be defined by task alone, it would be possible to divide them into two distinct groups. The first group would contain IS used in banking systems or restaurant billing systems. These types of IS are transaction processing systems. The second group would contain IS involved with decision support. Here the emphasis is on data manipulation, analysis, and modelling to support decision-making. In this scenario, the system needs to be retrieval and flexible. As Maguire rightly suggests, GIS can be any of the two IS, although it is more firmly based in the second group.

A technical definition of IS has been given by Laudon and Laudon (2000), as a set of interrelated components that collect (or retrieve), process, store, and distribute information to support decision making in an organisation. This definition encompasses the characteristics of GIS and those of related spatial IS such as Database Management Systems (DBMS), Computer Aided Design (CAD), computer cartographic systems and remote sensing[22]. Further problems of understanding GIS in the context of other spatial IS can be attributed to the fact that many systems which do not encompass the properties needed to be a true GIS are often proposed as being so. A brief examination of what these systems are and what they lack makes an understanding better. **DBMS** are computer-based software used to establish, manage and retrieve databases. They lack the display power and analytical capabilities of GIS. **CAD** has been designed to create and define objects in space. In relation to GIS, its analytical power is limited, it has poor links with database systems, and it works best only with relatively small data sets. CAD has some elements in common with GIS, and historically some GIS software packages have developed from CAD software (Worboys and Duckham 2004). **Computer cartographic systems** are computer systems with the ability to create maps. Although these systems have outstanding display capabilities, they lack ability to do analysis (Maguire 1991). **Remote sensing** is the art and science of making measurements of the earth using sensors mounted on airplanes or on satellites. Remote sensing is probably the closest to GIS in that it has the ability to collect, store, retrieve and graphically display spatial data. However, it has difficulties handling data not in raster format[23] and since analytical examination of spatial data tends to take place in vector format remote sensing falls down in its analytical capabilities.

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[22] All these systems predate GIS. In fact, GIS have evolved from these systems (Maguire 1991).

[23] There are two main models for storing and representing spatial data in a GIS: the raster and the vector models. Raster data represents geographical features and variation by dividing the world into discrete squares called cells, for which a value is stored. Each cell knows its location implicitly from the origin point and its location relative to this origin. The exact location of each cell is not stored, just the origin, cell size and number of cells from the origin. Vector data represents geographic features and variation as point, line or polygon that specify location or boundaries and stores information about the objects (ESRI 1997).

In section 2.2, it was seen how the technological perspective (Maguire 1991) of describing GIS gravitates towards four different approaches. Although the four approaches highlight differences between aspects of function and user needs, they all contain a common thread that makes GIS unique from other IS, namely that GIS deals with spatial data. This point is also evident in the definitions listed in Table 2.1. Chan and Williamson (1999) described the unique features that distinguish GIS from other types of IS as 1) data of entities and relationships managed within a spatial framework, and 2) ability to perform spatial analysis. Yeh and Li (1998) point out that the strength of GIS lies in the fact that it deals with data related to location in real world.

Spatial IS are interlinked and often employed in an integrated fashion. For example, remotely sensed images and GPS data serve as input into GIS, and aerial and satellite images are often verified with GPS coordinates. The power of GIS comes from its ability to relate and integrate these different, yet related spatial technologies. Current trends in research and development within GIS and their related spatial IS is very Internet-focused, through web-based mapping and the establishment of initiatives such as the geography network, geospatial data clearinghouse and warehouse, and other online data resources. The increasing role of Internet and the World Wide Web in the interest of these technologies implies that the development of spatial IS cannot be separated from the general trends of information systems and technologies. Overall, GIS has been described as a conceptual, cognitive bridge, linking various sciences; physical as well as social (Talen 1998).

2.3.2. Perspectives on IS implementation process

The implementation process of technological innovations can be studied in three perspectives: *technological determinism*, *managerial rationalism* and *social interactionism* (Lyon 1988, Bijker and Law 1992, Campbell and Masser 1995, Campbell 1996). The purpose in this section is not to try and trace the various academic strands which have contributed to these perspectives. Such review has been adequately carried out elsewhere (Lyon 1988, Bijker and Law 1992, Campbell and Masser 1995, Campbell 1996). Instead, this section will concentrate on the social interactionism because it forms the backbone for this research. Nonetheless, a brief overview of the other two perspectives is given below.

2.3.2.1. Technological determinism perspective

The key feature of technological determinism is the stress placed on the inherent technological aspects and capabilities of a technical innovation. It proposes that the technological merit of an innovation would be so apparent that they would inevitably lead to the adoption of an innovation. This facet is perceived to override all others and as such is sufficient to justify adoption, and to lead inevitably to its implementation (Campbell and Masser 1995). It suggests that the process of adoption and implementation is purely guided by technical capabilities of the innovation. In the field of GIS, proponents of this view argue that GIS implementation can be studied solely by itself, outside of the context of its construction or use. They assume that problems associated with GIS implementation can largely be resolved by more sophisticated technical solutions (tools, models, principles).

2.3.2.2. Managerial rationalism perspective

The key articulation of the managerial rationalism is that the implementation process of a technology innovation is a combination of both, rational management and technical qualities (Campbell and Masser 1995). The underlying thinking is that the process of bringing an innovation into an organisation is more than just a technological issue. That, innovations are not simply expected to be utilised because of their inherent potentials but rather as a consequence of the strategies laid down by managers within that environment (Campbell and Masser 1995).

2.3.2.3. Social interactionism perspective

The social interactionism perspective suggests that the chances of achieving utilisation of a technological innovation are far more problematic, with the outcome resulting from complex interrelationships between the innovation and the context in which it is located (Cambpell and Masser 1995). That technology is ambiguous until social processes are converged to define it (Latour 1987, William and Edge 1996, Tatnall 2000). For example, the diffusion of innovation is essentially a social process in which subjectively perceived information about a new idea is communicated from person to person (Rogers 2003). The meaning of an innovation is thus gradually worked out through a process of social construction technology (Cambpell and Masser 1995, Wiliam and Edge 1996, Rogers 2003)[24].

The social interactionism emerged from a long-standing critique of crude forms of technological determinism (Edge 1988, William and Edge 1996). It was linked to opposition of ideologies of technological imperative that were prevalent in governments and industries in the 1970s and 1980s with suggestions that particular paths of technological change were inevitable (William and Edge 1996). Social interactionism research investigates the role of social, political, economic and cultural factors in shaping 1) the direction and the rate of innovation adoption, 2) the form of technology (the content of technological artefacts and practices), and 3) the outcomes of technological change for different groups in society. Social interactionism does go beyond traditional approaches, concerned merely with the "social impact" of technology, it extends to examine what shapes the technology which is having these "impacts" and the way in which these impacts are achieved (MacKenzie and Wajcman 1985). William and Edge (1996) pointed out that this perspective has offered the prospect of moving beyond defensive and reactive responses to technology towards a more pro-active role.

Recent literature indicates a growing interest in viewing IS as social systems that are technologically implemented. They serve as the agent for significant social interactions, which implies their connection to human communication through the medium of language (Hirschheim *et al*. 1995). Proponents of social interactionism claim that IS is by its very nature a social technology because its existence depends on social elements like language, and other forms of social influence, and other norms and behaviours (Hirschheim *et al*. 1995, Checkland and Holwell 1998). In fact, all technological solutions are social solutions (Hirschheim *et al*. 1995). Consequently, problems associated with the design, and implementation of IS are regarded as dealing primarily with social complexities and only secondary with technological complexities (Weinberg 1975). Weinberg also suggest that social complexities should be distinguished from technical complexities, because the former are of different sort and more ambiguous. IS implementation, continues Weinberg, is a far more complex phenomenon than is realised in most cases.

As William and Edge (1996) note, by simply establishing that technologies are socially shaped leaves open many important questions about the character and influence of the shaping forces. In seeking to grasp the social complexities involved in technical innovations, proponents of the social interactionism are forced to go beyond simplistic forms of social determinism, which like technological determinism, see technology as reflecting a single rationality. A critique has been made, for example, of the dominant neo-classical tradition of economic analysis which assumes that technologies will emerge readily in response to market demands (Coombs *et al*. 1987). By taking note of the wider context, social interactionism offers a possible scene to study and discuss

[24] This discussion is extended later in this chapter (section 2.5)

social and organisational influences on GIS implementation, and the consequences GIS has on reshaping that wide context.

2.4. The Social Aspects of GIS

The 1990s saw "GIS and Society" emerging as a distinct theme in the literature, articulated mainly by geographers inspired by social theories of various derivations (Taylor 1991, Pickles 1991, 1995, 1997 & 1999, Edney 1991, Smith 1992, Dobson 1993, Obermeyer 1993, Sheppard 1995, Harris *et* al. 1995, Onsrud and Rushton 1995, Harris and Wiener 1998, Harvey and Chrisman 1998, Chrisman 1992, 1993 & 1996). Initially, the critics have focused on the positivistic[25] aspects of GIS (Taylor 1990, Lake 1993, Pickles1995), then on the hype of GIS, pointing to potential surveillance and privacy consequences (Pickles 1995), and the role of GIS in new ways of waging destructive remote control wars (Smith 1992). Generally, these critics often portray GIS as a force out of social control, something external to the social discourse. They sought to make space for studies of the implications of GIS for society at many scales and through many processes. Nonetheless, although the GIS and Society debates became prominent only in the 1990s, Tomlinson had earlier on recognised the importance of non-technical elements in the success or failure of a GIS effort (Chorley Report 1987). Chrisman (1997) has also provided valuable insight into the social, political and ethical implications of GIS use.

By and large, GIS research has been dominated by work improving the technological capabilities and potentials of the technology and enhancing the technical know-how of users. From a technological point of view, the state-of-the-art in the development of GIS is remarkable. Yet, while such contributions undoubtedly make an important contribution, it is increasingly recognised that the effective implementation and stabilisation of GIS technologies depend at least as much on a range of societal issues as on the technical worth of the system (Chrisman 1997, Edney 1991, Masser and Onsrud 1993, Budic 1994, Pickles 1995). GIS is both a technique and a social relation (Pickles 1995, Sheppard 1995). Chrisman (1997) states that for a broader GIS research agenda, as GIS finds its way into practical use, it must be accountable economically, politically, socially and even ethically. The argument that GIS is a scientific discipline based upon objective facts provided fodder for an extended critique by a variety of authors (Taylor 1990, Taylor and Overton 1991, 1992, Lake 1993). For example Taylor and Overton (1991) stated that "data do not exist, they have to be created". Certainly, the impact of GIS goes beyond producing specific data and/or information. As de Man (2000) notes, in some cases, for example, the symbolic value of owning a GIS and the social status associated with this ownership is more important than the use of the technology. Far from being an objective science, some authors asserted that the spatial information collected and represented within a GIS is fundamentally linked to the political, economic, social and technical structures within a given society.

Society and a numerous social structures influence the nature of spatial representations. Likewise, certain characteristics of spatial information can influence a society. Chrisman (1997) noticed that research in GIS rarely takes account of this two-directional flow of influence. This again relates to the argument that GIS research has been conceived without overt consideration of social factors. Derived from abstract laws of geometry, GIS principles have been presented as universal (de Man 2000), whereas, social contingencies of GIS have been considered aberrations, deflecting the logical trajectory of the technology (Onsrud and Pinto 1991). Studies of science, IS and society (Bloor 1976, Bijker and Law 1992, Latour 1993, Checkland and Holwell 1998) provide strong documentation of complex networks linking social organisation, political structure, economic interaction and cultural foundation to the development of a technology. Already in

[25] Read more about positivism in chapter three.

1976, Bloor for instance, has argued that social relationships underpin the development of an innovation. Chrisman (1987) commented that Bloor's argument is against the study of impact from technology to society, but that it ends up asserting that the social dominates everything else.

A workshop held in November of 1993 entitled "Geographical Information and Society" extended the debate on GIS and society. A special edition of *Cartography and GIS* documenting the workshop was published in 1995, entitled "GIS and Society". In this collection of essays, a number of authors made important claims for addressing the broader implications of GIS research. Sheppard (1995) for example, called the GIS community to recognition of GIS's applicability to pressing social issues, in addition to acknowledging that social structures construct and represent information in a variety of ways. Chrisman (1996) in his contribution to NCGIA's Initiative 19 (GIS and Society: The Social Implications of How People, Space, and Environment are Represented in GIS) argued correctly that in order to understand the linkages between GIS and society the GIS community must accept three following principles:

- Social context influences GIS and GIS influences society
- Multiple social structures interact in this process
- GIS technology cannot be reduced to some mechanistically determined parts.

Arguments about GIS and society often slip into a discourse of technological determinacy. GIS proponents and critics alike assert, consciously or unconsciously, that technology is inherently independent from the social world. This, according to Chrisman (1993) perpetuates the two major tenets of technological determinism:

1. Technology engages unilinear progress from less to more advanced systems;
2. Technology is an imperative to which social institutions and people must adapt.

Many GIS-technologists have been well aware of the wider political aspects of GIS implementation, and that many GIS applications are being performed in a socially naive manner by users who are largely oblivious to the potentially broader implications of what their technology is being or maybe used for (Openshaw 1991). Worried that instead of trying to improve this neglect, Openshaw argues that so much ill-informed critics have been written about GIS, apparently by geographers and others who simply lack the understanding of what GIS can and cannot reasonably be expected to do, or else are motivated by other concerns that result in them viewing GIS from perspectives that continually seek to question its legitimacy. Openshaw (1991) warns that it is useful to recognise that in excess of 90% of all GIS applications (or maybe even 99.9%), are of no significant consequence to people and society. They involve applications that are concerned with the management of the physical infrastructure. Apparently the problems with GIS that are of broader relevance to society lie elsewhere. For this reason, Openshaw suggest a reconstruction of critiques to focus on the role of GIS in three different domains which he sees offering a potentially useful rationalisation of the various debates about GIS and society. The three domains are:

- The wider role of GIS in ongoing information technology developments affecting the whole society with the emergence of IT States;
- The nature of GIS as a database technology being used to represent information about people, and
- The use of GIS in spatial decision support applications that impact people.

It may be supposed that most of GIS applications are concerned with the management of the physical infrastructure as Openshaw (1991) argues. However, even in physical infrastructures problems can be identified which affect people and society, directly and indirectly. Weiner *et al.* (1995) provides a specific example of how "top-down" GIS in physical environment can be exclusive, undemocratic and only present one answer to a problem with multiple solutions. During the former apartheid era in South Africa's Soil and Irrigation Research Institute a maximum of 12% slope angle for ploughable land was set. This was based on the requirements of mechanised cultivation and GIS land suitability analyses was carried out accordingly. This slope angle reflected the Institute's viewpoint and constituency as hand hoeing and animal ploughing, as practised by the majority of black farmers, allows cultivation on much steeper slopes. The information created excluded a large percentage of local user-base without explicitly stating that this solution represented only one of many possible answers. The example illustrates that the physical infrastructure cannot be addressed without reference to the users of the resource being investigated and the social within which they operate.

Openshaw's response captured the surprise, frustration and anger of the GIS community to the degree and intensity of such critique. Some GIS proponents on the other hand (e.g. Goodchild 1995), acknowledged the validity of some of the critiques and offered a valuable prospective for GIS and society research. Chrisman (1993) warns that both proponents and critics alike need to see where exactly the social comes into GIS, as it may not be in the places they are watching.

In 1998, geographers in Durham convened a workshop to consider the implications of GIS in terms of power and participation. The resulting document "Participatory GIS: opportunity or oxymoron?" (Abbot *et al*. 1998) called for caution and exposed the risks inherent in visualising place-specific local knowledge and making it available for public consumption, without ensuring sufficient control of the process and outputs generated by legitimate custodians of such knowledge. Since then, GIS practitioners, researchers and activists around the world have developed and tested a range of integrated approaches and methodologies, which led to many innovations within what is now referred as Participatory GIS (PGIS). Consequently, most recent debates on the social aspects of GIS have called for the integration of local community perceptions into conventional GIS (Weiner *et al*. 2002, Craig *et al*. 2002, Vos 2003, Weiner and Harris 2003, Fox *et al*. 2005, Wood 2005, Minang and McCall 2006).

PGIS combines a range of spatial information management tools and methods such as participatory sketch maps, aerial photographs, satellite imagery, GPS, communication and advocacy to represent people's spatial knowledge in the forms of virtual or physical maps used as interactive vehicles for spatial learning, discussion, information exchange, analysis, decision making and advocacy (Rambaldi *et al*. 2006). PGIS implies making GIS and related technologies available to less-favoured groups in society to enhance their capacity to generate, manage and use their own indigenous spatial knowledge, as well as externally-generated spatial information in contexts such as (Craig *et al*. 2002, Weiner and Harris 2003, Minang and McCall 2006, Taylor *et al*. 2006, Rambaldi *et al*. 2006):

- Self-determination (e.g. protecting ancestral land and resource rights and entitlements);
- Management and amelioration of conflicts amongst local community groups, and between communities and local authorities in regards to access, use, control and allocation of natural resources;
- Collaborative research;
- Collaborative resource use planning and management;
- Intangible cultural heritage preservation and identity building among indigenous peoples and rural communities;
- Good governance in regards to transparency and consensual spatial decision making;
- Awareness raising and assisting with education and social learning for new generations;
- Equity promotion with reference to ethnicity, culture, gender, environmental justice and hazard mitigation.

According to Weiner *et al*. (2002) and Rambaldi (2006), PGIS has proved to be an effective way in facilitating the integration of spatial technologies into community-centred initiatives, and if appropriately utilised, it could exert profound impacts on community empowerment, innovation and social change. In September 2005, a conference was held at the Kenya College of Communication Technology. Attending the conference were over 150 people from about 45 different countries worldwide, to support the belief that PGIS can ultimately encourage positive social change (Corbett *et al*. 2006). The key themes of the conference included networking, the creation of PGIS resource centres and defining PGIS good practices. The papers presented for the conference demonstrated a diversity of PGIS objectives, methods and results, as well as the rapid diffusion of PGIS practice around the world (for example Corbett and Keller 2006, Rambaldi *et al*. 2006, Khem 2006, Jardinet 2006, Minang and McCall 2006, Taylor *et al*. 2006). The conference strongly argued that as PGIS is inherently multidisciplinary, it should incorporate a number of different moral and ethical guidelines. As Rambaldi (2006) puts it "a good PGIS practice is embedded into long-lasting spatial decision-making process, is flexible, adapts to different socio-cultural and bio-physical environments, depends on multidisciplinary facilitation and skills and builds essentially on visual language". In addition, Rambaldi states that practice of PGIS is scattered with critical stepping stones all calling attention to troubling dilemmas and overarching issues about empowerment, ownership and potential exploitation.

In developing countries, most researchers at the Kenya conference have reported that PGIS is practised essentially in rural contexts, heavily dependent on external technology inputs, and actors involved are mainly local elites, NGOs, development scientists and other advocates of spatial technologies. McCall *et al*. 2005, notes that PGIS projects in most developing countries are often externally driven and geared towards data management instead of community empowerment[26]. After a two year study of PGIS projects in Asia, Fox *et al*. (2005) concluded that "spatial information technologies transform the discourse about land and resources, the meaning of geographic knowledge, the work practices of mapping and legal professionals and ultimately the very meaning of space itself". Fox *et al*. also documents those communities that do not have maps become disadvantaged as rights and power are increasingly framed in spatial terms. In their conclusions, Fox *et al*. critically notes that mapping has become necessary to a point that failing to be on a map corresponds to a lack of existence, and to own land and resources. The same authors contend that this must be framed in the need for developing "critical clarity with respect to mapping based on a comprehensive understanding of both intended and likely unintended consequences of our actions".

Although more recent work about GIS and society has become more nuanced, the earlier polemical phase still influences the discipline's intellectual agenda in the discipline. Recently also, Dobson and Fisher (2003) suggested that GIS technology has progressed to the point that society must contemplate a new form of slavery characterised by location control. Dobson (2004) defines the concept of geoslavery as a practice in which one entity, the master, coercively or surreptitiously monitors and exerts control over the physical local of another individual, the slave. It also seems that geographers have all too readily adopted a rhetoric of technological determinism. This position assumes that technology has its own internal logic which, once engaged moves inexorably towards results and becomes a singular forms without much ability to be influenced by political, economic or social goals (Sejersted 1997).

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[26] See also under section 4.2.2. below.

2.5. Frameworks of GIS implementation

A review of literature suggests that while there have been a number of systematic studies of GIS diffusion in developed countries (e.g. Onsrud and Pinto 1991, Masser and Onsrud 1993, Campbell and Masser 1995, Chan and Williamson 1996 & 1999), there has not been enough work in developing countries in the relative sense. Where such studies have occurred, focus has mainly been on critical organisational problems that inhibit successful application of GIS in developing countries (e.g. Nkwambe 1991, Ramasubramanian 1991, Sahay and Walsham 1996).

Researchers have used many conceptual frameworks to explain the process of GIS adoption and implementation in various organisational settings. These frameworks differ to a greater or less extent in their terminology and approach. The dominant conceptual frameworks are discussed below, with a view of locating one that is best suited to serve the purpose of this research.

2.5.1. Diffusion of innovation

Diffusion literature has influenced much of the research investigating the adoption and implementation of GIS in organisations (Onsrud and Pinto 1993, Obermeyer and Pinto 1994, Campbell and Masser 1995).

Rogers (1983, 1995) defined an innovation as an idea, practice, or subject that is perceived as new by an individual or other unit adoption. He identifies five characteristics that will influence the speed and ease the adoption of an innovation[27]: 1) *relative advantag*e, the degree to which the innovation is perceived as better than the idea it supersedes. The greater the perceived relative advantage of an innovation, the more rapid its rate of adoption will be. 2) *Compatibility*, the degree to which an innovation is perceived as being consistent with the existing values, past values, past experiences and needs of potential adopters. An idea that is incompatible with values and norms of a social system will not be adopted as rapidly as an innovation that is compatible. 3) *Complexity*, the degree to which the innovation is perceived as difficult to understand and use. New ideas that are simpler to understand are adopted more rapidly than innovations that require the adopter to develop new skills and understanding. 4) *Triability*, the degree to which the innovation may be experimented with on a limited basis. An innovation that is triable represents less uncertainty to the individual who is considering it for adoption, as it is possible to learn by doing. 5) *Observability*, the degree to which the results of the innovation are visible to others.

Although Rogers' original work in describing the above characteristics was not focused on GIS, in a subsequent article, he suggested that the adoption of interactive IS such as GIS were most likely to proceed in a similar manner (Rogers 1993). In the same articles, Rogers illustrates the rate of adoption and subsequent diffusion of innovation as an "S-shaped diffusion curve", that demonstrates a small number of early innovation adopters and an increasing number of adopters over time; the curve levels off after an innovation has reached a critical mass of users. Apparently the rate of adoption of interactive information systems such as GIS is contingent on the creation of a critical mass of adopters since the relevance of the innovation increases as the number of users of the innovation raise. In the case of GIS technology, the progress of adoption is defined by a steeper S-curve, which takes off when the adoption rate reaches between 10 and 20 %. Campbell and Masser (1995), in agreement with Rogers, have noted that GIS diffusion include the process of reinvention and modification to increase GIS capabilities and potentials during the implementation, and the process of change and adaptation of GIS to the needs of its users. Such re-definition and modification is necessary to increase the rate of adoption.

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[27] These characteristics are drawn from agricultural innovation primarily, but they seem to apply across many areas.

The theory of diffusion of innovation has proven useful for studies of GIS diffusion in the context of both developed and developing countries, at both organisational and individual scales. However, a diffusion of an innovation does not necessarily lead to successful utilisation resulting in benefits. Campbell and Masser (1995) suggest that diffusion should be an umbrella concept encompassing the process of awareness raising, adoption, implementation, routinisation and utilisation of the outcomes. Elsewhere, Zwart (1993) has argued that the ultimate achievement of GIS diffusion is the embodiment of the technology into the organisation's business process.

Given that the characteristics of GIS and spatial data are somewhat unique relative to the characteristics of other IS, GIS presents a unique set of problems for organisations seeking to develop and implement useful spatial applications (Onsrud and Pinto 1991). Out of this argument, Mennecke and West (2001) synthesised a new model to show how Roger's five characteristics could influence GIS adoption (Figure 2.1). The two authors have then concluded that a logical way to view the factors affecting GIS adoption and use is to collapse these variables into two broad categories: technological and organisational factors. Technological attributes will likely determine where and how GIS is or can be used. Similarly, when organisational factors are considered, we expect that the environment where GIS is implemented will influence the diffusion process.

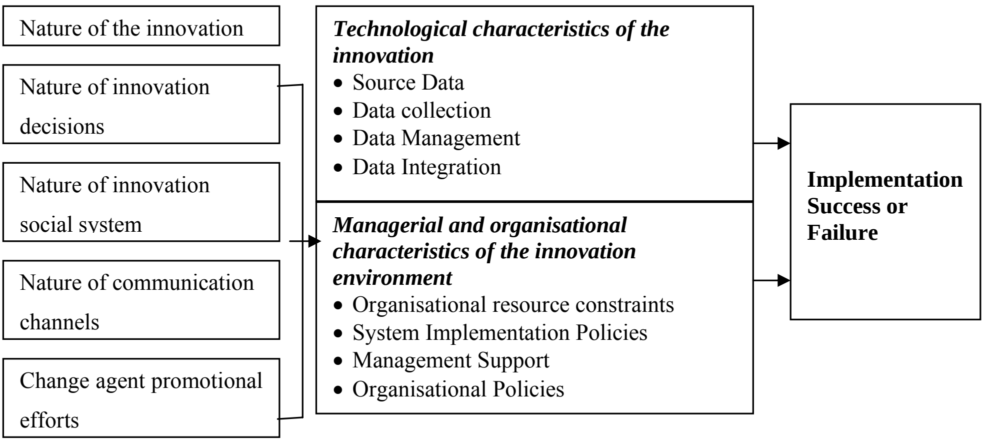

Figure 2.1: GIS implementation framework (after Mennecke and West 2001)

Diffusion is the fundamental process responsible for the transfer of innovation (Campbell and Masser 1995. Many researchers (Emmanuel 1982, Taylor 1991, Yapa 1991, Hassan and Hutchingson 1992, Rogers 2003) have agreed that despite its high desirability, transfer of technology across the national boundaries is a complex, confusing, and difficult activity. There appears to be a great deal of ambiguity surrounding the precise meaning of technology transfer. Hall (1999) defines technology transfer as the process whereby technological materials, methodological bases, skill and capabilities developed originally for one culture or setting, are utilised in another culture to the general purpose for which they were developed and generated. In developing countries, awareness on advantages of spatial information systems has risen considerably (Woldai 1995, Bassolé *et al.* 2001). Apparently, this awareness is largely due to activities such as information transfer through electronic networking, participation in international, regional and national conferences and seminars, many internationally sponsored projects, long and short term training of developing countries professionals in Europe, USA and regional training centres.

Literature on GIS transfer to developing countries has seen a shift in focus. Generally, it appears that articles on the subject are written from a developed world viewpoint, and emphasise case studies of 1) establishing GIS programs in developing countries with international assistance (Furst *et al*. 1999; Ikhuoria 1999); 2) accomplishing projects through importation of GIS software an affiliated technologies from high income countries (Cadwallader and Riethmueller 1999, Martinez 2000, Bocco *et al*. 2001); 3) initiating international training programmes from universities in western countries (Dunn *et al*. 1999) or 4) pursuing combinations of these approaches. The general conclusion of the vast majority of these articles is that GIS technology alone is not what developing countries need and that it is necessary to create a culture of acceptance for GIS in these countries, involving a combination of educating a local workforce and providing some form of foreign assistance.

Diffusion research has been criticised for its pro-innovation bias and its tendency to blame individuals for problematic situations (Campbell and Masser 1995, Flynn and Preston 1999, Tatnall 2000), and its methodological limitation (Ramasubramanian 1999a). Ramasubramanian has further criticised that in absence of longitudinal studies or case studies, diffusion research data are frequently gathered from surveys and questionnaires, a method which artificially freezes the diffusion process that takes place over time into a snapshot. Apparently, researchers rely on respondents to reconstruct the process of adoption and diffusion, who are prone to corrupt data by recalling events and sequences erroneously. Some authors such as William and Edge see innovation as a contradictory and uncertain process.

> "It is not just a rational technical problem-solving, it also involves economic and political processes in building alliances of interests (among, for example, suppliers firms, technologists, potential uses, funding bodies regulators) with the necessary resources and technical expertise, around certain concepts or visions of as yet unrealised technologies." (William and Edge 1996)

Some homologous frameworks have described this process as building socio-technical constituencies (Molina 1989), socio-technical ensembles (Bijker 1993) and socio-technical systems (Hughes 1993). According to William and Edge (1996), the process is characterised by imperfect knowledge and bounded rationality. That is to say, success in implementing a technology is not just a matter of having the money, or of achieving good technical solutions. As often experienced, there may be difficulties, for example, in ensuring the flows of information between the various expert and specialist groups with their differing perspectives and knowledge base (Walsham 1997).

2.5.2. A typology of GIS implementation

Examining the diffusion of GIS in British local government, Campbell and Masser (1995) developed a typology of system implementation. Based on two surveys of British local authorities conducted in 1991 and 1993, Campbell (1993) and Campbell and Masser (1995), concluded that organisations tended to approach GIS implementation in three different ways; *a classically corporate approach*, *a fiercely independent approach*, and *a theoretically/ pragmatically corporate approach*. (These approaches are each briefly discussed below).

Under the ***classically corporate approach***, computer services or planning departments typically take the lead in developing the implementation plan that guides the implementation process. As Cambpell and Masser (1995) noted, a local authority that takes this approach is likely to proceed with GIS in a top-down fashion. Ramasubramanian (1999a) has argued that while this approach can potentially be an effective pathway to implementation, inter-departmental rivalries over access to information, personality conflict and data standards frequently prove to be stumbling blocks.

A local authority that adopts a ***fiercely independent approach*** to GIS implementation involves a single department championing the cause of GIS within the organisation. Typically, this department is involved in technological service provision, experienced in information management and employ technically skilled staff. With this approach, many projects tend to flounder because the department fails to put effective data sharing and distribution mechanisms in place (Cambpell and Masser 1995). On the other hand, if GIS awareness is highly variable within the organisation, this approach becomes inevitable.

Organisations that began with one or the other of the above approaches may eventually end up adopting a mixed-model of GIS implementation. This is what Campbell and Masser refer to as ***theoretically/pragmatically corporate***, an approach that evolves when a single departmental approach expands to include a few other departments. According to Wulfsohn (1995), corporate approaches are favoured in government because they innate rationality and comprehensiveness. Antenucci *et al*. (1991) provide a basic argument in support of this approach stating that the major benefit of the corporate approach or "multi-agency model" is the reduction of redundant activities among separate departments. This is achieved as departments share resources; particularly, the most expensive resource: data.

Interestingly, while theoretically/pragmatically corporate GIS is espoused as the way to go, in Campbell and Masser's study, only about 35% of systems in British local government in 1993 were implemented in this style. The same study showed that about 50% of systems were implemented in a fiercely independent style. The rest of systems were implemented in a classically corporate style. It seems that departments are intuitively voting with their feet for a system that suits their needs and cultures (Wulfsohnn 1995).

Although Campbell and Masser's typology was primarily based on a study of British local government, the authors have argued that its applicability to other organisational contexts lies in its conclusion that GIS should be conceptualised and investigated in social and political terms. It is important to point out that Campbell and Masser's study was based on diffusion of innovation model.

2.5.3. The GIS paradigm

The GIS paradigm stems from Huxhold's (1991) (cited in Huxhold and Levinsohn 1995) work on GIS adoption and use in local governments. Building on Huxhold's work, Huxhold and Levinsohn (1995) developed a framework that links data management principles, the technology and organisational settings. These elements are held together by an operating GIS paradigm that provides a community of users within a particular organisational setting, a common reference point of how and why they use geographic information (Figure 2.2). The GIS paradigm is essentially a conceptual foundation for the use of spatial information that provides a common base of reference or focus for the other three elements. Data management principles represent a logical structuring and management of large databases that contain spatial and attribute data of interest to the organisation. Technology represents the effective combination of various hardware and software components that enable the automation of numerous spatial data handling functions. Organisational setting is considered as a management environment that provides resources and enables changes to be made for incorporating GIS utilisation through the organisation.

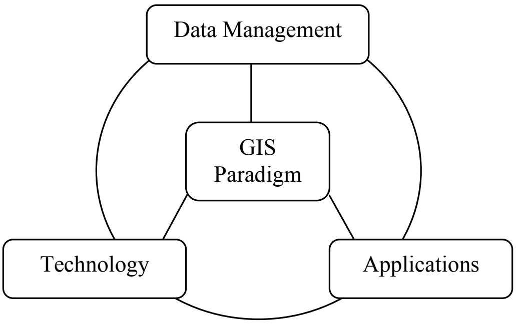

Figure 2.2: Elements of GIS implementation framework
(after Huxhold and Levinsohn 1995)

The four elements of the framework are interdependent, so that change in one element inevitably affects the others. In the view of Huxhold and Levinsohn, it is the GIS paradigm that determines how spatial data are represented and managed, influence the choice of technology, and finally identifies strategic and routine actions that need to be undertaken to achieve successful implementation. Thus, to successfully implement a GIS, all the four elements must be managed together to ensure their alignment and compatibility throughout the implementation process. Design and implementation of a GIS thus becomes an iterative process during which each element is investigated in relation to the others until a design that best aligns all the elements is produced.

Applying the GIS paradigm will help identify changes to organisation likely to result from implementation of a GIS and thus achieve a balance among the data management, the technology and the organisation structure (Huxhold and Levinsohn). The two authors have assumed that organisational setting is synonymous with its management environment. Given there are naturally huge disparities between groups of decision-makers and users within any one organisational setting, it is rather naïve to assume that an orderly rational decision-making approach will result from such an assumption (Ramasubramanian 1999a).

2.5.4. Factor versus process approaches to GIS implementation

The literature on GIS implementation reveals two broad research trends: *factor* and *process* approaches. Many researchers have taken the factor approach where they identify factors that enable or impede GIS implementation in a particular organisation (Yapa 1991, Croswell 1991, Van Teeffelen 1992, Onsrud and Pinto 1993, Sahay and Walsham 1993, Kammeier 1996, Dunn *et al*. 1997, Cavric *et al*. 2003). On the other hand, some researchers have adopted the process approach, which investigates the dynamic nature of GIS adoption (Ramasubramanian 1999a). Process approach analyse the key steps or decisions that are made during the implementation in order to identify how GIS implementation occurs in reality (Obermeyer and Pinto 1994). Process models are generally found useful as they assist in identifying the critical steps that need to be taken to secure the acceptance and productive use of new innovations such as GIS.

Both approaches have their strengths and weaknesses. The factor approach is criticised that it tends to perpetuate a static view of GIS implementation, although this approach has proved to be very useful in identifying new research questions. Researchers investigating GIS implementation in developing countries have mostly employed a factor approach to identify the benefits and constraints associated with GIS implementation. Process approaches, on the other hand, by focusing on individual decision tend to ignore the overarching factors that caused particular decisions to be made (Ramasubramanian 1999a).

Overall, all the implementation frameworks reviewed above consist of sequential steps to guide the GIS implementation process. These frameworks have mostly been based on efficiency, anticipated outcomes of system implementation, organisational objectives and the individual viewpoints of those affected by the system. While the detail and tedium steps provided by these frameworks maybe prudent to guide implementation, they do not provide a theoretical basis to support investigation of the implementation dynamics. In recognising that GIS is composed of technological and social systems that interact with and influence each other, it is necessary to adopt an appropriate research framework that can effectively deal with these networked systems. In the following section I will introduce actor-network theory which I contend is an alternative framework for the purpose of this research.

2.6. Actor Network Theory as a Research Framework

2.6.1. The concept of ANT

In introducing the Actor Network Theory (ANT), it would be the norm to start by defining the key terms. But ANT has a dense language that is an integral part of the framework and must be placed in context. I will therefore present the framework and the definitions of concepts together as this section extends.

ANT emerged during the mid-1980s, primarily with the work of Bruno Latour, Michel Callon and John Law. Emerging from a Science and Technology Studies (STS) interests in the elevated status of scientific knowledge and counter to innovation models, ANT is concerned with the socio-technical divide by denying that purely technical or purely social relations are possible (Latour 1987). It offers the notion of heterogeneity to describe technology implementations in social settings[28]. ANT privileges neither social nor technological accounts of scientific production. The use of heterogeneous entities then avoids questions of “is it social?” or “is it technical?”, but the right question should be “is this association stronger or weaker than that one?” (Latour 1987). No project is purely technical, nor is it purely social. ANT considers both social and technical determinism to be frawn and proposes the socio-technical approach (Latour 1987) in which the social and technological positions are equal. It asserts that the world is full of hybrid[29] entities (Latour 1987) containing both human and non-human elements and that nothing is purely social or purely technical. In expanding the scope of analysis to include any influential element associated with the production of technology, Latour emphasises description at the expense of explanation.

An actor (also termed actant), is any agent, collective or individual, that can associate or disassociate with other agents (Latour 1987). ANT accepts humans, non-humans (e.g. technologies and organisations), and their intermediaries (e.g. agreements) as actors. Actors are not fixed and do not have significance in and of themselves, instead, they derive significance through relations with other entities (Latour 1987). Individual actors are not static or unitary; they change over time, across social and political contexts, and in their relation with other actors

[28] Another STS approach that considers interactions between science and society is *social worlds and arenas theory* (Strauss 1978 & 1993, Becker 1982, Clarke 1990). This theory adopts a broader perspective concerned with negotiated social orders and the distributions of power, whereas ANT encourages examination of specific actor’s interactions.

[29] Latour’s “hybrid” has some similarity to what Haraway (1991) calls a “cyborg” as both human and non-human parts in operation are blurred in such a way that it is difficult to distinguish one from another.

(Singleton and Michael 1993). Both human and non-human actors are considered equal for the purpose of critical analysis and inasmuch as they have the ability to act and be acted upon (Latour 1987). By considering actors equal, the analytical focus shifts from them (the actors) to the characteristics and behaviour of interactions between society and techno-science. Basically, ANT's primary interest in actors is not their context, but their interactions and effects on other actors (Law 1992, Singleton and Michael 1993). In ANT, identities are negotiated through deployment of various human and non-human intermediaries, which thereby mediate the relationships between actors.

When actors and their interactions are together they form a network (Latour 1987). Latour has also cautioned about the existence of other networks such as technical or social network, which should not be confused with actor-networks. Technical networks exclude human actors inasmuch as social networks exclude non-human actors. Actor-networks integrate both human and non-human actors with linkages consisting of stabilised translations (explained below) and interactions between the actors (Latour 1987). Actor-networks are inherently unstable over time and so have to be continually maintained by the engagement of actors involved, or else they may fail and be replaced by other networks (Law and Callon 1992). Callon (1987) proposes that entities become strong and stable by gathering a "mass of silence others" to give them greater strength and credibility. A network becomes durable partly due to the durability of the bonds that hold it together, but also because it is itself composed of a number of durable and simplified networks (explained below) (Tatnall 2000).

Entities that compose networks are often converted into inscriptions or devices (Latour 1987). Inscription devices are objects such as combinable textual (documents, reports, academic papers and books), cartographic, or visual representations, and computer programmes, that do not necessarily operate to define a network (although they can), but they play an important supporting role. Latour uses the term "immutable mobile" to describe these things that remain stable and unchanged when moved around through space and time. These immutable mobiles also help extend the networks by enrolling new actors. As ideas are inscribed in technology and as these technologies diffuse in contexts where they are assigned relevance, they help achieve socio-technical stability (Latour 1987).

Individual actors in the network are usually associated with their different networks of their own interests. When delineated, this makes some networks fractal or contracting infinitely (William-Jones and Graham 2003). A network viewed as fractal is unwieldy, complex and all but useless for coherent analysis (William-Jones and Graham 2003). Given this density, individual networks may be simplified or "black boxed" to look like a single point (Latour 1987). This means that behind each actor in the network there hide other actors more or less effectively drawn together (Calon 1987). It also means that any changes in the actor-network affect not only actors directly involved, but also the networks they simplify. The entry of new actors, desertion of existing actors or change in alliances can cause the black boxes to be opened and their contents reconsidered. Actor-networks therefore rely on a continued maintenance of its simplification for its continued existence. These simplifications are under constant challenge and if they break down the network may collapse, and may reform in different configuration as a different network.

A major concern in this study is how to understand the complexities of GIS implementation. A common method in handling complexity lies in the simplification (Latour 1987, Law 1999, William-Jones and Graham 2003, Tatnall 2000). Suchman (1987) warned that simplification runs the risk of removing just those things that constitute the description needed, by concealing the parts played by many other actors. Without the detail from the part of all actors, the understanding of the complexity of GIS implementation, in the case of this study, might be superficial, lacking the necessary detail which would allow a more holistic account. Of course some simplification is required in order to represent the infinite possibilities of complex situations (Latour 1987, William-Jones and Graham 2003, Martin 1999). The challenge lies in selecting which details to include and which to leave out. Law (1999) emphasises an appropriate research approach must ensure that complexities are not lost.

2.6.2. Translation and supporting concepts

Every actor in the actor-network is seen as an independent entity, able of resistance or accommodation. So then, for the network to hold and stabilise, there must be "something" that encourages the actors to be involved in the network. That "something" is called "translation"[30] (Latour 1987). A network's stability requires continual translation of interests, since each actor has their own diverse sets of interests. Between humans, translation is analogous to persuasion and negotiations of common interests (Latour 1987). Policies, behaviours, motivations and goals are translated and changed in their interactions with others (Latour 1987). Between humans and non-humans, translation occurs for example during design when the object is imbued with a script or a set instruction that determine how it will function and the extent to which it maybe shaped by other actors (Martin 1999, Akrich 1992). While scripts may affect human behaviour, and a range of other social and technical interactions, the scripts are not necessarily fixed. They (and thus the technology) could be translated by other actors in uncertain ways not intended by the designers (Singleton and Michael 1993). When the technology is translated by other actors, the technology may "drift" (Martin 1999).

Actors that are strongly aligned through translation each share a vested interest in the activities of the other and form durable interactions. Actors that are poorly or weakly aligned require frequent negotiation of their interactions or may cease to interact. Latour (1987) refers to the challenges to align between actors in the network as "trials by strength". Callon (1991) speaks of convergence as a special case of translation that aligns the elements of the network. It means that any one actor's activity fits easily with those of the other actors, despite their heterogeneity (Callon 1991). It is possible that actor-networks can become so transparent or accepted that they are no longer recognised (Martin 1999). In such case, alignment and durability lead to "punctualisation", a point where the network supporting an actor disappears from the view. This happens when the network components that are responsible for the production of objects or performance of functions are summed up in symbols or artefacts that encapsulate the network (Callon 1991).

Another important phenomenon and concept of ANT is irreversibility. Irreversibility refers to the degree to which in a certain situation it has become impossible to go back to a point where alternative possibilities exist (Callon 1991). A translation is irreversible in that it is impossible to return to the previous situation. A network that irreversibilises itself is one that has become heavy with immutable, durable devices (black boxes) and inscriptions. Latour (1987) introduces the "centre of calculation", as a location where the accumulation, synthesis and analysis of observations to yield greater understanding. The interactions that take place in an actor-network are mediated through objects (Law 1992) or circulation of entities (Latour 1997). Serres (1987 – cited in Martin 1999) introduced "quasi-object", an object that both circulates and transform while circulating. Callon (1991) describes these circulating objects as "action intermediaries". These action intermediaries are important elements that can both shape and delineate interactions.

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[30] The choice of the word "translation" derives from Callon (1985) who defines it as "the methods by which an actor enrols other".

To address the need to treat both human and non-human actors fairly and in the same way, translation advances three methodological principles (Callon 1986). The first is *Agnosticism*, which imposes analytical impartiality towards all actors, and requires that all interpretations be unprivileged. It advocates abandoning any *a priori* assumptions of the nature of networks, causal conditions or the accuracy of actors' accounts. The second principle is g*eneralised symmetry*, which advocates the use of a single explanatory frame when interpreting actors. It means that the researcher should never change registers when examining the social (individuals and organisations) and technological (computers and their programmers) entities. The third principle is f*ree association*, which advocates abandoning any *a priori* distinctions between the technological or natural and the social. These distinctions are the effects of networked activity, and are not causal and thus cannot provide explanation.

2.6.3. Critics of ANT

In a review of the use of ANT, Walsham (1997) noted four areas of ANT critique in the literature: its disregard for social structures, its symmetric treatments of human and non-human, its lack of political moral analysis, and its power to describe as opposed to explain.

Disregard for social structures

ANT's strong focus on empirical case studies which provide a rich description of networks and translations has been accused of concentrating on how things get done, ignoring how the broader social structures (macro-structures) shape the social entities (Walsham 1997, Reed 1995, Fuller 2000). Latuor (1991) has contended that the macro-structure of society is made of the same stuff as the micro-structure, and that ANT can be used to move between scales.

Symmetric treatments of human and non-human

An often mentioned critique of ANT is the radical symmetry between human and non-human actors (Lee and Brown 1994, Murdoch 2001, Avgerou 2002). The critique argues that human actors have different (superior) moral status from machines or agreements, and thus require a special recognition. Proponents of ANT have robustly met this critique by explaining that the purpose of treating humans and non-humans as symmetrical is to aid in detailed description of the network, and does not entail that all entities be treated as identical for all purposes, nor that various relations between actors be egalitarian (William-Jones and Graham 2003). On the other hand, as Haraway (1991) argued, the social entities involve more and more interaction with machines, to the point that humans are becoming cyborgs.

Lack of political moral analysis

ANT's is also criticised of amoral and apolitical stance in that it apparently ignore the political biases that can underlie the spectrum of choices for key actors (Winner 1993). Moreover, ANT does not provide specific guidelines for examining the ethical and moral implications (Walsham 1997). Star (1991) points to the failure of ANT to account for the effects that a technology can have on those who are not part of the network that produces it, and therefore fails to support value judgements on the desirability or undesirability of such effects. Bijker (1993) responded to this criticism by stating that the amorality of ANT is not a necessity. Moral and political positions are possible, but one must first describe the network before taking up such positions.

Power to describe as opposed to explain

ANT studies (which are mostly case studies) produce detailed and long empirical descriptions. To avoid infinite networks, ANT calls for judgement from the researcher to set a boundary as to what actors are important within a network, and which are not. The critique in this aspect is that ANT fails to provide explanations for the dynamic restructuring of actor-networks. Latour (1987) explains that the point of ANT in this view is to analyse how in networks a limited number of configurations is enacted.

ANT has also been criticised for having developed with a dense vocabulary and many case studies make rather an eclectic use of the conceptual vocabulary, and to a lesser extent, its methodology (Walsham 1997). The ANT theorists recognise the need to keep their vocabulary in motion. Latour (1999) speaks of “the ridiculous poverty of the ANT vocabulary”, that has proven a clear signal that no academic definitions can replace the rich vocabulary of the actor’s own practice. He also states “a great deal of our (ANT) vocabulary has contaminated our ability to build to let the actors build their own space”.

2.7. Understanding Innovation as Actor-Network

As already given above, Rogers (1983, 1995) defined an innovation as an idea, practice, or subject that is perceived as new by an individual or other unit adoption. Introduction of GIS into an organisation inevitably involves innovation as the systems will be seen as new by some of its users. Of the four GIS implementation frameworks reviewed in section 2.5, it was noticed that Rogers’s innovation diffusion approach has by far dominated research in GIS adoption and implementation. In fact the other three have somehow just built on Rogers’s model. As seen above, using this approach, researchers have mostly concentrated on issues like sequential steps to guide implementation of GIS, evaluation of success of GIS implementation based on accomplishment of organisational objectives, data availability and data accuracy. Most of these efforts have assumed homogeneity of the organisational setting across the adopting units, hindering treatment of the multifaceted relationships that exist between internal and extended elements of the organisation in social, technical and political arenas (Martin 1999).

Although innovation diffusion approach has provided many useful insights to understand the adoption and diffusion of innovations in the past, recent work in the implementation of complex technologies point out its limitations (Walsham 1997, Walsham and Sahay 1999, Tatnall 2000, Holmström and Stalder 2001, Lyytinen and Damsgaard 2001, Tuomi 2002). Most of these researchers point to the pro-innovation bias, which Rogers (1995) himself also warned about. The implication that innovations are unproblematic, complete, unambiguous objects that ought to be adopted and therefore will diffuse through a social system in a linear temporal sequence. Innovation diffusion approach is governed by a process view that gives a linear explanation for how diffusion of innovations takes place (see section 2.5.1 above). The process of innovation adoption and diffusion is however emergent, and its complexity may be too unstructured to be explained in a step-like model (Tatnall 2000, Baskerville and Pries-Heje 2001). An alternative view on innovation diffusion is offered by ANT, which recognises the complexity and disorderliness of the social system in which the innovation is attempted to be implemented.

2.7.1. The innovation translation model

ANT proposes the concept of translation to replace diffusion. Translation sees innovation spreading as a result of how actors “translate” the interest of others so that they become aligned with their own interests. Successful translation of the interest of both human and non-human actors so as to create effective alliances contributes to effective innovation adoption and implementation. Rather than viewing innovation as a linear process moving along a predictable and visible path, innovation translation contends that right from the start, technical scientific, social, economic and political considerations have been inextricably bound up into an organic whole (Callon 1987). The effectiveness of the adoption and implementation of the innovation is dependent on how actor-networks are created, stabilised and strengthened over time. The movement of an innovation through time and space is thus in the hands of people, each of whom have their own interests and may react to the innovation in different ways (Latour 1987). Following these ideas, the introduction and implementation of GIS in an organisation for example, will come as a consequence of the actions of everyone in the chain of actors involved. Each of these actors can shape the innovation to their own ends. “They may modify it, deflect it, betray it, add to it, appropriate it or let it drop” (Latour 1987). Latour also emphasise that it is not just a matter of each of the actors in the chain either resisting or transmitting the innovations in the same form that they received it, but that shaping of the innovation is essential for its continued existence. In shaping the innovation, the converging interests of the actors, which at first are only “as assembly of disorderly and unreliable allies”, slowly, evolves into something that closely resembles a black box (Latour 1987).

At base, innovation translation attempts to trace the innovation process as it develops or does not develop. This is done by tracing the complex, negotiated and contingent processes associated with the ordering that any innovation requires. It traces the manoeuvres, compromises, twists and turns of a negotiation as it changes or translated during the process of adoption and implementation. The ANT view of translation is however, neutral with regard to what is formed. It deals primarily with the formation process and its characteristics. In the case of this study, translation innovation will deal with the GIS implementation process and its characteristics. Innovation translation is not concerned with assessing what is dysfunctional behaviour and what is not. Rather, it concerns with understanding in some detail how and why translation process evolved in certain ways (Latour 1987).

Callon (1986) describes the process of translation as having four “moments”: problematisation, interessement, enrolment, and mobilisation of allies.

Problematisation “how to become indispensable”, takes its outset in a focal actor who defines the nature of the problem that needs to be solved and identify the other actors and their roles. However, the other actors may have different objectives for participating in the network. It is thus crucial that the answer proposed for the problem will be of common interest for the identified actors despite their different agendas and goals. This formulation is called an Obligatory Passage Point (OPP), which allows actors to recognise that they will reap benefit from their involvement in the issue. All actors must pass through the OPP to achieve their interests.

When a problem has been defined and actors and their tentative roles are identified, the network at this stage has to be stabilised. This step is what Callon (1986) calls ***interessement*** “how allies are locked in places”. Interessement is characterised by a series of processes by which the focal actor sought to lock the other actors into the roles that had been proposed for them in problematisation. The new actors’ link with the network needs to be strengthened at this stage. Law and Callon (1992) emphasised that the actor’s formulations of visions and mutual roles develop in the ongoing action. Through interessement the developing network creates sufficient incitement to both lock actors into fixed places - so that they participate in the proposed solution (e.g. a project), and to weaken the influence of other entities that may jeopardise the developing network. Incentives may be created to encourage others to overcome obstacle of passing through the OPP. A strong OPP exercise control over resources and is able to claim responsibility for the success of the network (Law and Callon 1992).

In the third moment, ***enrolment***, “how to define and coordinate the roles”, roles in the network are delineated and coordinated through negotiations, trials of strength and tricks that accompany the interessements to succeed (Callon 1986). In this moment, the vision of the proposed solution must be divided into more specific sub-goals, which must be accepted and fulfilled by other actors. Enrolment leads to the establishment of a stable network of alliances, but for enrolment to be successful, it requires more than just one set of actors imposing their will on others, it also require these other actors to yield (Singleton and Michael 1993).

Finally, through ***mobilisation***, “who speaks in the name of whom?”, which occurs as the proposed solution gains wider acceptance, actors become legitimate spokespersons of the group they claim to represent. Mobilisation requires that these supposed spokespersons are properly able to represent the others and will neither betray them nor be betrayed by them (Callon 1986).

The translation moments are often found to be more fluid and interrelated than Callon’s analytical innovation translation might suggest (Latour 1999). The fluidity of translation process is advanced by the order of things created and maintained through actor’s strategic efforts to negotiate and manoeuvre one another into networks or aligned allies (Latour 1999, Law and Hassard 1999).

2.7.2. Innovation Diffusion and Innovation Translation

Latour (1986) compared the innovation diffusion and innovation translation approaches. He concluded that in the innovation diffusion approach, an innovation is endowed with its own form of inertia and propelled from a central source. It then moves through time and space without the need for further explanation and it is unstoppable except by the most reactionary interest groups. It implies that once the innovation has been pointed to people, it should just be a matter of time before everyone except the most immovable, recognise its worth (McMaster *et al*. 1997). What needs to be explained, Latour suggest, is its acceleration or slowing down due to people; an effective change agent or a backward culture. Innovation, he notes, define three important elements in the movement of an innovation: the initial force with which the innovation is launched, the innovation’s inertia, and the medium through which it moves. For the diffusion model, anything can be easily explained by reference to the initial force or the resisting medium (Latour 1986). Innovation diffusion carries the implicit assumption that innovations remain invariable over time, which is especially problematic in the current period of globalisation in which technology is changing rapidly. In the case of innovation translation, an innovation is not endowed with autonomous power or “propelled by the inventor”. It’s movement is not caused by an initial impetus because there is none. Instead, it is the consequences of actions of everyone in the chain of actors. Latour (1987) argues that the mere possession of power by an actor does not automatically grant the ability to cause change unless other actors can be persuaded to perform the appropriate actions for this to occur. Basically, it is not a question of power possessed by an actor, but it is the number of other key actors in the implementation process that indicate the amount of power that has been exercised.

According to McMaster *et al*. (1997), innovation diffusion is firmly rooted in “high modernism” which explains its overwhelming desire to link cause and effect. Innovation translation on the other hand is not overly concerned with explanations, but in tracing processes that arise. Researchers underpinned by innovation diffusion’s pro-innovation bias can significantly influence the way in which research is conducted. By being agnostic, innovation translation on the other hand avoids the pro-innovation bias, and it prevents the researcher from judging the actors. While innovation diffusion examines attribute of the innovation and frame the innovations success or failure in terms of those attributes, innovation translation does not make judgement that the innovation is inherently “good” or “bad”, but simply reveals the influences that contribute to the fate of an innovation. By removing the limitations imposed by categories and compartmentalisation of human activities, innovation translation extends the analysis scope to include a greater range of entities and influences affecting innovation adoption and diffusion (Martin 1999). Moreover, by considering the actors participating in the adoption and implementation process as components of an actor-network, innovation translation is shown to support a broader understanding of the context for innovation adoption and implementation as well as contributing organisational, political and technical linkages (Martin 1999). Innovation diffusion hides away from all those not involved, all the negotiations, politicking, and all the behind the scene work that goes into the making the implementation success of failure (Tatnall 2000), and all that remains to be seen is the "official" sanitised version that tend to show the process as been tidy, logical and straightforward. In retrospect it would appear that the designers of the innovation were wise and thoughtful, and worked carefully towards a solution that was accepted gladly by everyone, but this appearance is deceptive (Tatnall 2000). The main differences between the two innovation diffusion and innovation translation are summed up in table 2.5 below.

Table 2.5: Innovation diffusion versus innovation translations
(after McMaster *et al*. 1997)

	Diffusion	**Translation**
Communication	A technology perceived to be new by the potential adopter.	A technology that has yet to be black-boxed.
Time	Communication channels can be categorised as cosmopolite or localite, and mass media or interpersonal. Innovations are transferred through these channels.	Translations are made by actors in enrolling the innovation.
Time	Speed of decision to innovate, earliness of adoption and rate of adoption are important.	Network dynamic in enrolment, control, and dissemination are what matter.
The Social system	Homophily versus heterophily. Sharing of interests of human actors.	Interessement between actors, both human and non-human, and goals. Black boxes form when interests move in the same direction.
The Technology	Changes are made to the form and content of the technology as a result of experience during implementation.	The technology is translated through being enrolled, regardless or whether its form or content is modified.
Socio-technical stance	The social system and the technology are separate. Diffusion is the adoption of technology by a social system. Technology transfer requires the bringing of social and technical elements.	The social system and the technology are inseparable. Successful innovation and technology transfer gives the appearance of separation, but this is merely evidence that the actor-network has stabilised.

2.8. GIS, IS and organisational change

Information systems are widely considered to be of central importance to contemporary organisations (Robey 1981, Hall 1991, Orlikowski 1992, Monteiro and Hanseth 1996, Madon and Sahay 2001). The emphasis of the literature is that contemporary organisations are entangled with technology and one cannot be investigated without understanding of the other.

In the view of one observer of IS research:

> "While most other areas of management knowledge have been critically re-examined, the question of computer impact has led a charmed existence. Despite the billions of dollars we spend annually on new computer systems, we have little systematic information about how computers actually work in organisations." (Robey 1981)

The literature specifically on the impact of introducing GIS in an organisation is relatively little. Most of the published literature is on the impact of IS in general. As already established above GIS is a special type of IS, hence a review of the literature on the impact of this general IS seem sensible to see if some of the general findings may also be applicable to the introduction of GIS. While generally agreed that the main role of IS is that of a support function in an organisation, the literature consistently cites that it is difficult to establish a coherent relationship between IS and organisations (Robey 1981, Mayntz 1984, Yap 1986, Walsham 1993, Onsrud and Pinto 1993, Obermeyer and Pinto 1994, Winter *et al*. 1995, Campbell and Masser 1995, Ramasubramanian 1999b). Campbell (1997) suggests that the difficulties in assessing the relationship between IS and organisations are in part caused by incomplete knowledge of the pathway by which the technology is implemented in organisations. Nonetheless, when we begin to examine the implementation of IS within organisations, we find that IS and organisation cannot be treated as entirely separate categories (Robey 1981).

Yap (1986) and, Laudon and Laudon (1998) suggests that organisational factors may determine the use of IS or the use of IS may influence the organisation, or some combination of both. Organisational structures, procedures, flow of information and communication, and social and political processes may be altered by the introduction of new systems. Likewise, these elements of an organisation may affect the use of IS in several ways. The group that manages the systems exerts significant control over its use and the development of new applications. The organisational chart – lines of authority and communication influences how the technology diffuses within an organisation. Not only do IS and organisations have a mutual, recursive influence on each other, but they both tend to undergo continual or periodic change (Laudon and Laudon 1998, Checkland and Holwell 1998).

Researchers attempting to explain the interrelationship of IS and organisations have used various theories and models. Two classes of researchers have a stake in the basic question of how computer IS work in organisations: management information systems (MIS) research and organisation theorists. Neither group has made the answering of this question a central focus of its concern, although a small number of individual researchers of varying disciplinary persuasion have done so. In the case of MIS research, the difficulty may be illustrated by focusing briefly upon two puzzles, which have, in contrast, attracted substantial interest: the problem of information requirements determinations, and the problem of measuring IS success. Although information systems are organisational phenomena, they are not as yet a principal subject of research by organisation theorists. Moreover, with a few exceptions, IS are ignored as a major variable in organisation design (Robey and Zmud 1992). Notwithstanding Robey and Zmud's observation, it is worthy acknowledging that modern organisations have undergone a revolution in the adoption and application of information technologies. From the viewpoint of organisation theory[31], it should be interesting to see how this revolution may be understood.

In describing the relation between IS and organisations, Markus and Robey (1988) emphasise an *emergent* perspective, focused on the interaction between organisations and technology, in contrast with both a technological determinism (in which information technologies and systems are presumed to have known, inexorable effects on organisations) or a social interactionist perspective (in which information technologies and systems are seen as inexorably shaped by organisational intentions and actions). Kaplan (1997) employs a social interactionist perspective to explore the role of organisational factors on computer information system implementations.

[31] Here the term 'organisation theory' is used in the broad sense to cover such diverse areas as organizational behaviour, organizational design and development as well as management strategy and policy.

She concluded that the way technology is designed, and implemented in a particular organisational setting depends on individual and group's objectives, preferences and work demands. Scott-Morton (1991) has identified five principal sets of organisational factors that influences IS implementation: organisational strategy, structure, management process, people skills and the perceived role of the new systems.

The nature of the changes brought about by IS is that they extend beyond a mere use of new tools to cover deeper cultural changes. Many authors emphasise that the real benefits of IS come from the capacity of organisations to plan, and use the systems, and to align these systems to organisational strategies (Campbell and Masser 1995, Bartholomew and Caldwell 1995). Yet, many practitioners report that IS activities seem sometimes disconnected from the organisation aims and goals (Hammer and Champy 1993).

Recognising that organisational issues can be critical factors in determining the success of IS has meant a wakeup call for information scientists to develop a much richer conception of what organisations are, how they behave and how they are likely to respond to the introduction of new information technologies (Checkland and Scholes 1990). Section 3.3 above has described three perspectives on the implementation process for technological innovation. Under the same frames, Campbell and Masser (1995), have provided a convenient tripartite summary of the evolution of attitudes towards the host organisations into which IS are introduced. Under the ***technological determinism perspective,*** the host organisation is assumed to provide an unproblematic, almost unconsidered, environment into which new systems can be introduced. Any problems within the organisation are symptomatic of old-fashioned thinking of Ludditism (Reeve and Petch 1999). The ***managerial rationalism perspective*** recognises that introducing new technology will cause some problems of adjustment within the organisation. However, this perspective still considers the implementation process to be dominated by technical factors rather than by organisational structures and strategies (Cullis 1996), because the conception of an organisation is still that of a rational, almost machine-like, structure which is amenable to logical adjustment. Problems arising in the process of introducing a new technology, therefore, can be accommodated by logical restructuring of organisational procedures. The ***social interactionism perspective*** view organisations as very complex, social structures which cannot be expected to behave rationally. It views organisations as being composed of groups of individuals each with their own motivations and ambitions (Checkland and Holwell 1998, Campbell and Masser 1995). In such a conception, the implementation of a new technology, no matter how impressive, is by no means assured (Reeve and Petch 1999). Whether an information system is a success will depend upon a complex interaction of, often informal, political and social forces within the host organisation. If individuals and groups in the organisation cannot be persuaded to adopt the new system, the system is little more than very expensive junk (Reeve and Petch 1999).

Reflecting on a history of introducing IS in organisations, Eason (1988) concluded that the process had proved to be high-risk taking, where complete failure is not uncommon. Eason compares the difficulty of introducing IS into an organisation to that of transplanting an organ into a human being. If all goes well and the host accepts the transplant, great benefits can be achieved, but there is a great risk of rejection and failure. Sometimes success is achieved only by taking actions so drastic that they severely weaken other parts of the organisation (Reeve and Petch 1999). These two authors also note that there are stories of systems failing, products failing to meet their specifications, suppliers being sued by clients, clients switching suppliers halfway through projects and projects being unceremoniously ditched. Wastell and Newman (1993) have argued on the same line that many dysfunctions of IS implementation are due to its inherent stressful nature and the adverse impact that this has on participants. This stressfulness emanates from the high complexity (technical and managerial) of IS projects, that such undertakings typically involve a daunting combination of exacting cognitive demands, high levels of risk and uncertainty, political strife and the need to accommodate multiple stakeholder interests (Wastell 1999).

Specifically, research on GIS and organisations has shown that the difficulties associated with the introduction of GIS into organisations are primarily due to the complex nature in which organisations adopt new systems (Campbell and Masser 1995, Huxhold and Levinson 1995). Somers (1989) provides a useful perspective on organisational change and GIS. Campbell and Masser (1995) offers an insightful analysis of organisational factors in the utilisation of GIS. The adoption is influenced by a variety of factors including internal organisational context, management activities, and personal factors. This adds to the external factors that must be taken into consideration as well as development process per se (Onsrud and Pinto 1993).
One of the organisational benefits of GIS is said to be improved decision-making process (Maynard 1992). Ironically, not much research has been done to try to understand how (and even if) the introduction of GIS in deed impacts the decision-making process, especially in developing countries. Another yet important benefit of an organisational GIS is the ability of the organisation to think corporately through the integration and dissemination of information in the form of a common business model (Cartwright 1990). Moreover, GIS creates opportunities for organisations to get involved in new areas of business due to their ability to rapidly and effectively process spatial information. As already established by Campbell (1991), the process of introducing GIS into an organisation is a social process relating to people's lives and power structures as much as it does to information flows. Organisational problems are often more complex and more crucial to success than the technical problems involved (Campbell and Masser 1995).

Onsurd and Pinto (1993) reviewed GIS implementation from an organisational theory perspective. They listed over 30 factors that might influence the adoption of GIS within organisations. Incentives and barriers to change in organisational practices included personal factors, real and perceived costs and benefits, intra- and inter-organisational communications, organisational and decision-making structure, methods of technology introduction and training and many others. Organisations experience resistance to the introduction of GIS for various reasons. Often it is due to the fact that it disturbs traditional ways of doing things and requires managers to think and structure the organisation in new ways. Other times resistance revolves around specific personalities and power plays (Huxhold and Levinson 1995). Fear of change takes the form of bureaucratic inertia when agencies seek to maintain the status quo by fulfilling their explicit mandates as narrowly and expeditious as possible, rather than seeking more effective ways to serve policy makers and the public. These social factors (among others) are probably the most important ones slowing down the development of GIS and other IS in developing countries.

2.9. Summary and Conclusion

This chapter has reviewed six bodies of literature deemed relevant for the current study. The chapter has thus provided an insight of a very broad range of debates and approaches that can be related to GIS and its related technologies. In this section, a synthesis of the chapter is provided.

The use of GIS has become all pervasive by its applications in all spheres of life, and GIS technology is impacting societies profoundly. The nature and forces of this technology have both clear and blurred impacts on the way societies view, value, and use spatial information in decision making process. Although more recent work about GIS and society has become more nuanced, the earlier polemical phase still influences the discipline's intellectual agenda in the discipline. PGIS has become an area of growing significance and active interest at all scales. This interest stems mostly from the concern that those using the GIS run the risk of promoting a top-down technocratic planning and decision-making process. That is to say, the so called 'GIS experts' will impose their ideas on local indigenous communities, thereby disempowering them.

When considering the ongoing rapid pace of current technological advances in the filed of Internet connectivity and its relation with GIS, it is clear that these trends are set to continue for the foreseeable future. What is not clear however, is whether societies, especially those in developing categories (see chapter 4), and even more particularly in remote rural areas, will be able to keep pace with these changes.[32] The Internet can be viewed as a huge breakthrough broadening the use and accessibility of GIS technology. GIS practitioners are thus forced to resolve issues of privacy, confidentiality and data ownership.

GIS is a modern technology that has seen a steady increase in popularity as more and more organisations adopt and implement it. Along with this increased interest has come a boosted awareness of the complexity and difficulties that most often exist in attempts to introduce and implement GIS in organisations. Unfortunately, research has mostly concentrated on attempts to develop strategic frameworks that organisations can follow to implement the GIS. Such frameworks are predominantly informed by innovation diffusion's pro-innovation bias. Generally, much effort has focused so much on the technical side of GIS while neglecting to develop a concomitant understanding of the non-technical actors in the implementation of GIS and related technologies. ANT theory was presented as an alternative framework within which the complexity and difficulties of GIS implementation can be studied.

[32] See for example the TCRC case study presented in chapter 8 of this thesis.

Chapter 3: Research Methodology

3.1. Introduction

In chapter two, I have described and contrasted two approaches under which the implementation process of GIS could be investigated; the traditional diffusion innovation approach and the alternative innovation translation approach provided by ANT. Underpinned by pro-innovation bias, diffusion innovation expects the adoption and diffusion process of an innovation to take place in a sequential manner. To those of us who have been involved in the actual implementation process of GIS, it is clear that the process is rather complex, crammed with emerging phenomena. Despite this fact, some researchers (see chapter two) have concentrated on the final result of the implementation process, and by omission of the details of the process, inadvertently make the process seem straightforward and carefully planned and organised. Latour (1987) has argued that scientific research is not the logical top-down that it is often represented as being. Like Latour, I will contend that GIS implementation process is nothing of the sort. Instead, I will argue that to understand the implementation process of GIS, and how human and non-human interactions contribute to the final result, we need to use approaches that allow complexity to be traced. Alternative approaches to diffusion innovation have been developed in the literature that deals with the introduction of complex technologies in new social settings. In the field of information systems, ANT has been recognised as having a potential for understanding the complex socio-technical interactions associated with information systems (Hanseth and Montiero 1996, Walsham 1997).

Walsham (1997) has argued that ANT is both a theory and methodology combined, in that it allows a researcher to trace and document network entities, processes of translation and inscription, the creation of black boxes or immutable mobiles and the degree of stability and irreversibility of networks and their entities during his or her empirical work. In light of the characteristics of interpretive perspective research (will be discussed below in this chapter), it seems appropriate that this research adopts an interpretive stance from the perspective of ANT. Justification for the use of ANT is the fact that it recognises the complexity and disorderliness of the social system in which GIS technology is attempted to be implemented. Moreover, it allows investigations of social and technical issues of technology in a specific context.

3.2. Research Philosophical Perspectives

Guba and Linchon (1994) advise that there are four different philosophical perspectives that underlie qualitative research: positivism, post-positivism, constructivism and critical perspective. In relation to information systems, Orlikowski and Baroudi (1991), Hirschheim (1992), Walsham (1993, 1995 & 1998), and Klein and Myers (1999) offer three: positivist, interpretive and critical perspective.

3.2.1. Positivism perspective

A research can be classified as positivist if it is presented as being objective (Klein and Myers 1999, Orlikowski and Baroudi 1991). In consequence, positivism means valuefree. Positivism research seeks to explain and predict what happens in the world by searching for regularities and causal relationships between its constituent elements (Burrell and Morgan 1979). Generally, it assumes that reality is objectively given and can be described by measurable properties which are independent of the observer (researcher) and his or her instruments (Levin 1988, Carson *et al.* 2001). It means that the observation of phenomenon must be neutral and uncorrupted by theory, if the verification principle is to hold (Williams and May 1996). This often involves manipulation of reality with variations in a single independent variable in order to identify regularities in, and to form relationships between, some of the constituent elements of the social world. Predictions are made on the basis of previous observations and realities and their interrelationships. Positivist research can be replicated by carrying out the tests in the same conditions that originally existed.

Orlikowski and Baroudi (1991) noted that 96.8% of research in the leading IS journals follows a positivist tradition. Similarly, Alavi and Carlson (1992) carried out a review of 902 IS research articles, and found that all the empirical studies were positivism in perspective. In the case of GIS, Harvey and Chrisman (1998) has argued that GIS has its roots in the scientific principles of cartography and mathematics – which are also situated in positivism. Sahay (1998) added that positivism in which GIS is grounded was contributed to by the quantitative revolution of the 1980s within the field of geography. There has also been much debate on the question of whether or not positivism paradigm is suitable for the social sciences, with many researchers calling for a more pluralistic attitude towards IS research methodologies (Hirschheim 1985, Bjørn-Andersen 1985, Checkland 1981, Hirschheim 1992, Walsham 1998).

For social scientists, human beings do not behave according to causal relationships (as the positivism reasons), but they are constructed values. These values need not to be described but understood in their contexts. In order to achieve this understanding, researchers immerse themselves in the social contexts they are studying so as to hear, see, and begin to experience reality as the participant (Marshall and Rossman 1989). As Orlikowski and Baroudi (1991) notes, positivist research tends to ignore the fact that people think and act, that people are active makers of their physical and social reality. For example, in organisational studies, positivist research will study the way the organisation has been in the past, but then presume that patterns observed in the past will repeat themselves in the future. Organisations are thus often understood to have a structure and reality beyond actions of their members (see chapter two). Nonetheless, as implied by Hirschheim (1985), some of the difficulties experienced in IS research could well be attributed to the inappropriateness of the positivist paradigm for the domain. Similarly, some elements of reality might have been previously thought unmeasurable under the positivist paradigm and hence went unresearched (Galliers 1991). This can be expected because being reductionist in nature, positivism tackles specific aspects of the phenomenon being investigated, building an understanding of parts rather than wholes.

3.2.2. Interpretive perspective

A research is classified as interpretive if it is assumed that our knowledge of reality is gained through social constructions such as language, consciousness, shared meanings, documents, tools, and other artefacts (Klein and Myers 1999). Interpretive research address the world from the point of view of the people studied (Hammersley 1992); it attempts to understand phenomenon through meaning that people assign to them (Orlikowski and Baroudi 1991). The main idea is to reach an in-depth understanding of the social world and to interpret the meaningful character of social action (Klein and Myers 1999). Such in-depth understanding requires a researcher to immerse him or herself in the phenomenon to be studied (Carson *et al*. 2001). Thus instead of separating the researchers from the subjects and seeing them as simple sources of data, interpretive research defends and promotes the engagement between the researcher and the subject (Orlikowski and Baroudi 1991). However, such engagement must be exposed transparently so as to describe the conditions in which the results were found, i.e. research should be conducted subjectively. It is then required that the subject matters be set in their social and historical context so that the intended audience can see how the current situation under investigation emerged. Interpretive methods of research in IS are aimed at producing an understanding of the context of the systems, and the process whereby the systems influences and is influenced by the context (Walsham 1993).

Interpretive research does not predefine dependent and independent variables, but focuses on the complexity of human sense making as the situation emerges (Kaplan and Maxwell 1994). In organisational studies, for example, interpretive researchers insist that any observable organisational patterns are constantly changing. In IS research, they argue that organisations are not static and the relationships between people, organisations and technology are not fixed but constantly changing. In this view, interpretive seeks to understand a moving target, and each instance is treated a unique historical occurrence. Thus interpretive research is idiographic (Klein and Myers 1999). Because of this, some researchers have accused interpretive research for a lack of generalisation. On the other hand, Klein and Myers (1999) have remarked that one of the outcomes of the extensive debates in philosophy is that there is a philosophical basis for abstraction and generalisation in interpretive research. According to Walsham (1993), there are four types of generalisations from interpretive case studies: the development of concepts, the generation of theory, the drawing of specific implications, and the contribution of rich insight. As Walsham stresses, the key point is that theory plays a crucial role in interpretive research, and clearly distinguishes it from just anecdotes. But it should be noted that theory is used in a different way than is common in positivist research where researchers are interested in falsifying theories. In interpretive, theory is used as a "sensitising device" to view the world in a certain way (Klein and Myers 1999).

Although agreed that interpretive research does not subscribe to the idea that a predetermined set of criteria can be applied in a mechanistic way, it does not follow that there are no standards by which interpretive research can be judged. Klein and Myers (1999) have suggested a set of seven principles for conduction and evaluation of interpretive field research in IS, (summarised in Table 3.1). Particularly Klein and Myers' principles were concerned with addressing the evaluation of criteria for case studies and ethnographies, as long as the underlying philosophy is interpretive. In developing their principles, they used a hermeneutic philosophical perspective (the philosophical base of interpretive research). The authors see these sets of principles consistent with a considerable part of literature on interpretivism, and have even made some effort to apply these principles to some published interpretive research work. Agreeably, it is better to have some principles than to not have any at all, as the absence of any criteria is likely to increase the risk of interpretive research seen inappropriate. As the two authors stresses these principles are not like bureaucratic rules of conduct, because the application of one or more of them still requires considerable creative thought. This follows in part from the idiographic nature of interpretive research.

Interpretive approach is not as popular in IS research as has been positivist approach. For example, in Orlikowski and Baroudi's (1991) study, interpretive studies were found to comprise only 3.2% of the research sampled.

Table 3.1: Summary of principles for interpretive field research (after Klein and Myers 1999)

1. The fundamental of principle of the hermeneutic circle This principle suggests that all human understanding is achieved by iterating between considering the interdependent meaning of parts and the whole that they form. This principle of human understanding is fundamental to all other principles.
2. The principle of contextualisation Requires critical reflection of the social and historical background of the research setting, so that the intended audience can see how the current situation under investigation emerged.
3. The principle of interaction between the researchers and the subjects Requires critical reflection on how the research materials (or data) were socially constructed through the interaction between the researchers and participants.
4. The principle of abstraction and generalisation Requires relating the idiographic details revealed by the data interpretation through the application if principles one and two to theoretical, general concepts that describe the nature of human understanding ad social action.
5. The principle of dialogical reasoning Requires sensitivity to possible contradictions between the theoretical preconceptions guiding the research design and actual findings (the story which the data tell) with subsequent cycles of revision
6. The principle of multiple interpretations Requires sensitivity to possible differences in interpretations among the participants as are typically expressed in multiple narratives or stories of the same sequence of events under study. Similar to multiple witness accounts even if all tell as they saw it.
7. The principle of suspicion Requires sensitivity to possible “biases” and systematic “distortions” in the narratives collected from the participants.

3.2.3. Critical perspective

The critical approach is concerned with the way in which current social arrangements fail to meet human needs and ideals (Orlikowski and Baroudi 1991, Hammersley 1995). Their objective is a political one, which is to fight oppression and radically change the status quo (Burrell and Morgan 1979). Proponents of this approach believe that social reality is historically constituted and that it is produced and reproduced by people. While recognising that people can consciously act to change their social and economic conditions, they argue that their ability to do so is constrained by various forms of social, cultural and political domination (Klein and Myers 1999). Their main focus is on the oppositions, conflicts and contradictions in contemporary society, and thus seeks to be emancipatory. Research in IS is classified as critical if the main task is seen as being one of social critique, whereby the restrictive and alienating conditions of the status quo are brought to light.

3.2.4. Choosing of interpretive perspective

After reviewing the three above-described perspectives, I have concluded that the best alternative for the current study is interpretive. Reasons for choosing interpretive approach are as follows. First, since I am interested in investigating the complexity of GIS implementation process, it means that I must gain an in-depth understanding of the situation by tracing the actors and events, and describe them. Using interpretive will allow me to increase my understanding of the critical, social and technological issues related to the implementation of GIS in the host organisations.

Second, interpretive approach allows me to consider my own experience of implementing GIS in Namibia, so as to enrich the study. It recognises the value content of research, and encourages researches to expose their values and to be more aware of them during the research process as to be more conscious of their biases.

3.3. Research Methodology

Four methods of data gathering were used to elicit the needed information: review of the literature, author's participation in international and regional conferences, workshops and seminars with themes relating to the current study, survey questionnaire and case studies. (In addition, the author's perspective informed the research).

Literature review and participation in conferences and workshops provided an opportunity for testing and expanding the understanding of the research problematique, and allowed exchange of research experiences. Some of the statements, meanings and ideas developed in this thesis originated from in-depth deliberations held with individuals at the conference. Participants in these deliberations were diverse GIS users actively involved in GIS projects in their respective African regions and countries. The discussions were held to determine what other African GIS users perceive to be the scale of implementation and effectiveness of GIS and related technologies in developing countries, more particularly in Africa. The following conferences and workshops were attended:

1) International Symposium on Open Access and the Public Domain in Digital Data and Information for Science, held in 2003 in Paris
2) The 2003 AfricaGIS Conference in Dakar
3) The 2005 AfricaGIS Conference in Pretoria
4) The 2004 African Association of Remote Sensing of the Environment (AARSE) Conference in Nairobi
5) The SADC-SDI workshop held in 2004 in Pretoria
6) Planning workshop for demographic GIS in Namibia, held in 2005 in Windhoek
7) International workshop on strategies for permanent access to scientific information in southern Africa, held in 2005 in Pretoria

The time spent in doing field research represents, however, the core of the research. Empirical materials were gathered through an exploratory survey questionnaire and descriptive case studies. The reminder of this chapter describes in detail the methodology of and the rationale behind the empirical study.

3.3.1. Survey questionnaire

One of the goals of this study is to investigate the perceptions of the Namibian GIS community (state, NGOs, parastatals, academia and private sector) on four broad issues:

1. The depth of knowledge and understanding of GIS
2. The extent to which GIS technology and methods are implemented
3. Successful and unsuccessful GIS applications and implementation models
4. Attitudes and perceptions with respect to the impacts of GIS
5. Perceptions and organisational problems during GIS implementation

A survey questionnaire method was found appropriate to extract such information from the GIS community. Survey questionnaires usually inform research by providing information from a known sample of people gathered. Typically, data from survey questionnaire is collected without researcher intervention.

Two versions of structured questionnaire were designed to address two different target groups:

1. GIS direct users (power users): *staff members who directly (hands on) use GIS technology.*
2. GIS indirect users: *staff members who do not directly use GIS technology, but uses it indirectly (for example, by requesting GIS products from the direct user group). This category included immediate supervisors of the power users, managers and the top management of the organisations.*

The survey questionnaires are documented in Appendix two.

Pre-test of the survey questionnaires was carried out amongst GIS users (direct and indirect) colleagues at the MET, amounting to a sum of eight in total. This allowed minor changes to be made. The questionnaires were then, first sent out to 108 contact persons. These persons were identified from the National Metadatabase database, which was developed for MET in 2002-2003 (Noongo 2003). Another 17 contact persons were identified from NAMGIS website http://www.namibiagis.com, and still 58 others were identified during the course of this research, making a total number of 183 persons who received the questionnaire. The survey was administered via electronic mails, postal mails, personal visits and telephonically. In the cases where personal visits were made, it also provided opportunities for broad interviews with the users. The number of people who responded to the survey was 134 (43 non-power users and 91 power users).

In analysing the findings, the responses were entered on a Microsoft Excel pivot table from where the responses from all questions as well as for specific grouping could be accessed. The data was analysed using statistical analysis tools provided by Microsoft Excel. Descriptive statistics (percentage shares) were used to express the ratio of responses and enable interpretation of the data. Frequency tables presenting a numerical presentation of the distribution of the data were compiled. In certain cases cross tabulation tables or two-way tables are used for more than one variable. Some supporting statements from the interviews, comments from the survey responses, the literature and from my won experience were used in interpretations. The results are presented in chapter five.

3.3.2. Case study methodology

The information systems literature on ANT is almost solely confined to case studies. The need to study a complex topic within its organisational context led me to adopt a case study methodology. A case study involves a detailed examination of a single or a particular occurence (Merriam 1998). Its main concern is the detail and complexity of the case which it treats as a bound system (Stake 1988). Yin (1984) regards a case study methodology as the preferred method for investigating questions that ask how or why of both historic and contemporary events. Case study evidence can be drawn from a variety of sources, including interviews, direct observations, participant-observation, documents archival records (Yin 1984). Stake (1995) records three different kinds of case studies; instinct case study in which there is an interest in learning about the case itself, instrumental case study where the purpose is to understand something else, and collective case study where several instrumental cases are studied to provide better understanding of something else. Whatever the case may be, he contends that a case study should be treated as an integrated system. Yin (1993) also distinguishes three types of case studies: exploratory, causal and descriptive. Exploratory case studies collect data before theories or specific research questions are formulated. Causal case studies will look for cause-and-effect relationships, and search for explanatory theories of the phenomena. Descriptive case studies will require a theory to guide the collection of data and this theory should be openly stated in advanced. The more thoughtful the theory, the better the descriptive case studies will be (Yin 1993).

Case study methodology has been recognized within the information systems arena as appropriate approach for researching a range of implementation, utilisation and impact issues of an information system (Zwart 1986, Niemann *et al*. 1988, NCGIA 1989, Azard 1990, Onsrud *et al*. 1992, Onsrud and Pinto 1993, Walsham and Sahay 1999). Likewise, other researchers (Yin, Bateman and Moore 1985, Lee 1989) consider a case study methodology to be the richest way to examine the nature and use of a sophisticated technology that is implemented within a complex medium. Onsrud *et al*. (1992) have noted that case study methodology is often criticised for apparent lack of rigor, hypothesis generation capacity, cross comparability, validity and replication. However, the authors have also demonstrated that rigor can be achieved through the use of formalised measurement protocols. Yin (1984) also argues that case studies are not statistical samples and that the goal in case study research is to understand behavioural logic, *analytical generalisation*, not to enumerate frequencies, *statistical generalisations.*

The first use of information obtained from the survey questionnaire was selection of organisations for case studies. The purpose of the case studies was to pursue more fully issues raised in the survey questionnaire by discussion them at length with key persons, and to observe firsthand GIS applications. In order to focus on case studies that would cover a wide range of organisations in Namibia, a set of four selection criteria was developed and applied. Organisations with the following merits were favoured:

1. Whose GIS are *fully established* over those in early stages of implementation.
2. Those with a *long GIS history* for which some conclusions have been reached over the years.
3. Those that are *locally* based over those that are regional or international branches.
4. *Non-supplier* organisations whose purposes with GIS are research, policy or management, over those that existed simply to provide data to others.

Three organisations were selected for in-depth case studies (Table 3.2) below. It was also my intention to investigate organisations that represented different sectors and different approaches towards GIS implementation. In the selection of these three organisations, caution was also practiced so that the studied organisations represented different regions of the country, in order to avoid using all organisations based in Windhoek (see chapter six) as this would not have been a good representative to make comprehensive conclusions. I have also purposely avoided using organisations whose GIS implementation has already been studied by other researcher in one way or another.

Table 3.2: Organisations selected for case studies

Organisation	**Sector**	**Length with GIS**	**Focus**
Municipality of Walvis Bay	Parastatal	Since 1996	Town planning
Central Bureau of Statistics (CBS)	Government	Since 1999	Census mapping
Tuyeni Community Research Centre	NGO	Since 1996	Natural resources

A contact letter was written to the selected organisations inviting them to participate as case studies. The letters described the research intentions as purely academic, although the findings might benefit them. All three organisations respondent in agreement, and they suggested individuals that would serve as my contact persons. At the Municipality, the contact person was the chairperson of the GIS Steering Committee, while at the other two organisations the contact person was one of the power users (see below). The contact persons assisted in identifying and organising appointment for me to see their colleagues who are involved in the implementation and use of GIS. Some suggested informants were in different towns and some in different countries. For a thorough understanding of the complexity of GIS implementation, I visited those other informants in different towns and in the neighbouring countries (South Africa and Botswana). The decision to personally visit them for a face-to-face interview was reached when attempt to interview them telephonically proved unproductive. Email contacts were also established for those that were in different parts of the world, unfortunately many of them did not respond.

Participants can be grouped into three categories by their relationship to GIS:
Category one: *GIS power users and their immediate managers*
Category two: *Top management of the organisations*
Category three: E*nd users of the systems*

The initial interviews were conducted with category one participants, who were identified from the selected departments and projects involved in GIS implementation through a contact person at each organisation. They provided information relating to[33]:

- Historical development of GIS in the organisation (who were the main actors, their extent of involvement, and their relationships and interactions with other actors)
- Activities and objectives (GIS planning and strategies)
- Management issues (top management commitment, lines of communication and coordination mechanisms, costs and benefits, skill development, allocation of resources)
- Applications (past, current and planned, scale of implementation)
- Organisational computing environment (procurement approvals, networking, degree of system usage throughout department or organisation, strategic planning)
- Data and information issues (content, complexity and scale of spatial database, spatial database acquisition and quality control, methods for updating, linkage to SDI initiative)

Discussions with these persons moreover provided a deeper understanding of actor- networks within and across departments and projects, and additional participants were selected from these networks. Some key personnel were interviewed on more than one occasion.

Interviews with category two participants were conducted to learn the organisational viewpoint on their GIS projects. They provided information relating to[34]:

- The impacts of GIS technology in the organisation's goals
- Changes in organisational structure as a result of GIS implementation
- Internal uses of GIS products
- Future directions in the growth of their GIS.

Category three participants were interviewed to explore how they were making use of the results and products generated by GIS. Their particular interviews were also meant to learn whether GIS products were effective in their intended use.

Interviews lasted from 50 minutes to 2 hours. Extensive notes were taken during each interview. Tape recording was used in the first three interviews, and was soon abandoned because it was felt that participants were somewhat inhibited in their views when being recorded. Before starting the interview, respondents were clearly informed that the interviews were purely for academic research purposes. This gave many individuals a space in which they could reflect on and freely expresses their own reactions and views. For each case, prior to embarking on fieldwork, I conducted extensive web and library searches to familiarise myself with the participants context and tasks as much as possible before meeting them, so as to adapt the interview to their sphere of

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[33] The questionnaire in Appendix three guided the interviews and thereof discussions.

[34] The questionnaire in Appendix three guided the interviews and thereof discussions.

activities. The interviews led to additional readings (published and unpublished documents, internal reports, electronic mail archives, workshops proceedings, meeting minutes and WebPages). Additional information was provided by informal contacts with personnel outside the formal interviews. The approach used in the case studies interviews closely followed the web model described by (Kling 1987, Kling and Scacchi 1982, Yin 1984).

In ANT, non-human entities (e.g. technology) are also actors in the actor-network. It means that their roles in the network must also be identified and assessed. While it was easy to interview the human actors, the part of assessing the roles of the technology in actor-network terms presented a challenge. To make up for this, interviews laid emphasis on questions about the use and problems associated with GIS implementation. From the responses, I was able to interpolate the varying roles of the technology.

3.4. Informant's anonymity

Throughout the write-up of the survey questionnaire, the informants remained anonymous to protect their identity, and only the organizations they represent are mentioned. In the case of the case studies, informants had a choice whether to be mentioned or remain anonymous.

3.5. Potential Biases

The research strategy presents several potential weaknesses, including its limited generalisation beyond a narrow range of cases. As already pointed out some authors have criticised the qualitative case-based approach for its difficulty in generalisation beyond a few specific contexts.

The criteria designed for the selection of organisations to be studied as case studies presented the risk of overlooking important organisations. However, the Namibian GIS community is relatively small and many organisations and their characteristics are connected in various ways. This point was established by the results of the survey questionnaire, which demonstrated homogeneity among organisations with various applications of GIS. It is thus, seen realistic that three case studies would make a fair representation of the situation in Namibia. But still, neither the survey questionnaire nor the case studies claim comprehensive coverage.

As with any survey questionnaire or interview, the respondents, their experiences, training, background and organisational culture will bias their answer. To try to counter this, respondent's names are not shown, only their organisations, where quotes are made.

The author's own opinion about GIS implementation in Namibia bears the risk of certain subjectivity in the assessment of the compiled information. This is aggravated by the use of mainly qualitative information based on a number of self-assessed case studies, and especially that the author has had working relations with some of the persons interviewed. The overall analysis of both the survey questionnaires and the case studies cannot be separated from the author's own experience. These experiences clearly influence the thinking and the writing expressed in this thesis.

Chapter 4: GIS in Developing Countries

4.1. Introduction

The two aims of this chapter are to review the general conceptual approach to the topic of GIS in developing countries (figure 4.1), and to give an overview of the historical development as well as the present state of GIS development in Africa. The various challenges associated with GIS implementation in developing countries are explored and, in turn, the differing processes of GIS implementation are considered.

It should be stated at the onset that the task of this chapter is not an easy one. It poses a major challenge in that it inevitably forces the author to simplify and generalise to a greater extent. For most of the statements and conclusions presented in this chapter therefore, there will be exceptions. This is because developing countries cannot themselves be placed in one category. For example there are countries such as Burundi, Rwanda and Cambodia, which are extremely poor and/or are politically unstable. Then there are countries like South Africa, Malaysia, Thailand and Brazil, which are far better developed and have even developed their own GIS software. In Africa, there are a few countries that own a satellite, namely, Algeria, Nigeria and South Africa. The extent of GIS development in some countries does not even exactly fit the GIS developing nation stereotype due to the availability of technology, training opportunities and support for GIS implementation.

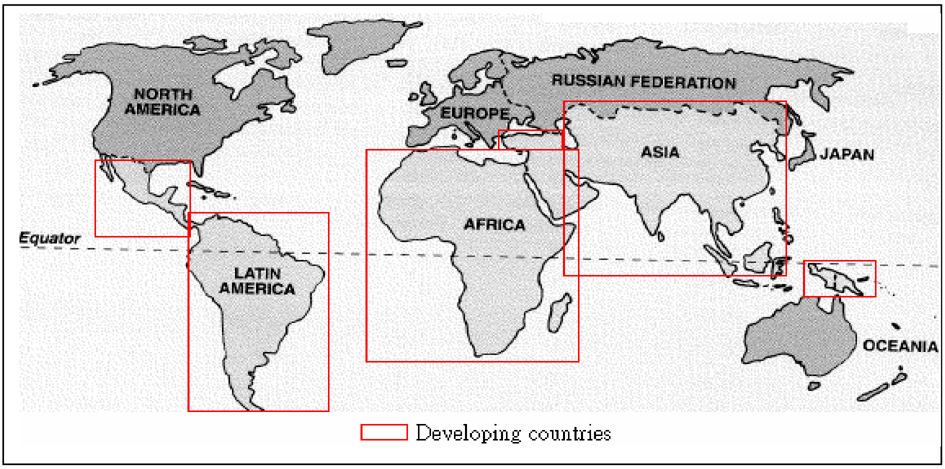

Figure4.1: Map showing developing countries

4.2. GIS in Developing Countries

Since its innovation, GIS has been perceived as a big improvement, and was often presented as a revolution in understanding geographical reality, and being the solution to the many earlier problems of environment and development in general. These perceived advantages were soon broadly recognised to lead better decisions and guide development in developing countries. Hence, in the late 1980s and the early 1990s the theme of "GIS in developing countries" was high on the discussion agenda and triggered a large volume of publications. Some authors focused on general conceptual approach to the topic (e.g. Freeland 1986, Cartwright 1987, Burrough 1992, Hall 1993), others searched to document the history and origin of GIS in developing countries (e.g. Akom 1982, Chen 1987, Taylor 1991, Nkambwe 1991, Ottens 1992, Van Teeffelen *et al*. 1992), some were comprehensive studies (academic dissertations e.g. Borley 1991, Simonette 1993), and still most others detailed project-specific GIS application in a certain region or country (e.g. Taylor 1980, Hardy 1987, Hyde 1991). A large number of review and discussion articles were also published in journals. For example, the *International Journal of GIS* devoted the whole issue of (1991, Vol. 5:1) to the topic. The articles in this volume formed an important milestone in the international discussion and debate on GIS in developing countries. In 1993, the German GIS *Journal Geo-Informationssysteme* dedicated another volume (1993, Vol. 6:2) to the same topic, with specific focus on case studies of German technical co-operation projects in developing countries.

The United Nations Conference on Environment and Development (UNCED) in 1992 widely acknowledged the advantages of GIS and explicitly proposed the simulation of technologies such as GIS and remote sensing in developing countries, to help overcome environmental problems (Agenda 21; chapter 40). In many ways, the recommendations of the UNCED also marked a natural progress of GIS implementation in developing countries. From 1992 onwards, international conferences on "GIS in developing countries" (GISDECO) were held in the Netherlands. The proceedings of the first GISDECO provided a solid synopsis of issue and trends of GIS development in developing countries at that time (Van Teeffelen *et al*. 1992). To date, the GISDECO conference series has been run every two years since its inception in 1992. The fourth conference held in 1998 in Pretoria, South Africa was the first held outside of the Netherlands. Events and conferences of this nature marked a gradual evolution towards maturity in GIS research in developing countries.

4.2.1. Temporal aspects of GIS development in developing countries

According to Christiansen and Van Teeffelen (2003), the innovations that prepared the ground for GIS adoption in developing countries started in the late 1970s with the work of Taylor (1980) in rural development application in Kenya. It was nonetheless the introduction of the IBM XT computer around 1982 that marked the beginning of GIS innovations in developing countries (Van Teeffelen *et al*. 1992). Since then, a number of early adopters have multiplied as donor organisations and consulting companies spread the technology (mainly the software) through cooperation projects. Primitive GIS - a combination of DBMS and CAD (Christiansen and Van Teeffelen 2003) were the first introduced.

In Africa, Ghana was one of the first countries experimented with technical innovations. Akom (1982) describes the difficulties associated with planning of computer GIS in developing countries, with particular experience from Ghana. In Mozambique, Freeland (1986) reports on (probably one of the first) software benchmark tests for GIS in Africa. Yapa (1988) has a detailed report on a GIS project in Sri Lanka: computer-aided regional planning. And Yeh (1987 – cited in Christiansen and Van Teeffelen 2003) provides an overview of early GIS activities in China. Already in 1987, the importance of information management was recognised in Sudan, although not necessarily from the viewpoint of a GIS. Calhoun *et al*. (1987) provide a report on attempts of establishment of computer IS in Sudanese Ministry of Finance and Economic planning. It was in deed these kinds of projects that marked the beginning of regular use of GIS and other computer IS in developing countries. Based on Akom (1982), Yeh (1987), Calhoun *et al*. (1987) and Yapa (1988) reports, the complexity of computer systems, a lack of appropriate skills, poor physical infrastructure and support systems, and high prices of equipments presented major obstacles and limited the spread of GIS to only a few installations. Van Teeffelen *et al*. (1992) notes that the real breakthrough of GIS adoption and implementation in developing countries arrived only in the early 1990s. Apparently this breakthrough has been induced by a sudden fall in computer prices, and availability of PC-based GIS programmes, which are comparatively easy to use.

Improvements on the availability of complementing systems such as GPS-receivers in developing countries further promoted the adoption and diffusion of GIS.

The adoption and implementation of GIS in developing countries can be put in three phases: initial-, proliferation- and ripe-phase. These phases are briefly described below.

4.2.1.1. The initial phase

The initial phase occurred very slowly, in risk-taking organisations at the urging of agents of change. In many countries this phase has been characterised by a gradual shift from analogous to digital methods and techniques (Crosswell 1991, Onsrud and Pinto 1993, Somers 1995). As could be expected, this phase was also characterised by almost all imaginable problems and frustrations. Van Teeffelen *et al*. (1992), documented most of the problems encountered; primitive hardware, difficult-to-use software, lack of computer- and GIS-literate staff as well as missing, sketchy, out-dated or obviously wrong data sets. As seen above, this phase has its prominence in the 1980s in countries such as Sri Lanka, China, Brazil, Ghana and Mozambique. In terms of organisational embedment, this phase was very much characterised by pilot projects with goals of testing and promoting GIS in developing countries. These pilot projects were introduced mainly in mapping and survey departments and most applications were of environmental concern.

4.2.1.2. The proliferation phase

Eventually, in the late 1980s and the early 1990s, GIS was increasingly spreading and winning its way in many countries. The spread of GIS in developing countries has apparently followed a sequence: first in Asia, then in Latin America and finally in Africa (Eason 1993, Christiansen 1998, Christiansen and Van Teeffelen 2003). Christiansen (1998) also noted that there was a time-lag of some years before this phase finally hit Africa. By this time, GIS diffusion in developing countries was primarily in the hands of international agencies, the UN programmes and bilateral agreements. Hence, most (if not all) of GIS activities were externally funded or were based on bilateral agreements (Kam 1996). With such as strong external dependency, the aid providers took the credit of manipulation and management of data sets, in a way that local involvement was very little (Woldai 1995). Mostly, these projects demonstrated the use of GIS on specific purposes, and did not necessarily attempt to establish a real demand. Many applications of GIS during this phase remained within the realm of mapping and inventory. In terms of organisational embedment, participating organisations were commonly the willing ones, usually with national mandates of monitoring or assessment of natural resources (Kam 1996). This period was also largely dominated by technological determinism approaches with little concern given to contexts of local adopting organisations (Christiansen 1998).

4.2.1.3. The ripe phase

In this phase, GIS is considered a mainstream technology. As Christiansen and Van Teeffelen (2003) pointed out, GIS is no longer considered an innovation but seen and used as a standard tool. While there is some truth in this, it remains debatable if many developing countries (especially African countries) have in deed reached this phase yet, given that many GIS activities in many countries are still externally funded. Moreover, as Campbell and Masser (1995) demonstrate, the adoption of a new technology and its effective utilisation are two very different things. What is obvious however is that developing countries have taken special interest and focus in exploring and promoting the use of GIS in various applications. This is for example manifested by various initiatives such as the increasing staging of continental (e.g. AfricaGIS, AsiaGIS), regional (e.g. SADC –SDI) and national conferences.

As Christiansen and Van Teefelen (2003) observed, the extent to which GIS is adopted and implemented throughout developing countries seems to be related to the economic independence of its nation. The literature seems to suggest that countries that have certainly reached the ripe phase are typically those with a strong economic well-being. For example, the advancement of GIS in South Africa (Africa), in Brazil (Latin America) and in Malaysia and Singapore (Asia) all point to a relationship between economic well-being of a nation and its level of progress with GIS diffusion.

4.2.2. Implementing GIS in developing countries

The academic and professional GIS literature has examined a range of issues related to the implementation of GIS in developing countries (Croswell 1991, Taylor 1991, Van Teeffelen *et al*. 1992, Hassan and Hutchingson 1992, Linden 1992, Eason 1993, Onsrud and Pinto 1993, Simonett 1993, Sahay and Walsham 1993, Kammeier 1996, Standley 1997, Christiansen 1998, Somers 1998, Budic 1998, Ramasubramanian 1991 & 1999, Harvey 1999). Focus has tended to be on local and regional governments. As Ramasubramanian (1999) rightly commented, such focus is not surprising because governments are considered to be the biggest users of spatial data, and thus frequently GIS implementation pioneers (Huxhold and Levinsohn 1995). Issues investigated include; factors which enable or impede GIS implementation (Ramasubramanian 1991, Croswell 1991, Onsrud and Pinto 1993, Sahay and Walsham 1996, Kammeier 1996), organisation and staffing issues (Hall 1993, Somers 1995), characteristics of GIS users (Eason 1993, Budic 1998), appropriate methodologies to investigate GIS implementation (Onsrud *et al.* 1992), cross-cultural issues (Harvey 1999), socio-political implications of GIS use (Pickles 1995), and the impact of GIS on the lives of ordinary citizens (Sieber 1997). Overall, the literature provides a good grasp of GIS implementation problems. The inhibiting factors have often been referred to as “transfer of technology” problems.

The appropriateness of introducing high technology into system- and information-poor environments that lack skilled professionals and support systems is frequently questioned (Taylor 1991, Cartwright 1991, Ramasubramanian 1991, Simonett 1993, Cavric *et al*. 2003). Many efforts in the transfer of GIS are supported by international aid agencies and donors (i.e. United Nations Environment Programme’s Global Resource Information Database (UNEP/GRID), United Nations Centre for Regional Development (UNCRD), United States Agency for International Development (USAID), the World Bank, etc). Simonett (1993) noticed that transfer of GIS is often done in a rather ad-hoc, project-based manners. Such manners have been considered to advance top-down, policy-level approach (Woldai 2002). Simonett also noted that GIS transfer to developing countries through such projects has been too dependent on external factors. Hence, in most cases, the transfer processes have failed to address the need of recipient countries to adapt and develop their own ways of using GIS technologies based on their own needs and processes, using their own methods and practices. The World Bank and the UN projects especially received critics for their stimulation of bigger national or international GIS centres (Vos 2003). The critics considered such bigger GIS centres as the new “white elephants”, implemented without coordination, with out-dated or useless data, and lacking clear goals. Christiansen (1998) finds the World Bank negligent of the socio-cultural context of its information technology projects in Africa.

Christiansen (1998) describes the early stages of GIS technology transfer to developing countries as a phase in which technically well established technology was suddenly discovered and adopted by a new group of users.

> “Due to the lack of experience with GIS applications these new users neither had the required technical know-how nor did they dispose of a proper conceptual framework to integrate this new tool into the project management and planning procedures of where the technology was transferred. In their rush to jump on the GIS-train, these new users overestimated the benefits and underestimated the required efforts. Incomplete or

> inadequate needs assessment led to misidentification of functional requirements of a system; hardware, software and data." (Christiansen 1998)

Most of these critics and concerns stem from the argument that many developing countries face problems that are much more serious than a lack of computer systems[35]. While many discussions have focused on implementation constraints, in the author's opinion, many implementation failures are not reported or glossed to avoid criticism. Nonetheless, transfer of GIS has inevitably been a new technological challenge.

Of recent, the literature has suggested that it would be better to follow a stepwise implementation, often referring to participatory methods (Abbot *et al*. 1998, Ramasubramanian 1999a, Jankowski and Nyerges 2001, Craig *et al*. 2002, Weiner and Harris 2003, Wood 2005, Minang and McCall 2006, Taylor *et al*. 2006, Rambaldi *et al*. 2006). They argue that more success will be attained through cooperation and through indigenous development and participation. The need to include local participation in GIS implementation processes has risen particularly due to the growth in research on sustainable rural livelihoods (Scoones and Thompson 1994, Carney 1998, Scoones 1998, Bebbington 2000, Abbot *et al*. 1998), participatory rural appraisal (Chambers 1994 & 1997, Moser 1998), and political ecology (Peet and Watts 1996, Blaikie 1999). Although these traditions have divergent goals, they share a general interest in addressing local scale processes through the use of participatory techniques. Though, Abbot *et al*. (1998) and Harris *et al*. (1995) have cautioned that participatory methods can alternatively potentially disempower and reinforce top-down planning. Participatory GIS has also been a subject of GIS and Society discussion (see previous discussion under section 2.4 above), where the contribution of discussion has been invaluable in identifying critical issues in guiding the design of alternative systems for implementation. However, although participatory GIS is gaining more and more popularity, precise definitions about what exactly they include are not yet established.

There are many examples of GIS implementation in developing countries by outside interest. In most cases, the introduction of GIS has occurred either through direct funding or through indirect recommendations from consultants and funding agencies (Vos 2003). In this view, it is reasonable to assume that many examples of GIS implementation are not necessarily initiated from organisational needs, but rather from a perceived need by other sources. Considerable less attention has been paid to GIS research and development programmes initiated and sustained without foreign financial or technical assistance. Particularly, literature from developed countries leads to a patronising scenario in which scientists fail to perceive the real potential of local expertise. Taken to the extreme, this position leads to statements such as:

> "Although there is common sense in the view that, to be useful, GIS must be introduced by indigenous scientists who understand the technological and socio-economical context in which the systems are to operate, it presupposes that such indigenous scientists are already in place and are able to overcome the complex technical and human resource management problems that mire use of this technology in developing countries. If such people are in place, they are more often than not powerless to bring about real change, although in some isolated cases progress has been achieved." (Hall 1999)

According to the World Bank (1999 – cited in Vos 2003), in those developing countries where the explosion of GIS projects took place, GIS has helped to put the environment and sustainable development on the agenda of planners and decision-makers. The extent of adoption of GIS, however says very little about the effectiveness of the adopted technology. In practice, the impact of GIS has been highly questioned, contrary with the hyperbole about its potential blessings. For

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[35] Although computer systems have also be considered potential development tools for developing countries, (see Chapter one above).

example, the evaluation of the first years of GIS experience in developing countries has not been positive (Yapa 1991, Van Teeffelen *et al*. 1992, Christiansen 1998). In a study on the effectiveness of GIS in South-eastern Asian countries, Kammeier (1996) concluded that the actual performance of many GIS lags behind the potential of the hardware and software already installed. Based on a survey in 11 countries in Sub-Saharan Africa, Linden (1992) arrived at a conclusion that the majority of existing GIS's is hardly used or does not meet the initial expectations notwithstanding the serious need of spatial information technology because of urgent problems such as the rapid depletion of natural resources together with environmental degradation. Implementing GIS in bigger organisations within state bureaucracies has particularly virtually been impossible (Yapa 1991, Gupta 2002), causing a discussion on the usefulness and feasibility of GIS projects and a demand for more attention to organisational aspects of GIS implementation.

The reminder of this chapter will now concentrate on GIS developments in Africa (figure 4.2, map of Africa).

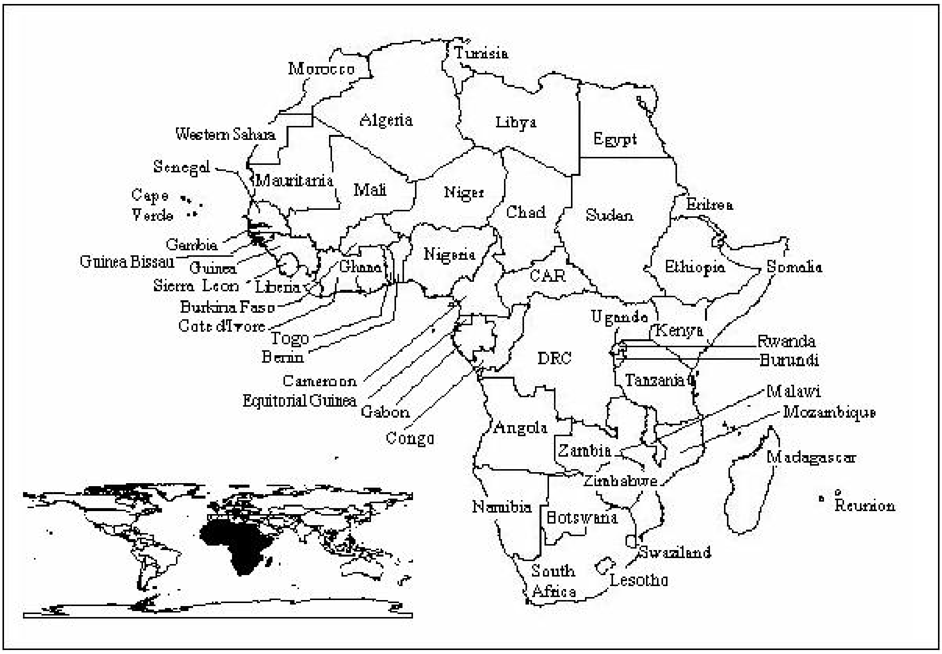

Figure 4.2: Map of Africa

4.3. GIS in Africa

4.3.1. Temporal aspects of GIS development in Africa

Understanding the ancestry of GIS in the continent provides a framework to understand its current extent of implementation and impact. Spatial information technologies in Africa are said to have started in the late 1970s (Hastings and Clark 1991), with its transfer by international agencies (Yapa 1991). Such transfer encompassed the acquisition of computer software, hardware and the development of human capacity to apply the technology. United Nations Environment Programme's Global Resource Information Database (UNEP/GRID) is central to GIS development in Africa. GRID, formerly established in 1985, became operational after several years of prototype testing and efforts to promote public awareness, including GIS for the production and application of spatial databases for global environmental study (Fanshawe 1985). Since then, GRID has been actively involved in providing support to African countries through training programmes and transfer of the technologies pertinent to GIS and remote sensing. GRID has worked dynamically with organisations and individuals in the continent to implement its programmes in different countries. Several incentives were given and many projects in various countries were conducted by donors to assist governments to build capacity in spatial information development (Prince *et al*. 1990). Generally, compared to many other GIS efforts in Africa, GRID has received a high profile, which Hastings and Clark (1991) regard as a mixed blessing.

Several bilateral programmes have concurrently been developed between certain African countries to help individual organisations in Africa to use GIS and related technologies. The Food and Agriculture Organisation (FAO) and the United Nations Institute for Training and Research (UNITAR), among other UN agencies have also been active in developing GIS and related technologies in Africa. Over the recent past, the United Nations Development Programme (UNDP) and the World Bank have also been gearing up. Primarily, much initiative of GIS in Africa resulted mostly from desires to apply computer technology to cartography, remote sensing, data management and environmental assessment (Hastings and Clark 1991). According to Nkambwe (2001) some organisations and sponsors have tended to over-emphasise their contribution as to justify their existence although they have not had a clear focus at specific areas of their contributions.

Regional centres for remote sensing and GIS

During the initial spatial information transfer period, a number of regional remote sensing and GIS centres in the continent were also created with international aid agencies assistance. The call for the creation of regional centres was first raised at the 8^{th} session of United Nations Economic Commission for Africa (UNECA) held in Addis Ababa in 1964. The purpose was for the centres to provide training in photogrammetry, photo interpretation and airborne geographical surveys. Under such initiatives, a group of countries would come together and draw up a charter that made each country member of a group a financial contributor to the running of the centre. According to Ribot (1985) (cited by Tchindjang *et al*. 2005), African continent since 1977 had five regional centres for remote sensing launched by UNECA (figure 4.3).

Such initiatives have had mixed success. Out of the five centres, only three have effectively functioned, while the other two (DRC - then Zaire, and Egypt) were short-lived, apparently because of a lack of attention to the local context and capacity (Ikhuoria 1999). The three remaining centres lived long with strong outside financial and technical assistance. The following account provides an overview of three remaining centres.

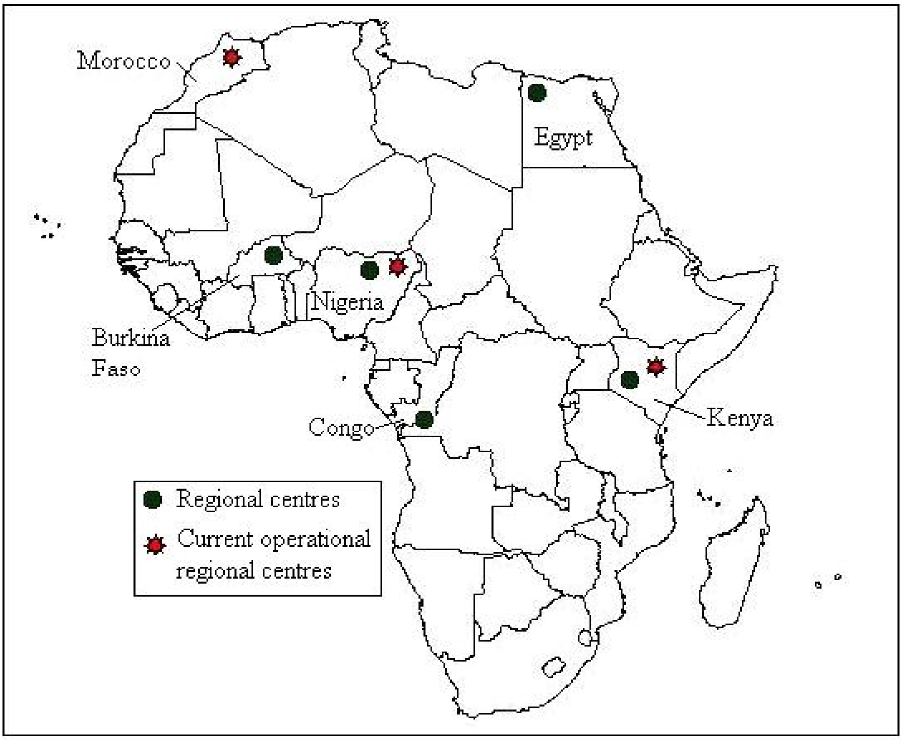

Figure 4.3: Regional centres of remote sensing and GIS in Africa

<u>*Regional Centre for Training in Aerospace Survey (RECTAS) in Nigeria*</u>
In 1971, four West African member states (Benin, Ghana, Nigeria and Senegal) signed the principal agreement that established RECTAS. RECTAS was eventually officially opened in October 1972, and four other member states joined thereafter (Burkina Faso in 1981, Mali in 1982, Cameroon in 1983 and Niger in 1984), figure 4.4. Until September 1987, the centre was known as Regional Centre for Training in Aerial Survey, before the name was changed and to become Regional Centre for Training in Aerospace Survey. The scope of RECTAS covers photommetry, remote sensing, cartography and GIS. Over the years, RECTAS has seen considerable level of readjustments to best fit in the social context of its country member states (J. Kufoniyi 2003, *pers. comm.)*.

For many years now, RECTAS has been active in: 1) providing theoretical and practical training in the field of geo-informatics, integrating photometry, remote sensing, GIS, cartography and airborne geophysical surveys, 2) conduction seminars, workshops and short-term courses with a view to providing an opportunity for dissemination of spatial information, 3) promoting studies and research in the field of geo-informatics, and 4) providing advisory and consultancy services to Governments of the member states of ECA, and other survey and mapping organisations in the region (J. Kufoniyi 2003, *pers. comm.)*. The consultancy service of RECTAS has included mapping, monitoring and management of natural resources and environment.

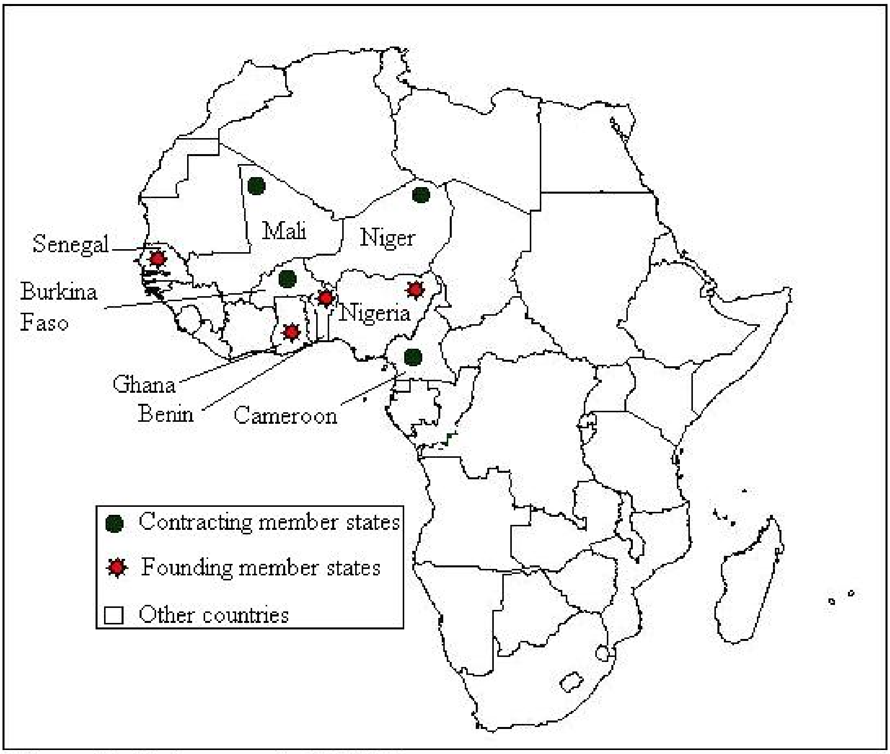

Figure 4.4: Member states for RECTAS

Regional Centre for Mapping and Resource for Development (RCMRD) in Kenya

RCMRD, previously (until 1987) known as RCSSMRS (Regional Centre for Service in Surveying, Mapping and Remote Sensing) was established in 1975 in Kenya, under the auspice of UNECA and the then Organisation of African Unity (OAU). It had five founding member states, and to date, it has fourteen contracting member states (figure 4.5). The main scope of RCMRD is similar to those of RECTAS: photommetry, remote sensing, cartography and GIS. However, RCMRD's mission is extended to the promotion of development, application and dissemination of geo-information for sustainable development in Africa. Like RECTAS, for various reasons, e.g. adoption of advanced technologies (W. Ottichilo 2004, *per comm.)* has gone through some organisational readjustments over the years.

Centre Règional de Tèlèdètecion de Ouagadougou (CRTO) in Burkina Faso

Centre Règional de Tèlèdètecion de Ouagadougou (Remote Sensing Centre of Ouagadougou) was created in 1978 with 15 member states (figure 4.6). The Ouagadougou centre has fallen into lethargy.

Centre Règional Africain des Sciences et Technologies de l'Espace (CRASTE) in Morocco

In addition to the above-described centres, another regional centre was established in 1998 in Morocco. CRASTE (in English - African Centre for Space Science and Technology). Figure 4.7 illustrates CRASTE's country member states. The main scope of CRASTE is training.

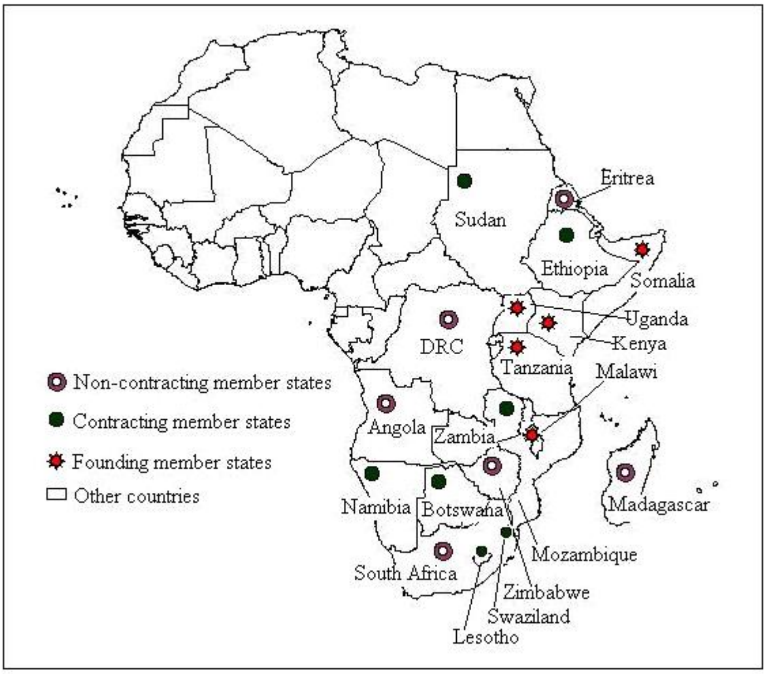

Figure 4.5: Member states for RCMRD

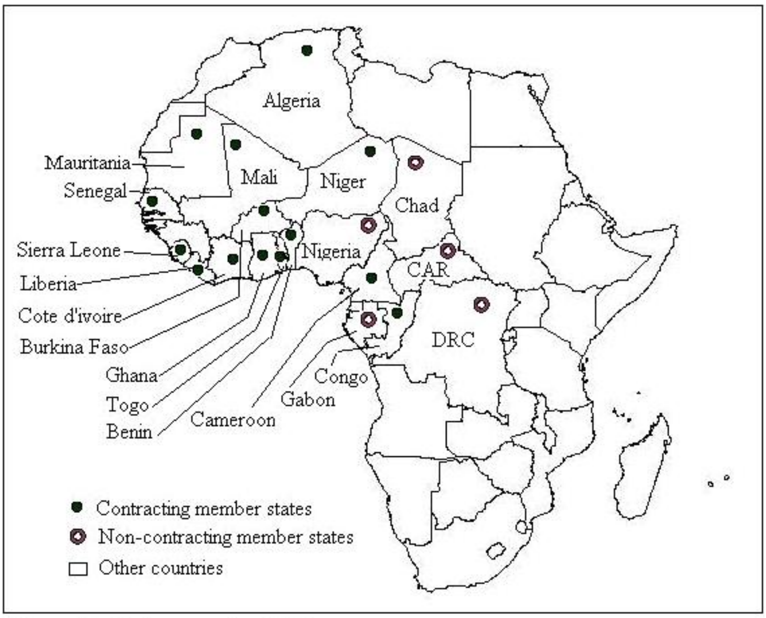

Figure 4.6: Member states for CRTO

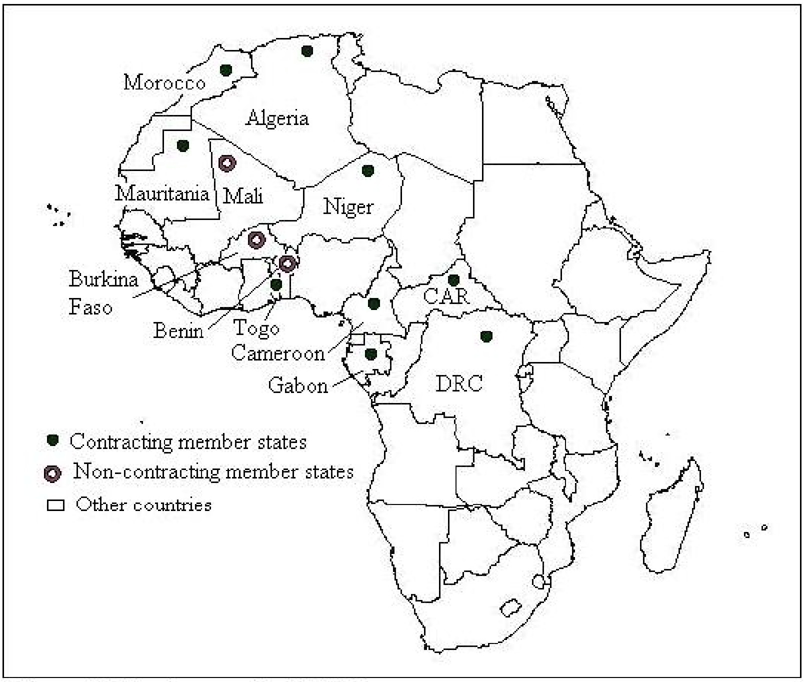

Figure 4.7: Member states for CRASTE

General roles played by the regional centres

The history of development of regional centres has given them an advantage of inter-governmental cooperation in their regions. Such cooperation is important for Africa's development. For example, as the importance of trans-boundary natural resource management gains high recognition, sharing of spatial databases between countries becomes important and crucial, and inter-governmental cooperation is inevitable. The regional centres are very instrumental in capacity building. In the 1980s and 1990s, they have played a significant role in capacity building in addition to training and education given outside Africa. Over the years, they have built and maintained close collaboration with many organisations in their member states, and with organisations in other regions of Africa and outside the continent. The working relationship between the ITC (Netherlands) and RECTAS is a good illustrative example.

National GIS centres

In addition to the regional centres, a few national centres specialising in remote sensing and GIS were also established in some countries with the help of international agencies (Woldai 2002). As noted above, critics considered such centres as new "white elephants". Examples of such centres include: the National Remote Sensing Centre in Sudan, National Remote Sensing Facility, now the Environmental Remote Sensing Institute (ERSI) in Zimbabwe, Mozambique's National Remote Sensing Centre (CENACARTA), Uganda's National Environmental Management Authority (NEMA), now the National Environmental Information Centre (NEIC), and Senegal's Ecological Monitoring Centre (CSE). As the names suggests, most of the centres were established primarily as centres for remote sensing. The roles played by the national centres included: capacity building (Fanshawe 1985) and spatial data production (Simonett 1993). Again, as

Simonett (1993) and Woldai (2002) remarked, the national centres lacked coordination and clear goals. This point has been more apparent in the case of Uganda, where NEMA and its GIS unit have evolved rather more slowly than other agencies in the country. At times NEMA even lost its leading role in the implementation process, and with it, its coordinating capacity (Gavin and Gyamfi-Aidoo 2001). But such initiatives did also pave the way for some positive developments. For example, CSE in Senegal has become a dominant centre in building up GIS departments throughout the country (A. Diop 2003, *pers comm.*). ERSI in Zimbabwe has become strong; active in capacity building, providing short courses training in GIS and remote sensing in the country, and to other SADC countries.

Overall, the development process of GIS in Africa has been dynamic. Summary of GIS development in Africa can be identified in four periods: the pre 1980's, the 1980s, the 1990s, and the 2000s. The groupings of these four periods are not necessarily based on the changing nature and trends in technology development, but also to make it easy to follow the temporal trends of GIS development in the continent.

4.3.1.1. The pre 1980s – the beginnings

Approaches to GIS implementation during this period have been summarized as; supply and technology-driven (Yapa 1991). Such approaches carried with them attitudes of "put the data in the computer, we will figure out later what to do with it" and "stop updating the system, the project is over" (Woldai 2002). Processing and interpretation of data was done outside Africa and only the final products were delivered in analogue formats. Nearly all of the fieldwork data was never delivered to Africa and was never (in many cases) able to trace (Fourie 1998). As can be expected, this approach hardly ever met needs of the end user. But again, the needs of the end users did not matter very much to the technology implementers (Christiansen 1998).

4.3.1.2. The 1980s – centralised and fragmented

The use of GIS expanded apparently as a result of the advances in remote sensing techniques, the availability of environmental data sets and the increase in power and functionality of micro-computing (Cavric *et al*. 2003). This period also saw considerable change in approaches, and thus came to be generally believed to have produced demand-driven, application-oriented and problem-solving approaches (Simonett 1993). Woldai (2002) has however described such demand-driven approach as a "Piecemeal Approach" in a sense that categories of users were not well identified, nor have their specific needs well surveyed. During this period, GIS was mainly used for pilot projects in few applications i.e. land management, urban planning and mineral exploration, and maps (in analogous format) were the prime mode of supply of spatial data and information. Christiansen (1998) noted that many of such data were poorly referenced. Field photographs, interpretation results, laboratory analysis, field notes and data, unpublished maps and reports were also poorly documented (Woldai 2002). Despite a considerable change in approaches, the period also witnessed a lot of inconsistency, duplication and standardization problems.

GIS was confined only to a few organisations i.e. lands departments, mapping and survey departments, geological surveys, and town and regional planning departments, (Cavric *et al*. 2003, J. Kufoniyi 2003, *pers. comm.,* S. Osai 2004, *pers comm.,* A.Bassolé 2003, *pers comm.,* Nkambwe 2004, *per comm.,* NAP 2002). Many of these organisations employed private sectors and GIS consultants to undertake pilot projects or augment their GIS capacity. In most countries, GIS was very much centralised and fragmented in government departments. There was little or no effort to integrate data and apply cooperative organisational approaches. This period was also characterised with considerable capacity and awareness building of the potential of GIS and remote sensing. For example, UNEP/GRID started training courses in GIS and remote sensing in

Nairobi. From other initiatives, a number of countries e.g. Botswana (Cavric *et al*. 2003), Nigeria (J. Kufoniyi 2003, *pers. comm.*), Uganda (Simonette 1993) received substantial financial and technical support from international organisations. UNEP also provided several government agencies with the Global Resource Information Database. Countries also received several financial sponsors from various international bodies to participate in seminars and workshops on GIS and related technologies.

A review of 23 university departments in Southern Africa (South African Geographical Society, 1988) reveals that of the approximately 200 academic members of staff, only three listed GIS as a field of academic interest, and only further 13 listed interests in the allied specialities of remote sensing and computer cartography. These regional views indicated the low recognition that GIS received in academic circles at that time.

4.3.1.3. The 1990s – stabilising but still fragmented

As many users of GIS in Africa articulate, this period witnessed the expansion of GIS in different parts of Africa and in various organisations (Woldai 1995, J. Kufoniyi 2003, *pers. comm.*, S. Osai 2004, *pers comm.,* A. Bassolé 2003, *pers comm.*). Many organisations, which were previously confined to analogue, map-making were eventually migrating to digital map delivery, although, the amount of data and data-types made available to users remained insignificant with highly questionable quality. According to Cavric *et al*. (2003), the use of GIS gained famous due to intensified use of land, environmental pressures and a high rate of new economic and physical development initiatives. Because of the importance of agriculture in many African countries, GIS tools were also extensively adopted in agriculture applications, such as crop production, forestry management, and pesticide control. This period also saw GIS becoming an important new analytical tool to support operational management and strategic policy-making in several countries (K. Lance 2004, *pers comm.*). The use of GIS was thus spreading into many other departments, such as central statistic offices, transport and communication departments, conservation departments etc. In southern Africa, particularly, GIS became prominent in departments of water affairs owing to countries' permanent shortage of potable water. Similar to the situation observed in the 1980s, many GIS systems were setup, used and maintained primarily by foreign professional employed by governments, without local counterparts and without effective mechanisms for the transfer of skills and knowledge. While these foreign experts provided excellent technical services, in often cases, they lacked awareness of indigenous culture and practices, which would enable more meaningful GIS applications. Mostly, capacity building was a slogan attached to any project. However, as the expatriates engaged with projects on short-term contracts (two – three years), they were usually not in a position to deliver appropriate training to aid the local staff.

Although, GIS was employed as a tool to handle spatially oriented projects, it is arguable that this technology was portrayed mainly as a set of databases without providing an overarching vision, which could have served to harmonise existing initiatives. Plus, while many efforts have related largely on projects, each effort have had their own donor funding, resulting in isolated databases. On the other hand, along with its adoption, a community of experts was emerging in most countries. With international aid, a number of GIS professionals were produced at postgraduate levels (mainly trained in western countries). Upon returning to their countries most of them take up positions at high administrative scale of their governments to promote GIS use and its applications, develop and maintain the systems (Cavric *et al*. 2003).

In this period, many organisations did achieve some stability and sophistication in their GIS applications. For example, the mapping and surveying department in Botswana became an important centre for GIS applications, development and transfer in the country. They later produced countrywide digital mapping atlas for the purpose of management of national large-scale data and for the production of cadastral, topographic and base maps (B. Morebodi 2005, per *comm.)*. At the same time some organisations suffered the ignominy of having written off sums spent on developing new systems which have proved to be to complex to operate, too demanding of data and updating.

Generally, notwithstanding its widespread use especially towards the late 1990s, researchers and scholars within the continent increasingly questioned the practicability of GIS in support of development and environment management.

4.3.1.4. The 2000s – towards maturity, decentralisation and coordination

GIS initiatives and investments have grown tremendously in recent years. Similarly, there have been a growing number of spatial data users and GIS applications on the continent, including several organisations with continent-wide activities and regional initiatives (NRC 2002). Examples of these include, the widely promoted Environmental Information Systems (EIS) for Africa with goals to promote the use of spatial information in Africa. Some of the initiatives that were birthed in the 1980s and 1990s came to gain stronger momentum in the 2000s. Though, the social and cultural environment in many countries has usually had difficulties in following the speed of technological changes.

The sad part of the story is that while most of the initiatives and activities have the potential to provide real benefits at the local scale, they are still implemented in isolation using different GIS software platforms and data standards (Gavin and Gyamfi-Aidoo 2001, K. Lance 2003, *per comm.*). As found in many countries (e.g. in Botswana (Cavric *et al.* 2003, B Morebodi 2005, *pers comm.*), in Senegal (A. Diop 2003, *pers comm.),* in Kenya (E. Khamala 2003, *pers comm.,* W. Ottichilo 2004, *pers comm.*), in Zimbabwe (T. Manyumwa 2005, *pers comm.,* D. Nyamhanza 2004, *pers comm.*), in Ghana (S. Osai 2004, *pers comm*., A. Bassolé 2004, *pers comm.*) information is till collected in different formats and standards designed for one specific mission, with inadequate consideration given to subsequent possible interorganisational or even intergovernmental data exchange and sharing. In other cases, there are also no standardised procedures for the encoding of spatial information. This results in wasteful redundancies and a reduced applicability of spatial systems.

Nonetheless, the overall absence of standards has prompted concerns regarding the quality of digital data. This, in turn, has prompted the development of spatial data infrastructures (SDI)[36] in many countries. Yet, some authors have felt that due to lack of policy driving forces in GIS implementation in most countries, GIS implementation process appears largely to have driven by immediate circumstances and funding opportunities (Cavric *et al 2003)*. Consequently, most countries lack nationwide vision for spatial information systems, including national spatial data infrastructures. The awareness of this need is growing rapidly and it is likely that in near future countries will have both the political will and the necessary stability to realise their ongoing efforts for creating such vision.

Increasingly, a number of African countries currently undertake reforms to decentralise responsibilities and decision-making power from central governments to actors at lower scales of political and administrative authority[37]. The rational behind decentralisation is that these reforms

[36] More information regarding spatial data infrastructure in Africa is available at http://.www.gsdi.org

[37] At the Africities 2000 Summit in Windhoek, African ministers of local Government and finance, majors and members of local Government associations adopted the Windhoek Declaration on “Africa Vision on Decentralisation”. According to the Windhoek Declaration, Africa is in quest for democratic governance that harmonises the sharing of

foster increased efficiency and equity in development activities. By virtue of their proximity to the people they serve, local authorities are likely to have access to better information about local conditions and better understanding of local needs and aspirations, and to be more easily held accountable by local populations. Concomitant with these reforms, the tendency has been to combine GIS with participatory rural appraisal to help local communities prepare development plans and make decisions about managing their resources. The spatial approach focuses on the spatial distribution, the inventory, contextual analysis and utilization of local resources. This is where the use of GIS is seen useful, as:

> "linking narratives, oral histories, photographs, moving images, and animation to GIS provides enormous capability to increase not only the richness and diversity of the information available but more closely parallels the ways in which communities know or conceive their space." (Weiner and Harris 1999)

The major challenge is to build a participatory GIS which is less-costly and user-friendly so that it is accessible and usable to local people at regional or district scale. Moreover, the process of decentralisation should not be viewed as an end to itself, but rather as an integral factor in the attainment of sustainable development.

Up until now, Africa suffers from lack of regionally-, or home-generated data, relying largely on international organisations for data and information. In some cases the data and information from such international sources is disputed as it is based on projections and is not verified. There are many reasons which force users to rely on data from international sources, including lack of up-to-date data in countries, lack of comparability of data across regions and within countries, and limitations in dissemination mechanisms such as databases, networking and connectivity. Commonly raised issues in as far as access to data is concerned are: data ownership or proprietary and organisational matters. The 2000s have also been characterised with the use of Internet and World Wide Web, which has helped in making data distribution and accessibility easier. Governments with support from development agencies have embarked on projects to establish SDIs to support the efficient use and coordination of spatial data. Spatial information and reliable data is further emphasised by regional key development initiatives. In 2001, there has been recognition from NEPAD that access to reliable spatial information is essential for effective realisation of NEPAD's goals for the strategic socio-economic development of Africa (Schwabe 2003).

With regard to GIS education, various universities in the continent have increased their commitment to GIS research and education. GIS students are drawn predominantly from the science faculties and are trained at all levels in aspects of geo-informatics in which the staff and graduate researchers have made strong research contributions. At many other universities, GIS is incorporated into courses on environmental and land use studies, cartography and spatial research methods. However, it seems that the training provided dwells more on technical aspects of GIS (K. Lance 2004, *pers comm.*, J. Kufoniji 2004, *per comm.,* P. Smith 2003, *per comm.,* C. Schwabe 2004*, per comm.)*.

One of major problems that inhibit the implementation of GIS in Africa remains the lack of trained manpower (Dekolo and Oduwaye 2005). Experience has shown that a lack of properly educated and trained personnel with vision and commitment to GIS projects has led to unsustainability of projects.

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responsibility between central and local scales that empower people, democratizes society and co-shares the responsibility to decide on policies that affect people's daily life.

In recent years, Africa, as the rest of the world, has seen the increasing use of the Internet for distributed GIS, data transfer and on-line GIS training. The Internet is awash with a wealth of maps and spatial imagery of varying quality and reliability. With the increasing Internet access and faster bandwidths in Africa (Schwabe 2003), Africa is well placed to benefit from Internet-based GIS. In fact, the Internet is now viewed by many (Schwabe 2003 as an effective means for access to, dissemination, and sharing of data and information. According to Schwabe (2003), all 54 countries of Africa now have full Internet connectivity with over 70% enjoying speeds in excess of 64Kbps. Internet connectivity and hosting is nonetheless unevenly distributed between countries in Africa and within the rural and urban populations of each country[38].

4.3.2. Applications and prospects of GIS in Africa

Although GIS has now been used in Africa for decades, its applications have largely been in environmental, natural resources monitoring and assessment, in mineral exploration fields, and in land surveying and mapping. Examples of environmental and natural resources applications include desertification monitoring in Burkina Faso, Tunisia, Cape Verde (UNCCD 2002), (Klintenberg *et al*. 2000) and agricultural production development in Kenya, Niger, Uganda, and The Gambia. In mineral exploration applications, examples include mineral prospecting in South Africa, Nigeria and Guinea. Land, because of its importance to the societies and economies of most African countries has been central to many GIS implementation efforts. Land Information Systems (LIS)[39] are testimonies of such efforts. Most African countries have implemented LIS, of one form or another and most national agencies responsible for land surveying and /or mapping have implemented some form of GIS for the management of land information.

Many GIS articles in the continent also suggest that GIS applications on urban planning and land use planning (particularly for mapping land suitability) are increasing rapidly. Examples of these applications are reported in Ghana (Braimoh and Vlek 2004), Tanzania (Boje *et al*. 1998), and Swaziland (Simelane 1995). The production of land cover classification undertaken in many countries in the 1990s is a prerequisite for most land suitability mapping. For example, in Zimbabwe, land cover provides basic data for a range of associated independent natural resources and environmental information systems (Mbudzi *et al*. 1999). These land planning applications are largely attributed to rapid urbanisation process presently experienced in the continent, which is placing considerable strain on resources and particularly on suitable land for development. GIS applications in integrated rural development are also coming along, and participatory GIS is gaining popularity. Typical examples of the latter are reported in Niger, Kenya, Zambia and Namibia.

The sad reality is that GIS has not been as extensively used in the socio-economic environment considering that many of the problems that Africa faces are because of social issues such as poverty and HIV/AIDS pandemic (E. Gavin 2004, *per. comm.*, G. Tadonki 2004, *pers. comm.)*. There is a general tendency for resource-based specialists to back away from such issues. This is somewhat reflected in the fact that many African conferences (with themes on GIS and related technologies) have until lately focused mainly on environmental issues. Of late however, many countries have captured census information at an enumeration area level into GIS. This somehow

[38] See for example the TCRC case study presented in chapter 8 of this thesis.

[39] GIS applied to land administration is commonly referred to as LIS. Dale and McLaughlin (1988) defined LIS as a system of acquiring, processing, storing, and distributing information about land, which is a combination of human and technical resources with organizational procedure that provide information in support of one or more managerial requirements.

has laid the foundation for the use of GIS in socio-economic field. But still, the true use of GIS for socio-economic analysis for development is yet to happen in many countries. This will perhaps happen when African leaders fully accept that information; particularly spatial information is required for the continent's development (B. Mhango 2003, *pers. comm.,* G. Tadonki 2004, *pers. comm.,* J. Gyamfi-Aidoo 2003, *per. comm*).

View of GIS users in Africa indicates a generally mixed attitude. They suggest that the relationship between information producers and decision-makers is an uneasy one. Second, it appears that many GIS projects follow a narrow perspective; in that they follow an unforeseeable implementation pathway and are technologically driven. Consequently, GIS products are perceived as non-efficient, and the demonstration that implemented GIS meet organisational needs remains equivocal. This is indicated by long lists of inhibiting factors. Many concerns have to do with the availability of resources, staffing and organisational changes (Box 4.1). It is noted that many difficulties in GIS projects are caused by our incomplete knowledge of proper pathways by which these technologies should be implemented, including motivations, objectives and implementation pathways. Most GIS projects are large and complex and cannot thus succeed without formal planning and well-documented procedures.

As mentioned above, with only a few exceptions (e.g. South Africa), the development of GIS in most African countries has been initiated by outsiders, mainly from the West. But, there has also been various positive initiatives from different regions of the continent to promote and advance the use of GIS. There are many of such initiatives worthy mentioning, but I cannot summarise them all here, as important as they are. I have therefore chosen to summarise two examples; a regional cooperation and a continental approach to GIS implantation and development, illustrated below.

Southern Africa GIS cooperation

Over the last few years, within southern Africa, a number of regional GIS projects have been developed particularly with focus on the state of environment assessment and natural resource management. Recently, focus has also been on HIV/AIDS and poverty monitoring, and on the development of spatial data frameworks. Various regional organizations, such as, SADC Environment and Land Management Sector (SADC/ELMS, based in South Africa), SADC regional training and research centre (based in Namibia at Gobabeb Training and Research Centre), SADC research and documentation centre (based in Zimbabwe), SADC remote sensing centre (based in Botswana) have been at forefront of developing and maintaining collaborations for the various initiative. Funding, in most cases, has been generated through partnership with the United Nations Environmental Programme (UNEP), United Nations Development Programme (UNDP), World Conservation Union Regional Office for Southern Africa (IUCN ROSA), and SADC/ELMS. In some few isolated cases, SADC Governments carry the financial obligations for the implementation of the projects.

At the time of writing, progress of these regional GIS projects are in different stages; few have been finalised, many are being implemented and still others are planned. Commenting on the successfulness of some completed projects, Mavima notes that:

> "Although many of these projects have been successfully completed, they did not always produce quality results. Many of them were not implemented in the right organisations. Consequently, the implementers were often not sure of how to do what needed to be done." R. Mavima (2004, *pers. comm.).*

In the same way, Mendelsohn remarks that many of the GIS regional projects do not always meet the objectives. Mendelsohn outlined a number of reasons for this failure:

> "…it has to do with the slow pace and high cost of implementation, lack of appropriate hardware and software in implementing organisations, inadequate expertise in local organisations and poor data quality" J. Mendelsohn (2003, *pers. comm.).*

Box 4.1: Views from African GIS users

"At times one gets a feeling that these global technological trends are irrelevant to us (Africa)" . We have spent considerable sums to hire a GIS consultant and acquire software and hardware in anticipation of major GIS products. … three years now, no usable products - we are still waiting. The project is ending in a year's time. There are blaming about the project implementation document being not too specific… these things would have been realised during the tendering process. "

Staff from L'Agence Bèninoise pour l'Environnement/Ministry of Environment, Habitat and Urbanisation, Benin

"The frustrating thing with GIS is when we struggle to obtain information from different agencies to feed into the machines. Without data these technologies are just decorations in our offices. Then when we get the data, things still do not work well because the data is in many cases not of preferred quality. Sometimes we get the data in a GIS format, but we cannot view the data, much less analyse and develop maps "

Staff from Karamoja Data Center, Office of the Prime Minister, Uganda

"Successful development, implementation and operation of a GIS require the continued support and interaction with top corporate management. The importance of top management support for such systems has been noted often in places like these (conference environment), but in many instances the importance of involvement has been overlooked in application settings. … top management support mean more than just allocating funds, although this is certainly an important factor. Also needed to establish systems goals and objectives along with operating procedures".

Staff from SADC Regional Remote Sensing Unit, Zimbabwe

"if only we could have access to data sets at our fingerprints… and if we could conquer the commitment of our top-level management to acquire technical expertise, GIS may work. With all these and many other problems in implementing GIS, conferences and workshops continue to describe projects as success with only few problems."

Staff from National Framework for Geospatial Information Management, Environmental Protection Agency, Ghana

"Opportunities for use of GIS tool are vast and growing – these opportunities revolve around the necessity for local Governments to prepare strong development plans which document broad-based participation and use of accurate, up-to-date information, in order to attract financial inflow from the central government".

Staff from Regional Centre for Mapping of Resources for Development, Kenya

"GIS and other modern information technologies are increasingly applied at all levels in authority. The only problem is that (in my view), GIS products are not really used in decision-making. Whether it is a question of technology trust by decision-makers or the products don't reach them is another problem altogether".

Staff from Ministère de l'Environnement et de l'Amènagement du Territoire/ Ministry of the Environment and Land Use Planning, Tunisia

In addition, to Mendelsohn's list, there is also a considerable lack of awareness on the benefits of GIS in the region (S. Osai 2004, *pers. comm.*). None of these reasons for failure can be said to be unique to Southern Africa; such problems appear time and again in GIS implementation in developing countries (Simonett 1993, Christiansen 1998, Ramasubramanian 1999b). However, a number of these problem issues were more acute in the Southern African context, apparently fuelled by a low level of political support and appreciation of the technology (C. Schwabe 2004, *pers. comm.,* E. Gavin 2004, *per. comm.*, G. Tandonki 2004, *per. comm.,* Gyamfi-Aidoo 2003, *pers. comm.),* a strong technical dependence on foreigners and a poor or absence of networking.

AfricaGIS

In November 1993, the Observatory of Sahel Sahara (OSS) and the United Nations Institute for Training and Research (UNITAR), with support of several other organisations launched "AfricaGIS conference series". The main objective of AfricaGIS is to provide a platform for geo-information professionals from Africa to learn about the application of geo-information technology, and be updated on the latest products and technological developments. It also provides an opportunity for interaction among practitioners to share information and knowledge to advance the developments and application of geo-information technology to meet African needs. Since its instigation in Tunisia, AfricaGIS conferences are held every two years in Africa, with different themes.

For example, the 6th edition of AfricaGIS conference was held in Dakar, Senegal in November 2003. Taking place one year after the World Summit on Sustainable Development (WSSD) in Johannesburg, and a few weeks before the World Summit on Information Society (WSIS) in Geneva, this edition was seen as a strategic event for Africa. The conference addressed itself to the challenge of how African geo-information community can better promote and support relevant programmes to meet needs within the framework of NEPAD. In addressing this challenge, participants deliberated on issues cross-cutting information need, development and appropriate technology. The conference revisited the Rio Summit, re-evaluating the role of geo-information in sustainable development[40]. Speakers at this conference have tried to evaluate the progress made in Africa in relation to access and usability of geo-information. Some major problems facing various initiatives to improve access to and use of geo-information were identified. The list includes: high costs of GIS technology, poor telecommunication infrastructure and poor human capacity. The progress of national spatial data policies was also looked into. The general feeling was that many countries still have a long way to go before such policies are developed and implemented.

4.2.3. Perspective on country differences

For most of the statements presented in the foregoing part of this section, there will be exceptions from country to country. These exceptions indicate that the development of GIS in Africa has not been uniform. It is arguable that in the literature, GIS development in Africa has been too generalised, especially when viewed from outside the continent. The diversity of African countries; high complex situations in different countries – which are also changing rather rapidly in response to economic pressure, political development, environmental degradation and international pressure, makes provision of a simple but accurate generalisation rather difficult. Approaches adopted for implementing GIS in various countries differed widely. For example, some countries focused on base mapping with comparatively little attention to the integration of organisational networking e.g. Madagascar (EIS-Africa 2001). In contrast, other countries e.g.

[40] Chapter 40 of Agenda 21 (from the Rio Summit) provided a lot of impetus to the development of geo-information and its application to environment and development issues in developing countries. Moreover, since the Summit the environmental-related conventions and declarations have continued to emphasize the role of geo-information. The Johannesburg WSSD Declaration further highlighted the important role of geo-information.

Senegal emphasised the production of national thematic maps with hardly any effort devoted to base mapping (Gavin and Gyamfi-Aidoo 2001). These two approaches ensured the design of systems to fulfil a particular demand, but have not created favourable conditions for developing a coherent and integral national GIS. Other countries concentrated on the establishment of organisational networking, still with emphasis on database development (e.g. Ghana). The Ghana approach seems to have been efficient in reducing duplication and improving coordination between agencies (Karikari *et al*. 2005). It is arguable, however, that this approach is only efficient as long as it is possible to find consensus among all stakeholders as participation is voluntary in most cases. If the key organisation withdraws from the cooperative agreement, it will fall apart. Still other countries relied extensively on technical assistance, while others stressed capacity building and strengthening. The influence of different colonial powers prior to independence is also evident in some countries. In addition, to some degree, traditions and social structures also differ across countries. The differences that may influence the implementation process of GIS to greatest extent are nonetheless the economic situation and political stability, (including democracy and governance).

Two countries have been selected as examples to demonstrate the difficulties of drawing a parallel conclusion for the continent with regard to the types and level of GIS implementation: South Africa and Burkina Faso. These countries provide diversity with respect to geographic locations and history, as well as the mode of GIS adoption, the level of its development and the intensity of usage thereof.

4.2.3.1. South Africa

In South Africa, although their GIS initiatives started only in the late 1980s, such initiatives have been promoted from within by the pioneering staff. During the apartheid administration South Africa faced an embargo. Hence, the development of GIS and of related technologies took place more or less from within, not financed by outsiders. This way of adopting a technology is felt sustainable.

Immediately after the end of apartheid regime in 1994, the new South Africa was faced with challenges of effective regional and national development strategies for sustainable development (Harris *et al*, 1995). At the same time, there was increasing realisation at both the central government and the regional scale of the needs to manage geographical information more effectively (C. Schwabe 2003, *pers comm.)*. Advances in GIS and remote sensing have particularly provided effective tools for realizing this objective (Weiner and Harris 2003). The demand for such services led to an increase in the demand for computer hardware, with the result that there has been an increase in the demand for computer assemblers and support staff (Singh 2001). It was also at that time that most organisations started introducing GIS on a large scale. As Cinderby (1995) states, the transition to democracy in South Africa has been supported by the rapid diffusion of GIS applications. In South Africa, as a result GIS has an influence not only on the information flow but on the organisational structure, culture and relationship with other organisations (Hill and McConnachie 2000).

To date, GIS implementation appears to be more widespread in South Africa than in any other African countries. GIS applications are developed at the national level for management of information from various themes and departments. Most of South African universities have well-established GIS facilities, as do the science councils, nature conservation bodies, the defence and police forces, private specialists, and the mining companies. There are also many GIS applications being used or developed by regional and local authorities. National efforts to coordinate GIS activities have been initiated by the Government and are managed through the

'National Spatial Information Framework (NSIF)' which is overseen by the Chief Directorate of Land Affairs (R. Rashopola 2004, *pers comm.*).

In South Africa, as elsewhere, natural resource management constitutes the most important field to GIS, with urban planning and public utilities coming in a close second and third place respectively (R. Rashopola 2004, *pers comm.,* C. Schwabe 2004, *pers comm.*). At the same time, GIS has been used for digital map production, in which cases, it has been accused of transforming bad data (from the Apartheid Administration) into impressive looking maps (Weiner and Harris 2003). In pre-1994 South Africa, the hegemonic power relations embedded within GIS were, according to Weiner and Harris (2003) eminently apparent. Grand Apartheid was a geographical project and it was through the agencies of the State that apartheid was implemented and maintained. Control over geographical information by the white state agencies placed the technology far from the realms of an objective system. The surveillant capabilities of GIS were critical components of colonial and apartheid socio-spatial control. The scramble for data and GIS in post-apartheid South Africa demonstrates the power relations associated with GIS access (Weiner and Harris 2003). Many thriving GIS consulting organisations linked to segments of the former Apartheid State were privatised before the transition of power. It seems the current types of GIS applications in South Africa tend to reinforce traditional planning applications.

As a result of complex technical and social processes of introducing a GIS into an organisation, GIS's have tended to cost more than anticipated (C. Schwabe 2004, *pers comm*), takes more time to implement than planned and turn out slightly different than originally envisaged (I. Slabbert, 2004 *pers comm*). Slabbert also notes that GIS requires significant resources, both to acquire the necessary data and to establish and maintain an operational system. According to Osai (2004, *pers comm.*), while GIS produce representations of nature, it ignores valuable indigenous knowledge.

4.2.3.2. Burkina Faso

In Burkina Faso, GIS was introduced by international consultants in the early 1980s, though development projects in sectors such as water resource management, regional natural resource management, and famine early warning systems (Bassolé *et al.* 2001). However, the actual operational use of GIS in the country was marked by the 1989 UNEP training workshop on vegetation mapping, where participants were supplied with personal computers and GIS software (C. Hendrickx 2003, *pers comm.*). During the 1990s, GIS was gradually introduced in various fields through governmental agencies. Since the GIS in government agencies has had a strong focus towards agricultural production and environmental monitoring, and to a lower geographical scale towards urban planning (Christiansen and Van Teeffelen, 2003), although applications on other fields have also been slowly developed (Bassolé *et al.* 2001). In the private sector, GIS gained popularity in consulting firms and in academia (Bassolé *et al.* 2001).

As early as 1991, GIS practitioners in Burkina Faso launched a National Programme for Environmental Information Management (PNGIM), a countrywide network of geographic information users and producers. Established within the context of the National Environmental Action Plan (PANE), the creation of PNGIM was viewed a very significant event in the development of GIS capacity in Burkina Faso (IES-Africa 1996). To date, PNGIM coordinates the development of GIS technology at national level (P. Kok 2003, *pers comm.*). PNGIM is however faced with a challenge of coordinating the production and use of geographic information in the country, producing a national plan for geographic information, strengthening the capacity of geographic information analysis in local universities, assess the usefulness of GIS in national and local decision-making and continue to build awareness and support for spatial analysis within the policy community at all levels (Bassolé *et al.* 2001, A. Bagré 2004, *pers comm.*). Bagré (2004) attributed the difficulties associated with access and use of geographic data to the lack of an information management culture in government agencies. This attribute is very much not unique to Burkina Faso but very common in many African government agencies. In Burkina Faso, however, although PNGIM produced a metadatabase in 1998, it has not been widely distributed (A. Bagré 2004, *pers comm.*).

Although stand-alone GIS systems are well distributed in the country, the situation remains somewhat intimidating. Until recently one single French company practically had the monopoly on the import, installation and support of GIS computer systems (P. Bankomi 2003, *pers comm.*). In the last 5 years, however, numerous small private (almost informal) enterprises were established which started by taking over technical support activities (Christiansen and Van Teeffelen, 2003). Most of these enterprises were established by students. In their assessment of GIS development in Burkina Faso, Bassolé *et al.* (2001) reached conclusions that:

- GIS is used mostly as a means of producing digital maps.
- GIS applications suffer from a lack of research input. Universities for example are often not involved in GIS projects. Consequently, outdated datasets are frequently used, and little opportunity is afforded for the latest scientific knowledge to be applied in the implementation of development projects.
- Although the PNGIM has promoted communication between data producers and users, there is no sustained dialogue between policymakers and GIS analysts. (This phenomenon is apparently attributed to a perception that GIS analysts are not open-minded, often working in isolation with a 'protectionist' attitude. Policymakers, on the other hand, are not sufficiently aware of he benefits of GIS technology).
- Development of national GIS capacity has been driven by a 'project-oriented' mentality that has influenced development policy in general in Burkina Faso. The expansion of GIS applications has been based on isolated projects rather than proceedings according to a strategic plan or holistic vision. Consequently, certain key institutional and policy issues have not been properly addressed.

4.4. Summary and Conclusions

This chapter has looked at the historical development, characteristics, uses and the progress of GIS in developing countries, with particular focus in Africa. The chapter saw that the introduction of GIS and related technologies in these countries has been undertaken mostly by expatriate consultants, with financial support from donors and international organisations. Their contributions, although positive in the main, have led to certain difficulties, especially following the life span of GIS project implementation. One serious shortcoming has been the lack of commitment by the adopting organisation. This has led to abandonment of GIS equipment and thus failure to include GIS into their organisational administration systems and structures. The chapter also saw that the main characteristic of the implementation of GIS in most Africa countries is localised arrangement of resources in different governmental agencies.

A large volume of literature on "GIS in developing countries" now concur the view that for GIS to be successfully introduced, it must be developed, modified and controlled by people who understand the specific social, economic and political context as well as the technical capabilities of GIS. Although there has been an incredible increase in GIS activities in developing countries since its initial adoption, Africa is still lagging in the implementation of GIS tools. The implementation of GIS on the continent has been restricted by numerous factors, most of which are commonly covered under the umbrella of financial, technical and staffing obstacles. However, even in situations with secured funding, hardware/software facilities and organised training programmes, efforts to establish successful GIS units in different organisations have not been always beneficial. Other identified problems include a lack of widespread recognition of the usefulness of such tools and technology for solving real life problems. This was said to be especially true among senior management of organisations. On the other hand, there are also promising GIS developments on the continent, including various regional and national efforts described above.

To date, after so many years of battling with basic prerequisites for better GIS status, networking and smooth data flow among different departments are still utopian dreams in most African countries. In relation to the many challenges of implementing GIS in Africa, a number of recent researchers have questioned the organisational settings and readiness of human actors to accept and apply GIS novelties performing daily duties and supporting decision-making process.

Chapter 5: The Survey Questionnaire

5.1. Introduction

This chapter is based on the findings of a survey questionnaire circulated among the GIS users in Namibia, to assert their perceptions on the use, effectiveness and impacts of GIS technology in Namibia. It provides a broad sweep of issues, and gives an indication of the thematic areas as it sets a scene for the case studies.

The general demographic information of the respondents is presented in Tables 5.1, and in Table 5.2 the key dimensions in the respondent profiles are highlighted.

Table 5.1: Demographic information of survey respondents

Variable	**Groupings**	**Sample composition**	
		(%)	**(N)**
Age	18 – 30	18	24
	31 – 45	40	54
	46 – 55	36	48
	Over 55	6	8
		100	**134**
Gender	Male	66	88
	Female	34	46
		100	**134**
Education	With formal GIS education	31	42
	With no formal GIS education	69	92
		100	**134**
Nationality	Namibian	61	82
	Non-Namibian but African	22	29
	Non-Namibian and Non-African	17	23
		100	**134**
Functional areas represented	GIS technician	36	48
	GIS expert	15	20
	Researcher	11	15
	Planner	9	12
	Information specialist	7	10
	Decision-maker	6	8
	Teacher	4	5
	Other [a]	12	16
		100	**134**

% = percent survey respondents
N = number of people who responded to the survey questionnaire
[a] This response represented consultants and independent researchers

Table 5.2: Key dimensions of respondents

Themes	Variables	Sample composition		
		(%)	(N)	
Type of organisation	Government	33	44	survey respondents by organisations
	NGO	23	31	
	Parastatal	14	19	
	Private sector	9	12	
	Research	17	23	
	Academia	4	5	
		100	**134**	
Level at which organisations operate	Local	74	99	
	Regional	19	25	
	International	7	10	
		100	**134**	
Length of experience with GIS	> 10 years	13	17	
	5 – 10 years	36	48	
	< 5 years	41	55	
	No idea	10	14	
		100	**134**	
Respondents routine use of GIS	Daily	41	55	survey respondents by users
	Weekly	17	23	
	Bi-weekly	11	15	
	Monthly	12	16	
	Never	19	25	
		100	**134**	
Respondent's self assessed knowledge of GIS	Very good	9	12	
	Good	37	50	
	Fair	33	44	
	Poor	14	19	
	Very good	7	9	
		100	**134**	
Respondent's level of GIS education/training	Post graduate	8	11	
	University degree	23	31	
	Short courses	28	37	
	Self taught	6	8	
	On-job training	35	47	
		100	**134**	

% = percent survey respondents
N = number of people who responded to the survey questionnaire

The organisations in which the respondents are employed belonged to different sectors and their sizes varied from a research agency of less than five employees to a government agency employing over 200 people. These organisations were at different stages of implementing GIS; some have been using GIS for a long time (over 10 years) while others were just in embryonic stages. Respondents occupied a variety of positions in their organisations, and their regularity of using GIS also differed in relation with their positions. Frequent use of GIS is generally confined to GIS technicians, GIS experts, researchers and information specialists. Although GIS is being projected as a decision support system, its use by planners and managers is less frequent and mostly indirect. On a self-assessment, majority of respondents considered their GIS knowledge to be fairly good, while a few rated their knowledge as rather poor or very poor. For many of the latter, they are GIS project co-ordinators and department directors. This significantly high rated perceived GIS knowledge is despite that only a few respondents have academic training on GIS. Most users have acquired GIS knowledge through short courses, on-job training and still others are self-taught.

There have been attempts to identify a few key patterns in the survey data, using cluster analysis. The hypothesis was that GIS users from different organisations (for example, users from government departments versus users from NGOs, or research-oriented users versus application-oriented users) would have different profiles. These attempts to pattern the responses were unsuccessful, primarily because the population of GIS users investigated seems to be homogenous. In general, they share the same opinions and difficulties. This would appear to vaguely contradict the social interactionism perspective on technology implementation, given the huge differences between the contexts and widely varying values and motivations of the organisations. This general homogeneity is thus, worth of consideration. The survey has however shown that the extent of implementation in government departments is generally lower and unstructured than those in parastatals and NGOs. These variations were least pronounced between NGOs and parastatals, as they both reported a fair degree of sophistication with regard to GIS functions being employed.

5.2. GIS Applications and their Characteristics

The survey demonstrates a considerably high degree of awareness of GIS in the surveyed group. It has also shown that a large part of GIS use is centralized in the capital city, Windhoek, where most government agencies, NGOs, parastatals and the private sector are concentrated. As most researchers have established, GIS is an efficient tool for regional planning and management (Sahay and Walsham 1996, Sieber 1997, Christiansen 1998, Ramasubramanian 1999a and Longley *et al*. 2001). However, regional planning and management is more efficient when done locally (Sieber 1997, Sahay and Walsham 1996). This centralised set-up thus, gives pause for thought, because providing ready-made schemes prepared outside of the communities may not lead to any solution at all. Many such initiatives have failed despite regular efforts by the government and the NGOs[41]. An added disadvantage is that the Namibian population is primarily a rural-centred, whereas GIS is Windhoek-centred. GIS is therefore not where the people are. It can be argued that GIS implementing organisations are best located to serve the needs of just certain sections of the country. Consequently, these technologies may end up creating digital divide between urban and rural communities, rather than being a tool to make the country digital. Hence, the question: GIS for whom and for what purpose, continue to beg for a satisfactory answer. Also, GIS comes with the promise of enhancing transparency, rationality and lucidity. A number of critical questions come up at this juncture:

- To what degree do rural communities benefit from a centralised GIS in Windhoek?
- What differences does the introduction of GIS actually make to their lives?
- Different political regions in Namibia exhibit different stages of development and have differing information needs. To what degree is this of centralised GIS able to deal with this heterogeneity?

A few projects have demonstrated the utility of locally providing GIS support to users (e.g. NNEP[42] in Ongwediva and CBNRM[43] in various conservancies, see also Table 6.8). In the late 1990s, Directorate of Surveys and Mapping (DSM) did set up three regional centres for the

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[41] For example, projects such as those of HIV/AIDS mitigation and monitoring being done at national scale hardly benefit the local scale and thus their impacts are ever questionable.

[42] Northern Namibia Environmental Project

[43] Community Based Natural Resource Management

dissemination of spatial information. One is located in Windhoek and is supposed to cater for the central regions. The second centre is located in Rundu and is supposed to serve the northeast regions. The third centre is in Oshakati, for serving the north central regions[44]. It is important to point out that DSM is not involved in regional planning activities and these centres' main purpose is providing data to users through a system of cost recovery. The current situation at these centres is not happy reality. It exhibits a lack of political support and a poor commitment from the top management of the organisations involved (B. Hardy 2005, *pers comm.)*. Moreover, communication linkage from the Windhoek office[45] to the regional centres is weak or in no existence at all, and similarly, communication between the regional centres themselves is almost inexistent (U. Okafor 2005, *pers comm.)*. In the case of Rundu, the majority of users in the region are not even aware of the centre and its purpose. Those that know about the centre do not know about the products and services of the centre.

> "They call us here in Windhoek looking for services that the regional centre should be providing them with. …it is always the same excuse, oh sorry I didn't know about the regional centre here, … where is it situated, when was it opened?"[46]

The Central Bureau of Statistics (CBS) together with the Ministry of Regional and Local Government and Housing (MRLGH[47]) have recently engaged in a formulation of a project "statistical spatial data for regions" in efforts to spread GIS to all 13 regions, as part of the decentralisation process and the 3rd National Statistical Plan (NSP-3). The aim is to enable the country's 13 regions to implement their own developmental projects. The CBS has conducted a number of information needs assessment meetings in all the regions so as to identify the needs of its stakeholders.

GIS applications in Namibia are diverse and growing Table (5.3). A closer look at the sectoral applications across organisations, the natural resources sector, which includes environment and agriculture, is using GIS for a variety of applications across the country. Use of GIS is also high in land administration. This reflects and reinforces the pressure from donors and international environmental conventions, who have been the main financing of environmental projects, and the pressing land matters discussed from the earlier chapters. The environmental sector particularly, is also the most dominated by NGOs. Their involvement in many projects supporting environmental protection has stimulated GIS development in the country. GIS investments in the infrastructure sector are also considerably high. On the other hand, GIS applications in other sectors are relatively new and still in testing phases. In the transportation sector for example, only a few pilot projects been undertaken (V. Mubita 2004, *pers comm.)*. These pilot projects are said to have effectively demonstrated the potential benefits of GIS in this sectoral application. Major inhibitors of large-scale implementation have included a lack of awareness of GIS by those that design nation-wide projects and the significant costs of implementation.

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[44] See map of Namibia in chapter one

[45] The Windhoek office is the overall coordinator of the centres.

[46] Personnel from the Windhoek office at DSM (*pers. comm.*, 2005).

[47] MRLGH, through the Directorate of Decentralisation heads the decentralisation process in Namibia

Table 5.3: Applications of GIS in Namibia

Note: This table is not exclusive; it serves only the purpose of illustrating the diversity of GIS applications by various organisations

FIELD/ SECTOR	Environment					Natural Resources											Agric ulture		Infrastructure						Socio-economic		
ORGANISATION / GIS APPLICATIONS	DEA	DRFN	Nam. Nature Foundation	Okatumba Research	IRDNC	Scientific Services	Dept. of Forestry	Geo- Hydrology	NRSC	Survey & Mapping	Geological Survey	Dept. of Deeds	Min. of Fisheries	Geo Survey	InterConsult	NamWater	Dept. Of Agriculture	Land use planning	Telecom	Min of Education	NamPower	Weather Bureau	Municipalities	Transport Department	Central Statistics	Min. of Health	Min. of Education
Environmental Impact Assessment	●	○	○																				○				
Environmental monitoring	●	●																									
Soils, AEZ and land suitability																	●						○				
Water courses								●							○	●											
Natural resources management	○	○	○		○	●							●														
Registration/Title information								○	○			●						○									
Resource mapping				○	●	○	●	●	●	●																	
Roads and railways network																								●			
Administrative boundaries										●															●		
Electricity																					●						
Demography																									●		
Land use				○			○											●					○				
Oceanography													●														
Geology (mineral/oil prospecting)											●																
Health information systems																										●	
Physical planning																							○		○		●
Telecommunication																			●	○							
Environmental management plans																							●				
Meteorological information systems																						●					

Legend: ● Main ○ Minor   Government   NGO   Parastatal

Many infrastructural GIS also present themselves also as partly working on environmental topics, reflecting the importance of the label "environment" in Namibia, and for obtaining money from donors and politicians[48]. Local municipalities have also made an imperative investment in GIS. These investments have often come from their own budgets (G. Kozonguize 2004, *pers comm.)*, although considerable investments were also made through donor projects. Despite the fact that socio-economic applications could be very important for the development of a country, very few respondents indicated usage of GIS for these applications. This omission underlined their perception that it is not a prestigious application, and the blame should thus be placed on the society's priorities rather than inherent limits in GIS itself. On the other hand, isolated efforts of socio-economic GIS applications are noteworthy. The 2001 Population and Housing Census[49] for example, utilised modern digital cartographic methods. The survey gives some indication that government projects put more emphasis on influencing policy, reflecting the tendency of projects to be used as vehicle for structural change.

NGOs have been at the forefront of GIS application, with financial support mainly from foreign donors. Other GIS facilities especially in government have had mixed development, going through a long, frustrating, slow learning process with many GIS facilities being abandoned after the project ended. Government GIS applications are the most equally spread over many sectoral application fields, indicating a growing acceptance in various sectors of the benefits of GIS technology. In government, DSM has the longest history and the most advanced GIS, having inherited the technology (but not the infrastructure) from the South African administration. Other Ministries started later and have had many problems with the adoption and implementation of GIS. The University and the Polytechnic departments have developed somehow into a type of University/ Polytechnic – NGO for environmental issues, although this is more true for the Polytechnic since the University has a multi-research centre that does most of the research. Like in the case of NGOs, these departments often execute government projects; selling training and data production. NGOs and the academia tend to compete for government projects[50]. Several NGOs and consultancies use the final GIS maps of one project for producing proposals for another. This practice seems to have led to an emergent market for information production.

However, compared to the situation observed in many African countries, Namibia is still in early phases of its GIS development. If one excludes the remarkable examples of the Geological Survey, the Directorate of Veterinary Services, and DSM, most GIS projects (done locally) could better be qualified at best of "interesting pilot-projects" than fully operational real-scale applications. For example, the Directorate of Veterinary Services has a home-grown system based on Supercalc and Dbase. The DSM has completed the digital topographic revision of 30% of the country for the 1:250 000 and 1:50 000 map series. These digital data also contains metadata. It has the requisite equipment and software to develop and manage its spatial data infrastructure. These however need to be augmented with the requisite skills and abilities. Outside government, there are organisations with first-rate facilities, and personnel developing fairly sophisticated GIS systems.

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[48] From 1995 to 2000, over 80 million U$ has been committed to Namibia in the form of environmental assistance within four themes: natural resource management integrated coastal management, sustainable use of energy, and urban and industrial development. In 2003, an amount of ±15 million U$ was committed for environmental projects in Namibia from the Danish Government. In recent years, however, large sums of money are also invested in social problems such HIV/AIDS.

[49] The 2001 census was arguably one of the best ever censuses conducted on the African continent.

[50] NGOs and the academia have come to play an increasing advocacy as well as intermediary role vis-à-vis government and people on the ground. They are generally able to communicate effectively with both sides and can thus serve as gateways between them.

A well-acknowledged usage of GIS is the visualisation of the data and of the analysis process. GIS were also believed to be useful as a means of producing maps, data analysis, as a planning management tool, and only a few respondents use its modelling capacity (see Table 5.4). Map overlay and buffer operations are the methods most frequently employed for data analysis. The survey also indicated a broader use of GIS for data storage, monitoring and field tool interaction. Whereas some users refer to analysis as their primary use of GIS, my experience argues that the aims and goals of projects are often changed during the implementation process once analytical applications appeared somewhat too ambitious as a result of implementation problems and/or lack of spatial data. For example, it is not unusual for a project to change from the goals of making analysis to making inventories, and only make simple overlays in the end. Use of GIS in the infrastructure sector placed more emphasis on data storage and retrieval. In areas of environmental and natural resource management, data analysis, map making and field tool interaction were pointed out as improvements made possible by GIS technology.

Table 5.4: Purpose of use of GIS

Purpose of GIS use	**Sample composition**	
	(%)	**(N)**
Visualisation	81	74
Map production	66	60
Data analysis	53	48
Planning	47	43
Data storage	43	39
Monitoring	36	33
Field tool interaction	30	27
Decision making	26	24
Modelling	7	6
Education	3	3

This question was asked only to the power users and they were allowed multiple answers
(%) = percent survey respondents
(N) = Number of people who selected the purpose of GIS use, total (N) = 91

5.3. GIS Functionality in Relation to Applications

A number of planning approaches have been applied in Namibia, each of which has a unique ideal and has been adopted with a particular paradigm in mind. The survey revealed that to a greater extent, GIS has been integrated into these various planning approaches and that the strength of development planning has been enhanced by GIS applications. As a tool for planning, GIS plays a vital role in collecting and storing the required data and providing system models that could describe the present and project the future. Moreover, GIS enables greater access to the planning process through access to databases and through its participatory capabilities (Weiner *et al*. 1995). Having said this, it is tempting to believe that GIS can be used to find optimal solutions to developmental challenges. It is arguable that for three reasons this hardly happens. First, we cannot bring all information into a GIS; second, there are always uncertainties in information and methods; and third, is an optimal solution possible? In any case, the functionality of GIS as a planning and management tool is acknowledged, as illustrated in Table 5.5 below.

A closer look at Table 5.5, one could state that those functionality components which many authors[51] see as the main characteristics and perhaps main advantages of GIS are the one least utilised. A reason for this is that many organisations do not consider data analysis to form part of their mission. They tend to limit the objectives of GIS to the production, maintenance and updating of databases. The second reason is that many databases are still under construction and are not yet suitable for complex analysis. Given the situation, it can be argued that perhaps what is required is just a simple but robust system to facilitate routine procedures rather than elaborate system with highly sophisticated spatial analytical functions. On the other hand, given the need for spatially informed planning and decisions in Namibia (Nakanuku *et al*. 2001), organisations should not limit GIS to the production of data layers, the generation of databases and their maintenance and updating, but should also consider making the spatial analysis and simulations.

Table 5.5: Functional applicability of GIS in planning

Functional Applicability of GIS	**Functional Capability of GIS**	**Planning Applications**	**Scale of use in Namibia**
Spatial data acquisition and storage	Create information that highlights different aspects (What is it?)	Systematic resource inventories	☺
Spatial data manipulation, map production and presentation	Geographical visualisation (Where is it?)	Identification of locations suitable for proposed developments	☺
Database development and integration	What is the trend? (How is it?)	Monitoring of proposed developments	😐
Spatial analysis and queries	What is the pattern?	Analysis of relationships associated with the use of resources	😐[52]
Spatial simulation and modelling Decision Support Systems	Compute possible scenarios (Which is best?) Multi criteria evaluation Spatial statistics	Potential impacts of proposed developments Management needs of comprehensive plans Assessment of ability and adequacy, strategic and tactical planning	☹

☺ - much used, 😐 - little used, ☹ - rarely, or not at all used

Additional possible explanations for the neglect of the analysis and modelling functionality include; first the possibility that users have not yet realized the full capacity of these applications potential. This scenario could easily be associated with new users who might not yet be fully acquainted with both the software and the potential of GIS. Such users are likely to have little (if any) experience with advanced GIS-based spatial analysis and modelling, and are hence prone to confine their applications to the computerisation of the familiar conventional planning and data

[51] See for example Aronoff 1989, Maguire 1991, Simonett 1993, Christiansen 1998, Chrisman 2001, Longley *et al*. 2001.

[52] This under-utilization of GIS analysis potential in not a unique phenomenon to GIS applications in Namibia, rather it is a common trend for GIS implementation in general, more especially in developing countries (Christiansen 1998, Simonett 1993, Yapa 1991 and Maguire 1991).

manipulation. The second possible explanation could simply be a matter of technical know-how. Thirdly, availability of data could limit such functionalities.[53] Usually, advanced GIS-based spatial analysis and modelling requires ample datasets with good quality. Such datasets can be very expensive to acquire. Fourth and for most, it might well be that the present application practices only require the basic simple analysis. While this last explanation can be seen rather petty, other researchers (Christiansen 1998 and Simonett 1993) have come to similar conclusion. Simonett has even cautioned against the risk of a "black box", which may arise the uncritical use of complex analysis operations, which are possibly not even fully understood by the GIS users, on the basis of data, which are frequently unreliable and inaccurate.

5.4. GIS in the Organisations

The survey revealed that many GIS departments are still fighting for budgets and have problems with becoming fully integrated into their respective organisations (Table 5.4). There is a lack of ongoing funding and organisational commitment supporting GIS activities. All too often, GIS activities are only funded for the life of a project, and become Word processing and game centres once the visiting consultants return home.

> "After the project officially closed, many unforeseen problems rose; funding, personnel etc. Like, the only GIS person we had was sent to school and upon completion of her studies, they transferred her to Windhoek. Now all these GIS equipments (computers, GPS, plotters, software) are sitting there collecting dust because none of us know how to use them. … This is a complete abandonment of the technology".[54]

The lack of an organisation-wide strategy specifically related to GIS and to data storage and distribution is a major problem in GIS implementation (Table 5.6). Tomlinson (2003) emphasises the importance of developing such strategies within the organisation. A lack of organisational guidance often impedes the management of GIS activities. It is also worth a consideration, the practise of inserting GIS into projects that were initially designed without GIS in mind. These practices are especially common in Government departments and NGOs. Insertion of a GIS into a project as an afterthought or add-on component rarely integrates the technology into the organisation structure. Even when a GIS can be well executed from a technical point of view, project design strongly influences whether or not an innovation will be accepted and whether the information products generated will be effectively used (Woldai 1995). Timing of user needs assessment, pilot project and full project implementation are critical to gain organisational support and to ultimate GIS success. In other scenarios, GIS technologies have been incorporated in the top-down structures of organisations (Table 5.6). Weiner *et al*. (1995) warns that the adoption of GIS in top-down structures risks empowering the powerful and disenfranchises the weak when used for its planning and decision-making potentials. GIS can also be integral to organisation's decisions and often reflect the internal rules and values of the organisation implementing it. Decisions regarding what questions to address, what data to collect and how the data should be classified and analysed, and what interpretations are drawn from them, all suggests GIS is not that value-neutral. Regarding the choice of GIS software being used, majority of respondents use GIS software which they are most experienced with, although a considerable number of respondents also use it because of its adequacy for their work (Table 5.6). The situation regarding GIS methods being used is sound. In particular, there is general satisfaction with the methods of analysis, as majority of survey respondents indicated that present methods tend to meet their requirements. Though, 3% of respondents indicated no satisfaction with the

[53] See also Christiansen 1998 and Yeh 1991.

[54] Personnel from the regional office of MET in Ongwediva (*pers. comm.*, 2005).

current methods of analysis. Reasons given why current methods are not meeting requirements are as shown in the lower part of Table 5.6.

Tötemeyer *et al*. (1993), Nakanuku *et al*. (2001), Noongo (2002) and Mavima and Noongo (2004) have noted that there is a great deal of information within Government departments and among service providers that is not accessible. This may be due to the information not being in a spatial format or being regarded as confidential. Organisations may also perceive information to be their power base which they are afraid to lose; information is so relevant to power[55]. On the other hand, we can look at the power of information in a different way, information is not power on its own – it is what one does with such information that is power. Nevertheless, the greatest obstacles to information sharing across organisations seem to be behavioural rather than technical.

The set up revealed by the survey also raises considerable reservation as to whether the characteristics of the systems presently being implemented correspond with the recommendations contained in much of the GIS literature regarding GIS adoption and implementation, from organisational perspective. Access to information is also often a problem because organisations do not see the dissemination of information, especially in an easy to use format, as a priority. It is clear that we need a paradigm shift in communication.

At this point, the survey must also be evaluated with reference to some of the characteristics of the theoretical perspectives of GIS adoption and implementation discussed in chapters three. In the literature, GIS is becoming more and more easy to use and affordable. For many users in Namibia, GIS is still too complicated and too expensive. Crain and MacDonald (1984) described three stages in the adoption of GIS technology: inventory applications, analysis applications, and management applications. The later stage includes functions related to decision support such as ad hoc queries, modelling, simulation and forecasting. Christiansen (1998) suggested that functions and applications in stage three are still uncommon in many developing countries. With these considerations in mind, it is deemed useful to explore the extent to which the survey reflects on some of the key features of the implementation process identified by other researchers. Tables 5.3 through to 5.6 illustrates that GIS use in Namibia is still limited to activities of stages one and two. GIS tend to be used more for record keeping and query processing than for advanced analysis and modelling. Complex applications, which are time and knowledge demanding, have only been used at a nominal scale. Although the need for increased functionality of GIS has been expressed (Noongo ***et al.*** 2003), little impact has been made on the GIS mainstream. In many organisations, knowledge about GIS is generally confined to a few individuals. Another striking finding of the survey shows that the number of existing GIS personnel in every organisation is relatively small.

[55] Gaining access to information or denying others that access is one of the oldest moves in the power discourse (Yakura 1992, Checkland and Holwell 1998). Checkland and Holwell (1998) provide a good example to illustrate the point. The first true printed book in Europe, the Gutenberg Bible, appeared in 1455, and by 1501 an astute Pope, head of one of the most powerful institutions in society at that time – the Church, was suggesting to bishops that control of printing technology might be the key to preserving the purity of the faith.

Table 5.6: GIS implementation strategies

THEMES	VARIABLES	Sample composition (%)	(N)
The extent to which GIS is established in departments / organisations	Occasionally marginal service function	21	27
	Ad-hoc GIS use in projects	64	81
	GIS unit for service and research	15	19
		100	**127**
Planning of GIS activities in departments / organisations	Short-term workplan oriented	44	58
	Documented long-term workplan	32	42
	Organisation-wide strategy in place	24	31
		100	**131**
How GIS activities are funded in departments / organizations	No money specifically allocated for GIS	46	45
	Budget line within projects	33	33
	Independent budget for GIS activities	21	21
		100	**99**
Organisation's overall GIS data strategies [a]	Decisions of how to store and distribution data are made ad-hoc	35	27
	Some guidelines exist, but not overall co-ordinated approach	61	46
	An organisation-wide strategy on data storage and dissemination is in place	4	3
		100	**76**
Choice of GIS software used [a]	It was the one I had most experience with	26	22
	It was the most adequate for my work	23	19
	It was already available	22	18
	It was the easiest to use	12	10
	It was the most flexible to perform multiple tasks	9	8
	It was the cheapest	6	5
	It was decided by the supervising authority	2	2
		100	**84**
Applicability of current GIS methods [a]	Methods meet requirements	67	58
	Methods do not meet requirements	33	28
		100	**86**
	Reasons why methods do not meet requirements		
	Methods are not specific for Namibian conditions	*79*	*22*
	Methods are limited by availability of data	*14*	*4*
	Methods are too expensive	*7*	*2*
		100	***28***

% = percent survey respondents
N = Number of people who answered the questions
[a] These questions were asked only to the power users.

5.5. Impacts of GIS

Survey respondents were asked to indicate the impacts associated with GIS, as a tool for development and for decision-making. Provision was also made for issues not identified in the questionnaire to be raised. The findings from this part of the survey are particularly dependent upon the perceptions of the individuals, but still, they enable some general issues to be identified.

The results are presented in Table 5.7 below. GIS is recognised as an essential tool by many users, although there are those who doubt its usefulness altogether. The survey indicated that GIS has a considerable impact on increasing the productivity of organisations, stimulating contacts with other organisations, and helps generate new ideas. Moreover, GIS does improve communication and presentation of information. Alas, majority of respondents did not think GIS has a positive economic impact on their organisations, but it does save them time. The critical issue in this part of the survey is not whether GIS is important and essential, but whether users feel the benefits from it, given their administrative and planning activities.

In general, respondents seem to have mixed feelings about the impact of GIS on decision-making. While majority considered that GIS is a very useful tool in decision-making, not many of them thought that it helps them improve the process of decision-making. For most that considered the usefulness of GIS on decision-making, indications were that the impacts were more indirect. Imperative is that majority of respondents also thought that GIS has decreased their uncertainty in data analysis, which further impact on decision-making. Majority also acknowledged that GIS does in deed help save time in the process of decision-making, although its impact on improving the efficiency and quality of decision-making process was felt only by a few.

Generally, the impacts of GIS have been felt differently in different sectors that use spatial information. Several important GIS impacts have been observed, falling in two general categories: planned/need-drive and opportunistic impacts. In the first category, GIS activities are well planned in advance and are often needs-driven. Table 5.8 summarises three examples (NNEP, Namibia Forestry Strategic Plan, CBNRM), where planned GIS have successful helped to identify and guide Government action on environmental and natural resource management, and helped build a national network of GIS professionals. The needs-driven approach of the CBNRM programme, for the sake of emphasis and particularly, has built credibility with field users, led to a strong feeling of ownership by rural people and field-based support staff, fostered a culture of sensitivity to community needs among technical organisations that are partners in the programme, generated trust and a common vision among partners (communities, Government, donors) and built a critical mass to enhance sustainability of the program (J.Tagg 2005, *pers comm*). In fact, the use of GIS as a field tool during interactions with communities and for wider planning purposes is a "golden feature" to the use of GIS in Namibia. Although it should also be pointed out that GIS has gained local involvements only (or mostly only) in communities where the CBNRM projects are implemented. In the category of "opportunistic impacts", impacts of a GIS come either indirect or unexpected. Table 6.8 illustrates the Atlas of Namibia as an example.

Among the often mentioned benefits of using GIS[56], two general categories are distinguished: *tangible* benefits, such as cost savings related to personnel time and workloads; and *intangible* benefits, such as improved data quality, more timely and accurate information, and improved decision-making. From the survey, it can be argued that neither tangible nor intangible benefits of GIS have been fully exploited. It appears that many benefits of GIS are delayed or half-heartedly undertaken to poor understanding of the technology, ambivalence or outright hostility. Although not very apparent from the survey, it seems that the problems associated with GIS implementation outweigh the benefits. This argument will be revisited again in the context of case studies.

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[56] See for example Van Teeffelen *et* al. 1992, Christiansen 1998, Longley *et al*. 2001

Table 5.7: Perceived impacts of GIS

Perceived Impacts of GIS	Degree of perceived impact					
	Very much		Some		Very little	
1. Perceived operational impacts of GIS	(%)	(N)	(%)	(N)	(%)	(N)
GIS improve presentation of information	72	94	21	28	7	9
GIS is a useful tool	69	91	23	30	8	10
GIS helps save time	61	80	34	45	5	6
GIS increase the productivity of organisation	59	77	30	39	11	15
Using GIS stimulate more contact with other organisations	53	69	26	34	21	28
GIS provide better and faster information	52	68	27	35	21	28
GIS helps in generating new ideas	49	64	40	52	11	15
GIS improves communication of information	43	56	25	33	32	42
GIS have a positive economic impact	37	48	32	42	31	41

	Considerably		Some		Little	
2. Perceived impacts of GIS on decision-making	(%)	(N)	(%)	(N)	(%)	(N)
GIS helps save time in decision-making	61	80	24	31	15	20
GIS decrease uncertainty in data analysis	53	69	20	26	27	36
GIS helps improve the quality of decision-making	44	58	32	42	24	31
GIS helps improve the decision making process	41	54	38	50	21	27
GIS is useful to the decision making process	37	48	46	60	17	23
GIS helps improve the efficiency of decision making	32	42	39	51	29	38

% = percent survey respondents
N = Number of respondents who answered the question, total (N) = 131

Table 5.8: Examples of impacts of GIS in Namibia

Program/ Project Title	**Project objective**	**Project Duration**	**Impacts of GIS**
Northern Namibia Environmental Project (NNEP)	Enhancement of rural livelihoods in Northern Namibia by promoting planning for sustainable environmental management.	1997 - 2000	The project developed a computerised GIS system for natural resources of the northern regions. The system has been used by a large number of individuals and organisations in the government and other sectors to assist them with planning, monitoring and evaluating their activities.
Namibia Forestry Strategic Plan	To foster the long-term development of Namibia's forestry sector.	1996 - ongoing	Used as an analytical tool, GIS helped in identifying forests that are of national importance and which needed to be highly protected for present and future generations.
Community Based Natural Resource Management (CBNRM)	To restore a form of communal control and management of resources to local people and to enable them to benefit directly from the use of the resources.	1995 - ongoing	GIS generated base maps, community maps and databases, which have contributed to an improved spatial understanding of the features and some of the resources in conservancies. The production of up-to-date maps with appropriate information have been used for discussion and mapping of resource areas, delineation of potential conservancy boundaries, planning of water points, and recording and presentation of wildlife data.
Atlas of Namibia	Compiling and publishing an atlas that will cover all aspects of Namibia's geography	1999 - 2002	GIS provided an opportunity to develop an "Atlas database" – a database containing most (if not all) data used in the compilation of the Atlas book. (Specialists from a variety of fields were drawn into the project, generously contributing their data and knowledge in the interest of producing an accurate and well-rounded national Atlas. Some information provided fresh insights into the country's resources, since they have been produced from sets of data compiled for the first time). With accompanying metadabase, the Atlas database is freely available to all interested parties (http://www.dea.met.gov.na/data/Atlas/Atlas_web.htm). This puts information that affects the lives of Namibian inhabitants into the hands of all users from central Government to the persons on the ground. The Atlas database has become a tool that is used in public debates and the presentation of cases to planners and development committees.

5.6. GIS and Decision-Making

While GIS is significantly used for planning purposes in Namibia, it was seen in the previous section that little has been realised in terms of improved decision-making process. It is already established in the literature that successful use of GIS in decision-making depends also on the ability, capacity and willingness of organisations and individuals to fully absorb and use new forms and quantities of information (Campbell and Masser 1995). Decision-makers not familiar with these complex tools often question the significance of quantitative data used in GIS. There is also a danger in viewing GIS as a technological solution to complex issues of development where human values, emotions and practices are usually more vital than mere quantitative data.

While spatial information systems such as GIS can be powerful tools for decision-making; policy makers, government officials and planners need to be sensitised of its potential applications in their specific areas of interest. This means that, for GIS to have a significant impact on decision-making does not only require a functional technical system; equipment, accurate data and skilled analysts. It also involves a complex interplay between scientists, GIS expertise, decision-makers and civil society. For this reason, it is important to create an active dialogue between policy and decision-makers and the GIS expertise to ensure effectiveness of the technology. If such dialogue is lacking, it is likely that the usefulness of GIS will not be felt. In fact, one of the shortcomings of GIS in Namibia is its inaccessibility to decision-makers. This, of course will have major implications for the effectiveness of GIS at large. Figure 5.1 illustrates a conceptual framework which aids understanding the importance of ensuring a dialogue between GIS as a technical technology and the decision-making process which tend to be more political and social in nature. This framework is suited for understanding that the technology should aid people, to discover more about the spatial context of the problem, and by using its analytical capabilities, come to informed decisions. Information should guide policy and decision-making, and policy and decision-making should be guided by information. It is also stressed that to successfully integrate GIS into decision-making process, many difficulties will have to be overcome. While time and additional training can solve many technical problems, many of the human and organisational problems could prove more difficult to solve.

GIS may support a decision-making process based on the sensitive use of resources and the local's needs (Millar *et al*. 1994). But, like Bahaire and Elliott-White (1999) note, GIS is just a tool and it does not by itself ensure fairness, equity and compatibility with sustainability principles. Similarly, GIS does not make decisions itself, it may only facilitate data processing and analysis and communicate results but the final decision lies with decision-makers. GIS is also unlikely to alter the political character of decision-makers. Instead, scepticism of the political forces in decision-making is likely to be one barrier of GIS effectiveness in decision-making process. This point will be explored in much detail in the case studies.

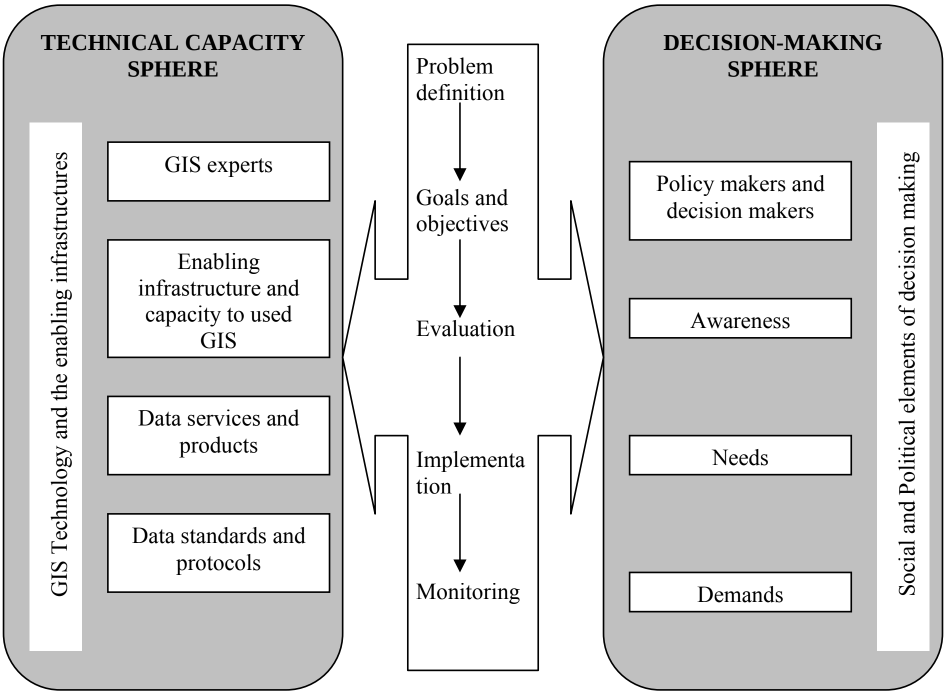

Figure 5.1: Conceptual framework
This idea is inspired by two presentations, one given by Craig Schwabe at AfricaGIS conference in Dakar - Senegal (2003), and the other given by Sam Osai at SADC SDI workshop in Pretoria - South Africa (2004).

5.7. Perceptions of Problems during GIS Implementation

The survey signalled many barriers to the effective use of GIS technology. In this study, the perceived problems will be used for understanding the effectiveness of GIS. This does not mean the focus is on the negative implications. On contrary, the perceptions of the GIS community at large provide an insight into the value and acceptability of the technology. This will constitute an important background for the case studies, as it makes possible to demonstrate the importance of considering the interaction of a technology with the people working with it. The survey suggests that the largest challenges for implementation of GIS may in deed be related to coordination and cooperation between different organisations using GIS. It appears that the pre-requisites for better coordination and cooperation are not in place. Several overview studies have been done in Namibia about the most bottlenecks of GIS implementation. The problems signalled by the survey and those identified by other researchers are summarised in Table 5.9.

Table 5.9: Perceived problems with GIS implementation in Namibia

Sources	**Problems:** Poor data quality, availability, accessibility	Lack of Funding	Lack of information policy	Poor organisational communication	Lack of GIS appreciation by high level bureaucrats	Lack of proper GIS skills
Current survey	√	√	√	√	√	√
Noongo et al. (2002)	√		√	√		
Mendelsohn (1996)	√	√	√			√
Uwiteb (1999)	√	√				
Tötemeyer et al. 1993			√	√		√

Perceived problems	**(%)**	**(N)**
Data quality, availability, accessibility	87	79
Lack of funding	69	63
Lack of information policy	61	56
Poor organizational communication	73	66
Lack of GIS appreciation by high level bureaucrats	52	47
Lack of proper GIS skills	44	40
Others	26	24

% = percent of respondents to the question,
= total % > 100% because of multiple answers
N = Number of people who indicated the perceived problems, total (N) = 91

Other mentioned problems included:

- Insufficient awareness of GIS potentials by GIS users
- Strong technical dependence on foreigners
- No networking
- Under-utilisation of GIS systems
- A reluctance by non-GIS colleagues to realise the potential capabilities of GIS
- Inappropriate implementation strategies
- Lack of consensus about what problems to be solved

5.7.1. Spatial data quality[57], availability and accessibility

For GIS to be useful for long-term sustainable development, the data used need to be dependable into the unforeseen future. With the increase of use of GIS and the high cost of data capture, organisations are looking for data from a variety of sources to provide inputs for their systems. Unresolved issues relating to data accessibility and availability, classification, data quality and data exchange between different systems has become a major impediment to the successful implementation of GIS. Large volumes of data sets are found to be unusable due to information retrieval that is mostly manual, tedious and fraught with errors and dubious manipulation. Although there has been some minimum coordination between some government departments and other organisations, regarding the development of standards and the sharing of data, significant opportunities for joint action have been lost. Generally, the willingness to cooperate and share information is unfolding (Noongo *et al*. 2003), although so far the coordination and cooperation between sectors is not close. There seem to be strong feelings of data ownership and competition between organisations that prevent organisations from adopting a common spatial database accessibly by users for various applications.

Prior to independence, it was an article of faith to many government officials to ensure that any information made available should inevitably protect the status quo. Officials were obliged not to give access to information (Tötemeyer *et al*. 1993)[58]. Yet, the attitude of the majority of officials towards information exchange and sharing may still be shaped by the past experiences. It shows that the legacy of the past is difficult to undo. But if we only blame the past and the various bureaucratic systems and avoid searching a change of attitude, we are not being honest to try to find solutions. One of the greatest barriers to the free flow of information can also be economic constraint. It is, nonetheless, often a question of priorities. At the moment, national information infrastructures in Namibia do not even form part of the national budget. It is sometimes argued that the cost of IS and information in general is expensive but it is nothing compared to the "cost of ignorance". It is unfortunately a fact that information systems in general are expensive to implement and maintain. But the cost associated with information is usually (only) a small fraction of the cost savings achieved through better planning and decision-making. The argument not to implement an IS due to cost considerations is therefore a case of "penny wise and pound foolish". The problem is that it is not always that easy to measure or quantify the cost saving achieved through having access to information.

In the literature, GIS is often praised that it entails explicit and transparent data management choices. The survey repeatedly contradicts this idea. Majority of respondents highlighted that GIS data created dependency on individual users. In the past, for as long as maps and printed paper files existed, departure of an information expert presented less impact if a knowledgeable person could reconstruct information on the basis of the data left behind. In the case of digitalised GIS data, some data becomes useless when the key person change jobs. This is true especially where metadata base are not in place, and cases where data sets lack metadata base are so common in Namibia. There are also popular cases where personnel leave the job/organisation without a proper transfer of responsibilities or explanation of how the data sets were organised. In some cases, data sets are left locked with passwords. While many authors suggested that the digitisation of data causes easier access to information (Burrough and McDonnell 1998, Longley *et al*. 2001), the problems with digitalised data in Namibia is, furthermore, related to data exchange. In a way,

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[57] The term *data quality* is somewhat vague summary expression for the number of different data quality aspects. On the micro-level, as suggested by Aronoff (1989), the main aspects to be identified are position and attribute accuracy, logical consistency and resolution. On the macro-level, Aronoff discerns completeness, time (topicality) and lineage.

[58] That was our past. Perhaps there is no need to remind ourselves of such experiences.

GIS seem to have intensified the culture of suspicion and secrecy, as opposed to better access. In my previous study regarding the status of data exchange in Namibia (Noongo 2002), GIS users alleged a fear that information given to anybody would lead to commercialization of this information without proper reward of the owner/producer of it. It is these kinds of dynamics that often lead to scenarios where access to information is hindered by lame excuses such as, organisation Y cannot make this information available because it is being revised or it is too politically/socially/economically sensitive. Or organisation Z is happy to give you its digital database, but there is none at the moment to make it available. Thus, although we are in the information era where the overwhelming drive is "digital", it is important to be realistic about the implications of digital and printed information.

Another problem has to do with work done for the government and donors by consultants or NGOs. Often times, the government and donor organisations tend to hire NGOs and consultants, including foreigners. The main problem with this practise is that it gets difficult to define and check data standards. The problem is intensified by the fact that sometimes the services are provided by un-experienced people. In the case of foreigners for instance, they are not always knowledgeable about Namibia. The data they produce will continue to be used, which in many times is not accurate and thus not reliable. Also, some NGOs and consultants tend to employ students to do the "dirty jobs" (e.g. digitising), since the well-trained GIS experts do not have the time nor the patience to do these strenuous work. This practise is problematic to data quality, especially when done under poor supervision.

Tötemeyer *et al*. (1993) suspects that the Namibian culture has generally moved from mutual legal separation to mutual convenient avoidance and evasion. The effect of this new culture, which is generally not acknowledged, is that some information systems and services are now just being used by non-Namibians; foreign visitors and researchers. Those who used such systems and services before the country's independence assume that the previously excluded ones are using them now. The previously excluded group are assuming that such systems and services are not meant for them. Both groups share the "let's leave them alone" attitude. It thus, appears that the challenge of making data and information accessible is far more complex than simply an exercise of coordination.

Volumes of important spatial and attribute data (especially historical data) are stored outside Namibia; in missionary museums of Germany and Finland, government archives of the colonising countries Germany and South Africa, United Nations (UN) archives and foreign NGOs involved in the struggle for Namibia's independence. Although the National Archives of Namibia made contact and negotiations with many of these museums and archives to obtain copies, microfilms, or in some instances even originals of such data, volumes of data are still contained in foreign countries, particularly in South Africa and in Germany. The Finnish Mission in Owamboland facilitated the transfer of a duplicate set of microfiche copies of all Finnish missionary archives from Helsinki to the National Archives in Windhoek (W. Hillebrecht 2004, *pers comm.)*.

5.7.2. Lack of spatial information policy

The survey identified the lack of policy factors influencing GIS in the country as another big problem. Nakanuku *et al*. (2001) and Noongo *et al*. (2002) highlighted the same concern as dilemma for the country.

Although Namibia has a national data policy (developed in 1994 by the Directorate of Data Systems (DDS), Prime Minister's office), such policy made no action plan for GIS activities in the country. Reason for exclusion of GIS from this policy was apparently because DDS does not coordinate "on the ground" (E. Hamutenya 2004, *pers comm.*)[59]. This situation calls for GIS activities to be integrated into a framework of national information technologies, because it is only when they are fully acknowledged in relevant social, political, organisational and economic context will they succeed. The most important factor determining the state of information infrastructure in a country is legislation (Tötemeyer *et al*. 1993). The absence of a national legislation on spatial information acts as barriers towards the free flow of information. On the other hand, although a supporting legislation can be seen as an advantage for a strong information infrastructure, statutory provision is only a legal instrument. Achievement of the purposes set out in such documents still depends on human efforts. In any case, Namibia has an extensive of regulations and laws. It should be fairly easy to incorporate GIS into, and harmonise GIS efforts with, the existing requirements. Yet again, communication between the organisations operating in GIS environment and those operating in the legislative environment is absent or weak in general or very informal.

In absence of a spatial information policy, GIS and other spatial-related activities of many programmes/projects in the country are not well coordinated. And as already mentioned, this often leads to duplication of efforts; overlapping in aims and applications, and using different standards. For example, some private sector firms are in possession of various government digital spatial data, which are being offered for sale. Such data include, among others, voting wards, census enumeration areas, roads network, farm boundaries, agro-ecological zones, etc. These data were acquired by the firms through contracts awarded to them by the line Ministries to create the digital spatial data from paper-based maps without proper agreement on data ownership and copyright. Another example, there is no clear organisational responsibility for the recording of fundamental data sets[60], e.g. administrative boundaries. This creates considerable confusion when data sets are created or information is required as to who is the appropriate authority to contact for information. Organisations are unclear as to where the digital data can be obtained and who has the responsibility for maintaining such data. To ensure the efficient utilization of the data, it is important that data is only created once and then shared. This will also ensure that only one organisation has responsibility for maintaining the data set. As different organisations create their own digital data, confusion over ownership of data has also spread. This has also led to conflicting data sets kept by different owners on same entity, e.g. conflicting land records on the same piece of land. The absence of initial coordination could prove very expensive.

While many organisations and individuals recognize the need for information production, these groups seek budget and aid donations independently of each other. This practice may lead to negative outcomes such as donor-rather than demand-driven activities, donor competition and imbalances between project-financed agencies and other agencies.

5.7.3. Lack of proper GIS skills

Many organisations are faced with the lack of adequate personnel with necessary expertise in spatial information systems to be able to develop, operate, coordinate and maintain the systems. Most GIS specialists in Namibia were trained in foreign countries and upon their return to Namibia, they are often promoted to managerial positions leaving the actual GIS operation unstaffed to be attended by juniors. Most of the juniors gain their GIS experience and knowledge while working on GIS projects, and may be sent to attend short courses and workshops locally

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[59] In addition, during the period of drawing up the policy GIS was still a very new technology known only by few people in the country. It is also possible that it was regarded as an application which the responsibility for would lie within individual departments.

[60] A dataset with national coverage needed consistently by a great variety of users from inside and outside the government agency in order to achieve their objectives.

and abroad. GIS users who only have on-job skills tend to work under the pressure of the technology capabilities while not understanding the background of the system, although they may have the desirable knowledge of the substantive discipline. It is easy to train technicians to specific tasks (data capturing, map editing etc), but developing sufficient skills to manage all aspects of a GIS project can be much more complicated, and will probably be reserved for GIS experts. It is thus argued here that although GIS software has become more users friendly over time, it cannot provide the comprehension and knowledge that comes through GIS systematic education and study[61].

5.7.4. Lack of GIS appreciation by top-layer bureaucrats[62]

In addition to lack of proper skill of the direct GIS users, many decision-makers have no experience with GIS and related technologies, and thus do not appreciate their potential for improving decision-making. There is also a lack of consistent management support for GIS projects initiated at different scales. Parallel to this problem is the orientation of GIS projects towards data production instead of application orientation. There is also a lack of planning for decision-support process, lack of communication between technicians and scientists in organisations. Even more alarming is the lack of research that could drive advanced data analysis and modelling techniques. Directors and project managers often do not perceive the importance of GIS training. Majority even believe that a short training package would be enough to run a GIS for the project or organisation. Effective training beyond technological proficiency is however, especially important for successful implementation in all contexts. Thus, technical training alone is considered insufficient to effectively deal with social, cultural, political and organisational context within which GIS is implemented.

One important consideration based on previous experience is to keep in mind that the adoption of GIS within many organisations did not always come without difficulties to convince the top-layer bureaucrats, who at time could finally sign up for a GIS project without apt convince. One should also remain aware that “when GIS specialists propose a new system, they are, in fact, stepping onto a battlefield across which corporate politics and tension rage” (Reeve and Petch 1999). Successful adoption and implementation of GIS in Namibia will therefore involve a range of challenges including the need to raise awareness of GIS among top-layer bureaucrats, initiating feasibility studies and pilot projects that are innovative and practical so to demonstrate tangible and convincing results, the need to provide frameworks within which GIS can evolve as a developmental tool in an orderly manner within organisations. Top-layer bureaucrat’s support is key to successful adoption and implementation of GIS, because without it, support for infrastructure and services that will enable GIS to operate effortlessly will be mired.

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[61] While the role of both training and education is crucial to any GIS implementation, the two are fundamentally different processes used to accomplish similar but unique objectives (Burns and Henderson 1989). The latter emphasises the salient features of GIS and imparts a conceptualisation of the more generic GIS. The former instils sufficient familiarity to enable the development, operation and management of specific systems (Banting 1988).

[62]The literature on theories of organisations (Reeve and Petch 1999, Laudon and Laudon 2000) suggests that the structure of any organisation represents a hierarchy of people in a pyramid structure of rising authority and responsibility. This pyramid is shown as an organisational triangle of three layers. The upper layer consists of the relatively small group of top management who determine the strategic direction of the organisation. The middle layer consists of managers, researchers, and administrators whose tasks include monitoring the performance of the lower layer, and preparing policy options for the top layer. The lower layer consists of operational personnel.

5.7.5. Lack of Funding

The survey identified the common problem as being the high costs of developing a GIS system and maintaining stability for GIS operation after project money dried up. In previous studies about GIS implementation in developing countries, financial problems were especially linked to the high cost of equipment. Later this argument was used less, reflecting the drop in price of computers and availability of cheaper software (Christiansen 1998). In the current study, financial problems were related to the cost of data collection, maintenance of equipments, and finances for sending staff to training.

5.8. GIS Organisational Models

An important aspect that emerges from the survey questionnaire and supplemented with the author's experience and the review of literature is to do with the characteristics of GIS being implemented in different organisations. Implementation of GIS in Namibia can be characterised in three models: project GIS, departmental GIS, and multi-organisational GIS (see table 5.10). These models are examined below.

Table 5.10: GIS organisational models

GIS model	Percent	Examples
Project GIS	57	· GIS for soils mapping and agro-ecological zoning at the ministry of Agriculture · GIS ad hoc use for Environmental Impacts Assessment at DEA · Land cover mapping at the Ministry of Agriculture · CAD/GIS project at Telecom
Departmental GIS	39	· Surveys and Mapping at DSM · GIS section at DRFN · GIS section at Okaukwejo Research Station · GIS department at Windhoek Municipality · GIS and remote sensing at the department of forestry
Multi-organisational GIS	4	· Community Based Natural Resources Management project run between MET and Namibia Nature Foundation · Napcod project run between two NGOs and two line Ministries

Percent = percent survey respondents by organisations

5.8.1. Project GIS

Project GIS are GIS developed by its users for a specific project, and operates as a fairly separate entity in the organisation. The data is collected to address a set of highly focused problems and is used for a specific application. There is usually very little need for integrating data from other applications. A typical project GIS would have one or two persons working on collecting the data and making basic analysis for the maps. Most often these persons would have other tasks besides the GIS assignments in the organisation. External consultants and experts are often hired to support project GIS implementation, although extensive reliance on them tends to create problems in long run. The tendency is that when project GIS is executed by consultants or contractors, products are produced on time and usually within budget. When executed in-house, impacts of project GIS is often questionable. Given the short life span of many projects (usually 2-3 years), project GIS tend to be limited in what can be done and achieved. It is observed that many applications of project GIS in Namibia have started with a project bringing an expertise from abroad or a newly GIS graduate from a foreign University. In most cases, the expertise works with local colleagues who are expected to learn GIS during the duration of the project. Majority of government agencies are typical examples of project GIS (see table 5.10). Management of GIS is found decentralised at project scales, with each project implementation GIS in their desired way. The underlying thinking in this sense is that of a managerial rationalism.

This model bears the risk of duplication of activities and even goals between projects within one organisation, and it can lead to splintered initiatives. Wherever there is more than one centre of GIS development, coordination becomes a primary concern. This is especially true in scenarios where communication mechanisms in the organisation are not in place. However, where communication mechanisms are well in place and are functional, a more cooperative approach through a process of negotiation and agreement between projects maybe employed. In this scenario, compromises are made, but as Somers (1996) stresses, “the whole is often worth more than the sum of its parts”, implying the top-down nature of this approach. Chan and Williamson (1999) labelled this type of model as a typical example of GIS in a “dispersed scenario” (possibly emphasising the decentralisation nature of GIS use) in which the organisational problems to be addressed by the adoption of GIS are often strategic in nature and have wide applications. Sharing from experience, it is common for organisations in Namibia to fail to maintain an acceptable degree of coordination between its constituent departments and projects. It follows from this that, projects in the same organisation lack communication over the boundaries of one project to another.

Because projects are usually donor funded, project GIS tend to receive very little (if any) financial commitment from the organisation. Donor funding are usually of short-term supported, before a project is faced out. This presents a common challenge observed in many organisations where after the project has ended activities are discontinued for mere reason that there is no provision of financial support. In many cases, this has led to abandoned facilities.

5.8.2. Departmental GIS

Departmental GIS on the other hand are large, complex and are integrated into a large organisation. They deal with more routine activities for different users, and involve powerful computer equipments, large databases and sometimes network building. Examples of departmental GIS include those in table 5.10, where GIS departments or units are set up to provide maps and analyse spatial data. The skills of data collection, database development and software usage are considered highly specialised and clustered within a departmental or unit team. Typically, a group of GIS expertise are responsible for different tasks in the department, where they share the GIS and databases. As observed in many organisations, most often, GIS users in departmental GIS are trained academics in application fields that have acquired GIS skills over the years of practical experience, short courses and workshops[63]. GIS may form a fundamental part of the functions of these departments or may be just added to the departments designated functions. Internal policies and guidelines on data access and sharing form part of a GIS implementation. This approach can be seen to be bottom-up GIS, where the adoption and implementation of GIS in the organisation is well coordinated. Where this model is employed, benefits such as reduced duplication in the organisation can be expected. Lynn and Dyke (1997) have similarly remarked that this strategy provides a more cost-effective implementation than

[63] Most foreign training was given through German, Finland and British development cooperation.

trying to set up several stand-alone GIS in the same organisation. Other arguments supporting departmental approach include increased capacity for data sharing, improved access to information and better-informed decision-making, increased organisational efficiency due to reduced duplication of efforts (in data collection, analysis and maintenance).

Significant commitment of staff and budget for GIS support is necessary for a successful GIS implementation in this model. Likewise, top management support and update strategies are essential. This could mean some organisational or functional adjustments should take place. While this model theoretically may achieve economies of scale, it can also place too much control in one department within the organisation. Moreover, a departmental approach may not have the necessary ability to cope with organisational changes, such as organisational restructuring. Added disadvantages of this model include the risk of isolating organisational departments and lack of support from the top management of the organisation. According to Somers (1996) departmental GIS tend to empower a group of technical operational staff to detriment of their managers. This observation could easily fit the Namibian context where the notion of technological change or innovation sometimes leads to resistance from superiors as they fear of losing their position in the organisation. Sometimes, as observed in various Ministries, a group of professionals were trained and a new department created for them through a GIS project. This, often times, created tensions over responsibilities with the old departments. This in turn is perceived to demonstrate the impracticability of introducing an isolated departmental GIS (Bromley and Coulson 1989). These disadvantages can shadow the benefits of departmental GIS and can even lead to the rejection of this approach.

5.8.3. Multi-organisational GIS

A multi-participant GIS is a “GIS project which involves more than one user, each of whom has a different reason for implementing a GIS” (Huxhold and Levinsohn 1995) with responsibilities shared among all. Examples of this model are not many in Namibia, but we can note two particular examples (see table 5.10). 1) The implementation of Napcod, which is spread between DRFN, MET, Nepru (Namibia Economic Review and Prospects) and the Ministry of Agriculture. GIS related activities of Napcod are implemented between DRFN and Nepru, while the overall program coordination lies between the four agencies. 2) The implementation of CBNRM, spread between MET and Namibia Nature Foundation (NNF). In this particular scenario, GIS related activities of CBNRM are implemented across MET and NNF.

Multi-organisational GIS involves cooperation efforts amongst the participating organisations. Depending on prior arrangements made, they may or may not share resources (hardware, software, time and skills), as they cope with distributed implementation and maintenance responsibilities across organisations. Multi-organisational GIS is the most difficult of all to implement. This is so because the participating organisations may each have own set of goals, functions and purpose for implementing a GIS. Their data requirements may also differ, and they may have completely different policies and decision-making rules making it a great challenge to jointly implement a GIS. They may also function under different political and technological settings. Generally, these variations can worsen under unstable political climates. Multi-organisational GIS may also bring about change such as significant reorganisation of functions across organisations, adjustments in policies and guidelines regarding data exchange and integration, use of software etc. Long-term and top management commitments among the participating organisations are thus essential.

A multi-participant GIS requires common data standards, software and agreed-on management and access principles for all who provide or use the data. The challenge is that different organisations may prefer different formats and data standards, depending on their record-keeping practices and responsibilities. In Namibia, the situation is worsened by the lack of national data standards, which leaves individuals and organisations to dictate their preferences. Although multi-organisational GIS are in their infancy phase today, their approach to GIS technology promises numerous benefits.

5.9. Strategic Framework

The survey findings as discussed above suggest a strategic framework (Figure 5.2.a) that encompasses activities and influences that must be taken into consideration when adopting and implementing a GIS. Three elements are identified as having a direct influence on the adoption and implementation process of GIS. 1) The enabling environment for GIS take-off and sustainability, which emphasises the political, social, cultural and economic situation. The social, cultural, political and economic context of the organisation charged with operating a GIS can be very critical, although often taken for granted. As observed in Chapter three, more often the literature on GIS has taken an abstract view and discusses the technical implementation as if it were mathematical truth that would apply in all possible situations. 2) The enabling infrastructure, which emphasises the administrative and technical operating systems, lines of communication, and complexity of spatial databases. This element provokes questions concerning the characteristics and procedures operating in the organisation. Some GIS experts would separate the technical (hard) issues from the non-technical (soft) issues, in this element. The line between hard and soft is not very simple, and as we learn from the literature, it is a serious misunderstanding to lump the concerns with non-technical infrastructures as somehow less important. In fact the importance of soft issues manifests itself in many ways, such as in terms of staffing support for the development of a system. 3) Organisational mandate, which emphasises the mission and objectives of the organisation. Organisational mandate determine the actual GIS requirements of the organisation, and is thus very important. Marvellous technical advances will not necessarily save a system that is not in line with the mandates of the organisation. Figure 5.2.b) is embedded in the strategic framework (figure 5.2.a). Each ring incorporates the specific issues of those inside, building to a more complex structure of the strategic framework. The first three rings are very crucial but in practice they are often given only a petite consideration, they are even missing from most of the technical literature on GIS implementation.

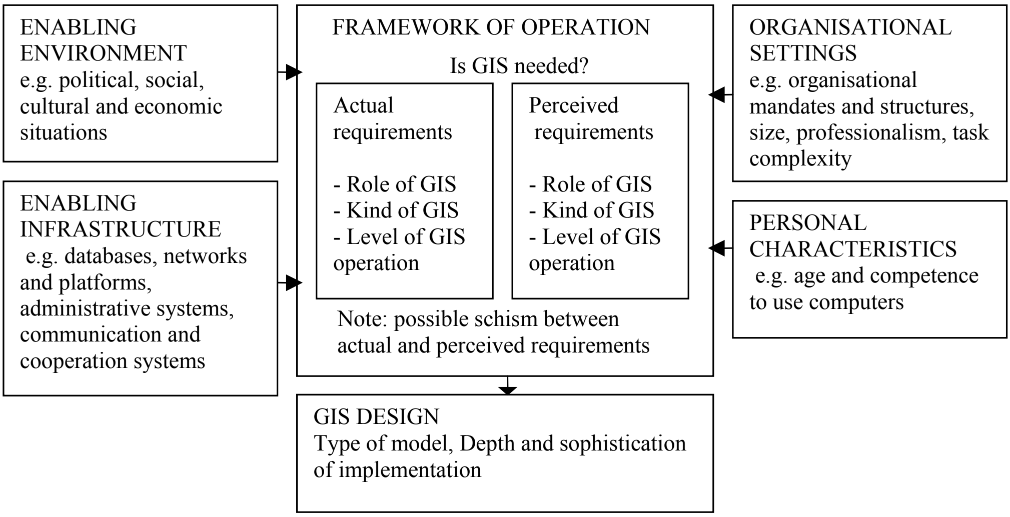

Figure 5.2.a: Strategic framework

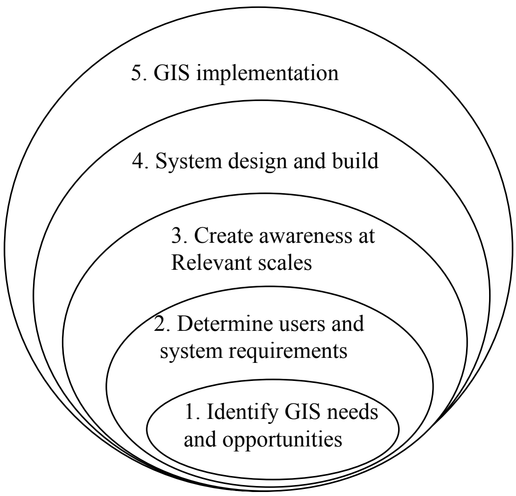

Figure 5.2.b: A nested scheme for implementation of GIS within the strategic framework (figure 5.2.a)

5.10. Summary and Conclusions

Namibia has no well-defined strategy to manage GIS implementation. The current situation is exemplified by the repeated efforts to set up a national committee to coordinate data production and distribution, promote the culture of data sharing and exchange. Some awareness of the importance of GIS, correlated to the use of GIS was evident with majority of respondents. Generally, GIS is mostly used for replacing the traditional manual techniques of dealing with maps and also the daily tasks related to data processing. The use of GIS in Namibia is still exploratory and ad hoc in nature, although there are some signs of growing maturity in GIS applications in diverse fields such as environmental and natural resources management, land use planning, surveying and mapping. While the potential of GIS technology for development in Namibia is considerable, there are many barriers to be overcome before that potential can be fully realised. More especially, the integration of the technology into a decision-making process is key. The starting point is to foster a high degree of awareness among decision-makers of the functionalities of GIS. The chapter has taken some trouble to sketch perception of the historical situation because it shaped the problems Namibia's information infrastructure is trying to solve today. This is also what we consider our most important challenge to overcome a heritage of division, and to obtain one Namibia's information infrastructure. One aspect that did not come out clearly from the survey questionnaire is the increasing use of Internet for GIS data viewing, dissermination and exchange. The author is well aware that most projects in the country are now using Internet for the purpose data dissermanitation and sharing.

It was revealed that GIS in Namibia is much centralised. This problem does not only need address for the sake of improving GIS usability but also for placing development and human well-being in the hands of local people who know and understand their conditions and scenarios better. The chapter revealed a lack of competence among users of the technology, both direct and indirect users. This can be considered as one of the most important obstacle for the development of GIS techniques. Also, the survey has shown that GIS technologies have been incorporated in the dominant top-down structures of many organisations. Comprehensive long-term plans to guide the implementation process of GIS remain elusive in many organisations. Most of GIS activities (especially in government departments) are happening in corners; GIS staff does their work in isolation and shares the final products only with acquaintances, internally and with outside organisations. Throughout the chapter it was shown that the major problems to be overcome in implementing GIS are more organisational procedures and strategies, managerial and human-based. This problem links with the problem identified in chapter 5 that some times certain units do not have clear mandates. It has to do with the way in which responsibilities are allocated and distributed between organisations and units, e.g. what organisation is responsible for what thematic data sets, how data records are to be kept and administered, and the skills and education of the people expected to run the systems that will determine the success or failure, and not the technology to be employed. The other thing is the issue of ensuring proper networking arrangements between existing organisations.

In addition to above-stated and other obstacles of infrastructure (electricity, hardware as signalled in the literature on developing countries), GIS implementation in Namibia is problematiced by a host of issues, including:

- Lack of a national spatial information policy, supported by legislation,
- Poor financial support, probably reflecting the low priority assigned to spatial information systems by the Government and also by the state of economy,
- Very little communication and cooperation among organisation implementing GIS and related spatial information systems,
- A general lack of technology acceptance and appreciation by the top-layer bureaucrats.
- The survey revealed that there are only a few users with the requisite training in GIS to take advantage of the technology.

Another important question that emerges from the survey finding is to do with what advises organisations to employ a particular GIS model over the other. This question will be dealt with in the case studies, which hopefully will provide an insight for understanding of choices and options that organisations have in GIS adoption. A strategic framework which was developed in this chapter will be used assess the routes taken in guiding organisations into adopting a GIS organisational model.

The survey results also have implications for the Government. The Government needs to recognise that in Namibia (as in many other developing countries), there is too much dependence on foreign donors and foreign firms, and that this constitutes a great challenge. On a basis that GIS is a “western artefact”, its adoption and implementation will require a foreign exchange component. What countries like Namibia certainly require is some financial and technical support for its successful diffusion. However, the government has to demand more control over project design and implementation using local experts. It should be a national priority to develop local expertise and collaborate more with other African countries and various platforms such as EIS-Africa.

Chapter 6: The Case Studies

6.1. Introduction

Based on the outcome of the survey questionnaire as described in Chapter five, three organisations were identified as the preferred candidates for the more detailed case studies. This chapter will describe the implementation process of GIS in the three organisations. In each case, I will start by giving a brief introduction of the organisational structure including its mandates to set the scene for background information. For each case, the key project leading to the adoption and implementation of GIS in the respective organisation is used to illustrate the strategies of GIS implementation and to illustrate the pervasiveness of GIS within the organisational contexts. The driving force for the initial GIS adoption in each organisation is identified and the structure of the decision-making is examined to identify the roles of different actors in the GIS implementation process. The use of GIS in each organisation is considered, focusing on the purposes for which GIS was initially introduced and on the current purposes for which GIS is being implemented. Table 6.1.1 summarises the basic information about the organisations used in the case studies.

Table 6.1.1: Organisations used in the case studies

	Organisations					
	Municipality of Walvis Bay		***Central Bureau of Statistics (CBS)***		***Tuyeni Community Research Centre (TCRC)***	
Area/Political region where the organisation is situated	Walvis Bay/ Erongo Region		Windhoek/ Khomas Region		Eenhana/ Ohangwena Region	
Type of sector	Parastatal		Government		NGO	
Duration of GIS implementation	Since 1996		Since 1999		Since 1996	
Focus	Town planning		Census mapping		Natural resources	
Coverage of interviews	(%)	(N)	(%)	(N)	(%)	(N)
Power users	100	6	95	4	100	2
Managers	65	11	70	4	100	2
Associated Consultants	5	1	85	5	0	0

6.2: The Municipality of Walvis Bay

6.2.1. The structure of the Walvis Bay Municipality

Walvis Bay is situated between the Namib Desert and the Atlantic Ocean, on the west coast of Namibia. With a population of 60 000 people, Walvis Bay is Namibia's second largest city and the country's main harbour (NPC 2003). Walvis Bay, meaning the "Whale Bay" has had a chequered history. The bay has been a haven for sea vessels because of its natural deep-water harbour, and being rich in plankton and marine life these waters drew large numbers of whales. This attracted whalers and fishing vessels. A succession of colonists exploited the location and resources of this strategic harbour settlement. The harbour's value in relation to the sea route around the Cape of Good Hope had caught the attention of world powers since it was discovered. This explains the complicated political history of Walvis Bay down the years (see Box 6.2.1).

To date, because of its strategic location and a well-developed port and transport infrastructure, Walvis Bay has become an important gateway between the emerging African markets and those of Europe and America. The driving force of the Walvis Bay economy is the fishing industry, while the innovative tax-free investment zone known as the Export Processing Zone (EPZ) has proven to be an attractive option for investors. Locally, the Walvis Bay fishing industry creates about 10, 000 jobs and generates 10% of Namibia's GDP (Walvis Bay Municipality 2005).

The Municipality of Walvis Bay (hereafter, the Municipality) covers an area of 1,124km^2 and 60km of the Skeleton Coast (Walvis Bay Municipality 2005). Prior to reintegration to Namibia (in 1994), Walvis Bay was managed by three municipalities, but since then only one municipality applies. The organisation is made up of 10 Councillors, one of whom is the Major. These elected representatives meet regularly as Committees and Council to make decisions on policies and address pressing issues. The Chief Executive Officer (CEO) is appointed by the Council for a period of 5 five years. This contract is renewable.

In 1999, the Municipality structure went through a restructuring, creating six departments to broaden the scope and improve the quality of services rendered to Walvis Bay residents, with due regard to the environment. The new structure of the Municipality is illustrated in figure (6.2.1). The department of Electricity and Power was moved from the Municipality to become an independent body (known as Erongo Red) in July 2005.

Box 6.2.1: Historical and Political status of Walvis Bay

1487: The first European, the renowned Portuguese navigator Bartholomew Dias anchored his flagship "Sao Cristavão" in Walvis Bay on 8 December 1487, on his expedition to the East via the Cape of Good Hope. He named the bay Golfo de Santa Maria da Conceição. However, the Portuguese did not formally stake claim to Walvis Bay.

1840: In the scramble for Africa, Great Britain, a premier sea faring nation at the time, annexed Walvis Bay and a small area surrounding the territory to forestall German ambitions in the region and to ensure safe passage of British ships around the Cape.

1910: Walvis Bay, as well as the Cape Colony, became part of the newly formed Union of South Africa. However, a dispute arose with Germany over the enclave's boundaries. This was eventually settled in 1911 and Walvis Bay was allocated an area of 1 124 km².

1915: South African Forces ousted the Germans and Walvis Bay was quickly integrated into the new martial law regime established in South West Africa. South Africa was later awarded control over South West Africa by the League of Nations.

1921: Civilian rule was restored in South West Africa and Walvis Bay became an integral part of South West Africa.

1971: With independence for South West Africa imminent, South Africa transferred power over Walvis Bay back to its Cape Province.

1977: In its attempt to avoid losing control of Walvis Bay to a possibly hostile SWAPO led government, the then South African Government reimposed direct rule and reasserted its sovereignty claim based on the original annexation.

1978: The United Nations Security Council provided for bilateral negotiations between South Africa and a future Namibia to resolve the political status of Walvis Bay.

1990: South West Africa gained independence. A new nation, Namibia, was born but Walvis Bay remained under South African control.

1994: Walvis Bay was formally returned to Namibia after the former South African government was pressured to resolve the political status of Walvis Bay.

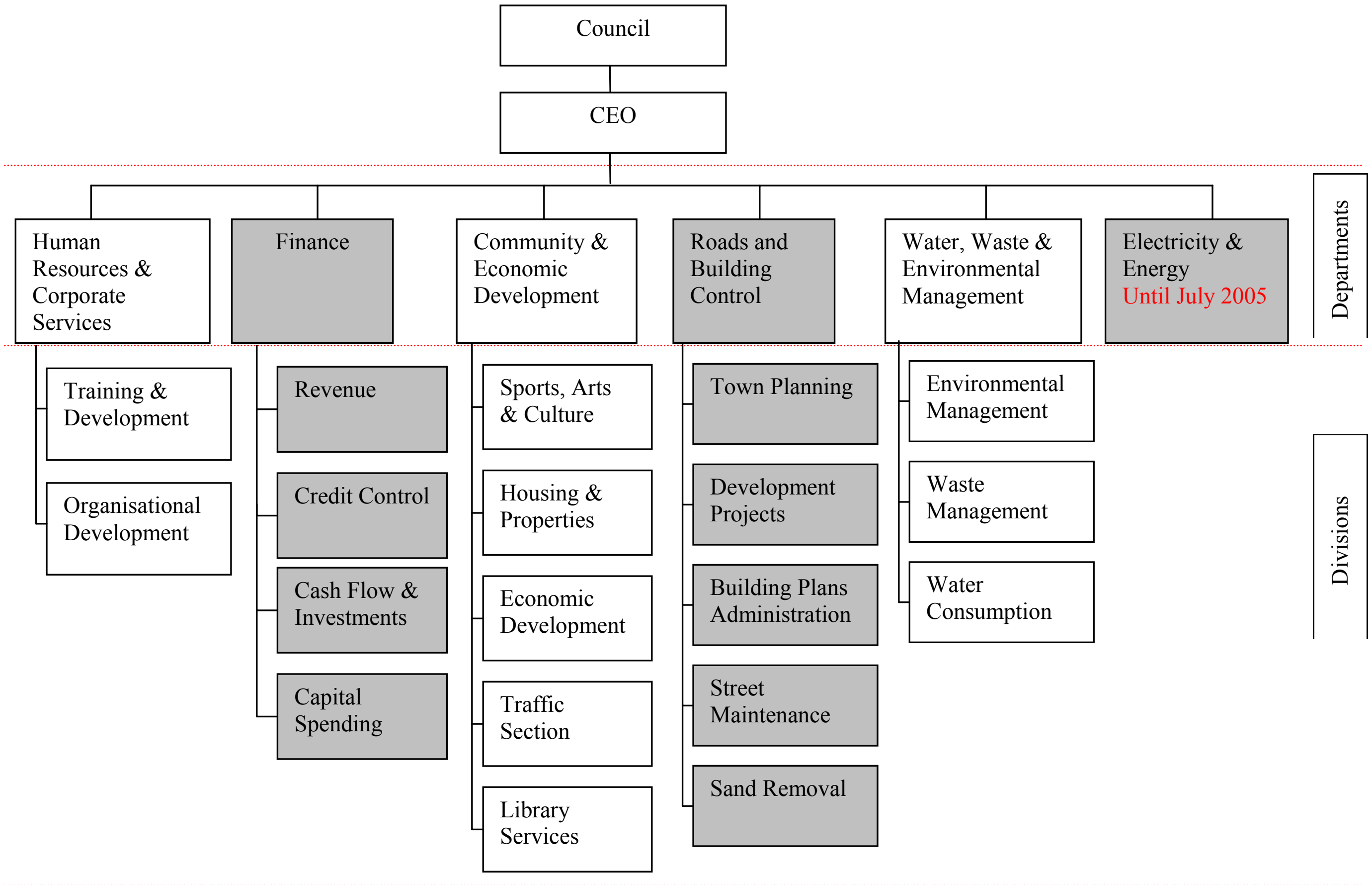

Figure 6.2.1: The Structure of the Municipality

6.2.2. Describing the Case Study through the ANT Lens

6.2.2.1. GIS initiation stage

The development of GIS at the Municipality began in 1986 with Ms van Heerden as a focal actor (figure 6.2.2). Ms van Heerden, a Town Engineer, had gained GIS knowledge through collaboration with counterparts at the Windhoek Municipality and the Directorate of Surveys and Mapping (DSM), as well as from participation at various GIS conferences and workshops.

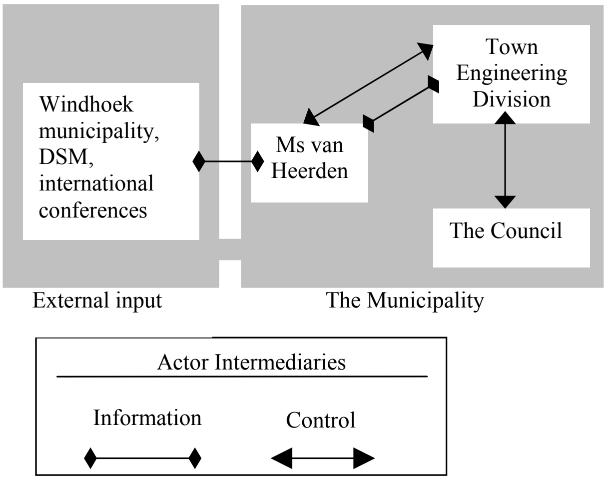

Figure 6.2.2: The Municipality GIS problematisation (1986 – 1995)

She defined that the use of GIS for town planning purposes would improve the performance of the Town Engineering division which in turn would improve the productivity of the Municipality. The capability of GIS to integrate data from different departments within the organisation was also used as an argument to convince other actors, which were mainly the managers of the various departments, about the usefulness of GIS. The managers originally had minimal knowledge of and commitment to GIS. Her effort to align their interests included presentations and demonstrations of what GIS technology is about, what it can do and its potential benefits to the organisation. In this problematisation, the solution was defined as the acquisition of a GIS. This solution demanded financial resources and human skills able to operate the GIS. A price range close to one million Namibian Dollars (approximately 20 000 US$ at that time) was predicted for the acquisition and setup of the GIS infrastructure (hardware and software). The Council was identified to provide the required resources.

Ms van Heerden's proposal met a flat refusal by the managers in the organisation. The strongest side of their reluctance was the cost involved in setting up the GIS. Afraid of how they would justify investing large amounts of money on a new technology, on behalf of the Council, the managers denied the roles defined by the focal actor.

> "One day my boss said to me … even if I seriously wanted to support your GIS idea, how will I explain the cost involved to the Council? … Then at one time my boss was faced with two options, whether to consider my request and motivate it or to motivate the purchasing of a new Water Management System (WMS) – which was suggested to us by one visiting American. My boss opted to motivate the purchasing on the WMS, though the Municipality had none to operate it. The cost of the WMS was in the same range as the GIS would have cost. The only difference was that the WMS is a tangible machine

> which everyone could see and imagine it doing wonderful work. Today as we speak, 17 years later, the WMS is still sitting in the box as it came, because the Municipality never got anyone to operate it." (Ms van Heerden)

Secondly, the managers did no really see the need or importance of implementing a GIS.

> "For them, they had all systems in place - if anything was needed was to improve those systems, and not to acquire new ones." (Ms van Heerden)

In this view, what is usually described as resistance to change may very well be a lack of motivation to accept a new system. Thirdly, their reluctance was in fear that GIS may cost them their positions in the organisation since they were backward with GIS technology and with computers in general and could even be considered technophobic. In this view, managers were resisting to implement GIS because they feared that its use could skew power towards the junior staff who were better vested in computing. They also saw GIS as technology-driven, pushing expensive systems with long-to-come benefits and an uncertain implementation process.

As time passed, Ms van Heerden did not give up on her desire to have GIS initiated at the Municipality. She believed that the manually operated functions of the Town Engineering Division (now Town Planning Division) could greatly be improved with the use of a GIS. While keeping a close contact with the Municipality of Windhoek which was progressing in their GIS implementation, year after year, she wrote proposals and motivations to the top management for the acquisition of a GIS. After nine years of struggling with the management, in 1995 the management eventually permitted the acquisition of a GIS by the Town Planning division, though they were still sceptical about its success given the cost involved. In addition to Ms van Heerden's tireless efforts in advocating GIS within the organisation over the years, there were other motives that encouraged the management to finally align their interests and give a "go ahead" situation for GIS initiation. The first motive was their desire to compete with the Windhoek Municipality, which by then was already advanced in their GIS implementation. The second motivation was established through a contact with the DSM. DSM proposed to the Municipality that all Erf Key identifiers conform to those used by the DSM. This proposal was an effort by the DSM to structure and standardise the Erf Key system in the country. The advantage of the structured-standardised Erf Key system is that it provides automatic listing of erven per registration division in all municipal areas. And thus, no manual renumbering exercise would be necessary. The success of these translations led to the formulation of the Erf Key project at the Municipality, which was used as a backbone for GIS initiation.

The specific objectives of the Erf Key project were three-fold and simple in concept as follows:

- Establishment of a GIS at the Municipality,
- Establishment of a Town Treasury Billing and Financial System (BIQ System),
- Establishment of a link between the GIS and the BIQ system.

These specific objectives focused on the development of new technologies at the Municipality. All three of them were technical processes, and arguably process-oriented than objective-oriented. The idea was that the GIS would contain the locations of all erven and information regarding ownership of such properties. The BIQ system would then contain information on the services available on the properties. A link between the two systems was essential to provide a means to ensure that a particular parcel (Erf Key) in the GIS database can be linked to its own and only its own related data contained in the BIQ database. This meant that the systems (GIS and BIQ) would use a common Erf Key identifier. Primarily the erven needed to be identified by the same designation in the index field of both systems to have properly corresponding data integration. Without this element, the desired link cannot be established, which would then defeat the purpose of the exercise. Important also in the development of the GIS-BIQ link was that neither the GIS nor the BIQ users may be allowed to alter data on the system under control of the other party.

This included accidental, malicious or virus type of data corruption. However, certain data fields would be updated by different parties and these changes must be visible and accessible for queries on both systems through the link[64].

6.2.2.2. GIS execution stage

The implementation process of GIS at the Municipality has been characterised by several actor-networks as this section will show. The first actor-network responsible for the actual GIS execution at the Municipality was established in 1996 with the Erf Key project (figure 6.2.3). The responsibility of the GIS part of the project lied with the Town Engineering Division (now Town Planning Division) in the Department of Roads and Building Control, whereas the BIQ system lied with the department of Finance. In July 1995, the Municipality requested for proposals/tenders for the "Supply of GIS Application Software to Walvis Bay Municipality". Concomitantly, another tender was put forward for the supply of the BIQ system. Asab DATA, (a Namibian based consulting company) won the GIS tender and was contracted for the delivery of a complete and working group of GIS application modules. On the part of the BIQ system, Custima SA (a South African based consulting company) was appointed for the delivery of the BIQ system. The two companies were then to work together in the establishment of the GIS-BIQ link. Regarding the supply of software, the task of both companies included software installation, implementation, integration and making ready to use to its full capabilities, to predictably satisfy the business requirements at the acceptable scale of performance of the Municipality. The companies were also responsible for sizing the hardware requirements and specification required to support the software application and providing this to the Municipality. The companies were given six months to meet the objectives of the Erf Key project. The entire funding for the project was made available by the Council. Asab DATA was given full charge of the GIS part of the project, apparently to avoid placing the blame for any delay or overrun on any other party.

Coopers & Lybrand (a South African based company) was contracted to fulfil the role of a Project Manager on behalf of the Municipality; coordinating the project and reporting to the IT Manager of the Municipality. This arrangement was necessary because the Municipality did not have the ample capacity to manage or oversee the project.

Asab DATA, in their capacity sub-contracted QGIS, a Namibian based GIS providing company, with specific responsibility for the delivery of ReGIS (Regional Geographical Information System) software. ReGIS software was recommended by Asab DATA and the Municipality gladly accepted the recommendation, seeing that ReGIS was the same software used by the Windhoek Municipality which inspired them. QGIS drew up a "GIS Strategic and Implementation Plan", which was accepted by Coopers & Lybrand on behalf of the Municipality.

[64] For the purpose of the current study, the establishment of the GIS is studied while reference to the BIQ System is also made.

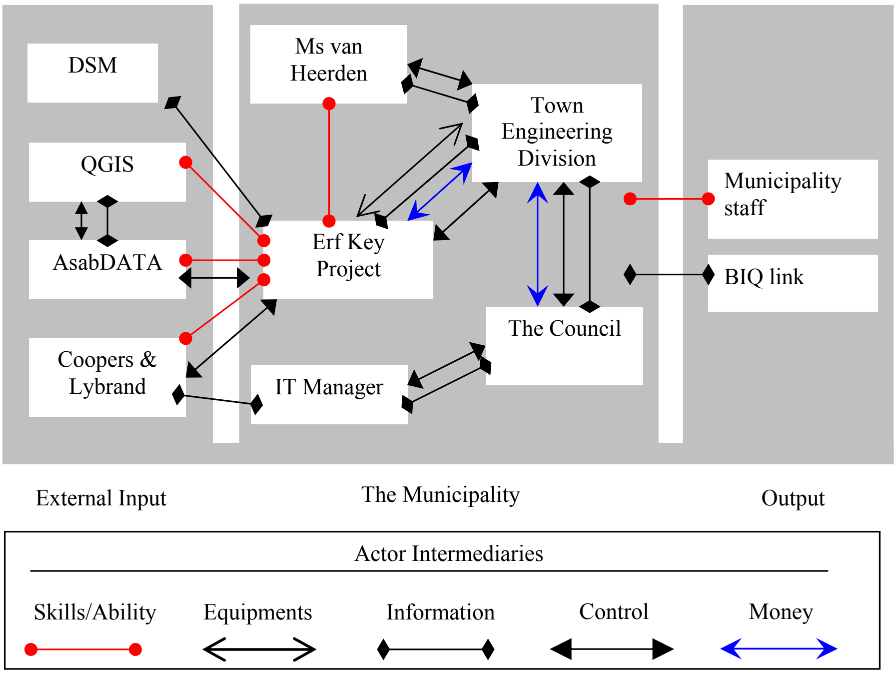

Figure 6.2.3: The Municipality GIS actor-network (1995 – 1996)

The GIS Application Software in the context of the tender consisted of the following:

- The full suite of system modules
- The Database Management System
- One of MS-Office or Perfect Office suites of office automation package

Prior to commencement of consultancy work, QGIS made demo-samples to demonstrate that ReGIS can be interfaced into the Municipality's activities and facilities. The break down of a full ReGIS consisted of: ReGIS Windows Edition Station, ReGIS Query, ReSEC (Network Security), ReTIN (Digital Terrain Model), ReSPAN (Spatial Analysis), and National Exchange Standard Interface.

To ensure efficient software delivery, the following payment terms for QGIS were agreed upon:

- 15% of the agreed purchase price is paid after successful installation of ReGIS
- Upon acceptance by the Municipality, a further 75% of the agreed purchase price is paid
- After acceptance by the Municipality of the non-core modules, a further 5% is paid
- The remaining 5% of the agreed purchase price is paid six months after acceptance, subject to successful integration between the GIS and the BIQ system.

Licence agreements for use of ReGIS software were drawn up and specified in QGIS' agreement with Asab DATA:

- Licence to use the ReGIS system on any hardware of the Municipality's choice, under any operating system of their choice.
- QGIS provides version support to the Municipality until the next ReGIS release.
- QGIS grants the Municipality free access to a help desk facility.

The Municipality took ownership of ReGIS software upon acceptance thereof. Although it was not categorically stipulated as an objective of the Erf Key project, the agreement between Asab DATA and QGIS included that QGIS provides training to the Municipality staff on how to use ReGIS software. The training was provided to 22 Municipality staff. Candidates for the training were not necessarily those that will be working directly with GIS but were selected because of the nature of their work – seen as requiring understanding of a GIS. Candidates were drawn from different departments and different positions. Out of the 22 trained staff, five of them were put on a mission of data capturing (see below under data capturing). Because GIS was a new technology to most of the Municipality staff, plus most of the staff members were not too acquainted with computers in general, the training provided was only understood by a few.

Coopers & Lybrand intervened when Asab DATA and QGIS could not stick to their plan in software delivery process. At the end of the project, each actor fulfilled their roles although to varying degree of success. The establishment of both the GIS and the BIQ systems was generally successful, except the link between the two systems was not successfully established.

<u>Diffusion of GIS in other departments</u>

As already mentioned, the Erf Key Project was implemented under the Town Engineering Division (now Town Planning Division) in the Department of Roads and Building Control. Soon after the GIS infrastructure was in place, two more departments got interested and GIS was incorporated into their structures and job descriptions (see figure 6.2.4 below). The diffusion of GIS into those two other departments also meant that the use purpose of GIS at the Municipality was spreading because these other two departments had different mandates (see Table 6.2.1 below).

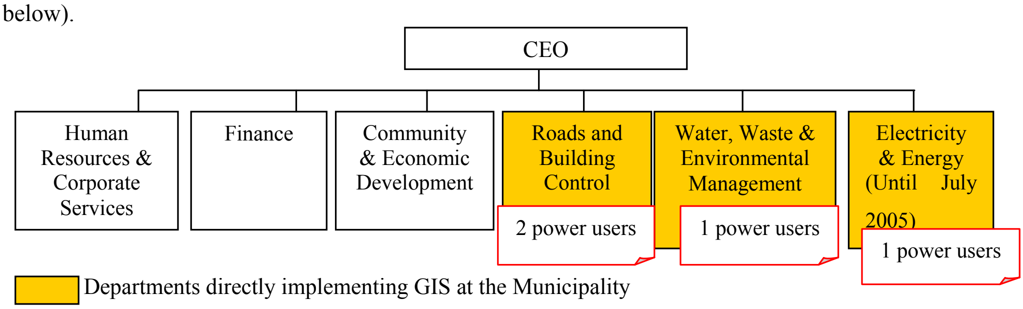

Figure 6.2.4: Diffusion of GIS in departments at the Municipality

Table 6.2.1: Purposes for which GIS is used at the Municipality

Department	**Purpose for which GIS is used**
Roads and Building Control	• Designing of township layout • Sub-division and consolidation of erven • General thematic mapping of town planning related matters
Water, Waste and Environmental Management	• Mapping the distribution and locations of wet services (e.g. sewages) in the municipal area
Electricity and Energy	• Mapping the distribution and locations of electricity cables, positions kiosk (point of distribution to customers)

GIS Steering Committee

As seen in figure 6.2.3 above, the time when Asab DATA was awarded the contract, the Municipality had an IT Department[65] run by an IT Manager. Although the knowledge of GIS of the IT Manager was little it was decided that he worked closely with the consultants so that the whole GIS establishment would not entirely be left to the consultants. In 1998, the managers of the divisions directly using GIS (see figure 6.2.4) raised concern regarding the lack of a defined management of GIS. Consequently the establishment of a GIS Steering Committee was recommended and approved by the Council in June 1998. The Committee was set to meet on a monthly basis. As per the manager's recommendation, the Committee consisted of three members, representing the departments that were using GIS by then. The Council proposed three more membership: an IT Manager and two Councillors. The membership of the Councillors were however more political as at that time, any Committee formed had to have at least one or two Councillors for political monitoring. The functions of the Committee were limited to policy and guidance to the GIS operators, and liaison with the Municipality's top management. Specifically, the objectives of the GIS Steering Committee were to:

- Provide management to the GIS daily operations
- Provide liaison (for GIS related matters) to the various departments
- Liaise with IT- consultants for data management and archiving
- Liaise with the Chief Executive and Management Committee on IS related issues.

The presence of the Councillors in the Committee was a distraction to some of the managers who felt they needed to be careful with what they suggest or support, as it may be interpreted otherwise. This definitely impacted the decisions made regarding the implementation of the technology. It was also reported that if the Councillors disagreed with any of the Committee suggestions or proposal, none really challenged them. This amounted fear was apparently attributed to the political environment of Walvis Bay at that time, having just been returned to Namibia in 1994.

Later, it was deemed important that membership of the Committee be extended to include representatives from all departments, whether they are using GIS or not, as well as all power users. This arrangement was to streamline communication between the various departments, between GIS power users and non-power users and between the Council and the GIS implementing staff. Moreover, financial implications of decisions taken by the Committee can easily be evaluated by everyone concerned on a first hand basis in order to strengthen the soundness of such decisions.

As time went by, the GIS management, although functioning, was felt burdensome to the Committee members. This was so because members were getting more and more involved in much of the day-to-day GIS operation, in addition to their usual daily duties. And now that the Committee had more members, decisions were made at a slower rate (the more people involved in, the slow the decision-making process). The Committee felt that this situation could easily be corrected by employing a GIS Administrator – a person dedicated to GIS and its day-to-day management. Following this recommendation by the Committee, and after consultation with the Human Resources Department, a request was forwarded to the Council for approval. Unfortunately the Council did not approve as they did not see the relevance of a GIS Administrator, despite a comprehensive motivation from the Committee.

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[65] Since 2000/2001 the Municipality's IT functions have been outsourced to an outside consultant, a process that is working well. With the implementation of the outsourcing of the IT function, all previous in-house IT posts were abolished. As a result, the Municipality now has no in-house IT expertise but relies entirely on the consultant.

<u>Technical management of GIS after the Erf Key consultancy period</u>

After the end of the Erf Key project consultancy period, the whole GIS infrastructure (ReGIS software, the hardware required to utilise the software, and the database) was managed by QGIS, under the extended contract (extended for a six months period). This arrangement was due to the fact that the Municipality did not have the capacity to manage their GIS. The training provided to the staff was not sufficient enough to empower them to manage the systems. Mr van Jaarsveldt of QGIS, was thus made available on site to solve problems and any complications that may have arise, thus fulfilling the role of a GIS Administrator.

The GIS Steering Committee was not happy with this kind of situation. They had preferred a self-sufficient GIS operation. The Committee thus made a recommendation for a Municipality staff to receive full training to take over from Mr van Jaarsveldt. However, information was received from QGIS that the suppliers of ReGIS software places strict prerequisite on candidates for such training, namely: a minimum of 18 months active experience with ReGIS software. At the same time the proposed trainee should show an aptitude for computers and computer software. This prerequisite left the Municipality with a complication that was not able to solve in-house with the staff compliment, since none of the staff had the required experience at that time.

Five optional solutions were proposed for this dilemma:

Option 1 – Do Nothing

This option meant that after the expiry of Mr van Jaarsveldt contract, no person shall be appointed to take over from him. Not appointing anyone implied a serious neglect since the GIS will most probably malfunction within a short period of time. With the large amount of funds already expended on the GIS project, further commitment was deemed compulsory.

Option 2 – Appoint a person from the private sector

Due to the “No Poaching” agreement in the tender agreement between the Municipality and QGIS, none of the QGIS staff could be appointed without breaching the agreement. An option was thus to locate a trained and experience person through normal scouting procedures. There was fear that this process may take an extended period, for persons with the relevant training and experience will most probably be employed outside Namibia, and getting them to Namibia would most likely cost the organisation a lot of money.

Option 3 – Appoint a consulting Administrator

This option was for extending Mr van Jaarsveldt’s contract through QGIS to the Municipality for an extended period of two years, until an in-house person could be trained.

Option 4 – Arrange Transfer of QGIS Systems Manager

This option was to discuss the issue with QGIS and “buy” Mr van Jaarsveldt from them. Although this might seem to be a breach of contract, the Municipality urged to point out to QGIS that as GIS consultants and experts they should have foreseen the situation that the Municipality will require a person with such capacity, and should have identified this to the Municipality with sufficient advance notice to enable the appointment of such a person.

Option 5 – Contracting QGIS via Modem

This option entailed a contract with QGIS whereby a modem link is set up with them. Should any enquiries or complications arise, direct contact could be facilitated via the modem and telephone. Fear raised on the cost of hardware and operational cost of such arrangement. The concern was also that, such kinds of arrangements normally are complicated by the interfacing problems via the less experienced operators at the workplace who may not be able to transfer subtle pieces of information, and may cause increased costs and frictions.

Finally, option 3 was taken and Mr van Jaarsveldt's contract with the Municipality was extended for two years. This option was found most advantageous solution as:

- Mr van Jaarsveldt was an experienced and trained person in the field of GIS
- He was involved with most of the design and set-up of the GIS infrastructure at the Municipality
- He was the one that provided training to the Municipality staff
- He was accustomed to the system and knowledgeable of the software, and
- He was familiar with the Municipality scenario.

Data capturing

Prior to GIS establishment, most map making was completed by hand drawing just as most of the Municipality's operations were manual. Thus, at the time when GIS was introduced at the Municipality, all data was in hard copies and were scattered in different offices and buildings. Following a successful translation to extend Mr van Jaarsveldt's contract, (figure 6.2.5) it was recommended by the GIS Steering Committee that at least five persons be released from their usual duties and be assigned (on a full time basis) to capture all data into a digital format. The five were taken from different departments: (a town planner, an electricity engineer, a data typist, a property analyst and a property analyst)[66]. Mr van Jaarsveldt worked with the data capturing team in drawing up a data-capturing plan to satisfy the following:

- Digitizing and associated tasks,
- Conversion processing from digitisation to map models, and
- Graphical output and graphical utilities.

Moreover, Mr van Jaarsveldt defined data standards, sources and scales, and carried out a pilot data capturing. Overall, it took three years of intensive work before all Municipality data was converted into a digital GIS database.

The following is a list of problems experienced during data capturing:

- Due to incomplete data records, many hours were spent searching for information
- Poor level of knowledge required to perform the task at hand, which included being able to:
  - read and interpret cadastral plans
  - understand the concepts consolidation and sub-division of erven
  - use the computer software for data input

About 80% of the data capturing staff was inexperienced in the above-mentioned.

- Inexperienced staff delayed progress and introduced more mistakes into the system. This necessitated a thorough checking procedure.

At the end of three years, all erven and units were captured. A great effort was made to capture associated data correctly. However, although the data went through several checks, the result cannot be guaranteed to the 100% error free. To date, the GIS database is continually refined and updated to reflect the latest Deeds Registry information.

[66] Of all these five persons, only one of them is still with the Municipality.

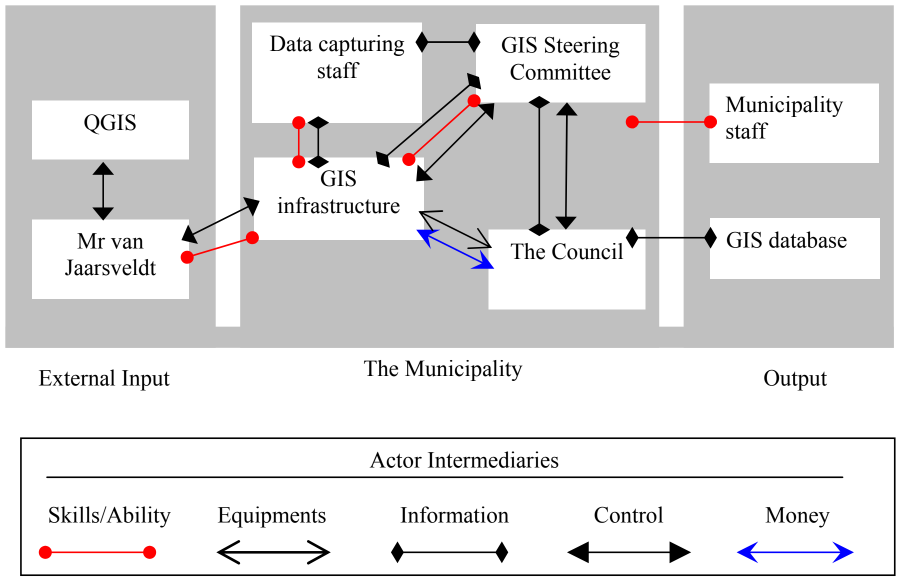

Figure 6.2.5: The Municipality GIS actor-network (1997 - 1999)

Upgrading from ReGIS to MicroStation

In 1998, two years only after ReGIS's installation, the Municipality started debating to upgrade from ReGIS to "something better". The main reason for the desire to upgrade was that ReGIS had proved to be less compatible with the Municipality's technology environment and support from Mr van Jaarsveldt was not all that sufficient. ReGIS was not written for a Windows environment whereas the Municipality was using all its computers with Windows as operating system. The Municipality was also hampered by the outdated alphanumeric database format of ReGIS. Plus, ReGIS did not allow multiple access to the database during data building phase – in other words it reduced access to the database to a single user at a time. This considerably slowed down the process of data building and update and caused additional maintenance on the database. Users also found ReGIS to be not user friendly, and for this they should always rely on Mr van Jaarsveldt. Moreover, due to the several shortcomings, in 1998 ReGIS's developers announced its discontinuation. This meant that ReGIS's developers were no longer going to be selling the product, and thus no further development on ReGIS was going to be done.

To determine the appropriate software to upgrade to, consultants were asked to submit tenders to test and demonstrate the capabilities of alternative software, - under the project "Provision of GIS and CAD software, training and support". Four tenders were received (two from Namibia and two from South Africa). The tenders were preliminary evaluated by the members of the GIS Steering Committee in conjunction with the IT Department. This evaluation was done to determine whether the offers were acceptable. The tendering companies were also invited for a demonstration at the Municipality. The companies' visits assessed the situation on site, with the view to provide the Municipality with a solution for software for the GIS system, the CAD software needed in drawing offices and to demonstrate the said software. During the visits, discussions were held with staff from various departments, to determine the requirements for GIS and CAD facilities.

In Nov 1999, a preliminary decision was made (by the GIS Steering Committee together with the tender evaluating team) to award the tender to a South-African based PQ Africa/ Real World for the provision as outlined in table 6.2.3 below. However, when their preliminary decision reached the Council they were challenged to answer questions related to their prior knowledge on the proposed AutoDesk World. This led to realisation that none at the Municipality knew much about AutoDesk World, except that the software was in its infancy. Therefore, the Council decided that the final decision be put on hold while the GIS Steering Committee re-appraise the entire objectivity of the GIS on a long term basis. The decision was also taken that the GIS Steering Committee finds out more about AutoDesk World, to avoid repeating their experience with ReGIS. The GIS Steering Committee thus embarked on several visits to other municipalities (within the country and in South Africa) to assess what GIS software they were using and seek advice about AutoDesk World. The consequences of the several discussions held during the visits lead to the believe that upgrading to AutoDesk World, the supposedly logical progression of ReGIS[67], was not recommendable due to various problems with AutoDesk World software. For this reason, a decision was reached to re-advertise the tender. In January 2000 the tender "Provision of GIS and CAD software, training and support" was re-advertised[68]. Four different consulting companies tendered (1 Namibian-based and 3 South African - based).

Table 6.2.3: GIS software required for Municipality

Level of users	**Description**	**Recommended software**
Data builders	• Advance application usage • Data manipulation • Interfacing with other applications • Data collation • Data management	AutoDesk World with MUG (Multiple User Geobase)
Power users	• Applies involved queries • Advanced data manipulation • No data input	AutoDesk World/ AutoDesk Viewer
Normal users	• Light use • Mainly prepared standard queries • No data input • Very basic data manipulation	AutoCAD MapGuide 50 viewer network license
Design CAD	Design CAD	AutoCAD 2000
2D CAD	Civil/ architectural sketches	AutoCAD LT 98

With the information regarding the software as determined by consultation with suppliers/consultants and internal appraisal, a decision was reached in September 2000 and the tender was awarded to EMCON (a Namibian-based company), in association with Geonet (a South African-based company), figure 6.2.6. In view of the relatively small role that EMCON was to play in the project, EMCON proposed to the Municipality if the contract agreement for the

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[67] AutoDesk bought the ReGIS source code in 1995 and in 1997 AutoDesk World software which was based on ReGIS was released.

[68] The decision to re-advertise the tender was timely because on 1 February 2000 AutoDesk announced that it would not be undertaking any further development of the AutoDesk World products. There were numerous reasons for this decision, but the primary one was that AutoDesk World was not an Internet product, and the use of Internet in the GIS field was rapidly being adopted. Thus AutoDesk decision was to redirect focus from GIS to the development of Internet and Internet-related technology.

project could be made between Geonet and Municipality (instead of EMCON and the Municipality) since Geonet were the suppliers of the software which also accounted for the largest part of the contract amount. Geonet in turn would make sub-contract agreements with EMCON for their part of responsibility on the project. The Council did not accept this proposal and thus EMCON entered the contract agreement with the Municipality. The Council's argument was that they preferred to enter an agreement or award the tender to a Namibian company than to a foreign company. The scope of the tender involved the provision of:

- GIS software for data capturing, data manipulation, and data queries
- GIS software installation on computers at the Municipality and commissioning of the software
- GIS data transfer from ReGIS to the new software
- GIS software applications training
- GIS software applications support, inclusive of specific subroutines
- GIS software maintenance
- Assistance with interfacing the new GIS with the BIQ System of the Municipality
- Provision and installation of CAD software for architectural, civil and electrical engineering applications
- CAD software applications training
- CAD software applications support
- CAD software maintenance

A Software Requirement Specification was compiled by Geonet in consultation with EMCON and the GIS Steering Committee. The GIS software recommended was MicroStation/J (a Bentley software[69]) and various degrees of customisation to best suit the Municipality requirement. MicroStation/J is designed for large-scale collaborative engineering across the Internet of corporate Intranets and supports the entire life cycle of products and assets, from conception to construction and deployment. Productivity is further increased by including discipline specific functionalities. Although the GIS Steering Committee was not aware of this product before, they took Geonet's recommendation as they were provided with full functions and capabilities that the software can do (which corresponded with what they were looking for). They were also provided with constraints associated with the software. But one factor that overwhelmingly counted to favour MicroStation/J was the CAD function that is built-in.

The licence agreement of the software allows 100 persons to use the software. Of these 25 have edit rights, 25 power user rights, and 50 viewing rights. These numbers were defined by the GIS Steering Committee. The software is owned by the Municipality and the maintenance contract exists between Municipality and Bentley systems (Bentley systems are administered by Geonet in all of Southern Africa).

[69] Bentley is a privately held International software company, specialising in engineering modelling software

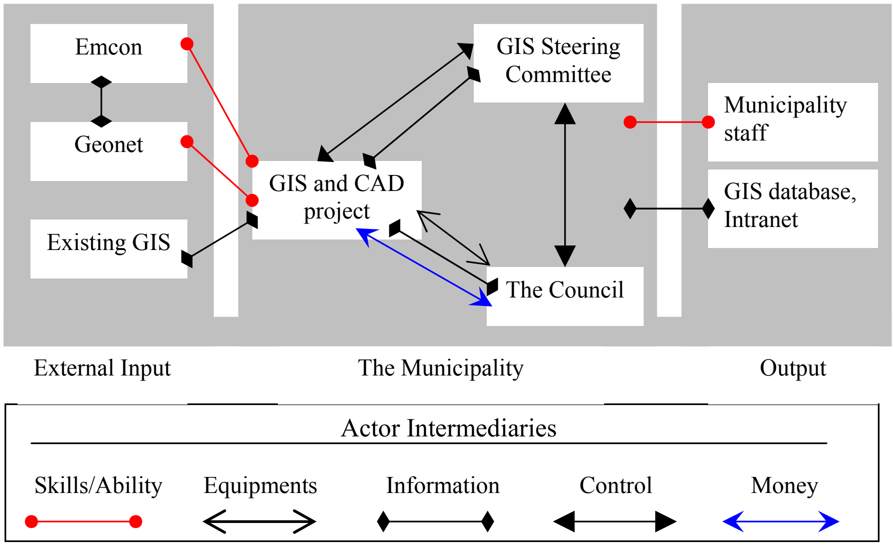

Figure 6.2.6: The Municipality GIS actor-network (2000 – 2002)

During the upgrade from ReGIS to MicroStation, all GIS data were copied to CDs and sent to Geonet's offices in South Africa where data cleaning and conversion from ReGIS to MicroStation format was done. This period was full of disappointments on the part of the Municipality for a number of reasons. First, Geonet was delayed in bringing back the data (in the new format) to the Municipality. And when the data was finally returned, the data sets were not complete as some information was lost during the conversion process. When Geonet presented the data sets to the Municipality, no mention about this problem was given. The data sets were then returned to Geonet for them to make a proper data conversion without lost of some entries and features. Geonet agreed to correct this mistake within a period of two weeks. When four weeks had passed without a word from Geonet, the GIS Steering Committee resorted to contact Emcon, who officially has the contract with the Council, in order to resolve the matter. Emcon's effort to contact Geonet through emails proved fruitless, as the emails were not getting any reply. Finally, the Director of Emcon telephoned Geonet offices in South Africa, and was informed by the receptionist that the contact person for this project was on holiday and that he was only expected back in two weeks time. With pressure from the Council, Emcon Director did not have a choice but to fly to South Africa, and have the data sets converted into the new format (by anyone that was present and able in the Geonet office). Within two days, the Emcon Director was back from South Africa with the data sets in the right format and complete. Once MicroStation GIS was fully operational, access to GIS database was available to all Municipality staff[70] through the Intranet, on a basis of read-only.

Geonet provided training to the Municipality staff on MicroStation software. The training was intended for power users and potential power users from all Municipal departments. The training addressed basic functions and capabilities of the software. It consisted of classroom lectures and lab format that provided the most practical and efficient hands-on reinforcement in the use of

[70] Basically to every staff who has access to a computer. All office-based Municipal staff has access to computers in their offices.

graphics tools and procedures. The training was arranged for five days (full-time). Interviews with the staff members that received the training revealed that the training received was not satisfactory. The training (although held at the Municipality premises) made use of sample data because the Municipality's data was still in South Africa for conversion to MicroStation format. When the Municipality data (in the new format) became available in February 2002, trainees had difficulties using them as they differed from the data used during the training. Also because the training was offered before MicroStation was operational at the Municipality, when MicroStation became operational the trainees had forgotten most of what they had learned in the training, because they had no opportunity to practice in the meantime. A system administrator manual that could assist them was also not provided. Another issue was that the trainees were not experienced enough for the level of training that was provided. On the other hand, Geonet had to adapt to the Municipality situation; computers with insufficient capacity and memory to handle the software, insufficient and poor connectivity servers, and power breakdowns due to poor supply of electricity to the building. Even thought the Municipality was advised in advance about what to prepare to smoothen the training process.

At the closure of the project, the Council was impressed with the product. However, the GIS-BIQ link was still not fully operational. ReGIS was finally phased out by the end of March 2002.

6.2.2.3. GIS stabilisation stage

<u>The structure of GIS</u>

With the departure of the Department of Electricity and Energy, the current GIS facility at the Municipality is comprised of six power users from two departments (Figure 6.2.7). Of the six power users, two of them have received formal GIS education. Others have learnt "as they went along", or have received training on specific GIS modules from local training agencies. The GIS facility which was created for the purpose of the Erf Key project does not fit within any one department. Rather, components of the GIS are now spread between the two departments. The departments directly implementing GIS work closely together, but also maintain close ties with other departments that are not directly involved in GIS implementation. While each department's functions are generally run within the group by the department staff, input is given in a participatory manner by other departments through the inter-departmental GIS Steering Committee meetings (see under GIS Steering Committee, below). This makes the GIS at the Municipality inter-departmental. In the current form, although GIS functions primarily within the two departments, there are routinely requests for GIS analysis (very basis analysis) and output (mostly maps) from other departments within the organisation. There is however no formalised process or policy through which this would occur.

As mentioned before, there is no individual responsible for the daily operations and planning of GIS at the Municipality. Day-to-day implementation and operation is vested among the power users. These users are responsible for the input of data and output of maps. Although not a permanent part of the GIS team, there is an external IT consultant who is responsible to the Municipality's network and the entire computing facilities. GRID (see under GIS Maintenance below) acts as a GIS Administrator for technical problems and for advanced computing that may not specifically relate to GIS but are detailed enough to be beyond the immediate capabilities of the power users. This team is then advised by the GIS Steering Committee, which oversees the general development of GIS within the organisation and provides input on long-range strategies and plans of the organisation. This structure provides an interactive, participatory process that allows for a diversity of input into both immediate and long-term operations of the GIS at the Municipality.

All GIS activities are carried out in-house, though consultants are used on major projects when there is no capacity in-house. Overall, GIS at the Municipality is implemented in a closed environment as GIS users interact very little with other GIS users in the country. The reason for this isolation is because users believe that they do not really need anything from other organisations. Usually the need for data creates dialog between organisations. In the case of the Municipality, they feel that they do not really require data from elsewhere as they have most of the data they need (see also under available databases below). If a new data set were required they would naturally produce it in-house. The only exception given was the CBS from where they obtain demographic information for areas under their Municipal. Attempts were also made to work together with DSM on the creation of cadastral maps for Walvis Bay. But since DSM was not able to deliver the maps, the working relationship did not hold strong.

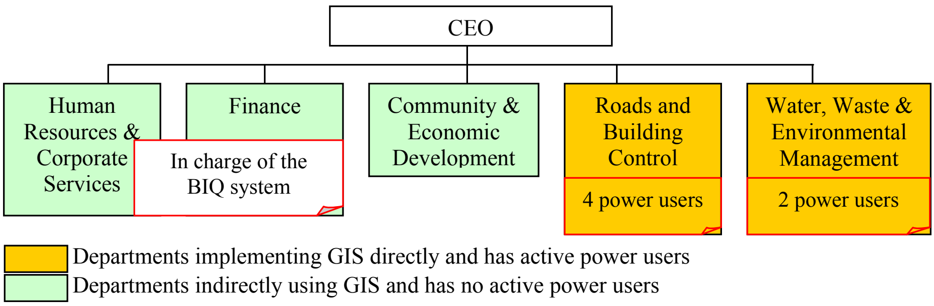

Figure 6.2.7: The implementation of GIS at the Municipality

GIS Maintenance

Immediately after the "Provision of GIS and CAD software, Training and Support" consultancy period, the Municipality entered into a two-year contract with Geonet, in terms of which Geonet must provide back-up support and GIS software upgrades (figure 6.2.8). This meant that whenever the power users experience technical/software complexities, they would contact Geonet (based in South Africa) via email or telephones to get help. This arrangement was apparently because of a lack of capacity at the Municipality to maintain the GIS. Plus, apparently there is no company in Namibia who have the capacity to maintain MicroStation. At first this arrangement caused inconvenience to the power users because Geonet was repeatedly failing to respond to email queries and telephonic messages. With time, and with numerous complaints, the situation saw some improvement, as Geonet was getting competent in responding to queries. At the end of this contract, Geonet was awarded an additional year for the same system maintenance and technical support. In additional to the provision of support, the new agreement also involved that Geonet provides GIS training to the Municipality staff. This contract is renewed every year.[71] The training is provided each year at the Municipality premises (GRID trainer travels to Walvis Bay), as they are supplied with training needs well in advance. All power users agree that the training has been worthwhile and productive. However, they wish that the trainer could come at least twice a year instead of once a year.

Additional to GRID's yearly training, the GIS Steering Committee has formed an in-house training system whereby the power users meet on a monthly basis to discuss problems and challenges experienced and seek solutions together. This in-house training system also provides training to other staff of the Municipality who are not necessarily power users but require GIS understanding in their line of work. The in-house training group also prepare internal workshops

[71] Geonet was renamed in 2001/2002 to GRID.

whereby a certain identified group (e.g. Executive Management or Managers) within the organisation is sensitised about GIS development and progress within the organisation.

As it is now, GRID has the sole system administration authority, being responsible for the overall maintenance of the GIS infrastructure at the Municipality. The Municipality power users are not too happy about this situation because this arrangement makes them too dependent on GRID.

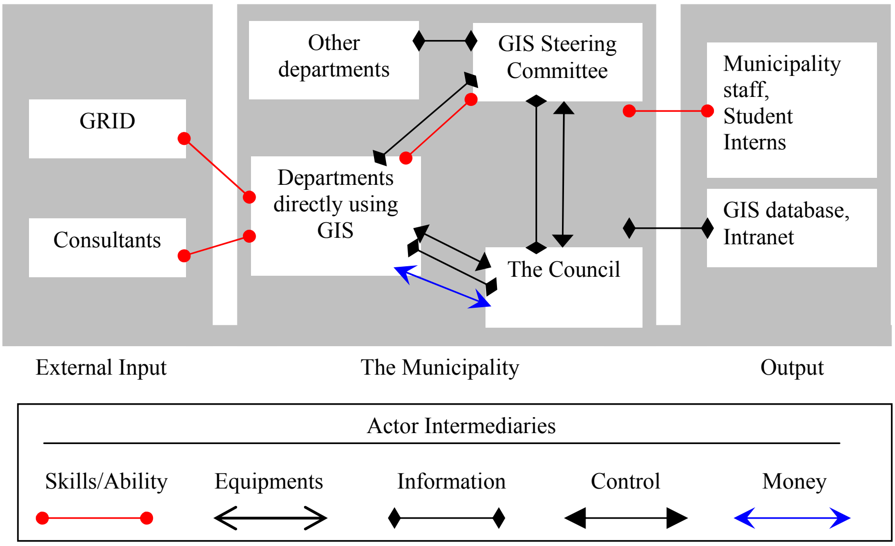

Figure 6.2.8: The Municipality GIS actor-network (2002/3 – current)

<u>GIS Steering Committee</u>

Formed nearly a decade ago, the GIS Steering Committee is still in operational to date. The culture of its monthly meeting is well sustained. However, compared to its initial set of objectives, the focus has seen a slight change. Initially, the Committee was to play a role of GIS management from a policy and coordination point of view. Over the years the Committee has become technical in its dealing with day-to-day GIS operation. This has caused some members who rated themselves as not "technical people" (including the councillors) to ask permission to be released from the Committee. In actual sense, the Committee is playing the role of a GIS Administrator at the site (carrying out a full time job on a part-time capacity).

Current membership to the Committee represents all (except one) departments of the Municipality (see figure 6.2.9). Membership was also extended to the Human Resource and Corporate Services department, but as they have strong feeling that they are not technical enough (and that GIS is for technical people), they declined sitting on the Committee. Nonetheless, the division of Customer Care (from the Human Resource and Corporate Services department) does have a direct communication line with the chairman of the Committee to whom they prefer to directly launch their complaints and contributions.

<u>The GIS-BIQ link</u>

The understanding of the status of the GIS-BIQ link among the Municipality staff is mixed. According to the power users, the link is working though not in its full capacity. It is possible to pick up information from the BIQ database, but not from the GIS database through the link. It means that the link is not working on two-ways communication as desired but on one-way. Ideally, the interface should have a two-way communication so that the strengths of both systems could be used to mutually benefit all users. Because of this broken link, the GIS database has been modified to include fields contained in the BIQ database and is then updated manually. Some managers are under the understanding that the link is up and running well. This poor understanding is based on the fact that when they use the GIS on the Intranet, they are able to see information contained in the BIQ database also. What they are not aware of is that those information are not appearing because of the two-way communication between the GIS and the BIQ system but because the data contained in the BIQ database has been manually entered into the GIS database.

Throughout the interviews, it came out clear that the Municipality is not satisfied with the work or rather empty promises made by the consultants on the establishment of the GIS- BIQ link. Box 6.2.2 below documents some feelings from the staff in this regard. The GIS users seem committed to making sensible the GIS-BIQ link work. In fact they feel obliged to prove to the Council that this link can be successfully established. The BIQ system users on the other hand seem withdrawn and de-motivated on establishing this link.

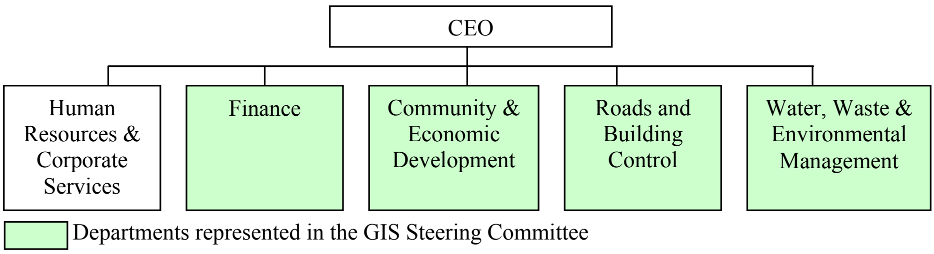

Figure 6.2.9: Inter-departmental representation of the GIS Steering Committee

Available Databases

Through various sources over a period of time, the Municipality has been able to amass a fairly large amount of spatial and attribute data for their principle areas of interest. All digital data is converted into a standard format and is stored in a standardised file system. The data is generally of good quality and is almost complete for all of the municipal areas of Walvis Bay. However, while of relatively good quality, there is no system in place to error-check the digital files. Hence, the files in the database are not always the most recent available and there is a considerable gap in the database. Because the power users do not have rights to modify the database (see under Challenges below), some important fields are missing in the database. There is a strong interest in updating the spatial database.

GIS database is available to all computers in the Municipality network through the Intranet. This set up facilitates easy access to GIS data by all Municipality staff. In this way, the benefits of GIS are freely and readily available to all computer users. Unfortunately, only a few staff members make use of the Intranet facility (see Box 6.2.3 for staff reasoning). For example, of the interviewed managers, only 20% indicated that they have used the GIS on the Intranet, although all of them have indicated that they are aware of this facility and that it was once demonstrated to them by the power users.

Box 6.2.2: Feelings toward the establishment of the GIS- BIQ link

“The document compiled by Geonet showed a mismatch of about 15% between the GIS and the BIQ Erf Key numbers. For the information to be reliable enough, such mismatches should not exist.”

“The consultants make promises that a link between the GIS and the BIQ system was not a problem and can easily be achieved. …Since 1996 I have been hearing such very same promise. All consultants that came to work on it promised that it was doable. But up to now, the two systems are not successfully linked.”

“The consultant ‘dumped’ something on the server with GIS data on, claiming it to be a workable link between the GIS and the BIQ systems.”

“With the GIS- BIQ link, it is always this problem or another. I don’t know how many times it was put on hold because a certain problem should be solved first before the link can be established.”

“We have operated for all the years without this link, I don’t understand why the GIS people are pushing so much for it even after seeing that it is not working. There have been many many meetings to discuss the links, but is just meetings all the time and nothing seem to be working.”

“We are struggling with our own BIQ system. Until we have it running smoothly our priority is not to have the GIS-BIQ link.”

“The GIS people are constantly mourning that the Council is not considering GIS as priority when for over 10 years they have not managed to convince the management that GIS can work, take the BIQ-GIS link which is still pending.”

Box 6.2.3: Attitude towards GIS Intranet at Municipality

“I’m aware of the GIS on the Intranet, but I have never used it. If and when I need information from the GIS, I usually just ask my colleagues who are working with GIS and they provide me with such information. … It is because I’m not used to searching things on a computer that I feel it is easy to just ask them.”

“I tried using the Intranet one time but the connection was slow, so I just gave up.”

“Information provided on the Intranet is really what we need. But because we usually have a long queue of customers, we find it unproductive to spend time on Intranet. So, we do work manually because that is what we are also used.”

“What we really wanted was the GIS-BIQ link, not the Intranet. If you ask for something and then the consultants deliver something different, should we just accept? Intranet is not useful for me because I do not have enough time to sit with the computer.”

“On the question of Intranet, I often conveniently forget that there is GIS on the Intranet. I would always call directly to the GIS power users and request the data I need.”

6.2.3. Challenges

A number of issues are perceived challenges that obstruct the wider implementation of GIS at the Municipality. These challenges are discussed in this section. But before that, the following paragraphs will summarise the situation in the departments that have not yet adopted the implementation of a GIS. The reason for focusing on these departments is to demonstrate with specific cases, some of the challenges hampering the implementation of GIS at the Municipality.

The Department of Finance

During the initial implementation of GIS at the Municipality, the Finance department was identified as one of the potential users and beneficiaries of GIS through the GIS-BIQ link. So far, the department's involvement in the GIS implementation has mainly been their representation on the GIS Steering Committee. At first they collaborated greatly with the GIS power users in search for a solution to establish the GIS-BIQ link. For them, GIS would only benefit them if such link is running. They anticipated an efficient system's link that would improve greatly their work, because if the link is operational they would not have to do things manually. After many years of trial and errors, they lost interest and gave up on the GIS-BIQ link and concentrated only on their BIQ system. They left the whole GIS-BIQ link issue to the GIS "technical people". After all, it was the GIS users who have been advocating the link. The communication and thus the collaboration between the BIQ users and the GIS users started degrading. To date, the department relies on the GIS database on the Intranet for their GIS needs. Unfortunately the Erf Key identifiers in the GIS database do not always correspond to the Erf Key identifiers in the BIQ database. This makes the GIS on the Intranet less useful for the department.

The Department of Human Resources and Corporate Services

Under this department, the division interested in GIS is the Customer Care Service[72], which provides property services to the public. GIS is useful in this division for the purposes of visualising the locations of properties where the division should provide the services required. This division, together with the Finance department is responsible for the maintenance of the BIQ system. However, as in the case of GIS, there is no person specifically assigned the task of operating and maintaining the BIQ system. The BIQ database is not always up-to-date, and there are often technical difficulties that makes operational of the system difficult. The Customer Care division is not directly involved in GIS implementation. The only way it would actively be involved would also be through the GIS-BIQ link, which unfortunately has not been able to fully operationalise. The division does however make use of the GIS on the Intranet from time to time. The only problem is that because they deal with long queue of customers, there is not always enough time to sit on a computer to look up for GIS data required. Plus, the network connection can be very slow at times. Alternatively, they prefer to look up such information from printed copies. This makes their work very manual.

The Department of Community and Economic Development

The Housing and Property division under this department presents a different situation. The department was identified by the GIS Steering Committee in 2001 as one of the potential beneficiaries of GIS. It was recommended that this department start implementing GIS, and a person was trained to become a power user. It was also acknowledged that the department did not have adequate computers for the installation of the GIS software. The computers in existent were of a small capacity and were too slow for running a GIS efficiently. A memo was then sent from the GIS Steering Committee to the CEO office recommending that a new large and faster computer be obtained for the division to enable implementation of a GIS. The ideal computer

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[72] The customer care service is the focal point through which customers, both external and internal, interact with the various functional areas of the department as well as the entire Municipality. This division provides a frontline support services to customers. These services would generally include service applications, account enquire, meter readings, account payment and service complaints.

recommended was described as: Pentium III 300 MHz, 64 MB RAM (DIMMS), 2 GB Hard Disk Drive, 21” Monitor, Keyboard and Mouse.[73] Because no funds were budgeted for a new computer for the division during that financial year, it was not possible to purchase a new computer[74]. The division was advised to include the purchase of a GIS computer in their next (following year) budget. It was also unfortunate that the CEO office did not see this division as a “technical division” and hence its need for a GIS was not supported. According to the CEO office, the division’s GIS needs could be handled by the “technical departments”. At present, the Town Planning division handles their requests and updates part of their databases. The Town Planning division is however not too happy to be doing the updates for the Housing and Property as they have their own jobs to attend to.

The case is that since 2002 the Housing and Property division has been including “a computer for GIS” in their budget, but the item simply gets no support from the CEO office. Due to the lack of a computer with the capacity to run a GIS, this division is not able to implement GIS directly. The person that was trained to become a power user continues to receive the training provided by GRID and participates in the in-house training system. This is so that when the division finally gets a GIS computer and starts using GIS, she will not struggle so much to use the system.

6.2.3.1. Organisational and human challenges

Figure (6.2.10) below illustrates the perceived organisational and human challenges in the implementation process of a GIS at the Municipality. A constant concern expressed by the interviewees is the absence of a GIS Administrator. On several occasions, the GIS Steering Committee has requested the creation, grading and filling of this post but the Council has not yet approved. The reason for this resentment from the Council has always been an issue of lack of financial resources at the Municipality to afford investing further in GIS as there were other priorities.

> “It is hard for the Council to spend on technical things, but very easy for them to throw large amounts dollars on politically motivated things… It is basically a matter of priority, not necessarily that there is no money.” (comment from one of the power users)

On the other hand, after having spent close to N$ 1 million on the establishment of a GIS, and seeing that the main purpose for which GIS was introduced (the GIS-BIQ link) has not fully been achieved, it is hard to expect the Council to enthusiastically invest more money on something they see as a closed system.

All GIS power users have different line functions according to which their performance is measured. GIS is not getting adequate attention due to this, “and it will remain second rated unless there is a person dedicated to it” (Mr Stewart, chairman of the GIS Steering Committee). At the moment, the power users spend on average only up to 20 - 30% of their working hours on GIS, with a few dedicating their private time to GIS activities. As the power users indicated, because of the little time they spend on the GIS, they are still not well familiar with MicroStation software. MicroStation is complex and unless used regularly efficient application may not be achieved. As it is now, the GIS is being under-utilised. The GIS is advance but for what it is used for is nothing but data updates and processing of a few queries. In creating the GIS Administrator position, the problems of GIS administration and applications could be resolved ensuring that the GIS is maintained and operated at peak performance. The need of a GIS Administrator is also

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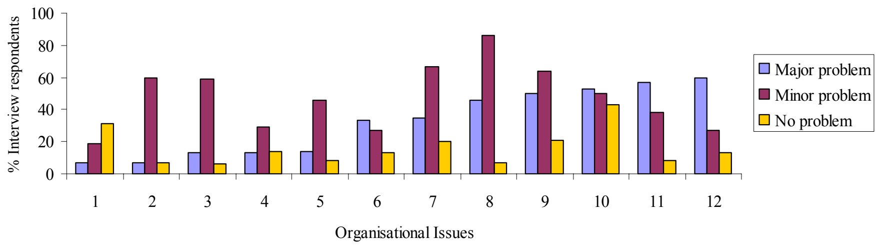
[73] These specifications characterise the same capacity of computers being used by other GIS power users in other departments.

[74] The same situation was experienced in the Town Planning department when they needed to buy a new computer for GIS operations. They did not have a budget for a new computer, but in their case, they were allowed to utilise funds from the Repairs and Maintenance budget.

very much needed to monitor the work of consultants, as came out clear from the interviews that the consultants have not always delivered what was required from them.

Leadership of GIS at the Municipality is being taken up by various individuals with special interest in GIS. With regard to data capturing, update and management, there is no strategic plan to follow for consistency. Again, because there is no person dedicated to GIS, this is one among many functions of the power users. At present, the chairman of the GIS Steering Committee (Mr Stewart, manager of the Roads and Building Control) is seen as the key person behind the GIS implementation at the Municipality. Mr Stewart is unfortunately leaving the Municipality this year (2006). Fear amounts among the power users and other GIS advocates as to what will happen once Mr Stewart leaves. This situation pleads for adequate human resources in the implementation of GIS.



1. Staff turnover
2. There is insufficient GIS training and guidance
3. Unclear project requirements
4. There are insufficient staff resources to implement GIS
5. Insufficient motivation of staff
6. There is no clear GIS strategy in place
7. Bureaucratic inertia
8. There is generally a lack of GIS skills in this organisation
9. The management of this organisation is not committed to GIS
10. There are insufficient financial resources to fully implement GIS
11. The management of this organisation is not aware of value of GIS
12. There is not designated person to maintain GIS

Figure 6.2.10: Perceived organisational and human challenges hampering the use of GIS at the Municipality

Another big problem is that insufficient attention is given to the administration and application of GIS at the Municipality. Insufficient resources are available to ensure that the GIS is being maintained and operated at a peak performance. It appears that the implementation of GIS has gone a long way to solving technical aspects of the GIS, but the administration and application of the GIS are still lacking. Lack of understanding of the capabilities of GIS is a blatant reality within the management of the Municipality. Most of the managers indicated that while they have heard about GIS, they did not know exactly what it is capable of and/or what it is used for at the Municipality. Others are disillusioned with the look warm success of the Erf Key project to the general improvement of information management in the organisation.

Over 65% of the interviewed managers think that GIS is for “technical people”. This kind of thinking has lead to a situation where the Housing and Property division has been identified by the GIS Steering Committee as having the potential to benefit greatly from GIS, but because the manager of this division thinks that his division is not a technical division, this division does not implement GIS. The manager also believes that the kinds of work carried out by this division are more field-related and not computer-related. Moreover,

> “As a matter of fact, the department has functioned all along without GIS and it has never been a problem. We definitely can do without GIS. Maybe, just maybe, it (GIS) will give us convenience, but I don’t believe it will give us something new.” (Manager of the Department of Community and Economic Development)

Then again, the managers have highlighted that there is a lack of proper marketing of GIS from the GIS users. This is despite a constant effort from the power users and the GIS Steering Committee in raising GIS awareness within the organisation. According to the managers, GIS advocators at the Municipality place more effort on technical training and little on the value and benefits of GIS. The managers feel that if they knew more about the benefits of GIS, they may not have resentment towards the technology.

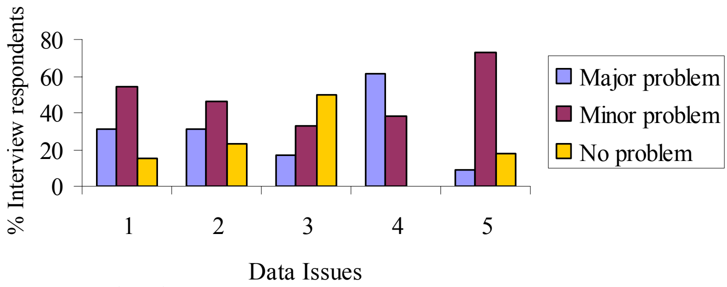
Because there is no adequate capacity at the Municipality for the maintenance of MicroStation, the Municipality is forced to deal with GRID for system maintenance and technical support. This situation, according to the power users makes the implementation of GIS a complicated task in a sense that users are limited to what they can and cannot do or explore. Because the power users have limited rights to the GIS modules, they feel they do not have the ownership of the GIS and they are always extra-careful to “mess” things up because having to call GRID every now and then for any problem is also an embarrassment for them. In some cases, the power users have suggestions for possible additional functions that were not envisaged at the time of initial system design and specification. Because the power users have no rights to system modification, their suggestions would usually wait for GRID’s next visit to the Municipality. Given that GRID visits the Municipality only once a year (except when something critical needs urgent solution), it frustrates the power users that their ideas are often shuttered off, because when GRID finally visits, they concentrate on training and tend to ignore the suggested modifications.

Another big challenge is the creation of the GIS - BIQ link, a vital element to the success of GIS at the Municipality. Because it has been impossible to successfully create this link between the two systems, the staff is losing interest in the whole GIS business (including the power users).

> “The initial reactions to GIS functionality (at the start of the Erf Key project) were very positive. Demonstrations of computer maps, analysis and interactive databases appeared dramatic to the staff (including the management), most of whom had never seen a GIS. … Unfortunately, it has been difficult over the years to prove to everyone that in deed GIS does work. What we thought should be the advantage of GIS has turned out to be the embarrassment of GIS due to the fact that GIS techniques have not been reliable to create the link between two systems with similar features, and to improve the efficiency of the departments.” (Ms van Heerden)

6.2.3.2. Data relate challenges

Overall, the Municipality is not faced with major problems related to data, though some problems associated with the cost of data acquisition, data completeness and accuracy were repeatedly emphasised (see figure 6.2.11 below). It was also noted that the Municipality does not have a metadata system in place. Most of their data sets are thus not documented.



1. Incomplete data sets
2. Accuracy of data sets
3. Lack of compatibility of data sets
4. Cost of data collection and capture
5. There is a lack of digital data in appropriate formats

Figure 6.2.11: Perceived data-related challenges influencing the use of GIS at the Municipality

6.2.3.3. Hardware/software related challenges

One of the greatest challenge facing GIS power users is the limited access rights they have on the system management (this problem was discussed already in detail under organisational challenges). The Municipality seem to have no problem with the current GIS software used as it serves well the purposes for which it is needed. The system is however considered too advanced for what it is used for. This under-utilisation of the system was also attributed to the lack of a GIS Administrator at the site (see under organisational challenges discussed above).

Regarding the hardware, limited computers with enough capacity to run a GIS presents a great challenge to some departments that would like to become power users of GIS. It was learnt that since 2001 to date, the Housing and Property division is hampered by a lack of a computer to implement the GIS. The department of Water, Waste and Environmental Management waited for close to three years before they were provided with the computers for GIS. This problem returns us to the lack of commitment by the management, who authorises the purchase of new computers. Figure 6.2.12 below illustrates the perceived hardware/software challenges influencing the implementation of GIS at the Municipality.

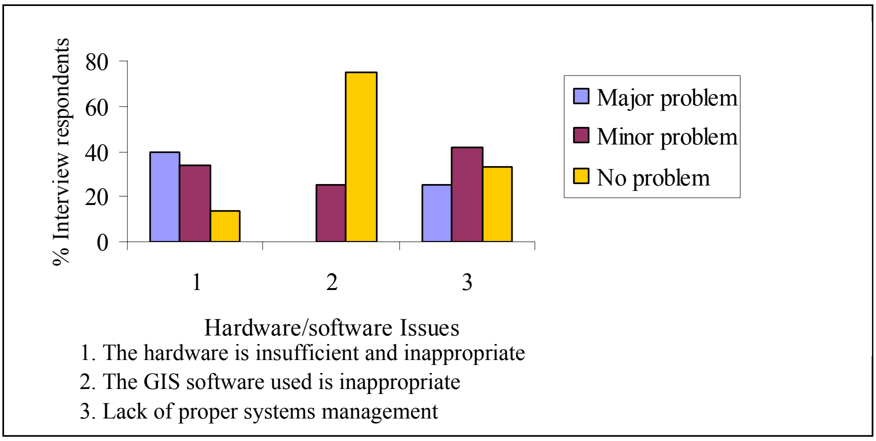


Figure 6.2.12: Perceived hardware/software challenges influencing the use of GIS at the Municipality

6.2.4. Case Summary and Conclusions

The idea of implementing a GIS at the Municipality was first introduced in the late 1980s. After the first enthusiasm shown in 1996 with the formulation and implementation of the Erf Key project, and practical results achieved a few years after the end of project, the efficiency of GIS at the Municipality has been sustainably reduced. The expected benefits in better organisational efficiency using GIS capabilities have not achieved its maximum. Today, after almost a decade of battling with the GIS-BIQ link for better GIS status in the organisation, this link is still a utopian dream. For most non-power users, GIS is recognised as an exclusive tool for “technical people” to make maps. This is contrary to the numerous other functions of a GIS. Advances in GIS technology have evolved faster than the organisational capacities of both the management and of the power users in the implementation of the technology. The role of GIS as a decision support tool, or even as an efficient tool is not very popular among the managers, who are comfortable with the less sophisticated manual instruments used in the past. For this reason, the technology is not given a priority. General awareness of GIS at the management level is generally low. On the other hand, GIS advocators at the Municipality are said to concentrate on technical aspects of the technology and not on its utility, to empower the management. Being uninformed, the managers rarely know how to take advantage of GIS and are often defying any further investment on the technology. On the part of the power users, the role of GIS for advanced functionalities (e.g. decision support modelling and spatial analysis) is not so popular. Hence, the technology is under-utilised.

It is evident that beside a few technical and data challenges, most of the current GIS challenges at the Municipality are related to organisational and human factors. The technical nature of GIS goes against the preferences of the Municipality: conservative and bureaucratic.

6.3: The Central Bureau of Statistics

6.3.1. The structure of CBS

Prior to Namibia's independence, no statistical organisation existed in the country. A local section of the South African Statistical Services (SASS) was responsible for the collection of any kind of statistics, as required by the office in Pretoria. Data processing, analysing, interpretation and dissemination were also carried out in Pretoria. The weakness in the statistical system, following independence, led to the formal establishment of the Central Statistical Office (CSO), now the Central Bureau of Statistics (CBS).

Charged with the responsibility of Official Statistics in Namibia, the mission of the CBS is to 1) produce and make publicly available objective, relevant, comparable, reliable, timely and easily accessible official statistics in all subject-matter areas of national interest and relevance, and 2) coordinate and oversee the production of all official statistics in Namibia.

The CBS is a Directorate in the National Planning Commission (NPC). The NPC was established in the Office of the President to plan the priorities and direction of national development. It was only natural to set up CSO (now CBS) in the NPC, the main users of official statistics in the country. The NPC is headed by a Director General, who in other countries would be called the Minister of Planning. The Commission, among other things is charged with coordinating statistical data collection, processing and dissemination.

The CBS is headed by a Government Statistician who is assisted by a Director and two deputy Directors. The Directorate consists of two subject-matter divisions: the Division of Demographic and Social Statistics, and the Division of Economic Statistics. Figure 6.3.1 is the current structure of the CBS.

The NPC was restructured in 1997. Up till that time, CBS had a Data Processing Unit which was discontinued during the restructuring and an NPC Information Systems Centre (ISC) was established in its place. The ISC is responsible for the IT infrastructure as well as for systems design within the entire NPC, including the CBS. CBS offices are based in the capital city Windhoek, in the same building as the NPC. Because of shortage of space, the Population and Housing Census project is however housed in a separate rented building. All staff in the main building (NPC building) have well furbished offices with a PC connected to a network supported by the ISC and have full access to the Internet resources. Primarily, CBS depends on funding from the Government, though various donor-funded projects are implemented from time to time.

Initially, the plans to establish the SCO envisaged a staff complement of about 130 to carry out the main functions of the office. In the event, a small number of about 75 establishments, only about 40% of the envisaged establishments were approved. Due to this major shortfall in staff resources, CSO has had to depend on ad hoc and technical assistance to carry out official activities. Other activities have been abandoned, and because of failure to meet user needs, a number of Government departments have been prompted to start their own statistical collections to meet their needs. This trend has continued in CBS even in the present years.

The CBS currently operates under the inherited Statistics Act No 66, enacted in 1976. It is recognised that this legislation is somewhat outdated and requires amendment in order to bring it in line with the current form of the constitution, other laws and regulations. During the time of writing, a Statistical Policy that serves as a basis for the adjustment of the Act has been drafted and reviewed by the NPC Statistics Advisory Committee.

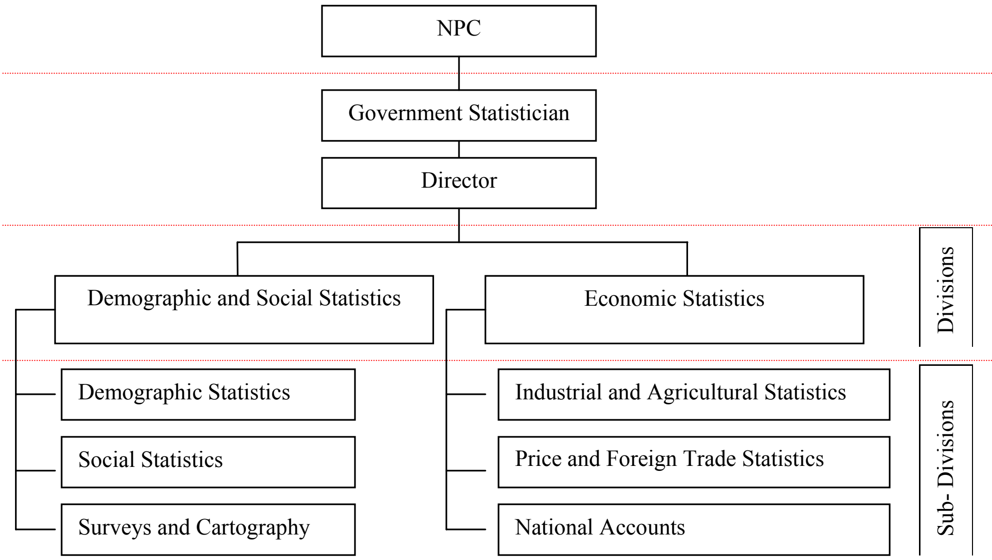


Figure 6.3.1: The structure of the CBS

6.3.2. Describing the Case Study through the ANT Lens

6.3.2.1. GIS initiation stage

The first Population and Housing Census (hereafter, the census) after Namibia's independence was conducted in 1991. The second census was conducted in 2001. During the 1991 census, the conventional approach to census cartography was used. Basically, a combination of available printed base maps and sketch maps were obtained from the official mapping authority (the DSM) and from other different sources in the country. The maps included the topographic maps, town maps and cadastral maps. The acquisition of maps immediately posed an immense challenge to the census mapping team, especially the lack of current base maps by then. The solution was to use sketch maps in cases where no maps were available or in cases where the available maps did not meet the mapping requirements for the census. Census demarcation fieldworkers were trained to sketch enumeration areas. On the whole, the entire 1991 census system was manual, as that was considered the only viable option available for census at that time under the circumstances.

The development of GIS at the CBS started in 1999 with the preparations of the 2001 census (figure 6.3.2). During the early preparation stage, SIDA (one of the main funding body of the census) [75] commissioned GeoSpace (a South African based GIS consulting company) to investigate the feasibility of using GIS during the 2001 census. This commission was based on a long-standing relationship between GeoSpace and SIDA. All agreements and lines of communications in this feasibility study were directly between GeoSpace and SIDA, while the CBS did not play any role or got involved in anyway. As a matter of fact, the CBS was not even aware that there was a feasibility study being carried out. In the final report of this feasibility

[75] Other funding came from the Governments of Namibia (about 70% of total budget), Spain and the United Kingdom.

study, Devinso[76], recommended that the census exercise could greatly benefit from GIS technology. Acting on Devinso's recommendation, SIDA proposed to the CBS the use of GIS in the 2001 census. Having participated in various census workshops and conferences, and having spent sometime at the Statistics South Africa where he was exposed to various SADC Statistics Committees, Mr Hangula (the Government Statistician and Head of the CBS) was already aware of GIS's potential as a means to improve the quality of the census. Hence, it did not take SIDA a lot of energy to convince the management of the CBS regarding the GIS use for the census. Right away, it was decided that the cartographic work for the 2001 census departs from the conventional cartographic methods toward digital mapping and the development of GIS technology at the CBS. This successful translation of interest led to the formulation of a "Census Cartographic Project", which forms the backbone for which GIS was introduced at the CBS. The main motivation for digital mapping and GIS adoption at CBS was that compared to conventional sketch maps, the GIS approach encourages higher accuracy, which results in better products and supports a wider range of applications that can be used also for the dissemination of the census results. A digital approach also results in lower maintenance and updating costs, as well as a sustainable benefit in a long run.

While Mr Hangula's prior awareness of GIS's potentials for improved census process facilitated the way for GIS adoption at the CBS, it also created tension among colleagues. At the NPC level, convincing the management was not so hard because the NPC management trusted and relied on Mr Hangula's recommendations. The problem was at the CBS's operational layer. There was a great resentment from those working under Mr Hangula, especially the demographic and social statistics sub-division who are directly responsible for the census. Three main reasons for this resentment were that:

- The idea of introducing GIS at the CBS was discussed under closed doors, between SIDA and Mr Hangula. That other CBS staff (who considered themselves to be in strategic positions) were not involved, but only received the news when the final decision was reached.
- The CBS was not equipped and ready to implement GIS technology. This argument was based on the fact that at that time, no single CBS staff had GIS skills and only a few members of the staff have ever heard about this technology before. The argument was further sustained due to the fact that the CBS did not even have an open vacancy for which a GIS skilled person could be employed.
- Those at the operational level who had heard doubts about GIS before sensitised others to believe that the technology was not reliable and does not work for countries like Namibia where the computing environment is poorly supported and maintained.

[76] Devinso (Development Information Solutions) is the demography division of GeoSpace. GeoSpace is a South African based commercial company with a vision of becoming the leading solution provider in Africa and developing countries for a wide range of GIS products and services (http://www.geospace.co.za).

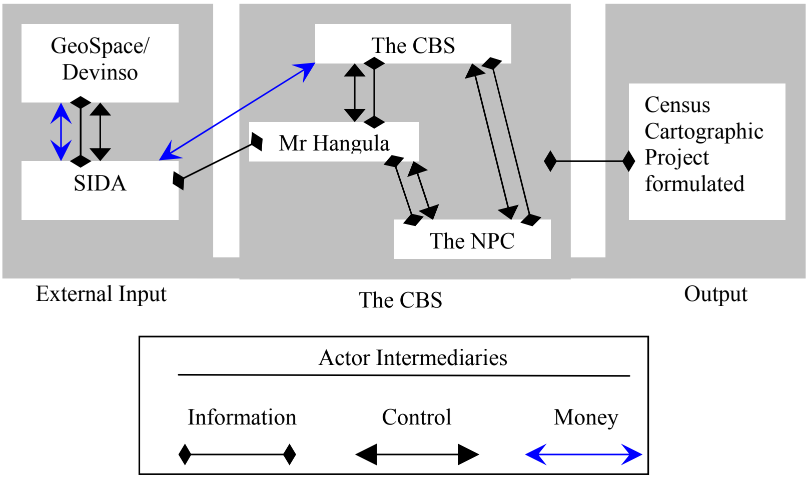


Figure 6.3.2: Actor-network responsible for GIS initiation at the CBS

Aware of the reluctance of the operational staff to change, Mr Hangula made several efforts to better align their interests with high dominant interest for use of GIS in the census exercise. His efforts involved organising in-house workshops to sensitise the staff about the concept of GIS. By this point, Mr Hangula has become the focal actor for the network responsible for the initiation of GIS at the CBS. Despite the resistance from the operational staff, Mr Hangula was supported by the Director General and the Permanent Secretary of the NPC who were quite enthusiastic about the technology. With the NPC's management and political support, the initiation of GIS at the CBS was approved. This translation led to the actual implementation of GIS at the CBS.

6.3.2.2. GIS execution stage

To facilitate understanding of the CCP, Box 6.3.1 below provides a short description of terms and concepts related to census practice. Presentation of the implementation process is split into three parts of the census: pre-enumeration, enumeration and post-enumeration phases.

Pre-enumeration phase

Figure 6.3.3 delineates the actor-network responsible for the initial implementation of GIS at the CBS, through the Census Cartographic Project (CCP). The main objective of the pre-enumeration phase was to systematically demarcate the entire country into enumeration areas and to produce a set of maps to be used during the enumeration phase. Due to limited in-house capacity at the CBS, Devinso was awarded an 18 months contract to develop a GIS based census demarcation methodology and assist with the implementation and management of the pre-enumeration phase. The work outsourced to Devinso was never advertised to give other GIS consultants an equal opportunity to apply. Instead, Devinso was appointed to carry out the work following its initial involvement in the feasibility study and because of their long-standing relationship with SIDA. In actor-network terminology the relationship between SIDA and Devinso had become irreversible. The fact that the head of GeoSpace/Devinso is a demographer by profession also contributed. Like in the case of the feasibility study, the CBS was not directly involved in the outsourcing of the pre-enumeration phase to Devinso. This is despite the fact that the contract prepared for the work was made between Devinso and the CBS. The consultant (Devinso) dealt directly with the donor (SIDA). This conduct created further tension from the operation staff towards Mr Hangula and SIDA. The CBS staff felt that Mr Hangula was siding with SIDA and Devinso who were encroaching to replace them with computer technologies. The atmosphere created placed Devinso in an awkward position of having to work at the CBS while knowing they were not welcomed. it also placed the technology at a high rate of resistance by the operational staff who related it with intruding approaches.

> “Some of us even wondered around the thoughts that what if this GIS is a new way to colonise us again. I mean, the fact that it was coming from white South Africans and other whites from Europe who colonised us previously. The question was why could the process not be transparent?” (CBS staff member)

Another staff added:

> “The first time they showed us the bible in one hand while hiding the guns on the other hand. What Namibian in their right minds would not consider that this time around they could show us the so-called technology in one hand and still hiding their colonial instruments on the other hand?” (CBS staff member)

On the part of Mr Hangula, he was very tolerant and pressed on despite the mishaps and accusations from his staff.

Box 6.3.1: Basic concepts related to census practice

According to CBS, population and housing census is defined to be the total process of collecting, compiling and publishing socio-demographic and housing data pertaining, at a specific time, to all the inhabitants of a country or delimited geographical area broken down to the smallest geographic area. The aim of a population and housing census is to collect, process and publish data on every individual within a defined geographical area usually a country. The aim of census mapping is to provide the cartographic basis to be used during the actual process of counting.

The census process entails three distinct phases. The pre-enumeration phase, during which planning and systems required for the census are being developed, tested and implemented. This phase basically provides the framework for the second phase, the enumeration phase. It is during the enumeration phase that the actual data collection takes place. The third phase is the post-enumeration phase, during which the completed census questionnaires are being coded and analysed, and reports and other products are being prepared and disseminated.

The conventional approach to census cartography deals with the systematic subdivision of a country of the study area into contiguous mosaic of small pieces of land. These pieces are made small but large enough in terms of population and area, to be manageable by one enumerator during the enumeration phase. These pieces of land are usually referred to as enumeration areas. The process of making the enumeration areas is called demarcation. Usually, census demarcation follows political and administrative boundaries of a country (Loots 2002).

Owing to the limited involvement of the CBS in the initial scoping of the project, the roles and responsibilities between Devinso and the CBS were not clearly defined. For the same reason, the CBS was not in a position to clearly put up their requirements. What they really wanted to gain from GIS was not clear, given that they did not have the initial initiative neither were they involved in the feasibility study. The CBS operational level argued that they lacked the basics understanding on the concept of GIS (i.e. its applications, potentials and benefits). Because of this lack of understand and their evasiveness (which was apparently rather evident) due to lack of support for the technology, Devinso ended up taking whole of the project; making proposals and taking decisions.

The following account summarises the activities and components of the CCP that were carried out by Devinso, under the pre-enumeration phase.
1) Establishment of the GIS infrastructure at CBS
2) Establishment of the GIS data warehouse
3) Evaluation of base map data
4) Collection of additional base map data
5) Enumeration area demarcation and NamPlan data collection,
6) Production of enumeration area maps for census field workers, and
7) Project closure

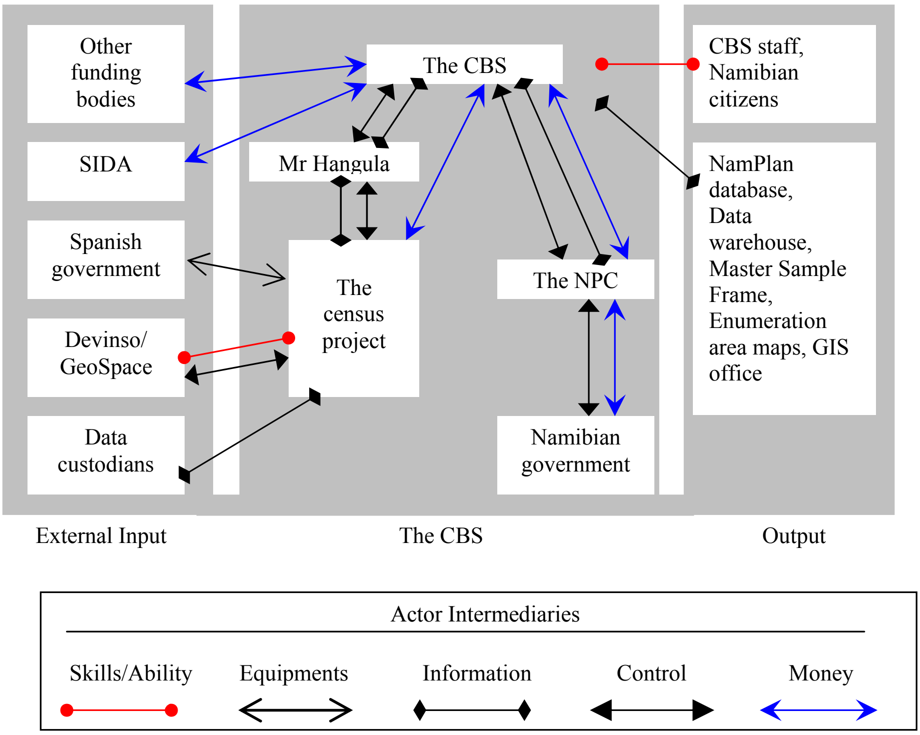


Figure 6.3.3: The CBS GIS actor-network (1999 – 2000)

1) Establishment of the GIS infrastructure at CBS

The specific objectives of this activity were; to specify the GIS system based on required outputs for the cartographic work of the census, to acquire and install the specified GIS hardware, software and network, to facilitate the arrangements for maintenance contracts for the GIS infrastructure, and to train CBS staff in the basic use of the GIS system.

Devinso's immediate task was to carry out a User Needs Assessment, which identified users of the system and their information needs. The assessment was carried out through a series of workshops within the CBS, whereby most of the participants were CBS staff members. Based on the requirements with regard to the specific system and system capacity, the *specification report* was drafted by Devinso and reviewed by SIDA. The report documented the details of the GIS functional specifications based on the requirements of the census, and stipulated the methodology and the budget to be invested on the GIS. Only a final copy of the specification report was handed over to the CBS. The argument for not involving the CBS in the reviewing process of this report was apparently that the CBS did not have the capacity for understanding the details of GIS specifications. The report documented that at the time when the CCP started no GIS infrastructure existed and very little GIS capacity was available at CBS and at NPC as a whole.

Devinso is not a distributor of any particular GIS software. For this reason, their approach has been to recommend the most appropriate software package for the user's unique needs (Loots 2005, *pers comm.*). For the CBS census applications, their recommendation was either Geomedia (Intergraph) or ESRI (ArcInfo/ArcView). With little understanding of GIS by the CBS staff and their little involvement in the whole GIS establishment, Devinso ended up making the choice of Geomedia software. The Spanish Government in support of the CCP donated additional equipments. The donation included one Oce 9400 printer, VP Max Pro Software, two Garmin GPS III's and other accessories. On the event of accepting the donations on behalf of the Namibian government, the Director General of NPC said:

> "Without properly executed mapping and cartographic work, the implementation of subsequent phases of the census becomes extremely daunting and diminishes the reliability of the collected data." (NPC 2000)

Devinso further offered advice on the furniture requirements for the GIS office and assisted with the acquisition thereof. By the end of January 2000, a GIS office was well equipped and furnished.

One of the objectives under this activity was also the training of a selected core GIS staff members from the CBS to enable them operate and maintain the GIS system after the project. Two training sessions were held. Although the training took place in accordance with the original contract, it was not successful due to several reasons. The most important being the fact that the CBS did not have a dedicated core GIS staff selected before the commencement of the project. The consultancy expected that the CBS would have a specific group of candidates chosen to learn the GIS. Instead, anyone who wanted to hear what the consultant was talking about was coming in and going out anytime as they felt like. This presented a frustrating atmosphere for Devinso and caused the training part of the project to report to report failure.

> "If the CBS would have had a selected group of candidates for the training, it would have enabled us to develop and implement a realistic training programme for them … taking into account the skills and abilities of the candidates. Meeting the training obligations from our side became a major challenge and a frustration because candidates best suited for the training were not always available for proper training continuation. …we had no control over their attendance. Also, because of this problem, no needs analysis was done to determine the exact training requirements. " (Mr Loots)

Those that attended the training revealed that the training was rather a waste of time because it was too technical for them. Apparently the technical and the GIS knowledge gap between the trainers and the trainees were just too big, and no action was taken to bridge the gap. On the other hand, given that Devinso's contract was only for 18 months, the level of training provided could not be expected to be any higher than simply the basic.

> "It was simple mapping exercises. They demonstrated how to use GPS, how to do digitising… but anything advanced was left for them to do as we sat besides them observing" (CBS staff commenting on the training provided by Devinso)

2) Establishment of a data warehouse

The objective of this activity was to provide a database with all necessary spatial and attribute data relevant for the production of enumeration maps. To achieve this objective, a prioritisation of the information products and the data requirement of those products were undertaken. Also based on the user needs assessment, a study was done to determine the existence and the availability of required spatial data sets. This was done in consultation between Devinso and the CBS. Devinso then visited all the major custodians of the identified spatial data sets. During such visits, it was determined what data is actually available, its accuracy and currency, as well as the cost of making the data available for the census purpose. Information on other possible suppliers was also obtained during the visits.

Following the initial consultative process, a meeting was called by the Permanent Secretary of the NPC to request the relevant organisations to make their data available for the census exercise. As a follow up to this meeting, Devinso wrote letters to all data custodians requesting access to data sets in their possession. The letter was signed by the Permanent Secretary of the NPC. Access to all available data sets was granted from all organisations right on time. The received data was converted into a common format and integrated into a data warehouse.

3) Development of a demarcation database

The key objective of this activity was to define and document the 2001 enumeration area database specifications. A set of enumeration area map criteria was defined through a process of consultation by Devinso in the form of workshops with the CBS staff. The criteria and minimum specifications, as was agreed for each settlement type are indicated in Appendix four. These enumeration area map criteria, together with the criteria for NamPlan (see under activity 5 below) formed the basis for the 2001 census demarcation database. The database was designed, developed, tested and populated with data from the data warehouse by Devinso, without any involvement of the CBS staff.

4) Collection of additional base map data

The data in the data warehouse was evaluated against the specifications for the demarcation database. The result of this exercise revealed areas in the country where the available base map data did not meet the agreed specifications. For such areas, additional data sets were then created. This activity was also carried out by Devinso, without any involvement of the CBS staff.

5) Enumeration area demarcation and NamPlan data collection

After the establishment of a fairly detailed base map for the entire country, the process of demarcating the country into enumeration areas began. Preliminary enumeration area demarcation was done on a GIS in the office prior to fieldwork in order to limit the time spent in the field. During the fieldwork, GPS coordinates were taken to ensure that the data collected for a given locality was eventually linked to the right polygon (locality) in the spatial database. The GIS part of the enumeration area demarcation was carried out by Devinso alone. Devinso and their CBS counterparts only started working together during the fieldwork stage.

During the fieldwork period, the Director General of the NPC requested that the NamPlan (Namibia Planning) database be created and the process be integrated with the census cartographic work. The objectives of the NamPlan database were specifically:

- To create a generic spatial planning database that can be used as a tool for development planning
- To develop NamPlan as a stand-alone database as well as a database that can be integrated with the census results or with other data sources in order to provide a flexible tool for effective and transparent governance.

For NamPlan, Devinso proposed the use of the same data model as was used for a similar exercise carried out in South Africa. NPC adopted this data model without change, (keeping in mind that NPC did not have ample understanding regarding GIS and data matters). NamPlan basically focused on data relating to localities and facilities such as accommodation facilities, commercial facilities, education facilities, government services, hostels, medical facilities, police services, prisons, religious facilities and various other services, amenities or facilities acting as important landmarks in the area. Information on the availability of services and infrastructure (water, electricity, sanitation, telecommunication, roads and public transport) at these localities were also recorded.

Devinso was also responsible for the development of fieldwork manuals (procedures and forms), data capturing applications and training of the fieldworkers. A demarcation fieldwork manual from the previous census (1991) was used as a template for the development of fieldwork manuals. In addition to the training provided by Devinso, a cartographer from Zambia assisted in training the CBS staff in cartographic work and fieldwork preparation (see under Additional Human Resources, below). For its part in NamPlan data collection, Devinso employed and remunerated four Namibian citizens who were not staff members of the CBS, apparently to ensure capacity building and skills transfer. These persons received in-service training in all aspects of NamPlan data collection, data downloading, data integration and verification. These persons worked together with the CBS staff during the fieldwork period.

6) Production of enumeration area maps for census field workers

The base map data together with census specific data were used to create a set of about 5 150 unique maps for the enumeration phase of the census process. The creation and printing of all the final enumeration area maps were done using bulk map creation and printing tools that are developed on a GIS platform. Devinso was responsible for this activity, without any involvement of the CBS staff. The detailed enumeration areas maps produced by Devinso contributed to a census that recorded the best coverage ever recorded for a Population and Housing census on the African continent (AfricaGIS 2005).

7) Project closure

The end product database and the enumeration area maps were eventually signed of and handed to the CBS. The final deliverable of the project was a project closure document.

Additional Human resources

As already established above, SIDA was one of the main funding bodies of the 2001 census. As part of the agreement between the CBS and SIDA, Statistics Sweden was appointed to act as a GIS census advisor to the CCP, and promote the development of GIS at the CBS. Because Statistics Sweden did not have the capacity for such coordination, it sub-contracted Mr Rydén from Swedesurvey to play the role in:

- Acting as an interface between CBS and the external consulting companies in the technical matters,
- Contributing to the development of concepts, methodologies and guidelines for the maintenance of the databases,
- Together with the CBS and in close collaboration with the relevant other actors, developing and implementing options for analysing, presenting and disseminating integrated statistical and spatial data, and
- Providing human resource development in the form of on-job training in data analysis, exchange and management, as well as advising in various types of short-term and long-term training needed in the field of GIS and cartography.

Also, during the preparations of the census project, the CBS had identified a lack of cartographic skills at their offices and had requested assistance from the Zambian Central Statistics Office. The Zambian Government later seconded Mr Akende (a cartographer) to assist the CBS.

Both Mr Rydén and Mr Akende arrived at the CBS towards the end of 2000, just as Devinso was in the final stages of the pre-enumeration phase. Working together, Rydén and Mr Akende's immediate task was to make sure that all hardware and software acquired through the pre-enumeration phase were left behind in the GIS office for the CBS. For a few months that Mr Rydén and Devinso were at the CBS at the same time, Mr Rydén became the spokesperson between the CBS and Devinso, because of his better understanding of the work carried out by Devinso. At the time of Devinso's departure, Mr Rydén and Mr Akende took over the GIS office which Devinso ran in isolation. At that time in point, the two were faced with a challenge of how to create interest in GIS among the CBS operational staff. According to Ms Mwazi (chief statistician and head of the GIS office), after the departure of Devinso the CBS had difficulties to take over the GIS office. They simply did not know what to touch or where to start with any thing. She emphasised that they were fortunate with the arrival of both Mr Rydén and Mr Akende. Figure 7.3.4 delineates the second actor-network in the implementation process of GIS at the CBS.

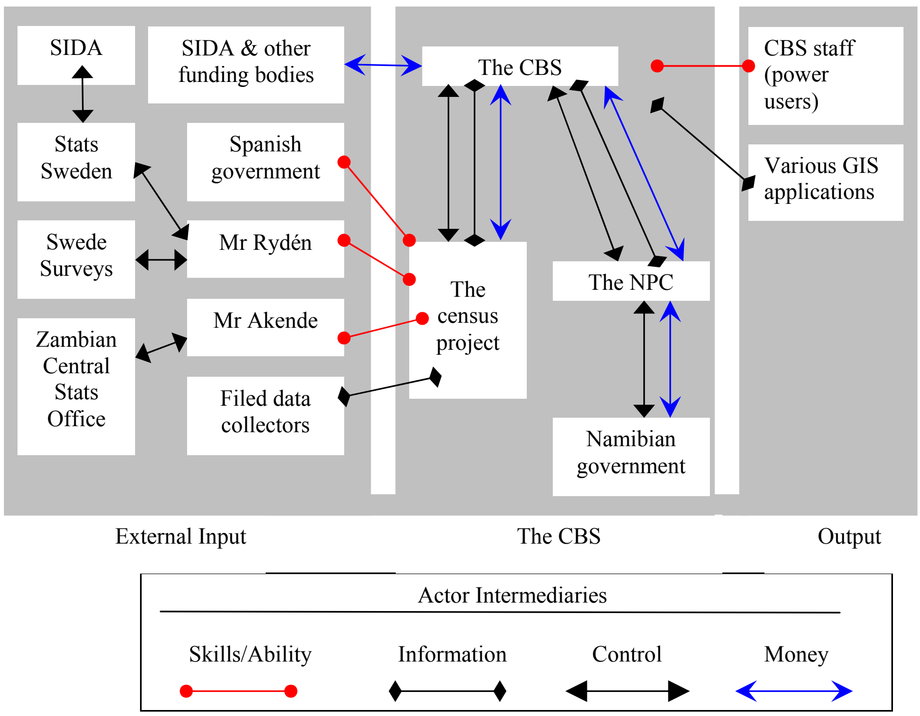


Figure 6.3.4: The CBS GIS actor-network (2000/1 – 2004)

Unlike Devinso, Mr Rydén and Mr Akende's experience with the operational staff was different. From the outset they were able to create a direct communication line with them. This was because of their realisation that conclusive GIS endorsement may prove to be difficult to achieve in the organisation if the operational staff feels excluded. At one point the top management may have to depend on advice from subordinates, especially because it is them that will eventually become directly responsible for the implementation of the technology. According to Mr Rydén, during his arrival even the IT department was very unsupportive regarding GIS. Their reason was basically that Devinso never regarded them and the GIS office (including the office network and server) was set up without the consent or any involvement of the IT department. The IT department was only expected to renter their service to the GIS office after Devinso's departure. The IT department showed resistance to providing any services to the GIS office. Their main argument was that they were not acquainted with the GIS office technical infrastructure, as no manual or documentations of the systems were left behind. Mr Rydén ended up providing the IT services to the GIS office, and with time he was able to acquaint the IT department to the GIS office technical infrastructure.

Enumeration phase

The enumeration area maps produced by Devinso during the pre-enumeration phase were used during the enumeration phase to support data collection and help monitor census activities. The enumeration phase was carried out by the CBS staff, complemented by a group of temporary census staff. The temporarily census staff was employed specifically for the purpose of executing the enumeration phase. Not many of the temporary census staff, neither the CBS staff were skilled to read the enumeration area maps. Thus, Mr Rydén and Mr Akende's first major task was to train the group to read the maps. The training also covered the basics of GIS and cartography concepts. Those from the CBS who participated in the training revealed that the training proved sufficient for them to acquire the basic understanding of GIS and cartography. They however indicated that they feared that to operate a GIS, computer experience was necessary and none of them were really acquainted with computers as such. According to Mr Rydén, interestingly, limited computer skills did not really temper enthusiasm in GIS. Apparently, some participants even indicated that they liked GIS mainly because it gave them an opportunity to learn to use a computer. On the part of the trainers, the training period provided them with an opportunity to identify candidates with better understanding of geography and those with high interest in statistical and spatial systems. According to Mr Akende, it was however unfortunate that some of the candidates with best geography knowledge and/or GIS keenness were temporary staff who were due to leave the group soon after the project. Among these were also the four people who were employed by Devinso and worked closely with the consultant. As could be expected, their GIS skills were advanced than of any other in the group.

Post-enumeration phase

Following to the actual enumeration, the next step was that of census data analysis and dissemination. The CBS staff assisted by the temporary census staff were trained to enter all data into the GIS database that was already created by Devinso. The training, which was organised for a full two months period, was again provided by Mr Rydén and Mr Akende. The process of census data entry for the whole country took three years to complete. "Basically, the team produced the work of one week in three years." (Mr Rydén)

In order to efficiently provide integrated statistical and spatial information to a wider group of users, the outcome of the census were inscripted in two applications that make information easily available and accessible to regional planners and professionals not skilled in statistics and GIS. The two applications are: (1) the Census Dissemination Tool, and (2) the Regional Planning Tool. They are briefly discussed below.

The Census Dissemination Tool

The Census Dissemination Tool is based on an application by the French company Netency (http://www.netency.com/netenam). It is an ArcView plug-in that allows an easy way to disseminate information over the Internet or via CD-rom. This application is distributed free of charge for non-commercial use, so long as the Netency logotype is displayed on the web page. On the user side, a non-GIS user needs only to have Microsoft Explore together with the free Adobe SVG viewer to view the final web pages with information requested. Basically, the Neten' Map

LT plug-in converts ArcView themes to SVG (scalable vector graphics) files, which are then displayed as web pages with the attributes as selectable variables. The resulting web page presents a map based on the values of the selected attribute valuables.

The dissemination of census results using the Neten' Map LT is done on two geographical scales: on a national scale showing census variables per region, and on a regional scale showing census variables per constituency. The data shown on the web pages is in principle the data published in the National Report and the Regional Profiles respectively. Users can do basic queries, generate and download reports, tables, graphs and maps. They can also request data updates through this web application. While not all census variables could be shown on both levels, the ambition has been to present as much data as possible on both levels.

The Regional Planning Tool

The Regional Planning Tool is based on an application developed by the German company Uismedia Lang & Muller (http://www.uismedia.de). It is also an ArcView plug-in (MapViewSVG) that provides the possibility to disseminate spatial and tabular information over the Internet or via a CD-rom. Like the census dissemination tool, on the user side, a non-GIS needs only Microsoft Explore together with the free Adobe SVG viewer to view the final web pages with information requested. The page is interactive and if the user clicks on the legend, the different layers can be displayed or hidden. This application also supports image data in GIF or JPEG formats. This application is produced using spatial data initially collected during the 2001 census and presents the data on a regional scale.

6.3.2.3. GIS stabilisation stage

Present status of the GIS office

The census was officially ended in August 2004. That also came with Mr Rydén's end of contract. It also meant a shift in how GIS is operated. Throughout, the GIS office has been funded and operated under the census project. At the end of the census project, the GIS office was temporarily added to the Surveys and Cartographic sub-division. In order to ensure the sustainability of the GIS infrastructure at CBS, and to guarantee that GIS gets the prominence it deserves for its optimal use, the CBS is currently underway of establishing a dedicated GIS division within the organisation (see under Proposed structure of the GIS division, below).

The GIS office is headed by a chief statistician and is operated by five power users, of which none has received formal GIS education. Also, neither of them is a geographer. Their professional backgrounds are mainly in statistics and economics. The chief statistician finds it challenging having to head and report on something she is still struggling to grasp. Moreover, because GIS coordinating was just recently added to her duties, she still struggles to find time enough to devote to it. All five power users were originally seconded from different sub-divisions of the CBS to work on the 2001 census project. Up until the end of the census project, all of them reported directly to their respective divisions. Also up until the same period, the power users were still expected to perform various duties from their respective divisions. They were only able to devote a few hours to the GIS activities because their performances were rated on their divisional duties, and not on the GIS activities. After the end of the census project, all power users were expected to report back to their respective divisions, on a full time basis. It was recognised that this move would have meant abandoning the GIS office, or at least leaving it solely in the hands of Mr Akende (whose contract ends in 2007). Instead it was decided that four of the power users be completely released from their sub-divisional duties and devoted to maintaining the GIS office, on a fulltime capacity.

According to these four power users, they did not have a choice in the matter. One of them even indicated,

> "I like GIS and all that, but I really am not a GIS person. I am an economist and that is what I would love to do."

Another one complained that,

> "When I was employed in this organisation the plan was never to be locked up in this computer room. …I'm not a technical person."

According to both Mr Akende and the chief statistician – who both interacts directly with the power users, it appears that about half of the group lacks interest in GIS as such.

> "You literally have to force them to do things – if you leave them for just a few minutes you'll find them doing other things like surfing the Internet." (Mr Akende).

According to the chief statistician,

> "The power users prove to have no confidence either on themselves to work with the GIS, or they simply do not have confidence on the GIS itself. We have to push them to do anything. They do not take initiatives and I being a non-GIS person myself, at time I just look at them and leave."

The GIS office is relatively well equipped with hardware and software although the power users complain that some of the hardware is becoming a bit outdated since their purchase in 1999.

> "Pretty much, the GIS office looks the same as we left it in 2000. A few things seem out of order, or simply abandoned. But that could be expected because the power users are not in the capacity to use all the equipments yet, or they may not have uses for them at all" (Mr Loots[77] 2005, after his visit to the CBS in October 2005)

With regard to the software, it was revealed that although most software have new versions in circulation the office is still using the old versions that were acquired by Devinso in 1999. At the moment this may not severely affect the work of the office since GIS is only used for simple analysis and production of illustrative maps. However, if in future new or improved methods for field data collection using GPS technology may be employed (as envisaged), it may result in a need to purchase some new hardware and upgrade the software. The weakest link related to hardware at the moment is the poor capacity of the office server. As databases are growing, the IT department has observed that the GIS office server is becoming too slow and its support for many users is becoming inefficient. In order to accommodate all data the capacity of the server thus may need improvement in a near future.

GIS office maintenance

Figure 6.3.5 delineates the actor-network involved in the maintenance of GIS at the CBS. The power users are responsible for the maintenance of all GIS applications that have been created throughout the duration of the census project. They are however not in a position to entirely run the office independently. Thus, Mr Akende provides technical support in areas of GIS and cartography. Mr Rydén's contract ended with the end of the census project, and is now based in Botswana. In their own capacity, the CBS has entered into a two-year agreement with Mr Rydén to visit the GIS office at least twice a year to provide GIS technical support, especially in cases where Mr Akende (he is more a cartographer, than a GIS expert) is not able to assist. Both the Government Statistician and the chief statistician have attested that the GIS office is currently heavily relied on the assistance of Mr Rydén and Mr Akende to fill the void of non skilled power users. This does not augur well for sustainability of the GIS activities.

[77] Mr Loots is the head of Devinso, the consultant that established the GIS infrastructure during the pre-enumeration phase of the census project.

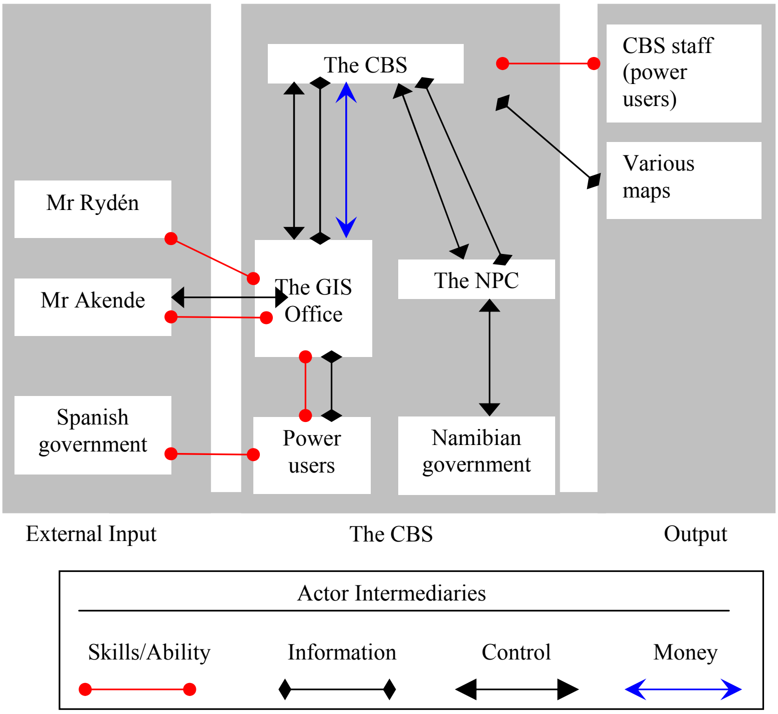


Figure 6.3.5: The CBS GIS actor-network (August 2004 – current)

The following applications are being maintained.

Maintenance of the Master Sample Frame

As a result of the move from analogue methods to digital methods of census, the CBS is now in the possession of a Master Sample Frame in a digital format. One major benefit of having the Master Sample Frame in a digital format is that it eliminates the costly process of re-demarcating the country once the preparation for the next census begins, provided that the frame is continuously maintained. One of the main tasks of the GIS office is the maintenance of the Master Sample Frame, which is also the key activity of any statistical office and is the basis for inter-censal survey programmes in Namibia. The next inter-censal is to be carried out during this year (2006). The Master Sample Frame also constitutes the base on which to carry out the 2011 Population and Housing Census. The frame is not only used by the CBS but is also extensively used for the selection of representative areas to visit during the undertaking of surveys carried out by other organisations, such as line ministries, NGOs, private companies and different UN bodies in the country.

The Master Sample Frame itself is the sub-division of the country into small units called Primary Sample Unit (PSU). Each PSU is categorised based on characteristics such as region/constituency, rural/urban, commercial/communal etc. These categories are used to target different population groups in the country and are the basis on which a sample is selected. Each PSU contains a number of households suitable for one interviewer to cover within a limited period of time. The Master Sample Frame is usually expected to last the period between two concurrent censuses. But, due to the population growth the number of households within each PSU changes and eventually reaches a level where one interviewer cannot cover the entire PSU within a given period of time. This condition is magnified by new developments and population migration in certain parts of the country. It is thus important that the Master Sample Frame is continuously maintained by identifying these changes and incorporating them in the database. Therefore, to this end the activities related to the Master Sample Frame have focused on the development of guidelines for incorporation of any major migratory development that may have taken place since the 2001 census.

Database Maintenance
Database maintenance is an ongoing activity at the GIS office. The datasets are reviewed and updated. This applies especially to the NamPlan database. Since the database's creation in 2001, several new layers have been incorporated in the database. Because the CBS staff still lacks necessary skill for database modification, Mr Rydén is mainly the person responsible for database modification (e.g. adding on new features or layers).

The GIS office has all its databases stored on a dedicated server, from which different databases can be assessed by the workstations. This arrangement presents a definite danger that several 'nearly identical' databases are often created. This has happened usually as a result of one user making a change on a feature in one layer and another user making a change in the same layer. The two databases will then be nearly identical. There has been various data processing related problems i.e. data security and their proper storage. These problem surface mainly because there is no power user designated for database maintenance (see also under challenges, below). Lately, delays have also been experienced in data processing and analysis. Often times, the office has to wait for some months for Mr Rydén to arrive from Botswana to assist in sorting out some of the problems.

The main users of the GIS database include line ministries, the private sector, researchers and training institutions, NGOs and parastatals. However, it also appears that CBS has not popularised the database enough as there are potential users that do not know about its existence.

Information Dissemination
Another main task of the GIS office is the timely dissemination of integrated statistical and spatial information. The office is regularly requested to provide such information in analogue and digital forms by various users. Most requests relate to different types of administrative maps showing the locations of NamPlan features (e.g. schools, clinics and availability of various infrastructures on such features). Major requests have also been for the production of maps for the elections, showing different localities that fall in specified constituencies. It is however sad that most requests comes from outside the NPC. The NamPlan database particularly was created with the NPC planning division in mind as the main user. But as it turns out, the database is mostly by used externals who most often use the information for further processing. With the intention of reaching a wider circle of users, most information products have been made free available on the Internet. The CBS has unfortunately not been in a position to monitor the rate at with such information on the Internet is used.

Available Databases
The GIS office has in its possession several databases containing spatial data, both vector and raster data. The vector data is mostly gathered from various ministries and other data producing organisations since the office is not a data producer per se, with the exception of the Master Sample Frame. When a certain data set is not available even from other data producers, however, the office does collect that data set. Since GeoMedia is the main software used for data capture and manipulation, all data is stored in GeoMedia Access Warehouses. However, most of the data

is also stored in ArcView shape format. This is to satisfy the need to feed the Regional Planning Tool, the Census Dissemination Tool and the production of Census Atlas maps. Moreover, this facilitates easy dissemination of data to users who do not have access to GeoMedia. The data that are stored in both two formats are those that are frequently requested. In order to make it easy for different users to integrate the data into their system, all vector data is stored in a geographic coordinate system, i.e. the feature coordinates are in longitude/latitude. The datum is WGS84. The user may then project the data into any desirable map projection without having to transform the data from one projection to another. The raster data is acquired either during the 2001 census or after the census from different sources. All data is stored in the GIS office server and only the power users have direct access to the server. Thus any access to the data sets by other users is directly through the power users. All data sets are documented in a metadata, which accompanies the data sets when distributed.

Training

As seen above, on-the-job training has been a continuous activity throughout the census project. All power users have also gone through a specific training for the maintenance of the key applications in the office, as well as the production of census atlas maps. Since these activities involve several different types of data extraction, manipulation and data presentation, training has provided a wide range of knowledge on GIS maintenance. But very little attention has been paid on the analytical functionalities of the technology.

In the end of 2003, the Spanish Cooperation offered a grant for advanced training to be carried out in Spain. The terms of reference for the training were compiled with input from the CBS, and the final tender document was finalised and submitted for the tendering process to the Spanish Cooperation in April 2004. It was specified in the tender that part of the training will happen in Windhoek and advanced training in Spain (at the University of Girona) for key GIS power users.

As a way of preparing the power users for the said training, and in order to bring all power users to an even scale in terms of GIS knowledge, the CBS requested a tailor-made GIS training from the polytechnic of Namibia. The polytechnic training was fully funded by the CBS. The training prepared the power users with GIS theoretical knowledge together with practical exercises. It focused on ArcView software – which by then most power users were not familiar with as they have been using GeoMedia in the office. The power users have revealed that this preparatory training greatly enhanced their GIS understanding and skills. Following a strong motivation from the polytechnic, as a complement to the GeoMedia software, ArcView software was introduced at the CBS after the training. The CBS covered the cost of the purchase of the AcView GIS software. ArcView software is a more pronounced desktop mapping software and thus seen better suited for the production of various maps regularly requested from the GIS office. An advantage with ArcView has also been the possibility of downloading free scripts and extensions (adds-in) that extends the functionality of the software. Moreover, ArcView supports up-and downloading of GPS data, which significantly improves the efficiency during fieldwork. At present, the applications developed at the CBS are based on ArcView extensions. However, GeoMedia software is still regarded the main software used for data capture.

All five power users received the Windhoek-based training and three of them have received the advanced training in Spain. Accordingly, the Spanish training has substantially improved the capability of these power users.

Proposed structure of the GIS division

At the end of the census project, Mr Rydén in his final report recommended the establishment of a GIS division at the CBS. This division was envisaged indispensable due to the fact that the NPC had then just embarked on the second National Development Plan (NPD II)[78]. Moreover, the NPC has been tasked with spearheading the Vision 2030 and coordinating various development programmes such as poverty mapping. The implementation of the NDP II and the monitoring of various development programmes related to the Vision 2030 particularly, were identified as having great potential to benefit from accurate statistical and spatial information, as to provide a spatial dimension to the national programmes. The current GIS office was identified to play a vital role in these processes. However as already stated above, the GIS office was established as a part of the CCP. Its capacity was also just meant to serve the census purposes. Thus, the office has not been in a position to fully meet the expected demands of the NPC as a whole. Mr Rydén's report shed fear that there was a risk that the activities of the GIS office could diminish as the census project ends if no permanent GIS structure was put in place at CBS. Moreover, the investments used to establish the GIS office were high and unless the Master Plan Frame and the supporting digital data were continuously maintained, the return of the initial investment could not be justified.

The management of CBS willingly accepted the recommendation of Mr Rydén's report (Rydén 2004), and resolved that to fully meet the demand of the NPC, the GIS work should be carried out within a dedicated GIS-unit with a permanent core staff who will readily maintain and upgrade the data available in the office and also produce new applications. They further deemed important to base the continuation on what has been already achieved in order to take advantage of the skills acquired during the CCP. Together, Mr Rydén and Mr Akende, in consultation with the management of the CBS drafted the proposed structure as presented in Appendix five. The current GIS power users have not been involved in the compilation of the proposed structure. They however strongly feel that they should have been involved because of their experience acquired during the years they have been working on GIS at the CBS. Although this structure was already drafted by the end of 2004, it has taken the CBS a long time to finalise it and send it to the public commission for approval. They hope to have it send to the public commission by March 2006. There is also pressure from Lux- development who intends to implement a Regional- GIS project with NPC, but demands that the GIS structure first put in place before undertaking of the proposed project.

6.3.3. Challenges

In spite of remarkable achievements with the census project, the CBS still faces challenges in areas such as adaptation of technology, skilled and motivated manpower, demand for processed data and trends in data concepts. In this section the main challenges hampering the successful implementation of GIS technology at CBS are presented.

6.3.3.1. Organisational and human challenges

Figure 6.3.6 bellow illustrates the perceived organisational and human challenges hampering the use of GIS at the CBS. The most outspoken organisational challenge at CBS is the general lack of skills and poor understanding of the concept of GIS within the organisation. Most people at CBS, including some of the power users associates GIS with computers and map production. As mentioned above, there are five GIS power users at the CBS, four of which are now dedicated to running the GIS office on a fulltime capacity. Unfortunately, these power users are not skilled enough to independently run and maintain the GIS functions. Since its establishment, the GIS functions have been run by staff recruited on temporally basis (contracts) or CBS staff members who were temporarily seconded to the census project from other divisions of CBS. Ever since the Swedish consultant left in August 2004, most professional activities such as the development of

[78] See Chapter two for more about the National Development Plans.

the GIS planning tools could not be completed. The CBS has not had an alternative but to continue to heavily rely on services of consultants until such a time when its structure is revised to enable the office to recruit personnel with expertise in GIS. The CBS is also heavily reliant on assistance of external consultants to provide on-the-job training to the power users. The staff has acquired some basic skills mainly on map creation, printing and field data collection.

The GIS activities are not split between the power users to allow them have a responsible component. For this reason, it so happen that sometimes each of them expects the other one to execute the job, and in the end of the day the job ends up not done. Except that they are responsible for GIS maintenance, currently the power users do not have job descriptions. The head of the GIS office attributes this to the lack of the GIS structure at the CBS. The management of CBS feels that presently not all power users have the dedication and vision needed to develop the office further and those that have the dedication are tied by the lack of directed technical education and an overall lack of vision of the GIS office. The power users on the end feel that the supervision and follow-up from the top management is not satisfactory (e.g. no job descriptions). Since the end of the census project, the GIS office is reportedly been left to itself and there are no guidelines on what the office should produce. Moreover, there is a lack of vision for future needs in terms of which data sets should be up-dated and how often, as well as how the data should be structured in order to satisfy the current and future needs of the GIS office. Other challenges include inadequate feedback mechanisms between the CBS top management and the operational staff, and unsatisfactory communication and information flow between and within divisions.

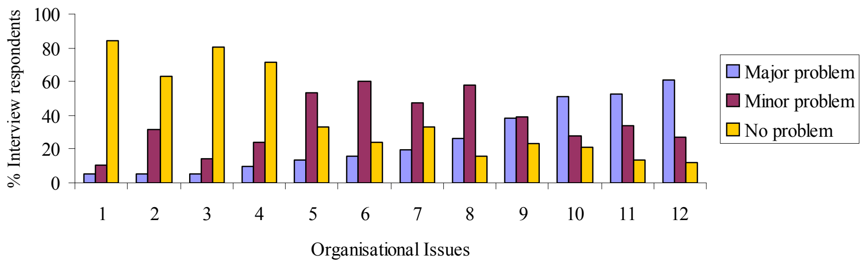
The GIS office works very much in isolation, as there are no mechanisms in place for efficient cooperation between them and other sub-divisions. As a result, other sub-divisions are not even aware of the activities of the GIS office, including their products. This could explain why majority of information requests received by the GIS office comes from external users. Much of the work done in the GIS office seems to be arbitrary to those from other sub-divisions since the products and services of the office are not utilised. At the NPC level, the organisation is inundated with a number of weaknesses which hampers the ability of GIS to meet the organisational needs in a satisfactory manner. To begin with, the GIS office was established solely to serve the census project. As it is now, the office is expected to meet the requirements of the whole NPC. But given its capacity, which was designed to serve at a project scale, the GIS office is not in a position to fully meet the expected demand of the NPC as a whole, without external support.

There appear to be inadequate advocacy to incorporate the GIS office into the CBS organisational structure. The organisational restructuring document was drafted already in the August 2004, and was intended to be submitted to the public service for approval by mid 2005. At the time of writing, the document has not yet been submitted to the public service.

6.3.3.2. Data related challenges

A main constraint with regard to data is particularly the slow phase in which different data sets are updated and maintained. It appears that there is uneasiness from the GIS power users to make requests to other ministries and organisations to obtain current information, and to follow up on requests done. This problem is not necessarily that current data are not available or accessible, but is largely due to the inefficiency of the GIS office. If this trend continues, the data sets in the databases will eventually become out-of-date and of no use to most stakeholders. Once this happens, it will decrease the usefulness of the GIS office.

The cost of data collection, especially after the end of the census project has become unbearable. This is especially so, as GIS is now supported from the Surveys and Cartography division although it was not really budget for. The CBS heavily rely on other organisations for data. While the data might be obtainable, the challenge is that they are not always compatible because custodians of different data sets store their data in different formats. Another challenge is that most often the data sets obtained are not complete. Figure 6.3.7 below illustrates the perceived data problems at the CBS.

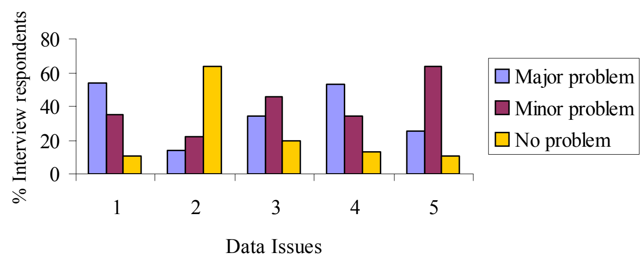


1. There is not designated person to maintain GIS
2. The management of this organisation is not aware of value of GIS
3. Staff turnover
4. The management of this organisation is not committed to GIS
5. There are insufficient financial resources to fully implement GIS
6. Unclear project requirements
7. There is insufficient GIS training and guidance
8. Insufficient motivation of staff
9. There are insufficient staff resources to implement GIS
10. Bureaucratic inertia
11. There is no clear GIS strategy in place
12. There is generally a lack of GIS skills in this organisation

Figure 6.3.6: Perceived organisational challenges influencing the use of GIS at the CBS

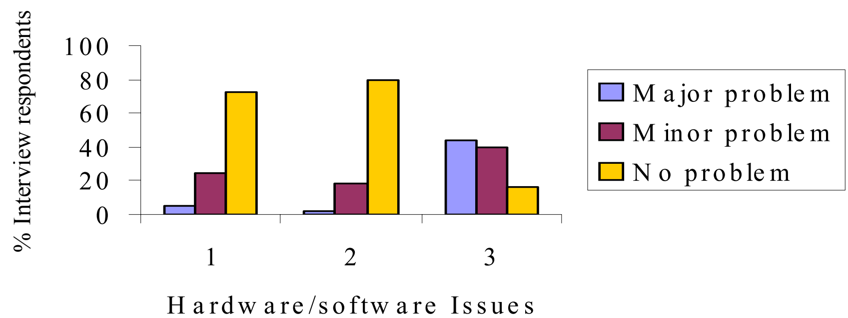
6.3.3.3. Hardware/software related challenges

Generally, the GIS office is not faced with hardware or software problems. As seen above, the office is well equipped with sufficient and appropriate equipments. Except that some of them might be getting old and will need replacement or upgrade in the near future. This is especially true if the office would produce and perform more advanced applications and analysis. A pressing concern is however the condition of the database server and its maintenance thereof (see under GIS stabilisation, above). Figure 6.3.8 below illustrates the perceived hardware/software problems.



1. Cost of data collection and capture
2. There is a lack of digital data in appropriate formats
3. Accuracy of data sets
4. Lack of compatibility of data sets
5. Incomplete data sets

Figure 6.3.7: Perceived data-related challenges influencing the use of GIS at the CBS



1. The hardware is insufficient and inappropriate
2. The GIS software used is inappropriate
3. Lack of proper systems management

Figure 6.3.8: Perceived hardware/software challenges influencing the use of GIS at the CBS

6.3.4. Case Summary and Conclusions

Although there could have been earlier trials of small GIS projects, the development of GIS at CBS effectively started in 1999 with the 2001 census project. However, when the GIS concept was first proposed for the census project the idea faced a serious opposition especially from the operational staff who thought that the actor-network responsible for GIS initiation had some hidden agenda. Fortunately, the Government Statistician (who believed in GIS from the start) had the support from the top management of the NPC. This was the only way GIS was able to be implemented.

GIS was introduced and implemented in isolation and without necessary synchronisation and cooperation, especially between the consultants and the operational staff. The process did not give regard to neither organisational culture nor its political background, and these were the main reasons the operational level staff rejected the technology.

Despite the success attained in the production of imperative output from the census project, the continuation process of GIS faces a number of threats and difficulties, among which the major one is the lack of skilled staff to independently maintain and create new applications. Other weaknesses include inadequate feedback mechanism and unsatisfactory communication and information flow between the management and the power users, inadequate motivation among the power users which has led to despondency in the management.

The CBS management has a vision to create a dedicated GIS division within the CBS's structure, as a way to integrate the GIS office within the organisational structure. The process to realise this vision has however been very slow. It is hoped that once established, the GIS division will employ GIS expertise.

6.4: Tuyeni Community Research Centre

6.4.1. The structure of TCRC

Tuyeni Community Research Centre (TCRC) was founded in 1994 by a group of two local researchers in Ohangwena region[79], north of Namibia. The establishment of the Centre came as a result of acknowledgement from these researchers that there was an urgent need for their local communities to utilise natural resources in a sustainable manner with focus on minimising their depletion. Aiming at this broad objective, the focus of the Centre is to establish sound community based natural resource management systems which promote sustainable development in Okongo and Eenhana districts.

The Centre is involved in research seeking to:

- Provide baseline information indicating the status of the environment
- Identify opportunities for improved natural resource utilisation
- Develop and test natural resource management plans

The Centre is also dedicated to empower communities to take control over their own development. This is done by building the capacity of community residents.

TCRC is a small non-profit organisation, headed by an Executive Manager (co-founder of the Centre). It has a Management Committee of 10 members, comprised of leaders in the local communities (mainly from business and agricultural sectors). The Management Committee is responsible for major decisions regarding the operation of the Centre and they meet every second month as well as when required. The day-to-day operation of the Centre is managed by the Executive Manager. The current structure of TCRC is as shown in figure 6.4.1. Being purely a non-profit organisation, TCRC depends on donors and sponsorships for funding. The Centre is about 60 km east of the town of Eenhana, in Ohangwena region. Currently, the Centre has three computers, a printer, and a single dial-up Internet connection. One computer is used for GIS. Other software on the computers includes Windows and Microsoft Office suite.

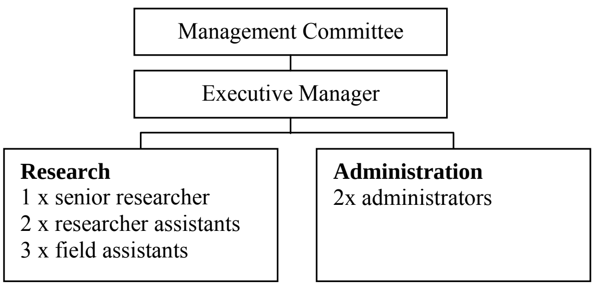


Figure 6.4.1: The structure of TCRC

[79] Ohangwena is one of the highest populous regions in the country, with the population of 239 135 in habitants, and it is the poorest region in the country with 97% of population living in rural settlements and traditional homesteads (NPC 2002). Many areas in the region lack access to safe water, electrical supplies, and the telecommunication links are weak. Road systems are poor and transport between settlement areas and health facilities is difficult. The author of this thesis originally comes from this region.

6.4.2. Describing the Case Study through ANT Lens

6.4.2.1. GIS initiation stage

The idea to develop GIS at TCRC was first discussed in 1996. The idea came from the Centre's Executive Manager who thought that the main activities of the Centre (mapping of natural resources) could be improved by the use of GIS technology. Particularly, GIS was advocated because of its visualisation capabilities – to visualise the spatial distribution and availability of resources, and to assess the impacts of interventions thereby enhancing the transparency of decisions regarding the use of natural resources. In addition, Executive Manager argued on the potential of GIS to monitor and evaluate the effectiveness and the implementation of various natural resource management plans.

The Executive Manager was already familiar with GIS, having used it partly in his Masters Degree research at the University of Stellenbosch in South Africa. Playing the role of a focal actor, he then made efforts to explain the concept of GIS to his staff but it was difficult without anything to demonstrate with, apart from printed maps in books. Also given the "low degree of education" of most of the staff members[80], the Executive Manager avoided going into any detail of GIS as it would just have petrified the staff. The Executive Manager also introduced the idea to the Management Committee, who also had no prior knowledge or understanding of GIS technology. The Management Committee recommended that while they are rather "too old" to understand computer technologies, the senior researcher be assigned the responsibility to investigate the possibility of the Centre to acquire the technology. While the concept of GIS was also very new to the senior researcher, feeling rather incompetent about it, he apologetically declined the responsibility.

The Executive Manager was left with no choice but to take up the responsibility. While contemplating on the idea to introduce GIS at the Centre, he was faced with a challenge of how to address the impacts of introducing the technology in a small non-profit organisation whose funding is sporadic and overly dependent on sponsorships. He also feared that with the low degree of education of the staff, and without somebody who would motivate the staff, develop and maintain the GIS database, and establish networks with other organisations using GIS, it was likely that the GIS would "just become a decoration in the office" without anyone to use it. "Employing a GIS expert would be a good idea but people with such expertise would want to be paid well, which we could not afford" (Executive Manager).

Given the perceived benefits of using GIS at the Centre, a consensus was reached that incentives be made to explore the possibility of acquiring the technology. To deal with the lack of GIS skills and abilities at the Centre, it was decided that the Centre would make use of students and volunteers with the relevant skills until such time when the staff members are capacitated enough to operate the system. In his capacity, the Executive Manager made a requisition to ESRI (Environmental Systems Research Institute) for possible donation of a GIS software. ESRI generously donated ArcView GIS software and a Windows 95, 32MB RAM, Pentium Processor computer. The GIS was then set up and operated by the Executive Manager, who because of his other duties was only able to spend a few hours on the technology. Moreover, at that time, the Centre was faced with unreliable electricity supply which challenged the usability of the GIS. Figure 6.4.2 delineates this actor-network.

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[80] Apart for the senior researcher who holds a national diploma from the Polytechnic of Namibia, all research assistants hold grade 12 certificates with other short-courses in natural resource management and community development. The field assistants are just people taken from the community, not necessary with any level of education.

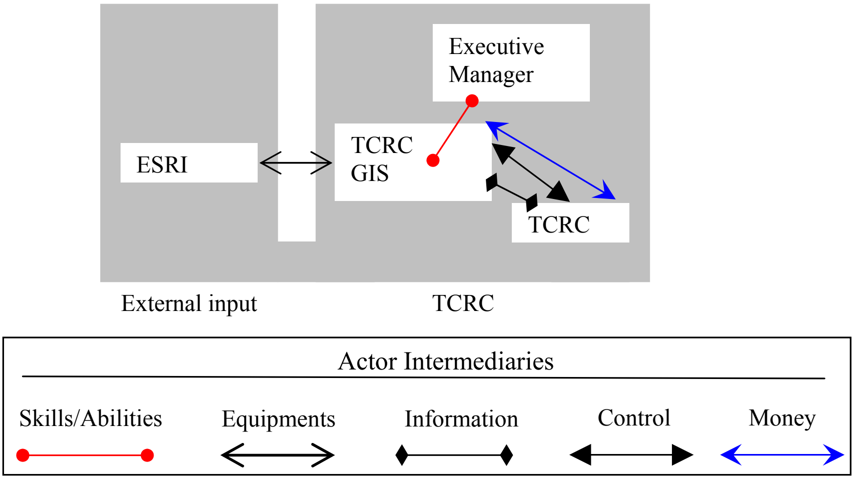

Figure 6.4.2: TCRC GIS actor-network (1996 – 1997)

6.4.2.2. GIS execution stage

Two versions of actor-networks have contributed to the execution stage of GIS implementation at TCRC. The first network was activated with the work of a doctoral thesis on arid rangeland management by Mr Souton, an American student from Cornell University (figure 6.4.3). As to how Mr Souton arrived at the Centre is not clear (whether by invitation or implication). According to the Executive Manager, Mr Souton arrived through his own connection with ESRI. In any case, the objective of his research was primarily to develop an integrated assessment for vegetation structure and composition and soil stability across multiple scales. This research was funded by the USAID, through which Mr Souton was then able to acquire data resources for his research. Apart from the data he collected on the field himself, TCRC also provided him with the data they had available – which was mostly hand drawn maps and tabulated information.

Mr Souton's academic research was used as the first actual GIS project at the Centre. The nature of Mr Souton's project required that he worked closely with the Centre and the local communities. It was easy for him to align the interest of the staff members at the Centre to his project, than to align the communities. First, the communities were not at easy to work with a "white man".[81] Second, because of language barrier between Mr Souton and the communities, all translation was done through an interpreter (assistant researcher). A number of community workshops were held to translate the interests and strategies of the local communities around those of Mr Souton's academic project.

[81] In rural Namibia, it is common for communities not exposed to relations with "the whites" to still link them to colonial eras.

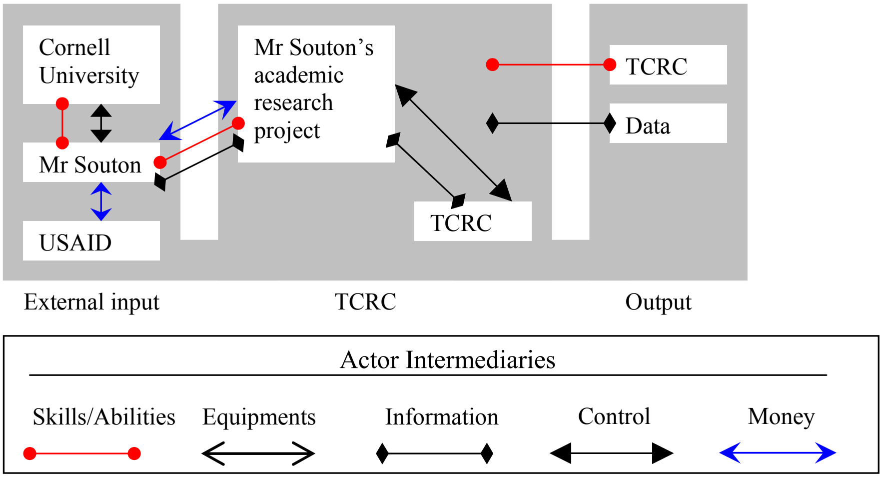

Figure 6.4.3: TCRC GIS actor-network (1997 – 1999)

Through Mr Souton's research project, TCRC staff developed interest in GIS technology. It should however be made clear that this interest was not created through the acts of Mr Souton as such, and he should not be viewed as a focal actor. Instead, it was the Executive Manager that motivated the staff to take advantage of the situation and develop interest in the technology. Mr Souton was requested by the Executive Manager to provide two research assistants with basic training on the concepts and uses of spatial data and GIS, i.e. data collection, development of databases, map design and how to use GPS devices. However, as these research assistants were not acquainted with the use of computers, Mr Souton ended up spending time training them how to use a computer instead of how to use GIS technology.

At the end of 1999, Mr Souton returned back to the United States to complete his doctoral thesis. Unfortunately, TCRC never got to see Mr Souton's final thesis, which would have contributed significantly to the activities, and to the development of GIS at the Centre. They also did not manage to keep in contact with him after his departure. This situation was apparently caused by inability of the Centre to make follows up because of their poor Internet connection, which still prevents them from "connecting with the world" (Research Assistant). The departure of Mr Souton was a major interruption that jeopardised the implementation process of GIS. Consequently, the use of GIS at Centre was abandoned for "something close to a year" (Research Assistant), because the skills developed during Mr Souton's stay were not sufficient enough for the staff to operate the GIS. As for the Executive Manager, he was reportedly constrained by time, and was consequently not able to work on the GIS.

Towards the end of 2000, the GIS execution actor-network was renewed at TCRC (figure 7.4.4). This network was prompted by the arrival of an American volunteer at the Centre. She was skilled in GIS, having just completed an undergraduate degree in geography. This volunteer came to know about the Centre through the Executive Manager, having met at a conference. Her arrival then revived the GIS facilities at the Centre. This time, the emphasis was no longer on rangeland management, but on community based natural resource management (CBNRM), for the production of base maps showing the availability and distribution of natural resources in the local community areas. The decision to focus the GIS on CBNRM was taken by the Executive Manager, based on the fact that CBNRM activities were central to the Centre and following that natural resource mapping exercise at the Centre has mostly been accomplished through hand drawing and community sketches. After all, this was the main reason why GIS was acquired at the Centre in the first place. The volunteer helped with development of a GIS activity plan, which she presented to the Executive Manager to integrally connect it to the overall strategy of the research activities at the Centre.

The volunteer was assigned to work closely with a Research Assistant (Mr Nghiyolwa), for the reason that once she leaves, Mr Nghiyolwa would take over the GIS operation as a power user of the system. Mr Nghiyolwa was one of the two Research Assistants that received computer training from Mr Souton. He revealed in the interview that he was very thrilled to be assigned to work with the volunteer as it was an opportunity for him to learn more about GIS technology and computers in general. Accordingly, GIS has improved interest in his work as well as improved his communication skills. "Even as working with computer maps, the community shows me some respect now." (Mr Nghiyolwa). The Executive Manager also invested time and effort to afresh his GIS skills (i.e. how to make analysis, update and query the database). His efforts were motivated by his keenness on GIS technology.

For input into the GIS, data collection in this network was carried out with the aid of local communities who are familiar with the environment, and have the knowledge as to where the resources were available. Participatory rural appraisal methods (Chambers 1997) were combined with GIS techniques for local communities' resource mapping. Various thematic maps (e.g. soil map, vegetation map) have also been created and labelled in local names.

> "Although the maps were created in the office here at the Centre, the local communities had the final say as to whether the information presented was accurate." (Executive Manager)

On request from the Executive Manager, the development of the database was prepared in such a way that it would allow further changes (in future) to be realised easily without reliance on external resources. Before her departure in June 2002, the volunteer developed instruction manuals for data collection, design and management of the GIS databases, and design and creating maps. The manuals were handed to Mr Nghiyolwa for future use.

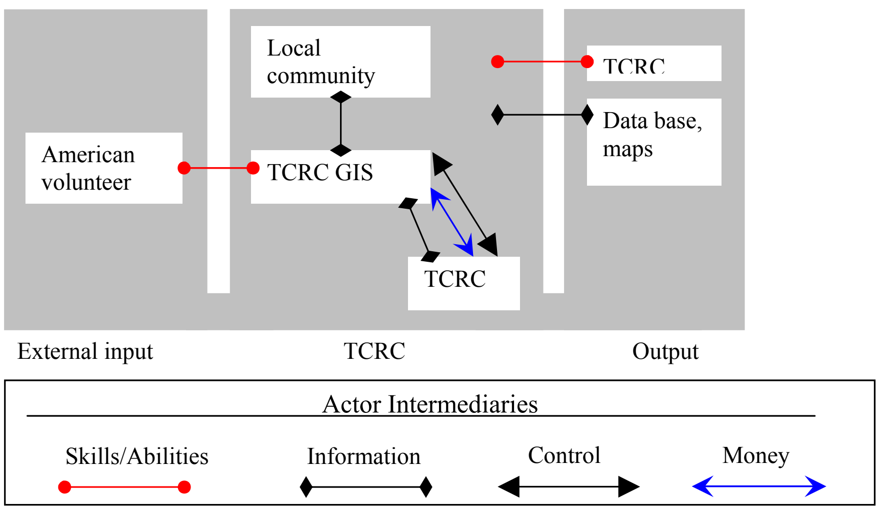

Figure 6.4.4: TCRC GIS actor-network (2001 – 2002)

6.4.2.3. GIS stabilisation stage

As a power user of the system, Mr Nghiyolwa is now responsible for the operation of the GIS at TCRC (figure 6.4.5). He is so enthusiastic in GIS that he invests his own time to improve his GIS skills and abilities. He is assisted by the Executive Manager who provides technical support and guidance to the concept of using the technology. To legitimate the use of GIS at the Centre, Mr Nghiyolwa's job description was re-defined to include the day-to-day operation of GIS. He was also released from some of his old duties.

The Centre is now using GIS maps to address local issues, and the use of these maps is said to have led to a better understanding of resource availability and distribution in the community areas, and towards conflict resolution in the community. GIS has been integrated in the ongoing activities of the Centre. Open community meetings are the main forums in which local problems and identified and addressed. These meetings are also responsible for decision-making regarding the contents of resource maps. Training underpins the alignment of the communities and the Centre. Ongoing provision of training to the communities include: map reading, use of GPS and data capture and participatory mapping. Basically, GIS technology is viewed as a facilitator between the Centre and communities and among the community members.

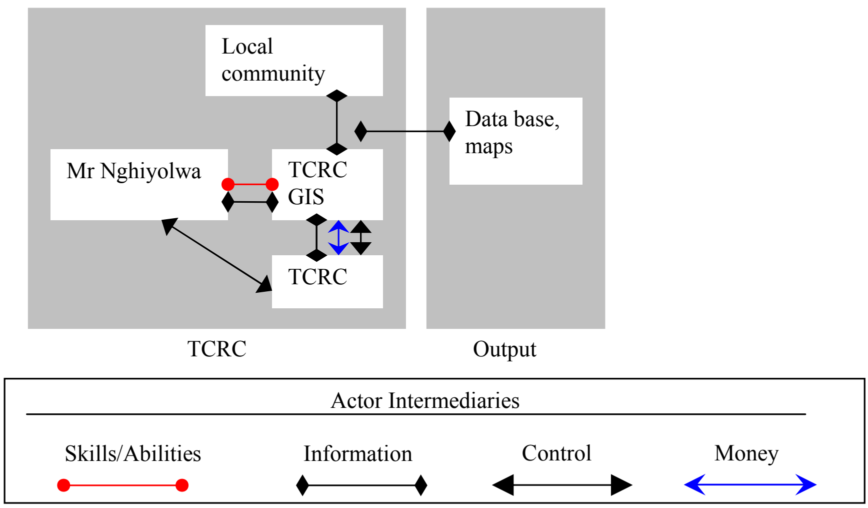

Figure 6.4.5: TCRC GIS actor-network (Mid 2002 – current)

<u>Available data sets</u>

The Centre has in possession detailed natural resource maps covering various themes such as soils, vegetation, land use and capability, location of water resources and settlements, population characteristics, and village boundaries. These data sets are all produced in AcrView shapefiles. All data is produced by the Centre in teamwork with the local communities and is treated as properties of the communities. The work carried out by the American researcher and the volunteer contributed to the establishment of the database, which is now continuously updated.

<u>GIS Impacts</u>

A GIS-based natural resource mapping at the Centre has improved the decision-making process with regard to natural resources. The resulting decision-making process has been described as efficient, participatory and transparent, involving members of the communities and the staff members of the Centre. GIS is believed to have responded to the user needs, giving an additional benefit of generation trust between the local community members and between the communities and the Centre. GIS is also said to have enhanced data collection, data quality, sustainability and creativity. The implementation of GIS at TCRC has also provided the opportunity to improve the computing skills of the staff, through the on-the-job training, in close cooperation with the two visiting Americans.

6.4.3. Challenges

The challenges outlined in this section were identified by the Executive Manager. Any other person that was interviewed at the Centre referred to the Executive Manager for this part of the questionnaire. Reason for that was apparently because he understood better what was happening. Therefore, this section will not be presented in the same pattern as the other two case studies.

Lack of communication and coordination with other GIS users in the country is a major limitation to the effective use of GIS at the Centre. Apart from collaboration with the local communities, the Centre hardly makes any alliances with other organisations using GIS, or involved in CBNRM activities in the country. The reason for this phenomenon is apparently due to the remoteness of the Centre, and its distance away from the cities (especially Windhoek) where most other professionals are situated. When contacts are established, they usually just “die naturally” because of the poor physical or communication infrastructures at the Centre. The Centre for example, is only able to a slow Internet connection over a dial-up line. Because of this problem, the Centre does not even benefit from the provision of GIS applications made accessible through the Internet. (Organisations are increasingly making their GIS applications available and accessible through the Internet).

Limited software and hardware resources are also factors hampering the effective use of GIS at the Centre. Since ESRI’s ArcView donation in 1996, about ten years ago, the same software is still being used without any update to new versions. The Executive Manager would like to have a new version of the software to enable detailed performance data analysis, however, due to a lack financial resources, this has not been possible. The computer that came together with software is also the very same one still used, although it does get service and maintenance from time to time.

Although the power user is able to generate the maps required to illustrate the availability and distribution natural resource in the districts, his abilities to manipulate GIS related information and analysis is still limited. This may affect the efficiency of an operational GIS, making the use of GIS prone to remain in the data collection and illustration stage because of a lack of continuity of staff training.

Funding is a major constraint to the use of GIS at the Centre. A lack of funding makes the updating of equipment impossible and maintenance thereof difficult. Poor physical or communication infrastructures in the area also add their share to these difficulties. What is important to note is that human resource development will also suffer if funding is limited. This is true for training and even more important for developing applications that will promote the significance of GIS to the Centre. It is also reported that although GIS maps are found useful at the Centre, and within the communities, most of the staff as well as the community users have not fully grasped the concept of GIS as a whole. Most of the staff is still not confident as to what and what is not realistic to expect from GIS.

6.4.4. Case Summary and Conclusions

The first GIS initiative at the CCF appeared in 1995 with the idea spearheaded by the Executive Manager. There was no pilot project that could be said to be the main vehicle through which GIS was developed. Similarly, no user needs analysis was developed to guide the acquisition of the

GIS. Instead, GIS developed in response to the Centre's desire to enhance its indispensability to the local communities. In this view, GIS has evolved in response to the organisational needs.

The introduction of GIS at the Centre led to the involvement of two Americans at the Centre and in the communities, who assisted with the technical aspects of GIS and provided training to the local staff. Due to lack of GIS skills and abilities at the Centre, the implementation process of GIS was slow and fragmented, involving technology abandonment until such time when it is possible to obtain external GIS expertise with little or no costs involved.

A very important element in the process of GIS implementation at TCRC is the cooperation and active participation of the local communities. The communities, the Centre and the two Americans involved in the process, each has had their own interests and special competence. This case study has shown that GIS is a participatory process in which the actors cooperate, each to satisfy their interests.

Despite the success attained in building strong work relations between the communities and Centre through the use of GIS, the stability of GIS faces a number of threats and difficulties. The Centre only has one power user. If he leaves, the situation is likely to repeat itself when previously GIS was abandoned because of lack of skills and abilities. Although the abandonment of GIS technology in those stages could also be related to lack of clear framework within which GIS implementation was attempted. The availability of funds to maintain equipments is also a key threat. Another limitation remains the remoteness of the Centre, which prevents it from effective collaboration with other GIS users in the country.

Chapter 7: Case Study Synthesis

7.1. Introduction

In the case studies, I have described how GIS technology was initiated, executed and stabilised into the organisations despite some serious challenges. The initiation stage of GIS implementation focused on the problematisation of the projects through which GIS is executed, and how the actors and goals were locked into a pattern of actions (interessement). The execution stage of GIS implementation focused on the successive events of negotiations and politicking throughout the projects (enrolment and mobilisation). This guided understanding of the GIS implementation as something partly created by the very conditions and assumptions that are present even before the projects are formulated. The stabilisation stage focused on how GIS technology has been regarded and operated after the end of the projects. This chapter is a synthesis of the case studies' findings. It will thus illustrate some of the translations characterising the process of GIS implementation.

7.2. Forces to Implement GIS

The three organisations implement GIS for various reasons specific to their missions. GIS is implemented because of its potentials and not necessarily because people have clear ideas about its actual benefits. Overall, five internal forces towards GIS implementation in the studied organisations can be summarised as:

- The desire to develop, retrieve and integrate spatial data sets.
- The desire to use spatially referenced information to find out about the spatial patterns of development at different scales.
- The desire to use graphic representations on planning, monitoring and management models to empower policy and decision-makers.
- The desire to reduce the amount of paperwork involved in completing routine tasks.
- The desire to produce timely and consistent information.

In addition, there were some external forces towards GIS implementation:

- The intensification of competition faced within the country (e.g. the Municipality desired to compete with the Windhoek Municipality, and the CBS wanted to re-claim its position as the main producer and distributor of statistical data in the country).
- Worldwide attention towards GIS and spatial technologies.

These desires are essentially the sources of problematisation of the translation process in the implementation of GIS, and they were guided and facilitated by individual actors.

The findings suggest that, some organisations implement GIS purely because they desire output or products from the technology, whereas others may implement the GIS because they desire the technology itself. Table 7.1 is an expansion of this argument. The strategies undertaken to implement the GIS would then depend on what the organisation desires. An organisation can however start with one desire which, depending on either success or failure of the initial desire, may change into another. For example, initially the CBS desired GIS driven outputs for the census project. After having received satisfaction from the project, GIS has now become a tool for improved quality and productivity within the organisation, or at least that is the direction headed to. The reverse holds for the Municipality, where initially GIS as a technology was desired. When the developed system failed to assure the hoped benefits, the desire is now just to have the outputs. TCRC has desired the output from the onset and this has not changed. As the case studies showed, when pursued, the desires to use GIS technology lead to a grouping of actors that come from different backgrounds and have different interests, interacting under multifaceted networks.

Table 7.1: Motivations to implement GIS in organisations

Motivation	Description
Desires output (e.g. inventories, maps, databases)	· Seek specified outputs or products by using the technology · No long-term plans in place · May or may not have in-house GIS skills · Highly dependent on consultants for technical output delivery · Consultant is likely to work in isolation (not together with the staff) · Capacity building is not necessary advocated · Funding for the production of GIS output is likely through external funding, and most often through a project
Desires GIS technology (e.g. for organisational efficiency, or for a long-term vision)	· Seek to implement GIS as an integral part of the organisation · Long-term plans in place · In-house GIS skills is compulsory · Consultants may be used for the initial system building, but eventually the in-house staff will take over completely · Capacity building is strongly advocated · Funding for GIS activities is likely solicited in-house

7.3. Actors and Actor-Networks

In describing the case studies from the view point of ANT[82], emphasis was placed on the efforts to create a consortium of actors involved in the implementation process. The findings demonstrate that the process of GIS implementation is heterogeneous, consisting of the contributions of both human and non-human actors. This section will now focus on different aspects of translation which reveal details about the actors and the actor-networks involved in the implementation process of GIS.

7.3.1. Actors

Because of the different management strategies and financial support systems, the implementation process of GIS in each of the studied organisation has had different actors, each with their specific qualities and limitations. Some actors entered the networks through invitations, some through lobbying and others through implications. Overall, the key human actors in GIS implementation are shown in Table 7.2, and their characteristics and roles are discussed below. It is to be noted that there are other human actors such as the media, professional forums and academia whose roles tend to be indirect. The case studies have also demonstrated that actor's roles in the network may change over time. This change is often a result of actor's reaction to prevailing situations. A change in actor's roles triggers a series of other translations that impact the actor-network.

[82] See chapter seven

Table 7.2: Human actors in the implementation of GIS

		Organisation		
Actors	**Roles played**	**The Municipality**	**The CBS**	**TCRC**
Focal actors	· Serve as a point of contact · Assist in preparing a GIS implementation plan · Provide technical insight and experience · Identify GIS priorities · Identify and lobby for required resources	√	√	√
Management	· Obtain funding · Approve resource allocations and timetable for implementation · Monitor implementation progress	√	√	√
Consultants and expatriates	· Help organisations plan, implement and use the GIS by providing a spectrum of technical services such as system design, database design and development, data migration and systems integration · Provide capacity building to the staff	√	√	X
Politics	· Provide political support crucial for a "go ahead" situation	√	√	X
Donors	· Provide financial and technical resources	X	√	√
Students and volunteers	Same as consultant (see above)	X	X	√

√ - Applicable   X - Not Applicable

7.3.1.1. Focal actors

The commitment from the focal actors proved important to secure establishment of GIS. Focal actors tirelessly pursue the goal of GIS implementation by "selling" the idea to their management and co-workers. These actors are indispensable to others throughout the implementation process, but most especially during the problematisation moment in their respective organisations. But as Campbell and Masser (1995) warned, these actors may make a contribution to securing commitment to a GIS project, but much will depend on the personalities of the individuals and their willingness to listen and take account of the existing organisational culture. The Municipality and the TCRC cases demonstrated that involving not only potential users of the system in the initial scoping of GIS initiatives, but also any other person in the organisation who may impact or be impacted by GIS is ideally because the people who will end up becoming users are frequently not people originally envisioned as users. Moreover, as seen in the CBS case, a new technology can be a cause of concern for employees. Involving them early helps them better understand what GIS can do, how it may impact them, and how they may contribute to its implementation.

7.3.1.2. Managers

The findings reveal that the managers at various scales within the organisational hierarchy play important roles in the implementation process of GIS. In all three cases, the managers involved in the process included not only those under which the GIS is directly implemented but also from other departments or divisions.

Overall, the findings suggest the role of managers as gatekeepers in the development of GIS in organisations. Their crucial roles are those of handling organisational side of GIS, i.e. organising and allocating funds, appointing and assigning staff and other organisational hurdles. Effective GIS implementation depends very much on the behaviour and attitude of the managers, and success thereof increases with their willingness and motivation. Manager's awareness and support on the ability and benefits of GIS was one of the leading forces in the process of introducing and implementing the technology in all three organisations. Lack of support from their side obstructs the implementation process. For example, because they have the mandate to justify the way financial resources are invested, it is often difficult to get budgets approved for the purchase of new technologies (e.g. a new computer to run a GIS as seen in the Municipality case) when the managers are not in favour of the new technology. As seen in the case studies description, they have the power to influence organisational procedures which are key actors in the implementation process.

Owing to the variation in the manager's personal characteristics, their varying experiences and background on GIS and other related technologies; each one of them may have different visions and different strategies for the implementation process. On the one hand, managers with a more focused vision may concentrate on the development and maintenance of one particular application of GIS that serve a specific need of the organisation. This has been the case at the CBS and TCRC where the development of GIS has been specifically for census related applications, and for resource mapping respectively. In the CBS case for instance, over the years, GIS could easily have diffused into other applications of the CBS or even at the NPC scale. But because the Government Statistician has been more focused on the census products, GIS was advocated only up to a project scale with a specific purpose. On the other hand, other managers may not be too motivated to spread or even allow the use of GIS for other applications. This scenario was documented at the Municipality where certain departments have been identified as potential beneficiaries of GIS, but such departments could not implement the GIS because their managers do not see the alignment of GIS with the vision of their departments.

7.3.1.3. Consultancies and expatriates

Consultancies[83] have the GIS skills and abilities pertinent in the implementation of GIS. Their roles are mostly dealing with the technical know-how of the GIS systems, such as hardware and software procurement, system design and application development. The Municipality and the CBS cases represent a classical situation where the GIS infrastructures in the organisations are established and maintained under the assistance of consultants, expatriate experts and foreign companies (Karikari *et al*. 2005, Nkambwe 2001). In both cases, the use of GIS has proliferated mainly with technical and training support from these groups of actors. Overall however, the CBS has made more (and continues to) use of external contractors to assist in the development and maintenance of their GIS applications, even though they have a larger in-house power users. But this is also understandable because none of their power users are GIS experts. In the case of the Municipality, after the initial GIS establishment by external contractors, the Council now prefers

[83] Throughout in this thesis, "consultants" and "external contractors" are used interchangeably.

to use their in-house power users for their GIS application development and maintenance. The assistance of external contractors is only supported when and if the situation really calls for them. Unfortunately though, the technical maintenance of their GIS system is entirely in the hands of external contractors who are not even based in Namibia but in South Africa. The GIS Steering Committee is not content with this situation, but the decision to change the situation lies with the Council, who still do not see the need to employ a GIS Administrator at the site to take over from the external contractors.

The TCRC case is different, as they hardly make use of consultants because of their financial support system. Instead, they welcome students and volunteers with skills and abilities pertinent to the Centre. The roles played by these actors in the implementation of GIS at the Centre are not much different from what the consultants have carried out in the other two cases.

As already established in chapter six, dependency on consultants and foreign expatriates is one of the great challenges to the country. Their roles while positive in the main, have also led to certain difficulties which seem adamant to overcome following the lifespan of the projects. The problem is that, at the end of the project, both the consultants and the expatriates leave. As seen with the CBS case, while the roles of these actors have been significant as far as technology transfer is concerned, the end of the project has not been satisfactory. The skills and abilities developed to maintain the GIS are never adequate for the local staff to operate the GIS independently. On the basis of other researchers[84], the argument is that if GIS is to be introduced successfully into an organisation, then it must be localised. Unfortunately, while understanding the social context better, local people often do not understand the technical capabilities of GIS, as seen in all three cases in this study. On the other hand, GIS is a “western artefact” and would most likely require a foreign exchange component in its installation and implementation. This point was also argued in the findings of the survey questionnaire presented in chapter six.

7.3.1.4. Donors

Because GIS development and implementation is typically a resource intensive venture, it is frequently linked with donors or other types of development assistance (Christiansen 1998, Ramasubramanian 1999a, Nkambwe 2001). In the studied organisations, the involvement of donors in the implementation process of GIS was documented in the CBS and TCRC cases. The strength of SIDA influence throughout the duration of the CCP was apparent. Not only did they contribute financial assistance that enabled the implementation of the project, it was also them that independently hired GeoSpace to carry out a feasibility study on possible usage of GIS in the census exercise. Acting on GeoSpace’s recommendations SIDA then brought forth the idea to introduce and implement GIS at the CBS. In addition, they provided a GIS technical advisor to ensure coordination, technical assistance and capacity building during the implementation process. The CBS case is a typical case of the government, where most projects are donor driven or are joint collaborations between the government and international agencies[85]. The involvement of donors has however usually been limited to short-term projects of limited geographic extent (Shiponeni 2005, *pers comm.,* Kavela 2005, *pers comm.,* Nghitila 2005, *pers comm.*).

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[84] See Chapter four

[85] In general, the main funding sources that are engaged with GIS activities in Namibia includes, the USAID, the World Bank, Deutsche Gesellescheft für Technische Zusammenarbeit (GTZ), the World Wide Fund for Nature (WWF), SIDA, UNDP, Global Environmental Fund (GEF) and International Fund for Agricultural Development (IFAD). Many of these funding sources have established long-standing relationships with parent organisations.

In the case of TCRC, donors were only directly involved by donating the GIS software and hardware. Except, TCRC did not have a choice on the type of software donated to them, but as the Executive Manager revealed it did not matter for them which software was given to them.

> "The important thing is that we received the software and we could now use GIS to make our maps." (Executive Manager)

Other than that, the entire implementation process was left to the Centre. But if we bear in mind that the financial support system of TCRC is solely dependent on donors and sponsorship it becomes clear that the involvement of other donors in this case have become a black box.

The implementation of GIS at the Municipality has not directly benefited from any specific project introduced by donor agencies. In fact, the Municipality does not depend on donors. According to the Municipality managers, donors do not seem to see any potential in investing in them, plus donor money is expensive as it comes with many conditions[86].

7.3.15. Politics

Politics are central in the implementation process of GIS as enabling actors that afford interressement. This outlines the importance of political support, in which case when it is absent the interessement moment could not proceed. The roles of politics are described in detail under section 7.4.3, control, of this chapter.

7.3.2. Creating an Obligatory Passage Point

The presence and functions of an obligatory passage point (OPP) is important to draw different actors relevant in the implementation process in one network. If there is no clearly identified OPP, existing actors may not align under a common interest, and other relevant actors may not be identified. This section will now investigate the presence and functions of OPP in the three cases. The aim of this investigation is two-fold: 1) to seek understanding of how the OPPs were created and how their functions drew all relevant actors together given their different interests, and 2) to seek understanding on how the actors avoided or faced the challenges that they were faced with in the creation of the OPP as well as in their alignment with the OPP. The organisations are investigated individually.

The Municipality

When the first problematisation[87], did not meet alignment with the Council, the process of enteressement could not proceed. The standardisation of the Erf Key system in the country marked the second attempt at problematisation. Through Ms van Heerden, the DSM proposed to the Council that the Municipality's Erf Key system be digitalised to conform to the proposed national standard. Ms van Heerden made herself indispensable to other actors (the Council, the managers and her co-workers) by defining the nature of the problem and forcing others to accept a way forward (the Erf Key project). Successful translation of this interest led to the formulation of the Erf Key project at the Municipality. The roles and responsibilities of the key actors were identified in the project implementation draft document[88]. The Council would make a major investment for the acquisition and implementation of GIS technology, external contractors would have overall responsibility for the technical establishment of the GIS, staff members of the town planning division were to work together with the external contractors to build the necessary capacity. It is important to note that while all key actors proposed and their responsibilities

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[86] The Municipality of Walvis Bay is said to be one of the richest in the country, and one that is less dependent on donors.

[87] Ms van Heerden's first trial at problematisation in 1986.

[88] drafted by Ms van Heerden

identified, the specifications of the GIS system to be acquired and established were not stated. This was left open for future translations between the Municipality and the external contractors who have better understanding of the GIS technology. A key element in the project implementation draft document was the dominance of support for GIS establishment and its function as that of support rather than to dominate the improvement of the then manual Erf Key system. GIS technology was defined as a "complex system", which might take a few days or many years to develop and implement fully. This could imply that the Municipality was ready to accept that GIS would or would not produce desirable changes within a shorter period of time. The Erf Key project is considered an OPP by its initiators as a vehicle to ensure the Erf Key system conformity to the proposed national standard, but also to achieve GIS establishment within the Municipality. Figure 7.1 illustrates the Erf Key project as the OPP as well as involved actors and their various interests.

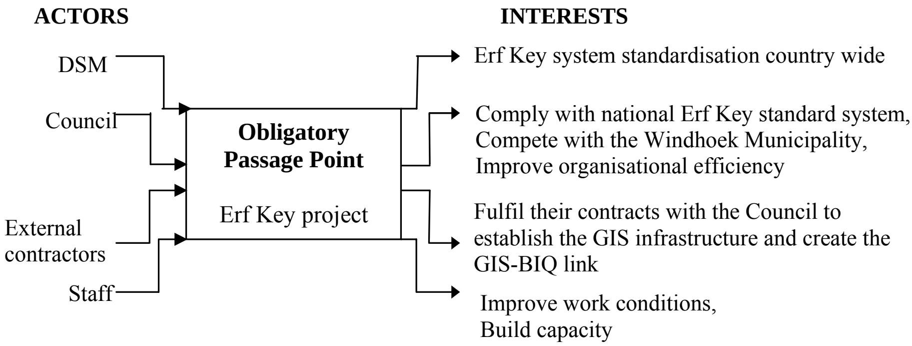

Figure 7.1: Obligatory Passage Point in GIS implementation at the Municipality (1)

Two years after the Erf Key project, the GIS system (ReGIS) was found inappropriate for the purpose of its use, plus it did not align with the technological environment of the Municipality. Additionally, the producers of ReGIS were closing down, which meant that no further ReGIS upgrades could be expected. Another problematisation was prompted to find a solution, which required acquiring of a new GIS system. Following the withdrawal of ReGIS, tension existed among the GIS users about the possibility of acquiring a different GIS system, "something better". The fact that it had initially taken the Council nine years to give a "go ahead" situation for GIS implementation, and that the Council had[89] just invested a lot of money on GIS caused the GIS users to panic as to whether the Council would enrol in this translation again. The GIS users sought to approach the Council through the managers who were members of the GIS Steering Committee. Being in strategic positions in the organisational hierarchy, the manager had easy access to the Council, and given the bureaucratic nature of the organisation, it was expected that the Council would easily align with the managers than with the power users. The managers were thus appointed spokespersons for the collective GIS user group. In this way, the managers became indispensable to others (the Council, GIS and BIQ users) by forcing them to accept the proposed acquisition of a new GIS system. The managers were able to construct an internal network of relations in which they acted as the mediators.

[89] Only two years ago

Unlike the previous approach taken during the Erf Key project where the specifications of the GIS software to be acquired were not specified, this time the specifications were clearly stipulated. This shows how human behaviour was shaped by the experience that shaped the initial implementation trial. In the previous scenario, the consultants basically defined the system requirements for the Municipality, and as it turned out, their assessment proved erroneous.

> "As experienced consultants, they should have been able to detect the incompatibility between ReGIS and our technological environment. Moreover, through their user needs analysis, they should have been able to identify missing links between ReGIS and the number of users that can work on the system simultaneously."[90]

In this problematisation, the OPP was the GIS system. The Council established responsibility to provide financial resources and technological infrastructures for the new GIS system. External contractors aligned to provide the requested system and the staff members would provide the necessary information to the contractors, and build their capacity. Figure 7.2 illustrates this second creation of an OPP.

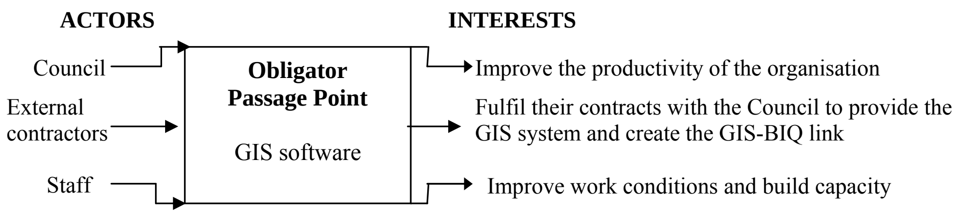

Figure 7.2: Obligatory Passage Point in GIS implementation at the Municipality (2)

The CBS

The decision to implement GIS at the CBS was done confidentially, firstly between SIDA and GeoSpace, and secondary between SIDA and the Government Statistician. The role of SIDA is quite outstanding in these translations as a key actor. The Government Statistician, guided by his previous experience and background became the focal actor. Negotiations between SIDA and the Government Statistician led to the proposal of the CCP, defined as the OPP, through which all actors should pass regardless of their varying interests (figure 7.3). Within the CBS, the Government Statistician was key in this initiative, and was able to draw on sources of power to translate actors towards the OPP. Given the bureaucratic routines and procedures of the CBS/NPC, it was important for him to mobilise a strong network of influential actors. This action involved building a network around the proposed CCP, in a negotiated process of consolidating alliances with other actors. To enrol the top management, the Government Statistician appointed himself the spokesperson of the collective CBS. An added advantage was that the Government Statistician had high visibility and authority in the CBS, which gave him legitimacy to silence other fellow actors. Appointing himself a spokesperson for the other presented tension within the organisation because some of those other fellow actors felt that their strategic positions as part of the CBS management was threatened. This tension was expected to expire naturally because nothing was made to correct the situation. What was important was that the management has given a "go ahead" situation for the CCP.

[90] Comment from the chairperson of the GIS Steering Committee

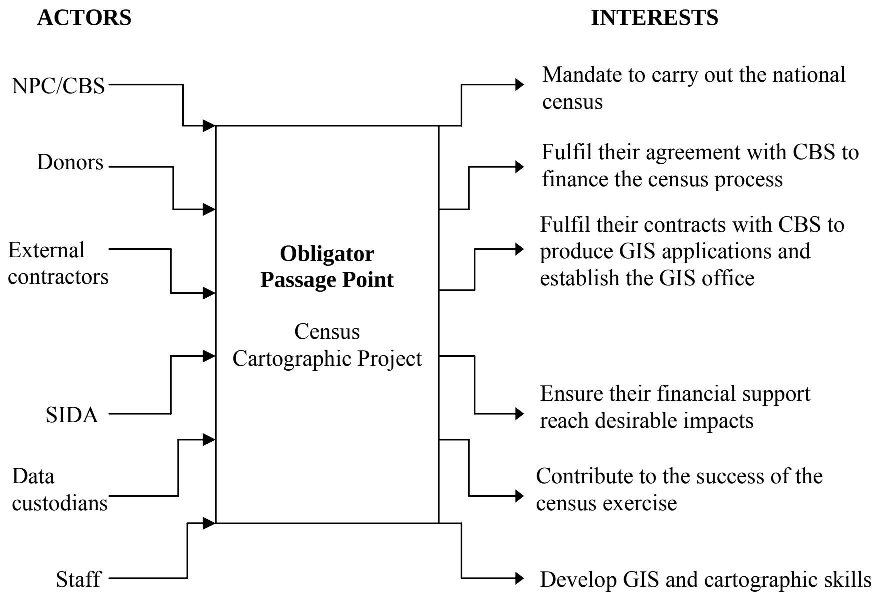

Figure 7.3: Obligatory Passage Point in GIS implementation at the CBS

The TCRC

The idea to introduce GIS at TCRC came from the management. The role of GIS was defined as that of improving the manual mapping exercise of the Centre so as to facilitate active participation of local communities in natural resource management. The Executive Manager's commitment and belief in GIS as a tool to better the productivity of the Centre became the human driving force behind its implementation. It was already envisaged that the introduction of GIS at Centre would bring new meanings and would reconfigure existing interactions between the Centre and the local communities.

The OPP in this case is not clearly definite. On the one hand, the Executive Manager assigned himself a spokesperson for the others, and took up the responsibility to oversee the process of introducing the GIS into the existing network. It meant that from that point on all new actors had to pass through him. This would then make him the first OPP. On the other hand, GIS technology can be seen as an OPP, as it represents the solution to provide incentives in the local communities to improve natural resource management and advance participatory strategies. Figure (7.4) illustrates both the Executive Manager and GIS technology as OPP.

Once the doctoral researcher had passed through the OPP[91] and was successfully enrolled into the network, he immediately set up his new OPP that would allow him to carry out his research. This new OPP was his academic research project, and it gave him control over the GIS activities at the Centre. He decided how to include other actors in the project, defining their roles and interest. This OPP is illustrated in figure 7.5 below.

[91] Considered either the Executive Manager or the GIS technology

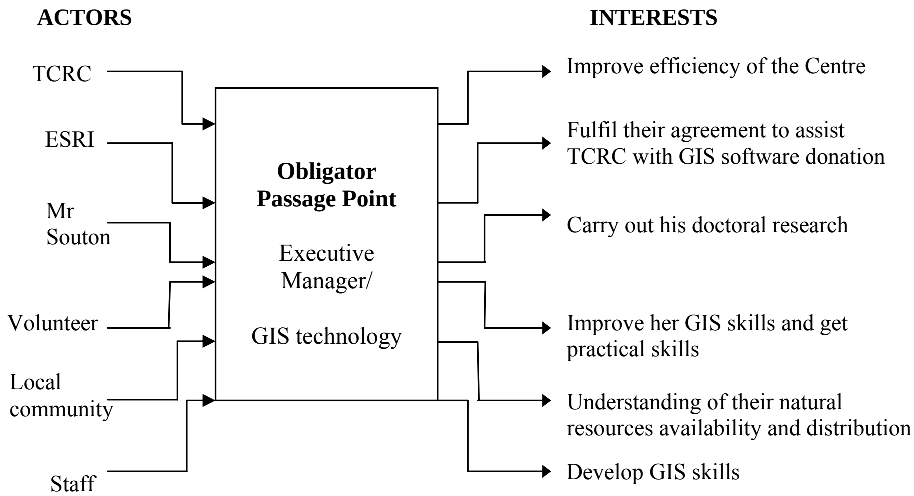

Figure 7.4: Obligatory Passage Point in GIS implementation at TCRC (1)

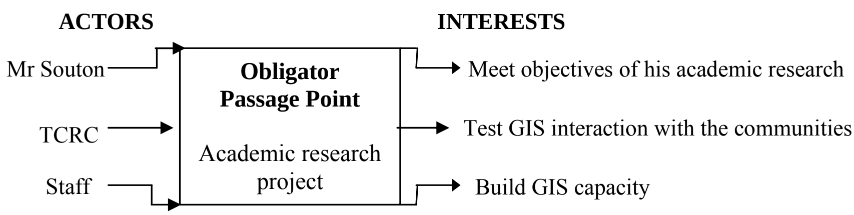

Figure 7.5: Obligatory Passage Point in GIS implementation at TCRC (2)

7.3.3. Local and global networks

According to Law and Callon (1992), it is possible to plot any project on a two-dimensional graph where the x-axis measures the degree of mobilisation of local actors and the y-axis the extent to which global actors are linked to describe the translation process (figure 7.6). In this section, I will attempt to apply this network analysis to the case studies. This analysis aims to contrast the involvement of local and global networks in the implementation process of GIS. Global actors are defined here as any actor who is foreign to Namibia as a country. By local actors, I refer to any actor (individuals and agencies) who is citizen to Namibia. The analysis is presented in the subsequent paragraphs whereby each organisation is assessed individually.

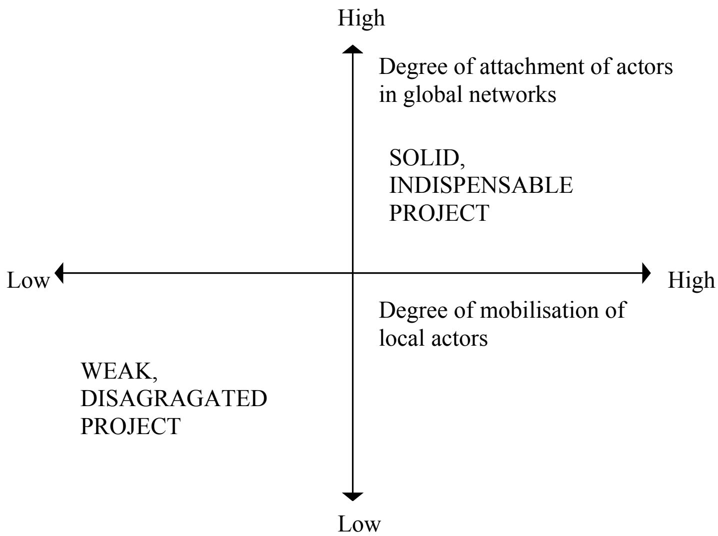

Figure 7.6: Mobilisation of local and global networks (after Law and Callon 1992)

The Municipality

Figure 7.7 is an analysis of local/global networks in the implementation of GIS at the Municipality. The Erf Key project was initiated in-house, although there were some external motivations. These other motivations, while external to the Municipality, they were still local in the context of a country (1).

The formation of the network that led to the actual establishment of GIS within the Erf Key project (2) effectively built on the local network, although some consultants were affiliated to other global networks which were simplified in the Erf Key project. The project was coordinated from Coopers & Lybrand, based in South Africa. Through this translation, a global network was initiated (3).

The need to create the GIS-BIQ link drew strength to the global network because actors responsible for the BIQ system within the Erf Key project were external to the country and they had affiliations to other global networks (4).

Through the establishment of the GIS Steering Committee, a local network was created (5) responsible for all GIS activities in the organisation. This network however proved unstable with the withdrawal of ReGIS system. Moreover, the GIS-BIQ link did not completely align with other actors. The need to replace ReGIS led to a re-definition of GIS objectives in the organisation. Consultants external to the country in partnership to local consulting companies formed a network that installed the current GIS system at the Municipality (6). The involvement of external consultants in this partnership was much stronger than the local consultants.

Through the GIS Steering Committee, the Municipality now has sole coordination of their GIS. However, given that Bentley's software maintenance in Southern Africa is coordinated from South Africa, a global network in this circumstance is unavoidable. GRID has more technical control over the GIS than the Municipality does (7).

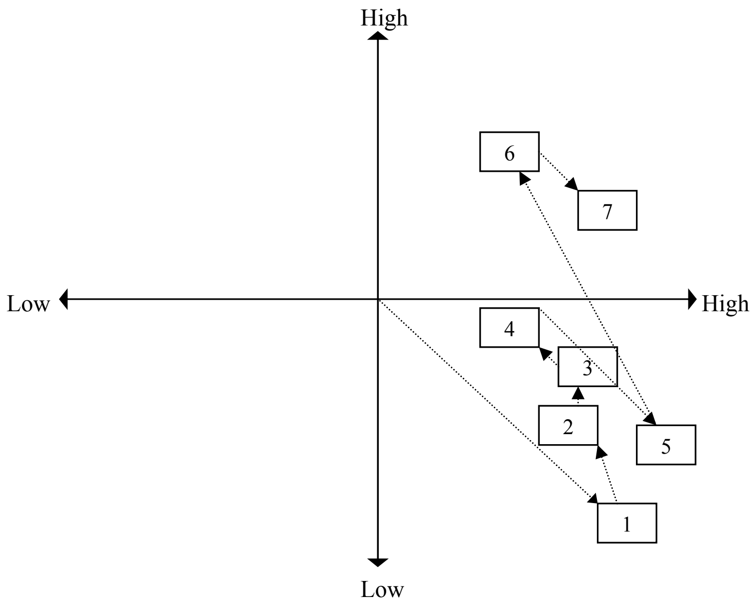

Figure 7.7: Mobilisation of local and global networks at the Municipality

The CBS

Figure 7.8 is an analysis of local/global networks in the implementation of GIS at the CBS. The census project started at the centre of the diagram and moved up the vertical axis as the Government Statistician and SIDA, guided by GeoSpace's recommendations, proposed a migration from manual to digital-based census exercise (1). This proposal was translated to the NPC's top management who provided support that led to the official formulation of the CCP (2).

The establishment of GIS at the CBS was outsourced to GeoSpace/Devinso, who took sole responsibility of the outsourced component of the project. Devinso collaborated directly with SIDA and the Government Statistician from time-to-time. In this network, the Government Statistician was mainly present to be kept informed. Any major decisions were made between Devinso and Sida (3). The donation of equipments by the Spanish government moved the global network further high (4).

The involvement of local data custodians for the provision of required data sets, strengthened the local network (5). Fascinated by the technology, the Director General of the NPC's requisition for the creation of NamPlan database also strengthened the local network, but the proposal and decision by Devinso for NamPlan to adapt a South African standard moved the global network high again (6).

A major part of the field work for the demarcation of the country was carried out by the CBS staff, having been trained by Devinso. Their involvement was excluded to field work while Devinso took the responsibilities for all office based GIS activities (7).

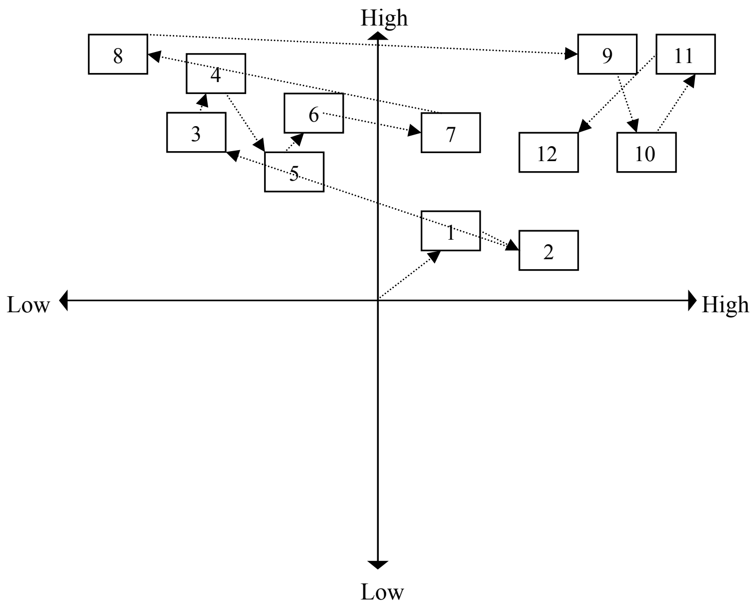

Figure 7.8: Mobilisation of local and global networks at the CBS

Soon before the end of Devinso's contract, the arrival of Mr Rydén and Mr Akende moved the strength of the global network, weakening the local network (8). The departure of Devinso provided opportunities for local participation as Mr Rydén and Mr Akende's approach was to cooperate with the operational staff as much with the management (9).

The Spanish offer for training of the power users was again strength to the global network (11), but before that, the GIS-tailored training prepared by the CBS in conjunction with the Polytechnic of Namibia constructed a local network (10). As a result of this translation, the CBS invested on additional GIS software for the GIS office.

At the end of the census project, the CBS was expected to take over from the external contractors. Due to lack of proper skills and abilities, Mr Rydén was contracted for the maintenance of the GIS office, and Mr Akende's contract is still valid. Although the power users are now more involved in GIS activities than before, the operation of the office still largely rely on Mr Akende who is based at the CBS and Mr Rydén who visits occasionally. At present, the CBS provides all resources required for the operation of the GIS office. The CBS is also in the process of fully integrating the GIS office into their organisational structure (12).

<u>The TCRC</u>

Figure 7.9 is an analysis of local/global networks in the implementation of GIS at TCRC. GIS initiation started within the Centre, although that was just a birth of an idea (1). The need to acquire a GIS software prompted the creation of a global network (2). It is interesting to note that no local network formation was attempted for GIS software acquisition. Reason for this was apparently that there was no known actor in the country who could potentially donate or sponsor a GIS software.

After ESRI’s software donation, an attempt to construct a stable local network at the Centre to operate the GIS was inefficient because of a lack of adequate capacity to operate the GIS (3).

The arrival of GIS skills and abilities with Mr Souton revived the GIS and created a global network (4). A very weak local network was created at Mr Souton’s attempt to build the capacity of the staff (5). After the departure of Mr Souton, another attempt to create a stable local network was inefficient for the same reason, lack of adequate GIS capacity at the Centre (6).

The arrival of the American volunteer created another global network that invigorated the GIS again. The volunteer worked closely with a local staff member (7).

At the time of the volunteer’s departure, a local staff member was better equipped to take over the GIS operation. Technical support is provided by the Executive Manager, and the local communities assist in data collection and verification. In this way, a local network was formed. As the Centre continues to make use of manuals developed by the American volunteer, the global network has become a black box in this network (8).

Most of the GIS data in the country are now being made available through the Internet. Due to its poor Internet connectivity, TCRC is hindered to access the data and even network with other organisations (9).

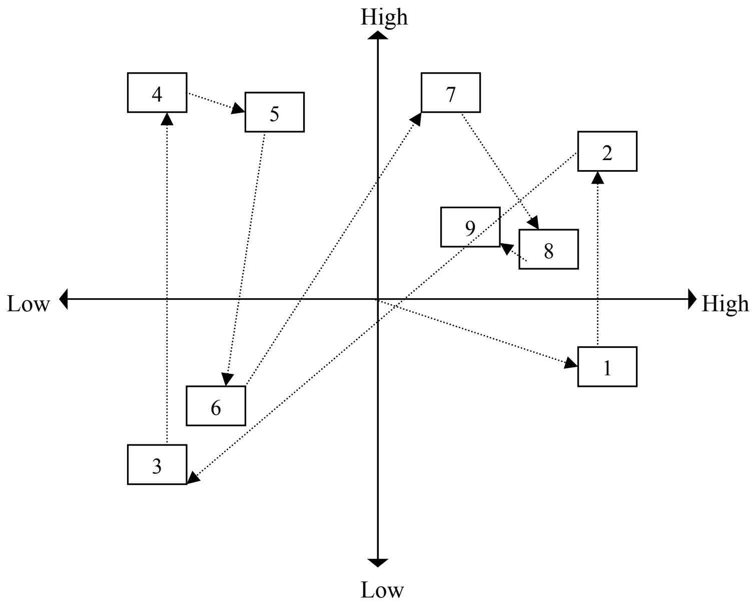

Figure 7.9: Mobilisation of local and global networks at TCRC

According to innovation translation, the success of each project in reaching the initial targets set for it crucially depends on the creation of an effective local network that operates independently of the global network. In the case of the Municipality, the local networks that were created produced outputs that differed from those in the original project documents. At the CBS, the local networks have not really operated independently of the global networks. The products produced in collaboration with global networks however met the requirements of the users in the local networks, and the census project was judged a success. The success of this project was also crucially dependent on the mobilisation of a local network of actors who provided and produced required information within the time scale and budget of the project. The TCRC case is hard to assess in this view because they did not really have a defined point of entry through which its local network could be measured. GIS at TCRC was initially implemented on ad-hoc, depending on prevailing situations. The mapping exercise for which GIS was initially intended for never really formulated a project, and there was really nothing in writing that explicitly described the objectives of GIS at TCRC.

7.3.4. Alignment through intermediaries

In all three cases investigated, there was no single actor-network that connected all actors involved in the implementation process. This is because throughout, diverse networks are constructed and dispersed as needed. Actors shift over time, depending on the specific aspect in focus. There is an ongoing interaction among the actors in the networks, which cause influences and impacts among them. This would explain why actor-networks are not fixed but keep on changing, though the rate of changes vary depending on the need for new or improved actions. This suggests that GIS implementation is an ongoing effort that is constantly challenged by actors defined by the context of the organisation.

In chapter seven, actor-networks were delineated and used to show how action intermediaries linked the actors in the work. In this section, the overall alignments by intermediaries are evaluated to see how alignment characterises the implementation process. Of the five intermediaries used to delineate the actor-networks, alignment through the provision of money, provision of information, and control are evaluated in some details. These three intermediaries are chosen for this evaluation because throughout the case studies, they have demonstrated to play a major role in determining the alignment of actors and stability of the networks. Alignment through people's skills and abilities has also played a major role in determining the stability of the network, and its evaluation will be useful in connecting human and technical object actors, but such evaluation would require measuring technical performance (Martin 2000). So as not to leave it untouched, an overview of these two intermediaries' alignment will be related to the extent of technology use, ability to produce the required outputs, and training that is given as a means to align the power users' skills and abilities.

7.3.4.1. Provision of money

The CBS

In terms of money, the CBS has had the strongest actor alignment and network stability. The funding bodies fulfilled their agreements with the CBS to finance the census project, which in turn allowed the CBS to satisfy its mandate to carry out the 2001 national census and disseminate the information, at the same time reclaiming its position as the national lead agency for socio-demographic data in the country.

The Municipality

The on-going persuasion for financial support at the Municipality is evidence of a weak actor's alignment on the part of the managers and the Council. On the other hand, these actors did align from 1995 throughout to 2002. This is evident as throughout that period, the implementation of GIS was fully funded with commitment from the Council. Even when the alignment with the GIS system broke down two years after the Erf Key project, it was the Council that established responsibility for success when it invested in the system for the second time. However, because of continual failure to successfully establish the GIS-BIQ link, these actors have now developed a hostile attitude towards GIS technology, causing the instability of the network. The Council is one of the strongest actors in the Municipality GIS actor-networks, as it has total control and power over the contribution of other actors and it is responsible for the provision of money which is essential for the progress of the networks. So, if the Council withdraws interest from the network, then the entire GIS implementation is challenged.

The TCRC

Alignment in terms of funding in TCRC actor-network is strong. Funding for the production of GIS output is provided by TCRC, which has a vested interest in the success of the Centre. But bearing in mind that TCRC is heavily dependent on donors and sponsorships, the stability of the network remain at risk depending on whether the Centre gets funding or not.

7.3.4.2. Provision of information

The CBS

Alignment in terms of information has been very weak within the CBS since the inception of CCP. From the onset, participation of the operational staff member was not promoted. Neither was there any active dialogue between the management and the operational staff. In absence of this dialogue, the operational staff members became isolated outside the active networks. Their attitude towards the active networks became hostile. It was even reported that during the user needs analysis carried out by Devinso, the staff contribution was very low. This poor contribution was attributed to the hostile attitude of the staff towards the technology and its advocates. Having worked on the 1991 census project and on the intercensal projects, most of the staff had great potential to contribute both in the formulation and actual implementation of the CCP. But because of the unfavourable strategies[92] adopted for the CCP, their contribution in terms of information or even skills rendering was blocked. Poor alignment is still reflected by the fact that the end users within the CBS, for whom the GIS technology was meant to support, hardly make use of the GIS products. Most of them are not even aware of the availability and accessibility of GIS applications developed by the GIS office. On the part of the GIS office, no initiative has ever been taken to promote their GIS applications within the organisation. Neither has the other divisions requested to be capacitated with regard to progress and status of GIS applications. It even appears that the GIS office relies more on external data custodians for database update, even though some of the information could be obtained from within the CBS. A manager from the Economic Statistics division within the CBS described the GIS power users as being “too timid to come around and ask for information, or even tell me what information they have that could benefit me.”

The CCP has dependent on external data custodians from the start. Alignment in terms of information provision between the CCP and the external data custodians has been strong throughout. Strong collaboration with data custodians is in some cases typified by a Memorandum of Understanding (MoU) between the GIS office through the CBS and other agencies. In these MoU, the agencies make their information available to the GIS office. In return, the GIS office fills for them the gaps that might be in their databases. In these translations, the CBS play the role of a connecting link between the different agencies. As revealed in chapter seven, external users groups are the main users of the GIS applications produced at the CBS. The sharing of credit for the often-applauded successful 2001 census exercise, and dissemination of information thereof manifests a strong alignment between local and global actors in the CBS case, and shows the stability of the network in terms of information circulation.

The Municipality

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[92] See also under organisational readiness in sections 8.4.1.

Alignment in terms of information at the Municipality is rather mixed. From the start of the Erf Key project, all information need for GIS system was held in-house. The staff members who were familiar with the information collaborated effectively with the consultants, which show a strong alignment. Through the GIS Steering Committee, alignment in circulation of information within the organisation has been strong, as the Committee forms a platform through which the departments share information and contribute to the implementation process. The power users also interact through information sharing and exchange across the departments, which suggests a strong alignment. On the other hand, the fact that the Council has not been satisfied with the work done by the consultants (their constant inability to create the GIS-BIQ link) shows a poor alignment in terms of information circulation. Similarly, the withdrawal of interest from the GIS-BIQ link expressed by the finance department indicates a weak alignment in terms of information circulation. Basically, the GIS users and the BIQ users were held together by the formation of the GIS-BIQ link. Since the link has proved virtually impossible to establish, the stability of the network is threatened as some of the key actors pull off. Furthermore the fact that the Intranet facility which has made the GIS database accessible to all staff members is underutilised demonstrates poor alignment on the part of the users.

The TCRC

At TCRC, alignment in the provision of information started off strong as Mr Souton's project was provided with all relevant data in possession of the Centre, plus the local communities contributed significantly to the collection of field data. In terms of information circulation, however, alignment started very weak with Mr Souton not making his doctoral thesis available to the Centre. Following the revival of GIS with assistance from the American volunteer, alignment in terms of information has been strong. Both the local communities and the Centre actively participate in both data collection and verification. The GIS maps produced by the Centre are used by the local communities for their planning and resource management purposes. The circulation of these maps represents the network that has turned into a black box. Strong alignment in information circulation is also exhibited by the fact that credit for improved working environment between the Centre and the local communities is distributed among actors.

7.3.4.3. Control

The CBS

The top management of the organisations tend to have control over the actor-networks. At the CBS and the Municipality, the top management is mostly politicians. At the CBS, the role of political support has been paramount. Seeing that the operational staff members had clearly dis-allied themselves from the focal actor, had it not for the control power of the top management, the implementation of GIS would not have been possible although the financial resources were in place. Although they did not enrol, actors at the operational scale could not deny entry to this stranger, GIS technology. They had to cope with its introduction as a valid solution in a sense that the decision to implement it was based on legitimate power of the management. The moment the CCP was officially formulated, the GIS started to act, although initially very fragile and vulnerable, and the staff could not ignore it. Its fragility and vulnerability is in a sense that its presence in the network was not favoured by all of the actors. The unfolding events following its existence in the network affected the staff members, some of which were literally forced to work with the technology. The CBS case shows how a specific combination of management and financial support led to the implementation process dependent on bureaucratic routines and procedures of the organisation. The development of NamPlan database at the CBS was not initially planned as an activity of the CCP, but occurred only because the top management asked for its development. This clearly shows a strong alignment in terms of control over the production of desired applications from the CCP. Control over the responsibility for successful GIS implementation was also in the hands of SIDA, although their main interest was more to ensure that their financial support is well utilised and has reached desirable impacts. But as clearly shown in the case study, SIDA structured the way different groups of actors viewed GIS and how each of them related to it. This was especially obvious for actors internal to the CBS.

The Municipality

Discontinuation of political and management support at the Municipality and the bureaucratic nature of the organisation pose a challenge to the stabilisation of GIS within the organisation. The top management of the Municipality has had control all along as to what and how it should happen. At first when their interests were not aligned with those of the focal actor, they completely refused investing on a new technology. Because of their control power, GIS could not be implemented until such time when their interests aligned with those of the focal actor. It is interesting to note that the same managers who refused the technology nine years ago were the same persons that enthusiastically came to advocate the same technology during its execution stage, and still, the same persons who after seeing no anticipated progress from the part of the technology are now showing hostility. It shows that throughout, alignment in terms of control did not reach an irreversible stage, although the networks might have seemed stable at one point.

The TCRC

Alignment through control at TCRC has been strong throughout. This could obviously be explained by the fact that the focal actor is at the same time the top manager of TCRC who has the control power of the activity of the Centre. Throughout, the Executive Manager has had control over other actors in the network. The fact that he approves and is able to delegate who should be added to the network and defines the roles of the new actors reflects a strong alignment in terms of control.

The control authority of the Municipality and the CBS cases could be used to argue that GIS implementation process is a power game among the actors with different interests (Bloomfield and Best 1992). The implementation and its success thereof depend on the power of various alliances in the network. These actors would most likely be the ones providing financial support to the implementation process as seen in the two cases. On the hand, the case studies have also shed light to suggest that consultants exercise power over their customers. In the case of the CBS, Devinso had control power over the CCP; taking decisions as they saw them best suiting the CBS. In many occasions, it was seen that the CBS was by-passed not involved in decision-making regarding GIS issues. In the case of the Municipality, regardless of the agreed terms, the consultants proved to exercise power and deliver[93]. In fact, networks are oriented towards contracts between the consultants and the organisations. At the CBS for example, contacts within the organisation were less important during the execution stage than those with the consulting actors. In TCRC case, after allowed entry into the network, Mr Souton created a new OPP which gave him control, changing the OPP that initially held actors together. These findings suggest that those who are powerful are not necessarily those who hold power in principle, but those who practically define or redefine what holds everyone together (Yakura 1992). This shift from principle to practice allows the vague notion of power to be treated not as a cause of people's behaviour but as a consequence of translation (Bloomfield and Best 1992).

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[93] Yakura (1992) focused on the power relations between information technology consultants and organisations. She concluded that the ambiguity of information technology, the blurred boundaries between what is technical and social, for example favours the consultants as they are able to generate and manipulate meanings to legitimate their proposals and offerings. Yakura does not however tell us how power exercised by the consultants over their customers becomes stable.

7.3.4.4. GIS skills and abilities

Alignment in terms of GIS skills and abilities to operate the GIS as seen in all three case studies is one of the major challenges in the stabilisation of GIS in the organisations. Alignment of these intermediaries is strong only in relation to external contractors. These actors exhibit fine GIS technical know-how and they are often well skilled in general computing which complements their alignment. The CBS has had the strongest skills and abilities alignment in relation to the external actors. All three external contractors (Devinso, Mr Rydén and Mr Akende) have been able to effectively use their skills and abilities to produce the required applications. Because of their skills and abilities, Mr Rydén and Mr Akende have been instrumental in aligning the skills and abilities of the power users (I will return to this point shortly). TCRC has the second strongest alignment in terms skills and abilities to operate the GIS in relation to external contractor – although in this case it has been in relation to the doctoral researcher and the volunteer. In the case of the doctoral researcher, it is hard to evaluate his alignment in terms of these intermediaries because of my lack of knowledge regarding success of failure of his doctoral research project. In the case of the volunteer, it appears that alignment was fairly fine as she was able to set up the GIS database, create a template for natural resource mapping, and provide to the current power user. Alignment in terms of skills and abilities in relation to the external contractors was weak at the Municipality. In the first place, this is suggested by a continual failure to establish the GIS-BIQ link. But as I mentioned above, evaluation these intermediaries require measuring the technical performance. In the second place, weak alignment is suggested by the failure from Geonet to convert the ReGIS data format into MicroStation data format effectively.

The problem in alignment of these intermediaries lies in the fact that external contractors are only effectively present in the network during the duration of their contract period, which is usually a very short period of less than 12 months mostly. During this period, they are expected to align the skills and abilities of the power users. As seen in all three cases, this has not overly been possible to achieve. In all three cases, the implementation strategies included a component of training, also referred as capacity building for the external contractors to align skills and abilities of the power users. These strategies have been implemented through short-term technical training focusing mainly on the technicalities of a particular software.

The Municipality has the most GIS skilled power users. The training activities undertaken at the Municipality is said to have led to the strengthening of technical skills of the power users, who are now able to offer a wide range of technical expertise including training of new potential users in the organisation. It should however be noted that most of the power users at the Municipality have had GIS courses during their graduate education. The power users at the CBS have also received a series of short-term modules, within and outside the country, though they are still unable to independently operate the systems. To make matters worse, they are said to lack motivation and willingness to work with GIS. As Huxhold and Levinsohn (1995) points out, staff who are lacking in the necessary technical and communication skills, dedication, creativeness and willingness to accept new concepts will most likely ensure failure. In this case, the power users are unable to take advantage of opportunities which could also pave a way for professional growth. Opportunities for training have arisen in form of long-term advisors at the site, a tailor-made training at the Polytechnic in different areas of GIS, as well as a series of training modules in Spain.

Approach to training has been different at TCRC. The power user (together with the Executive Director) was initially trained at the Centre by the doctoral student and volunteer. The volunteer's training, particularly, as the power user revealed has been of great benefit. The power user has also invested a lot of effort to self-learn the technology. Concomitantly, he was allowed two opportunities for GIS short-courses at the Polytechnic of Namibia. His skills and abilities to operate the GIS is said to have aligned with the purpose of GIS at the Centre. The Executive Manager provided the technical assistance when required.

In the cases of the Municipality and the CBS, the training was sometimes inappropriately timed, occurring before the installation of software or was too technical for the degree of comprehension of the staff. In those scenarios, some of the staff that initially were willing to use the technology did not feel adequately prepared and some got even scared by the technicalities of the technology. Where the training was appropriately timed, such occasions provided motivation and willingness for the staff to use the technology. Throughout the case studies, a very common situation points to a time factor that limits the power users to master the technology, i.e. short-courses and parallel office duties. In such situations, individuals often end up frustrated and then they start expressing anxiety and animosity towards the technology (i.e. experienced at the CBS).

7.4. GIS Implementation Complexities

The discussions raised in the preceding sections frame GIS implementation as a complex process of intertwined actors influencing and impacting each others. I have argued that the moment GIS is allowed entry into the networks, it starts acting bringing with it change into the organisations. In this section, I will use the findings of the case studies to demonstrate the impacts of actors on each other, more particularly the impacts of GIS technology. I will attempt to track change that GIS has brought in the organisations.

7.4.1. Implementation in relation to change

The introduction and use of GIS in all three organisations triggered some unplanned modification in the conducts and procedures of the organisations. Of the three studied organisations, change was more pronounced in the Municipality and the CBS cases. As the use of GIS technology grows and develops, its position within the organisational structure becomes an issue. In both these two cases, the general consensus from GIS advocates is that having a dedicated division or unit responsible for all GIS operations within the organisation would greatly enhance the productivity of the technology which in turn benefits of the organisation. For this reason, these organisations have established organisational structures and plans that help them coordinate a formalised GIS stabilisation.

The CBS is currently underway of materialising their vision of having a dedicated GIS division within the organisation. This GIS division is envisaged to take over all GIS applications and activities currently carried out by the GIS office, and serve as a focal actor for GIS implementation. In dealing with this vision, the CBS is expected to determine explicit functions and responsibilities of the staff working in the division, put in place strategies for the exchange of information among different departments and divisions, as well as how information could best be made available to other organisations and to the general public at large. Political support and action is indispensable with regard to the creation of this division and to the establishment of enabling procedures. As is the case now at the CBS, the bureaucratic nature of the organisation is hindrance to the effective implementation of GIS. As seen in the case study, the CBS exhibit a lack of transparency in their decision-making procedures, and a lack of effective dialogue between the management and the staff directly responsible for GIS technology. These organisational problems will most definitely continue to impact the GIS negatively unless otherwise something is done to improve the situation. The findings of the CBS case have revealed that once the GIS division is established, a consortium of personnel will be employed to effectively run of the division. In light of this the scarce financial and technical resources of a government agency would require a flexible approach that would offer a reasonable remuneration to the staff and keep them embraced with technology development.

The implementation of GIS has caused change at the Municipality with regard to lines of communication and reporting, and collaboration between the departments. The establishment of the GIS Steering Committee bridged the gap between the Council, the management and the operational staff. In a sense, it has enabled an active dialogue across the organisational hierarchy. As seen in the case study description, the Municipality has also developed a network of power users to share problems experienced and seek solutions together. It is an effort unique to the organisation that has resulted into a common understanding of GIS problem areas in the organisation. Not many organisations in the country have such an extensive approach, and this practise is said to have increased the information flow between departments. At the Municipality, the implementation of GIS has also resulted in considerable change in job descriptions of not only the power users, but the managers too, to include the operation and management of the technology into the official duties of these actors. Change in job description was reported at TCRC as well, although not as specific as at the Municipality.

Change as a result of GIS implementation was also reported at the individual scale. In all three organisations studied, the use of GIS has contributed to the transformation of relationships among some employees. In TCRC case for example, it was found that the use of GIS maps has enhanced the participation of local communities in resource mapping and decision-making. It implies an improved working relationship between the Centre and the local communities. At the CBS, the network created by the operational staff in their attempt to resist GIS technology has now developed into a black box. Through this network, the staff is said to have grown locked into a strong working relationship to an extent that they often cover-up for each other. Unfortunately, as observed and hinted by the management, the staff's relationships to some extent has become more playful than work oriented. For example, the power users "spend so much time teasing each other than actually working.[94]"

The experience of working with external contractors and foreign expatriates has also not only been relevant to push the technology but also in terms of contacts that have been established with potential partners for future collaborations. This has already been the scenario in the CBS and the Municipality cases. At the Municipality, immediately after the Erf Key project, when they required external assistance for the maintenance and data capturing exercise they turned to Mr van Jaarsveldt due to the fact that he understood the Municipality's scenario, having been involved in the initial establishment of the system. Similarly, at the end of the CBS, having acknowledged the inability of the power users to completely take over the operation of the GIS office, the CBS turned to Mr Rydén who initially was sub-contracted to the GIS office to fulfil the agreement between SIDA and the CBS.

In all three cases, findings demonstrate the top management of the organisations as the primary source of the organisational change, and their alignment as being crucial for GIS implementation. This is clear as we contrast the CBS and the Municipality cases. Although the operational staff at the Municipality had aligned their interest with GIS technology, the implementation could not proceed until nine years later when the top management have finally aligned their interest with the technology. At the CBS, although the operational staff did not support the implementation of GIS, the implementation preceded because of alignment of the Government Statistician[95] with

[94] Comment from the Chief Statistician

[95] The head of the CBS

support from the top management of the NPC (the Director General and the Permanent Secretary). This suggests that alignment of key influential actors is perhaps more critical than others in the organisation. Similarly, the TCRC was headed by the Executive Manager is the top manager of the Centre.

Suppose GIS problematisation had come from an operational staff member both in the CBS and TCRC cases, would the unfolding of events leading to the actual implementation of GIS been same? Most probably not. From experience, the CBS case would most likely have gone through the pattern experienced at the Municipality[96]. The focal actor would have had to deal with government obstinate bureaucratic procedures, which would have required a great deal of patience and understanding on the part of the focal actor. The Government Statistician really had an advantage of being part of the organisation management and that he had easy access to both the Director General and the Permanent Secretary. Of all the three organisations studied, TCRC is less bureaucratic in their routines and procedures. In absence of a taut bureaucracy, the unfolding events would probably not have been very much different. There might have been additional translations to align the Executive Manager. But seeing that the staff has a "follow the leader" attitude, the decision of the Executive Manager might have provoked a major influence, whether in favour or against GIS implementation.

7.4.2. Procedures

The bureaucratic nature of procedures for approval and procurement of the technology, as seen in the Municipality case can be cumbersome. It requires a great deal of patience and energy to find a way through the bureaucratic and political systems to obtain support and funding. This trend is likely to be the experience of the CBS in their vision to create a GIS division within their structure. It has already taken over a year to have the draft structure reviewed by all necessary parties within the organisation. Then it will have to be send to the public commission for approval. The public commission is known to be one of the slowest in the country. From experience, by the time approval is awarded, the person promoting these initiatives might even have left the organisation, or even the technology itself might be outdated and needing new upgrades, which would again cause delays.

In all three cases, the power users hold the primary responsibilities of GIS functions in the organisation (e.g. maintaining and updating databases, carrying out the analyses, attending incoming requests, etc). At the Municipality and at TCRC, the power users have clear mandates as to what is expected from each of them regarding the GIS functions. Power users at the CBS lack clear understanding of what is expected from them. They do not have job descriptions and the activities of the GIS office are not partitioned between them. For this reason, the work is often not done because they each expect the other person to do it. These findings confirm that GIS implementation is in deed impacted by organisational structures, policies and procedures. [97]

The power users are expected to give regular feedback to the department or project head who further reports progress on implementation to the top management. This line of communication is stronger at the Municipality and at TCRC, but very weak and inefficient at the CBS. At the Municipality, the power users are also expected to report progress in their monthly GIS Steering Committee meeting, where they receive input and feedback from all Committee members. In this way, the power users do not have the sole implementation dominance because input from the Committee is taken seriously. In the TCRC case, a strong direct communication is promoted

[96] See more details under section 8.4.3.

[97] See also findings of the survey questionnaire in chapter six.

between the power user and the local communities who are the end users of the GIS maps. The power user reports back to the senior researcher who again reports to the Executive Manager. The communities have power over the details of the maps. This means that the Centre does not have autonomy over the GIS system. Moreover, concepts and ideas are contributed by the senior researcher and the Executive Manager. At the CBS, the line of communication between the power users and the chief statistician (to whom they report) is said to be weak. The reason for this can partly be attributed to the fact that neither the power users nor the chief statistician has a special keenness on a GIS as such. Any direct communication between the Government Statistician (who is keener on GIS) and the power users is almost non-existence because of a strong bureaucracy embedded in the functioning of the organisation.

7.4.3. Organisational readiness

The readiness of staff members to accept and apply GIS novelty is crucial to assure successful implementation of the technology. Most of the problems experienced at the CBS could be related to organisational readiness and preparedness to undertake GIS technology. I will now try to outline evidence from the case study which support this argument. To begin with, the resistance of GIS by the operational staff actors was attributed to some extent to a lack of basic understanding of the concept of GIS. As the story unfolds it was revealed that there was no awareness raising or even consideration of the staff prior to the formulation of the CCP. The advocates of GIS in this case even ignored to take into consideration the cultural and historical background of the Namibian people and of the country at large. Consequently, some of the staff members even wondered in thoughts of fear of being colonised again[98]. Seeing the extent of fear that GIS was bringing among the staff members, at a later stage, the Government Statistician sought to raise awareness on the concept of GIS. It however proved that his timing was long overdue as the staff had already made up their minds and locked their argumentative attitudes towards the technology and its advocates.

> "It would have been better if they sensitised us well in advance about this GIS technology so as to give us a chance to "digest" the idea and prepare for changes that may occur as a result of technological development in the organisation." (CBS staff member)

Second, during the first training provided by Devinso, the consultant expected that the CBS would have a specific group of candidates well chosen prior to the commencement of the training exercise. As it turned out, there was no such kind of preparation on the CBS part, Instead, anyone who wanted to hear what the consultant had to say about "this GIS technology" was just coming in and going out any time they felt like. It could be seen that this was the chance for the staff members to at least gain some understanding about GIS. Unfortunately, as they had their official duties to attend to, they could only make efforts to attend the training when time and work load allowed them. The whole situation, as described in the case study, resulted into a frustrating atmosphere for the consultant, and caused the training component of the project to report failure. Third, throughout the implementation planning and needs analysis, most of the staff is said to have been excluded, apparently because of their poor understanding of the GIS. Bearing in mind that the same staff that is excluded is the same one expected to become the power user of the system. The so-called "poor understanding of GIS" could easily been eliminated through awareness raising as was the case at the Municipality. Fourth, the persons now working as GIS power users were literally dragged to work with the technology, and as seen in the case study, some of the power users would not choose to be associated with GIS if they had a choice.

It could be argued from a different point of view that most of the problems experienced in the CBS case came as a result of tensions created by the top-down strategy of implementation. This

[98] See the case study description

top-down strategy rests heavily on the power embedded in the management of the organisation. Informed by their allies, the management viewed GIS technology as a neutral tool to be implemented, and that other actors (including the organisation with its staff) will just contribute to its implementation. The other actors' possibility of influencing the implementation process or even the technology itself was not an element in such strategy. GIS was viewed as a given artefact to the organisation, an independent element and the organisation as another independent element. This view is a typical technological determinism or technological utopianism (Bijker and Law 1992, Campbell and Masser 1995). Due to the organisational structure of dominion, the staff members were forced to participate in the implementation of a system that is to a great extent is biased towards the management logic. The approach undertaken by Mr Rydén and Mr Akende emphasised active participation of the operational staff, and promoted the integration of the GIS office into the organisational structure of the CBS. In this approach, the agent of change is not viewed as the GIS (technology), but is the interplay between both the organisation (social) and the technology. In this interplay, the GIS further organisational goals, and the organisation furthers GIS goals. In keeping this view, the interplay is enabled by other actors such as lines of communication, procedures and strategies, tacit knowledge, databases and financial resources. Overall, GIS implementation at the CBS appear to have gone through a shift from technological determinism (Devinso and SIDA's approach) to social constructionism (Mr Rydén and Mr Akende's approach). The approach undertaken by Mr Rydén and Mr Akende avoided problems such as possible conflicts among actors, and avoided having themselves being caught up in the middle of CBS's internal networks.

At the Municipality, the focal actor vigorously advocated GIS within the organisation, especially to the managers who were initially very reluctant to idea of GIS and computer systems in general. As seen in the case study description, it took nine years before the management aligned with the concept of GIS. The management sought to fully understand the logic behind the technology and only until they felt confident was GIS finally introduced. On the other hand, it could be argued that over a period of nine years the management was not necessarily "digesting" the idea and the concept of GIS, but that there was also a mere resistance to change in fear of unfavourable changes that GIS could bring along, such as skew the power towards the junior staff who are advanced in GIS and computer systems. Nevertheless, the fact that the management has taken its time to build confidence and understanding of GIS before they could implement it shows that they did not just "jump on the jargon of the technology". At the instigation of the Erf Key project, the Council, the managers and the operational staff had a common goal, the establishment two systems: the GIS and the BIQ, and the linking of these two systems: the GIS-BIQ link. Prior to the project, the staff across the organisational hierarchy had been involved in discussions that aligned their interests. Unlike what happened at the CBS, during the project tendering process, organisational procedures were followed which made the process transparent and participatory. The Municipality had in place effective lines of communication, and although they also suffer the consequences of being a bureaucratic organisation, they had effective active dialogues across the organisation and they were more proactive than the CBS. The consultants worked closely with the operational staff who were to become the direct users of the system. As a result of their preparedness, it did not take long or efforts before GIS was diffused into other departments and became an inter-departmental tool connecting actors across the departments. It is also possible that through the many years of Ms van Heerden's struggle with the management, some of her fellow actors were already locked in the GIS interest, even before the Erf Key project was formulated. Introducing GIS technology through a project that was spread in different departments also stimulated internal discussions that aligned staff members understanding and interests.

TCRC had an advantage of being relatively a small organisation. As seen in chapter seven, prior to the introduction of GIS into the organisation, both the Management Committee and the staff members were well informed in advance about what GIS is, what it can do and why it was needed at the Centre. Taking into consideration the scale of education of both the Management Committee and the staff members, the Executive Manager sought not to go into much detail of the concept of GIS as he suspected that it may created fear and intimidation among the staff. This could be interpreted that the Executive Manager's approach was considerate to the social background of the stuff and even their emotions. The "follow the leader" attitude of the staff practically made it easy for the Executive Manager to take decisions and define strategies as he saw them benefiting the Centre. The problem was however in terms of technological infrastructures of the Centre. It was reported that when GIS was introduced, the Centre had problems of persistent power failure and poor Internet connectivity. In light of these problems, it can be interpreted that the technological environment of the organisation was not adequately up to standard to support GIS implementation.

7.5. Characteristics of GIS Implemented

The implementation of GIS in all three organisations can be labelled application-driven. At the CBS and TCRC, GIS is implemented and managed in a centralised structure. At the Municipality, GIS implementation and management is decentralised within different departments and through and inter-departmental GIS Steering Committee. There are advantages and disadvantages to both approaches. A centralised approach may lead to unnecessary bureaucracy and inefficiency. On the other hand, a lack of control from the centre may lead to fragmentation. Table 7.3 makes a short comparison of the two approaches. Initially, GIS implementation tends to be most successful when centrally implemented, but over a period of time they become more effective within a decentralised structure (Campbell and Masser 1995). While, it may appear that the decentralised approach works best in a long run, it should also be noted that a centralised approach may be the most suitable for some organisations (e.g. the TCRC, being relatively a small organisation).

Table 7.3: Comparison between central and decentralised approaches

Centralised approach	**Decentralised approach**
Advantages	
· Strong leadership · Relatively low costs · Fast to reach a decision (easy to agree)	· Assured sustainability · Cooperation stimulated · Wide-spread applications
Disadvantages	
· Limited spread of ideas · No sustainability · Greater risk of misinvestment	· Weak leadership · Time consuming to reach a decision (difficult to agree) · many meetings with little progress

For most users (even among the power users), GIS is recognised as an exclusive tool for map production, database management, visualisation and web communication. There is an exception for a few who see the potential of GIS as an analytical tool. At the Municipality, the technology's role as a decision-making tool is not so popular especially among the management who seem comfortable with the less sophisticated decision-making tools than GIS. On the other hand, little effort has been spent on transforming data into information for decision-making in this organisation. Basically, the applications of GIS at the Municipality are more or less digital versions of the "old ways of doing things". At TCRC, GIS maps form the basis for natural resource management. The local communities are able to interpret the maps and carry out their planning accordingly. At the CBS, the use of GIS applications for decision-making is hard to pronounce given that the applications of GIS are not so widely utilised within the organisation. For external usage, the CBS does not have in place mechanisms to track usage of their data by external actors.

Reflecting on the GIS organisational models described in chapter six, GIS is implemented at three scales. At the Municipality, when the technology was first introduced into the organisation, its applications were project based. After a while, the GIS matured in the organisation and became more widely used as a departmental resource supporting a broader range of functions in the organisation. Finally at the third scale, GIS has become a mainstream system that is part of the organisation's information technology architecture. At this scale, all computer users in the organisation have access to the GIS databases through the Intranet, and all staff members are able to make contributions regarding the implementation of GIS through a participatory inter-departmental GIS Steering Committee.

The CBS is still at scale one (project-based). Their chances of progressing to scale two (departmental) are greater, because they have already identified the need to create a dedicated GIS division that will take over the current GIS office, which was established and currently functions solely for the census project purpose. This progress towards creating a dedicated GIS division has however been very slow. This has been attributed to the inherent difficulties of Government bureaucratic systems. GIS at TCRC could be placed at a project scale because it is utilised only for a specific purpose although not necessarily under a well-structured project.

The operational status of GIS in these three organisations can be divided into three stages: operational stage, maintenance stage and development stage. In the operational stage, the staff of the GIS office should be familiar with the hardware/software and the data hosted by the office. They should be able to handle most (if not all) requests coming to the office. In the maintenance stage, the GIS office should be ready to efficiently maintain the data sets and major applications. In the development stage, the GIS office should be in a position where it is independently able to develop its own applications. As seen in chapter seven, all three organisations are on the development stage.

Data issues are the most critical technical issues within the implementation process of GIS. As seen in the case studies, each organisation uses their choice of GIS software, which in the end produces data of multiple formats. Multiple data formats inevitably complicate data transfer processes and results in some data redundancy and duplication because of incompatibilities in different GIS software. This appears to be a significant barrier to accomplishing a unified GIS within the country. Data standards may address some of these issues. But now there are just too many standards being promoted by different bodies. This is an issue of concern as it has led to some confusion among the power users as to which standard to apply. Nevertheless, all three organisations use different data standards (in-house defined). It shows that there is a need for national data standards. The author strongly believes that this can only take place if there is a proper coordination between the Government, NGOs, parastatals and the private sector. Standardisation will ensure that different parties generate data that can be exchanged and combined without any discrepancies since their data adheres to the same standards. This goes together with the development of metadata for the data sets.

It appears that organisations implementing GIS often are uninterested in comprehensive systems. This thought is exemplified by the fact that organisations tend to build and maintain a GIS that only includes data directly related to their regulatory mandates. For example, an organisation that deals with natural resources (e.g. TCRC) often builds and maintains a GIS that includes only data on natural resources. They would then give little (if any) priority to the other data types, such as

population dynamics (contained at CBS), which are essential for development. Related to this is the architect of databases. The way databases are set-up and stored makes it difficult for a GIS to make use of information because emphasis is placed on storing and update rather than analysis of the data. Consequently, data retrieval and analysing becomes a tedious process and a complex task.
In carrying out the case studies, the purpose was to investigate the implementation process of GIS and assess the effectiveness of the technology. So far the chapter has effectively described the implementation process and only shed lights here and there with regard to the effectiveness of the technology. Practically, assessment of GIS effectiveness is not easy to measure because there are no benchmarks at which to compare the results. For a more practical investigation, GIS effectiveness can be assessed as a measure of success of the solution that was proposed and agreed upon at problematisation. The success or failures of the projects studied in each case study are clearly presented in the case study descriptions. To avoid unnecessary repetitions, the subsequent paragraph will provide a summary of the success or failure of the case study GIS projects.

The objectives of the Erf Key project in the Municipality case were not fully met. While the GIS infrastructure was successfully established, the one major role hoped to be played by GIS; the facilitation of the GIS-BIQ link, has not effectively materialised. As seen in the case study description, it is against this failure that the management and the BIQ users measure the effectiveness of GIS within the organisation. In the CBS case, the main goal of the CCP was to migrate from conventional cartographic methods to digital census mapping and establishment of GIS technology at the CBS. These goals have both been successfully met despite a range of organisational hurdlers that threatened to block the implementation process. A sustained maintenance of the GIS office by the local staff, however, remains restricted by inadequacy of technical skills and abilities of the power users. In the case of TCRC, the objectives of GIS were not explicitly formulated, except that GIS was needed to improve the manual resource mapping activities of the Centre. This objective has been successfully met. As described above, the Centre and the local communities now engage in participatory resource mapping with the aid of GIS maps.

7.6. Summary and Conclusions

This chapter presented a synthesis of the case studies findings. Given that the case studies examined real-life experience of GIS implementation process, there is a reasonable confidence of the robustness of these findings both for deriving baseline information with which to track future changes in GIS implementation and with which to compare the situation in Namibia.

The chapter has described the implementation process of GIS as a long chain of translations through lengthy processes of interactions among actors who together form heterogeneous actor-networks. GIS implementation in the studied organisations was conceived by internal and external forces. Different human actors were demonstrated to have been involved in both the push and the pull side of GIS technology, thereby shaping and re-shaping project goals and expectations, and in return shaping the implementation process. Each of the three organisations exhibit a different pattern in their approach to GIS implementation, but in all cases whether and how a GIS project realises its goals depends on a number of factors. These factors: social, cultural, political, economic and technical form a web in which they interplay. While technical elements can easily be configured with necessary skills and abilities, the other four factors are unpredictable and hard solve. Particularly, organisational bureaucracy, economic stance and political support were found deep-seated that the implementation process may not instigate until they are in alignment. In fact, it appears that social, cultural and political values may even be embedded in the bureaucratic order of the organisations.

After a successful initiation of GIS in all three cases, events that followed throughout the implementation process could not have been predicted. These events were results of the various interactions between both human and non-human actors that required renegotiations to maintain actor's alignment. Each event contributes to the pool of experience in the actor-network. Each event was interplay of actors pursuing various interests, and translating other actors. The events involved shifting and being shifted by resistance and changing situations. On the other hand, evidence also pointed out that different actors guided by their varying personal characteristics, experiences and background tried to predetermine the sequences of GIS implementation, which often times did not lead to desirable progress. This demonstrates just how intricate GIS implementation process is. At this point we can ask, is GIS implementation simply an emergent process or is it planned? In a sense, the answer lies somewhere in the grey area in between. I shall return to this point in the concluding chapter of this thesis.

It was found that the complexity of actor-networks arises as the number of actors in the network increases. In this same view, Monteiro and Hanseth (1995) notes that the simpler a network is, the easier it is to align; the more complex the more complex it is to align. The process of GIS implementation was found to be so intertwined that even when commitment from internal actors is ensured, timing and events external to the organisation are critical factors that can shape the process. This was for example the case at the Municipality, where all internal actors were completely aligned with the Erf Key project, but events that followed involving external actors caused failure of the establishment of the GIS-BIQ link and of the alignment of ReGIS system. This finding sustains Latour's (1987) description of translation processes as dynamic and emergent, in such that a single actor does not hold privileged position over the development of events. It means that in addition to the organisational aspects inside the GIS-workplace, successful GIS implementation depends on strong relations with actors outside the organisational boundaries, e.g. in donor and consultants circles (Martin 1999).

The findings of the case studies confirmed the results of the survey questionnaire[99] that the implementation process of GIS is typically characterised by reliance on external contractors and expatriates. It was argued that the stability and sustainability of GIS technology designed by these actors is limited because the local workforce is often not left adequate skills and understanding of the concepts and principles underlying the particular GIS applications when the contractors leave. This was recognised as one of the biggest challenge of GIS implementation in all three cases.

The findings also have implication for the transfer of GIS technology and management strategies in the context of local-global interactions. It was found that local- global networks were essential for successful GIS implementation given that GIS is a "western artefact" being applied in a foreign context. The global-local interactions do not happen in a homogeneous context. Therefore to derive desirable benefit from these networks the local actors must be able to mediate global influences. Failure to do this may result in technology resistance and conception of sour relationships both between the human actors and between the human and non-human actors. This point was clearly demonstrated in the CBS case study.

Evidence from the case studies proved that in deed GIS technology brings about shifts in organisational structures and culture. Depending on the extent of its usage in the organisation, GIS can also alter power relations as the use of information and the utility of the technology changes. Managing organisational change intensifies the complexity of GIS implementation. The

[99] See Chapter six

top management of the organisations were found to be the driving human actors responsible for enabling change in the organisations because of the power invested in them by the bureaucratic orders of their organisations.

Chapter 8: Summary and Conclusions

The main objective of this research was to study the implementation process of GIS technology in Namibia, in a context of a developing country. This objective was fulfilled and this thesis is a result. The aim of the research has been to contribute towards understanding the complexity of GIS implementation. I argued that this aim could be realised from a social construction of technology perspective. In so doing, I adopted an interpretive stance, informed by innovation translation of ANT as a framework for understanding the complexities of interplays between social and technological entities.

In this closing chapter, I will first (in section one) analyse how each of the preceding eight chapters of this thesis has specifically contributed towards addressing the specific research objectives and research questions.

Section two of this chapter will discuss the limitations of my research and also suggest areas of opportunities for further research. Finally in section three I will discuss the contributions and the implications of this reaseach.

8.1. Overview of the Thesis

Chapter 1

The background and importance of this research were stated in chapter one, along with the specific objectives and research questions. It is appropriate to restate both the specific objectives and the research questions:

Specific research objectives

4) Studying the historical development, present situation and challenges associated with GIS implementation in developing countries, particularly in Africa.
5) Examining in detail the actions and perceptions of Namibian GIS users and the organisational context within which these actions take place.
6) Studying the motivation, implementation processes and stabilisation of GIS in Namibia.

Research questions

6) Through which processes is GIS implementation in developing countries, particularly Africa constructed?
7) What are the driving forces for GIS implementation in Namibia?
8) How is GIS technology transferred to the receiving organisations?
9) What are the strategies that organisations adopt in the implementation process of GIS?
10) Who are the actors and what are their roles in the deployment of these strategies?

The research was provoked by own personal experience, or rather own frustrations in several times of GIS implementation. To set an understanding of the context of the research, the chapter provided some basic information about Namibia, including the background information on the country's development policies and challenges. The main development challenges facing the nation and the government in particular were identified as: poverty reduction, land reform, employment creation, diversification of economic opportunities, equitable distribution of resources, and combating HIV/AIDS. Guided by own experience, the Namibian literature was reviewed to investigate the development of GIS in the country, and the extent of government's support for GIS initiatives. It was found that the government is profoundly interested in GIS and related technologies. The use of these technologies is even stipulated in the national action programmes, which are mechanisms for addressing the various challenges facing the country.

Chapter 2

Chapter two of the thesis reviewed a body of literature identified as critical for the research. The first body of literature reviewed the definitions of GIS with a view of identifying the precise nature of GIS technology, and also to see the general viewpoints of other researchers about this technology. One of the three perspectives on the nature of GIS has been identified as *organisational*. This perspective brought to the fore the organisational setting that affects the introduction and implementation of the technology in an organisation. The second body of literature, the *field of information systems* was useful to build understanding of developments and debates of the field in which GIS technology rests. The literature suggests that information systems are not only concerned with the development of new information technologies but also with questions regarding their implementation and utilisation in a specific context under different circumstances, as well as their wider implications. In placing GIS in the context of other information systems, it was found that GIS is a conceptual, cognitive bridge, linking various information systems; physical as well as social. The literature revealed three perspectives on information systems implementation. One scenario is technological determinism, which stresses on the inherent technical aspects and capabilities of a technical innovation. Another scenario is managerial rationalism, which argues that technological innovation is a combination of both, rational management and technical qualities. The third view, social interactionism is the one that underpins this research. It suggests that technologies are not independent of the context in which they are implemented, but rather gain meaning from their context.

The third body of literature, focusing on the social aspects of GIS captured a discussion about GIS in its wider social context. The debate articulates that effective implementation and stabilisation of GIS technology depend as much on a range of social issues as on the technological worth of the system. In fact, GIS was argued to be both a technique and a social relation. The debate aligns itself towards the social interactionism perspective.

The fourth body of literature is focus on the different frameworks frequently used in investigating the process of GIS implementation. It was found that the most popularly used frameworks are guided by diffusion innovation model and thus consist of sequential steps to guide the GIS implementation process. It was argued that while the detail and tedium steps provided by these frameworks may be prudent to guide implementation, they did not provide a theoretical basis to support investigation of the implementation dynamics. In light of this, it was suggestively argued that if we want to understand how GIS is implemented and how the human and non-human interactions involved contribute to the final product, then we need to use approaches that allow the complexity to be traced, and not diminished by categorisations (Law 1999), or assumptions about intrinsic attributes of human and non-human actors.

This led me into surveying the fifth body of literature, the *actor network theory*. The literature review of ANT focused on the concept of innovation translation which emphasise “following the actors and delineation of actor-networks”. This part of the literature also contrasted diffusion innovation and translation innovation to see how the two models differ in their approach of GIS (or innovation) implementation. This contrast led me to the selection of ANT as an alternative framework to the linear diffusion innovation model. In taking this decision I have been aware of various critics of ANT and that there are many other frameworks worthy considering for a research such as this. Given the aim of this research to investigate GIS implementation in real-life organisations, it was found necessary to review the sixth body of literature on the interplay of GIS and the organisational entities. The literature recognises that organisational issues can be critical in determining the success or failure of GIS implementation in their contexts. Similarly, GIS technology holds potential to impact and bring changes in the organisation.

Chapter 3
Chapter three examined the research philosophical perspectives underpinning qualitative research in information systems, from which interpretivism was favoured for this research. My confidence in interpretive stance was not only based on my own conviction but also on the experience of other researchers studying similar or related aspects of technological innovation implementations. The research methodology adopted to meet the objectives of the research was made up of four parts, namely; literature review, participation in international and regional conferences and workshops, survey questionnaire and case studies. In addition, my own experience has added valuable understanding. The time spent in doing field research represented the core of the research. Empirical materials were gathered through an exploratory survey questionnaire and descriptive case studies. The survey was undertaken to investigate the perception of the Namibian GIS community about the implementation aspects and impacts of GIS technology, and help guide in formulation of the case studies. The results of the survey questionnaire provided snapshots of issues, which formed the foundation for questions that explored the networked dimensions of GIS implementation in the case studies. Three organisations were selected for case studies. Interviews were held with individuals involved in GIS implementation in the three organisations. Effort was also made to collect as much supporting texts as possible.

Chapter 4
Chapter four of the thesis had two sections (dealing mostly with specific objective one and research question one). The first section provided a conceptual approach to the topic of GIS implementation in developing countries. The literature suggests that GIS implementation in developing countries is particularly difficult because of scarcity of financial resources and technical-know among the lay people. In spite of these and other challenges, a large volume of literature on GIS in developing countries still concur the view that for GIS to successfully develop in the context of these countries, its implementation should be controlled by those who understand the local context, as well as the technical capabilities of the technology.

The second section of chapter four gave an overview of the development and the present status of GIS in Africa. It was found that while there has been incredible increase in GIS activities in developing countries, Africa generally lags behind. Implementation on the continent has been restricted mostly by human and organisational issues such as financial, staffing, political, and general attitude towards the technology. The introduction of and implementation of GIS on the continent has been undertaken mostly by foreign expatriates and consultants, with financial support from donors and international organisations. Following the official end of GIS projects, the host organisations have shown lack of commitment to efficiently take over from the consultants and expatriates. This has led to abandonment of GIS equipments after the life span of the projects. It was argued that most of GIS initiatives in Africa have been technologically-driven as opposed to application-driven. In many cases, various authors have asserted that "the technology was looking for problems to solve". Nevertheless, there are also some promising GIS developments on the continent, such as regional efforts and some outstanding national initiatives.

Chapter 5
Chapter five presented the findings of the survey questionnaire (dealing mostly with specific objective two and research questions two and four). The survey findings offered insight into the general characteristic of the people implementing GIS, their perceptions regarding the technology itself and its impacts thereof, as well as the main challenges they are faced with in implementing it. Some ambiguous and surprising indications of possible tension within and across organisations

also emerged, especially with regard to data sharing and exchange. The survey's main findings can be summarised as follows:

- Namibia has no well-defined national strategy in place to manage GIS initiatives in the country.
- Generally, there is a growing awareness of the concept of GIS, although the technology's potential and capabilities are not that clear to many people.
- The use of GIS in Namibia is still very exploratory and ad-hoc in nature.
- Comprehensive long-term plans to guide GIS implementation processes are elusive in many organisations.
- GIS developments are more concentrated within Windhoek (the capital city), where the main offices and the professions are based. A number of critical questions came up at this juncture: To what degree do rural communities benefit from a centralised GIS in Windhoek[100]? What differences does the introduction of GIS actually make to their lives? Different political regions in Namibia exhibit different stages of development and have differing information needs. To what degree is this type of centralised GIS able to deal with this heterogeneity?
- GIS developments are more spread within the government sector, where its use dominates mostly in natural resources, and land administration and management sectors, and only to a lesser extent on the socio-economic sector. The reasons for dominance in these sectors were related to the pressure from donors and international environmental conventions who have been the main financial supporters of most projects.
- The survey confirmed the findings from chapter five that the introduction and implementation of GIS, especially on government departments and NGOs has been undertaken mostly with financial support from donors and international organisations.
- It was also found that different organisations employ different models of GIS implementation. This prompted the curiosity to find out what advises the organisations to employ a particular model over the other. Based on the survey results, a strategic framework was developed to assess the routes taken in guiding organisations into GIS models.

<u>Chapter 6 and 7</u>

Collectively, chapters six and seven dealt mostly with specific objective two and three, and research questions two through to five. In chapter seven, the findings from three case studies were compiled and described through innovation translation model of ANT, which traces the interactions between the social and technological actors as these actors render inseparable. The first case study described the process of GIS implementation in a local municipality. The second study case described the GIS implementation process in a government agency, and the third case study looked at the implementation process in a small rural non-profit organisation. The findings were synthesised in chapter eight.

It was found that the actors in the implementation process are neither uniform nor stable, but are ambivalently changing, coming into and out of existence. The process of implementation follows no predetermined path and that representing or viewing it as a straightforward and well planned process hides the complexity of this networked process by overlooking or simply ignoring the parts played by different actors as each tries to pursue their own interests. The discussion then goes to suggest that GIS implementation process involve the construction and maintenance of hybrid (Latour 1987) networks that connect multiple human and non-human actors into strategic alliances.

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[100] Bear in mind that close to 70% of Namibian population live in rural areas (see chapter two).

Unlike some popular claims in the literature that view technology as a primary source of change in organisations, I found that GIS as an actor did not dictate what occurred in any event of translation. The existence of GIS in the networks did however introduce more actors and strategies, making the networks rather complex. Social and political factors tended to play a more dominant role, but even them could not predetermine or define the emergent of events. The sources of translations were not limited to any group of actors. They originated from and affected both the social and the technological actors.

The findings showed that both the social and the technological actors are neither fixed nor independent (Orlikowski and Iacono 2001). In this view, we must try to understand how both the social entities and the technologies change over time and how they influence and shape one another. Orlikowski and Iacono (2001) added to their argument that technological objects are indeed not static but dynamic and contingent, and are prone to fail, redevelop and change. Latour (1987) claims that technological objects can take form through rejecting what it is perceived to be or rejecting translations in that they fail to align. They may also force further actions and objections in the social.

Admittedly, GIS may be implemented in a number of ways, but in its own capacity as an actor, it brings contextual change in its own favour. The fact that GIS was able to capture interests of other actors shows that this technology is not just there to be discovered but that it too has forces at work. Through these forces, it introduces its own actors as obligatory passage points (Callon 1986).

It was found that the implementation of GIS has mostly occurred through global-local networks. In this regard, GIS implementation can be viewed a cumulative process over time, very specific to each organisation, and collective in a sense that it involves local and global networks. The sad part of the story is that the global networks tended to have stronger alignments than the locals. This finding confirms the literature on GIS development in Africa (discussed in chapter four). I argued that implementation by local networks is significant if GIS is to yield results pertinent to the development of the country.

8.2. Limitations and Suggestion for Further Research

Throughout the research, I have concentrated on the implementation of GIS technology. Such a strong focus may be regarded as a limitation. Nonetheless, I believe that the findings do have some relevance for other related technologies.

The focus of the research was to address a specific set of research questions, dealing with the context, the process and associated players. Of course other research questions could have been asked and the research could have been broadened or narrowed down. In any case, I contend that the research questions addresses in this thesis were fruitful and yielded useful findings in light of the purpose of the research.

ANT has been criticised of its lack of ability to explain why certain events and translations occurred. As such this thesis may not have provided in-depth explanation on issues that emerged. Though, it should be noted that the aim of the research was not primarily to explain but rather to describe the process of GIS implementation. By following other theoretical frameworks, the research may have been able to construct explanations for the various phenomena, but this would have been (most likely) at the expense of accomplishing the purpose of the research.

The purpose of each case study was to describe the implementation process of GIS implementation, with a view to partly draw a generalised conclusion. However, because of the emergent shape and uniqueness of the strategies and procurers used in each organisation, this thesis is limited in generalising the findings to other organisations. I have however generalised some of the findings which were exhibited in more than one case study or when such findings was familiar to my own experience. Yet, I could not claim that the generalised findings apply to all organisations in Namibia. Some may apply to a group of organisations in one sector (e.g. NGOs), but not to others in a different sector (e.g. parastatals).

During the fieldwork, no matter how much I have tried to create a strong consortium of actors involved on the GIS implementation, it is inevitable that I would exclude some actors (e.g. procedures and strategies) and interests. If this thesis was shown to organisations studied in the case studies, their response regarding the representation of information would mostly like be that it is simplistic and they may even still identify other actors and intensify the complexities of the actor-networks. Despite this, I predict that the organisations would accept the representation of my “puppet” (Lee 1991) as being relatively fair. They may also find it useful for improving on certain aspects in their efforts to implement GIS technology.

Then there is an issue of my own bias. Interpretive research can be criticised for the bias of the researcher. In this thesis, it is possible to believe that because the researcher has been involved in GIS implementation processes in other organisations in Namibia, and that over the years she has built working relations with some of interviewees (in the case studies), she might be biased in her representation of information. On the other hand, both her accumulated experience and acquaintances with some of the interviewees helped her address the right questions and gain access to relevant documents.

This research also provides opportunities for further research. The findings suggest that conflict between politicians and professionals in the organisations may eventually emerge, as the politicians exercise power and control which often overrides the professional needs and interests. An avenue for further research could be to explore these types of contests relating to GIS implementation.

The findings have also hinted the impact of GIS technology on individual actors. For example one power user claimed that he gained “respect and recognition” as a result of been associated with GIS technology. Further research could explore the potential and extent of GIS technology in empowering the system users, which perhaps give them new identities.

It was found that GIS establishment in the implementing organisations was mostly outsourced to external contractors. The relationship between the organisation and the external contractors is seemingly loaded with power and control issues. An opportunity for further research is to investigate these relationships and their impacts on the implementation process. It will be interesting to see how the contractors’ forces meet the bureaucratic forces of the organisations.

8.3. Research Contributions and Implications

This research has contended that most of the widely used perspectives on information systems implementation fall short in aptly addressing the multifaceted process of innovation adoption and diffusion. This is most often due to the “top-down” pro-innovation bias which these perspectives inherently assume. With such a bias, these perspectives fail in reflecting the emergent events and translations of implementation process. Alternatively, this research has applied a theoretical framework by using innovation translation of ANT to establish a form of understanding of the interplay between the social and technological dynamics in the implementation process of GIS technology. Using innovation translation, the research has been able to address the socio-technical nature of GIS implementation. By giving equal consideration to both social and technological elements, it has been possible to avoid privileging one set of elements over the other. This research was entitled "The implementation of GIS in Namibia", because from the onset GIS was seen to be more than just a technology but also a process. The research understands GIS implementation as an organisational process, in which GIS technology is not value free. This understanding has been developed by arguing on the social contructionism of technology.

The findings of this research contribute to our understanding of the general status of GIS development in Namibia, and to questions of how the Namibian GIS community perceives GIS technology. The findings of the survey questionnaire suggest that the use of GIS technology in Namibia is generally widespread but the technology's impacts in solving real development problems has not come to reality.

There is no single strategy used by organisations in Namibia through which GIS is adopted or implemented. The case studies have contributed to our understanding of why and how organisations, depending on their political, cultural and financial support systems, have adopted and used GIS technology. The selection of the case studies makes further contribution to see how organisations from different sectors address the challenges associated with GIS implementation and usage.

The historical construction of GIS implementation in the three studied organisations is another contribution of this research. Emphasis was placed on creating a consortium of actors that formed actor-networks responsible for translating various events in their contexts. The case studies clearly showed how the implementation process was constructed by actors acting in the social settings. This finding brings further understanding that GIS implementation process is not altogether just predetermined but that its constructions are build within the specific social context of the organisations. This makes the findings of this research difficult to articulate a single manner in which GIS is constructed in Namibia.

A few questions were raised in chapter six concerning the impacts of GIS in rural communities given the technology's widespread in Windhoek, the capital city. The selection of TCRC case study contributed to our understanding of how local communities seek to benefit from innovations such as GIS. The findings of TCRC case study showed how rural areas, in addition to organisational challenges, are faced with poor physical infrastructural challenges which have somehow been eliminated in the cities. This finding has implication in suggesting that the digital revolution is perhaps futile to the majority of poor marginalised communities if there are no steps to ensure that technologies are accessible to them.

This thesis has argued that humans are social beings, whose social needs have to be recognised when introducing technological artefacts in their social contexts. It was found that the management of the organisations, while exercising authority invested in them by the bureaucratic orders of their organisations, have tended to sideline the interests of the operational staff members and speak for them instead. This thesis has recognised the need for the management to respect the rights of their staff, and treat them as legitimate actor. This practice can be considered as part of being a responsible management[101]. The management needs to be aware, from the start, about the capabilities and limitations of the technology especially that this may affect the professional responsibilities of their staff, and even alter power relations. A claim of mere understanding of the social, cultural, political and economic dynamics of a local setting is not enough, but that these

[101] Blyth (1998) defines responsibility as a legal or moral obligation for bringing about, or maintaining a certain state of affair.

dynamics should be cautiously considered in order to illuminate how GIS technology is ultimately implemented and incorporated into the practices of organisations.

Throughout the research, the aim has also been to provide results that can inform the process of GIS implementation in practise. The relatively newness of GIS development in Namibia means that there is only a few comprehensive research done on GIS development. In fact, it was found that no single systematic research relating to GIS implementation was ever done in the context of Namibia before. It is hoped that this research goes some way towards filling this void. As seen in the literature review (chapter 2) and throughout the depth of the analysis presented in this thesis, this type of study has also not been carried out in many other developing country contexts. Therefore, most of the findings may be applicable to the implementation of GIS in other developing cuntries.

Overall, the findings of this thesis have a potential to contribute to the following research agendas at a global scale: GIS in society, GIS implementation in developing countries, and international GIS transfer and digital divide.

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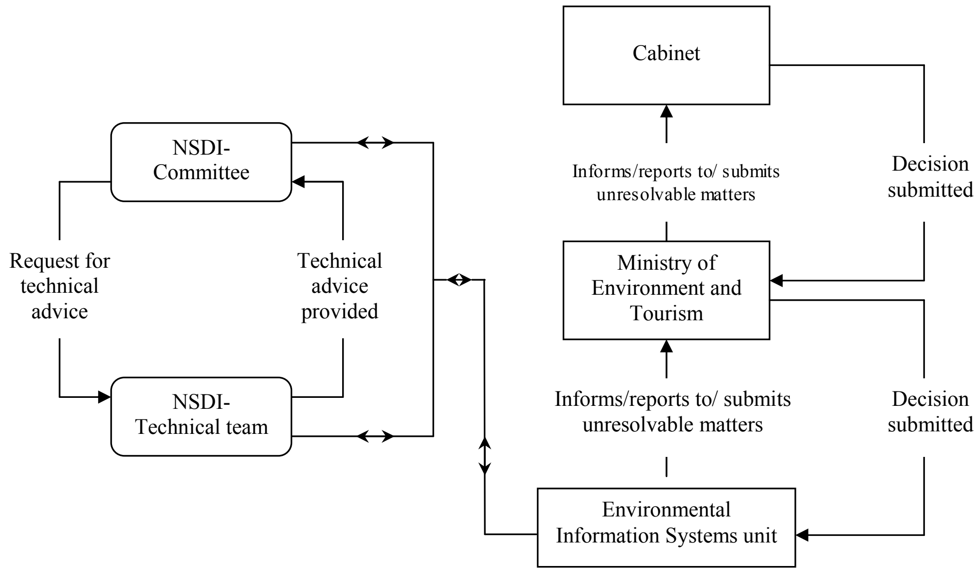
Appendices

Appendix 1: The proposed structure of the NSDI

In principle, the proposed NSDI consists of four components; the EIS Unit in the MET, the NSDI-Committee, the NSDI Technical Team and users, as displayed below.



The proposed structure of NSDI
Source: Noongo *et al*. (2003)

The **EIS Unit** in MET shall provide logistical and technical supporting services for the implementation of the NSDI. The Unit shall also assign personnel and the infrastructure necessary to fulfil these duties. EIS serve as the contact point for any kind of requirements from users. The **management of MET** is to serve as the liaison body to the Cabinet in order to regularly update Cabinet about ongoing activities and developments and to seek advice to resolve issues which cannot be solved internally. The **NSDI-Committee** is the overseeing and decision-making body. Its members shall be nominated by each Ministry to serve on a two-year term. This Committee should meet once every three months or on demand in case of an urgent matter. The decision of the urgency of a matter will lie with the EIS Unit and the chairperson of the Committee. Members of the NSDI-Committee should be from at least middle management level with basic knowledge about topics related to spatial data. It is suggested that each Ministry implements an internal committee in order to discuss spatial data matters. Therefore, requests, queries and concerns from users inside the Governmental organizations are submitted to the NSDI-Committee via the representative of the specific Ministry. The **NSDI Technical Team** consists of five persons that will assist the NSDI-Committee by providing technical advice and support in the scope of the decision making process. Members of the NSDI-Committee will select the people forming the technical team at the beginning of each two-year period, to serve for the same period of two years.

Proposed funding structure

The Government shall have the responsibility to provide the enabling mechanism for NSDI funding. Therefore, MET shall be supported with an annual budget for its support operations to NSDI. Government (at all levels) shall ensure that NSDI activities are adequately funded within each Ministry.

Proposed Capacity Building Structure

EIS shall assign two personnel (at least part time) to the duties of NSDI. It is the responsibility of MET to ensure, that the knowledge requirements of those personnel are available in MET or otherwise enable the specific personnel to obtain training to close the knowledge gaps. In order to maintain a sustainable implementation of the NSDI structure, EIS should compile detailed documentation about the configuration of the NSDI structure to avoid any difficulties due to turnover in personnel. Besides the responsibilities of those personnel to set up and keep the NSDI infrastructure operational, it shall also be their duty to support the other Ministries in matters of NSDI. This shall be done by:

- Encouraging Ministries to carry out training needs assessment;
- Facilitating and streamlining the capacity building process;

Keeping the Ministries informed about major new developments, improvements and changes in the fields of spatial data management.

Appendix 2: The Survey Questionnaire

(The cover letter was the same for both survey questionnaires)

Contact person: Emma N. Noongo, Mail address: P.O. Box 3807, Windhoek, Namibia
Fax: (+264) 61 240339 Tel: (+264) 61 249015, E-mail: noongo@cc.joensuu.fi

Introduction

This survey is designed to evaluate the implementation and effectiveness of Geographical Information Systems (GIS) in Namibia. The survey forms part of a PhD-thesis undertaken at Joensuu University, Finland. The thesis proposed for the study is that information systems, and in particular GIS, can provide powerful tools for development purpose in developing countries, such as Namibia. However, these tools can be challenged with constraints and problems that must be overcome before they are of any real use.

In recent years, GIS have become fundamental for environmental assessment, regional planning and natural resource management in developing countries. Moreover, GIS offer a wide range of possibilities in the fields of inventory making, planning and decision-making. Also in Namibia, there exists a growing interest in these tools, both in the public and private sector. GIS is an interdisciplinary tool. Therefore it receives attention from various disciplines. This is positive in a way, for indeed it is necessary that all the involved disciplines become partners in the process of implementation of the GIS.

The technical environment of GIS is very sophisticated, facilitated by advancements in computer operating systems, computer graphics, database management, computer-human interaction, graphical user interface design, and object-oriented programming methodologies. Developments in GIS are believed to be technology-driven and these approaches may not be the most appropriate in countries like Namibia, which have not well technologically advanced and lack political and economic capacity. The key concerns are (a) Can a technology initiated and concentrated in rich countries be valuable in countries with fewer resources such as Namibia? And (b) To what degree is GIS usage in Namibia contributing to desirable change and the proper usage of knowledge? At present, various organisations and individuals are directly and indirectly involved in GIS implementation countrywide. To the best of my knowledge, no extended evaluation has taken place with regard to the status quo of GIS implementation and its effectiveness. Hence, this survey questionnaire.
Most of the questions in this survey questionnaire are answered by checking (✓) the appropriate boxes. All information provided will be treated in the strictest confidence. Data from the survey will be aggregated and used solely for research purposes.

It is important that as many as possible GIS users complete this survey to provide a full and proper impact evaluation of the current and future situation of GIS in the country. Please feel free to send a copy of the survey to your colleagues.

Appendix 2.1: The Questionnaire for GIS Power Users

Section A – The respondent

1	Job Title	
2	Organisation/ Department	
3	Physical Address	
4	Telephone/ E-mail	
5	Nationality	☐ Namibian ☐ Non-Namibia but African ☐ Non Namibia and Non-African
6	Age group	☐18-30 ☐ 31 - 45 ☐ 46 – 55 ☐ Over 55
7	Which of the following best describe the position you occupy?	☐GIS technician ☐GIS expert ☐Information specialist ☐Planner ☐Researcher ☐Teacher ☐Others (Please specify)______________________________
8	What is your personal academic qualification?	
9	How long have you been using GIS?	☐ Less than five years ☐ Between five and ten years ☐ More than ten years ☐ I don't know
10	How often do you use GIS?	☐Daily ☐Weekly ☐Bi-weekly ☐Monthly ☐Never
11	How would you rate your GIS knowledge overall?	☐Very good ☐Good ☐Fair ☐Poor ☐Very poor

Section B – The organisation and department/ unit

12	To what extent is GIS established in your organisation?	☐Occasionally marginal service function ☐Ad-hoc GIS use in projects ☐GIS unit for service and research
13	How are GIS activities planned at your department/unit?	☐Short-term workplans/project oriented ☐Documented long-term workplan ☐Institution-wide strategy in-place
14	How explicitly does your department/unit count on funding?	☐No money specifically allocated for GIS ☐Budget (-line) within projects ☐Independent budget for GIS activities
15	What is the framework related to GIS in your organisation?	☐ Each project implement their GIS ☐ We have a GIS department/ unit responsible for all GIS ☐ GIS is implemented in conjunction with other organisations
16	At what level of administration is your GIS operated ?	☐ National level ☐ Regional level ☐ Conservancy/ community level ☐ Others (please specify) _____________________________

17	What is your organisation's overall data management strategy?	☐Decisions data management and disseminate are made ad-hoc ☐Some guidelines exist, but not overall co-ordinated approach ☐Organisational strategy on data management and dissemination is in place

Section C – GIS Education and Training

18	Have you received formal GIS education?	☐ Yes ☐ No
19	Where did you receiver your GIS training?	☐Local Institutions ☐Abroad/ overseas ☐On-job training ☐Self-taught ☐Others, please specify_____________________________

Section D – Reasons and purposes

20	For what purpose do you use or intend to use GIS for (tick up to 3 most important reasons)?	☐ Map production ☐ Modelling ☐ Registration ☐ Data Storage ☐ Planning ☐ Decision Making ☐ Educational ☐ Visualisation ☐ Data Analysis ☐ Monitoring ☐ Other purpose (please specify)______
21	Why have you chosen the GIS software you use?	☐ It was already available ☐ It was the cheapest ☐ It was the easiest to use ☐ It was the most adequate for my work ☐ It was the one I had most experience with ☐ It was the most flexible to perform multiple tasks ☐ It was decided by the supervising authority ☐ Other reasons (please specify)______________________

Section E – Data Access Procedures

22	Which of the following best describes the access to your data (tick one)?	☐ Unrestricted ☐ Restricted to most ☐ Restricted to some ☐ Unavailable for external use ☐ I don't know
23	Where access is provided, which of the following applies (tick one)?	☐ Free ☐ Free to most ☐ Free to some ☐ Charged ☐ I don't know
24	Where access is provided, in what formats are the data available/ provided?	

Section F – Operational effectiveness of GIS

		Very much	Some	Very little
25	Does GIS stimulate you to use computers more?	☐	☐	☐
26	Does GIS increase the productivity of your organisation?	☐	☐	☐
27	Does GIS help you in generating new ideas?	☐	☐	☐
28	Does GIS improve presentation of your information?	☐	☐	☐
29	Does using GIS stimulate more contact with other organisations?	☐	☐	☐
30	Does GIS have a positive economic impact?	☐	☐	☐
31	Does GIS help you save time?	☐	☐	☐
32	Does GIS provide better and faster information?	☐	☐	☐
33	Is GIS a useful tool?	☐	☐	☐

Section G – GIS effectiveness in decision-making

		Considerable	Some	Very Little
34	Generally, do you consider GIS useful to the decision making process?	☐	☐	☐
35	Generally, has GIS helped you improve the decision making process?	☐	☐	☐
36	Has GIS helped you save time in decision-making?	☐	☐	☐
37	Has GIS decreased your uncertainty in data analysis?	☐	☐	☐
38	Has GIS helped you improve the quality of decision-making?	☐	☐	☐

Section H – Problems in GIS implementation (Tick up to three most important ones)

39	☐Data quality, availability, accessibility ☐Lack of funding ☐Lack of information policy ☐Poor organizational communication ☐Lack of proper GIS skills ☐Lack of GIS appreciation by high level bureaucrats ☐Others (please specify)______________________________

Appendix 2.2: The Questionnaire for GIS Non-direct Users

Section A – The respondent

1	Job Title	
2	Organisation/ Department	
3	Physical Address	
4	Telephone/ E-mail	
5	Nationality	☐ Namibian ☐ Non-Namibia but African ☐ Non Namibia and Non-African
6	Age group	☐18-30 ☐ 31 - 45 ☐ 46 – 55 ☐ Over 55
7	Which of the following best describe the position you occupy?	☐GIS technician ☐GIS expert ☐Planner ☐Researcher ☐Teacher ☐Information specialist ☐Others (Please specify)________________________________
8	What is your personal academic qualification?	
9	How long have you been using GIS products?	☐ Less than five years ☐ Between five and ten years ☐ More than ten years ☐ I don't know
10	How often do you use GIS products?	☐Daily ☐Weekly ☐Bi-weekly ☐Monthly ☐Never
11	How would you rate your GIS knowledge overall?	☐Very good ☐Good ☐Fair ☐Poor ☐Very poor

Section B – The organisation and department/ unit

12	Which of the following best describes the function of your organisation?	☐Government ☐NGO ☐Parastatal ☐Research ☐Academia
13	What is the size of your organisation staff?	Overall staff number ____________ Staff number with GIS knowledge/ skills ____________
14	How many years has your organisation been using GIS?	☐ Less than five years ☐ Between five and ten years ☐ More than ten years ☐ I don't know
15	At what level does your organisation operate (tick the most appropriate)?	☐ National ☐ Regional ☐ International
16	Is your organisation satisfied with the GIS products produced by the staff?	☐Yes ☐No If not, why? ____
17	To what extent is GIS established in your organisation?	☐Occasionally marginal service function ☐Ad-hoc GIS use in projects ☐GIS unit for service and research
18	How are GIS activities planned at your department/unit?	☐Short-term workplans/project oriented ☐Documented long-term workplan ☐Institution-wide strategy in-place

19	How explicitly does your department/unit count on funding?	☐No money specifically allocated for GIS ☐Budget (-line) within projects ☐Independent budget for GIS activities
20	What is the framework related to GIS in your organisation?	☐ Each project implement their GIS ☐ We have a GIS department/ unit responsible for all GIS ☐ GIS is implemented in conjunction with other organisations
21	What is your organisation's overall data management strategy?	☐Decisions on data management and disseminate are made ad-hoc ☐Some guidelines exist, but not overall co-ordinated approach ☐Organisational strategy on data storage and dissemination is in place

Section C – GIS Education and Training

22	Are you satisfied with the GIS skill-level of your staff?	☐Yes ☐No If not, why? ____
23	What, do you think is the level of education required for working with GIS?	☐Post-diploma ☐University ☐Post-graduate ☐Other (please specify) ___________________________

Section D – Reasons and purposes

24	For what purpose do you use or intend to use GIS for?	☐ Planning ☐ Management ☐ Decision-making ☐ Other (please specify) __________________________________

Section E – Operational effectiveness of GIS

		Very much	Some	Very little
25	Does GIS stimulate you to use computers more?	☐	☐	☐
26	Does GIS increase the productivity of your organisation?	☐	☐	☐
27	Does GIS help you in generating new ideas?	☐	☐	☐
28	Does GIS improve presentation of your information?	☐	☐	☐
29	Does using GIS stimulate more contact with other organisations?	☐	☐	☐
30	Does GIS have a positive economic impact?	☐	☐	☐
31	Does GIS help you save time?	☐	☐	☐
32	Does GIS provide better and faster information?	☐	☐	☐
33	Is GIS a useful tool?	☐	☐	☐

Section F – GIS effectiveness in decision-making

		Considerable	Some	Very Little
34	Generally, do you consider GIS useful to the decision making process?	☐	☐	☐
35	Generally, has GIS helped you improve the decision making process?	☐	☐	☐
36	Has GIS helped you save time in decision-making?	☐	☐	☐
37	Has GIS decreased your uncertainty in data analysis?	☐	☐	☐
38	Has GIS helped you improve the quality of decision-making?	☐	☐	☐

Appendix 3: The Case Studies

Appendix 3.1: The Questionnaire for GIS Power Users and their immediate supervisors

Record of the interview
Code number ____________
Date of Interview _________

The respondent

1	How many years have you served this organisation?	
2	How many years have you been working with GIS?	
3	What is personal academic qualification?	
4	Have you received formal GIS training? If yes, where did you receive you GIS training?	☐Yes ☐No ☐Local institutions ☐Abroad/Overseas ☐On-job training ☐Self-taught ☐Others (pls specify)_____________
5	Do you feel that you have sufficient freedom to initiate new GIS ideas?	☐Yes ☐Fair enough ☐No
6	What exactly do you use GIS for?	
7	Can your work be done successfully without GIS?	☐Very much ☐Some ☐Very little

Support Services

8	How available is each type of support when you need it?	**Always**	**Sometimes**	**Seldom**
	Technical support (e.g. computer and software fixes)			
	Instructional support (e.g. to incorporate GIS into instructions)			
	Data support (e.g. access to data sets)			
9	How often do you need each of support?			
	Technical support (e.g. computer and software fixes)			
	Instructional support (e.g. to incorporate GIS into instructions			
	Data support (e.g. access to data sets)			
10	In cases where support is provided, who provides it?			
	Technical support (e.g. computer and software fixes)			
	Instructional support (e.g. to incorporate GIS into instructions)			
	Data support (e.g. access to data sets)			
		Always	**Sometimes**	**Seldom**
11	Do you take the initiative to contact other departments in this organisation for support?			
12	Do you take the initiative to contact other organisations for support?			
13	Do you feel that your department/ project head encourages you to innovate and try new ideas?			
14	Do you take initiative to create dialogue with your managers?			

Actors in GIS adoption and implementation

15	To what extent did the following actors influence the development of GIS in your organisation?			
	Actors	**Major influence**	**Minor influence**	**No influence**
	Government			
	Senior management of the organisation			
	IT managers of the organisation			
	Government IT coordinators			
	Donors			
	Department/ project coordinators			
	GIS champions			
	Users of GIS products from different departments/ projetcs			
	Other non-users who may have a vested interest in the development of GIS			
	Counterparts in other organisations			
	Academia			
	Vendors and suppliers of various components of GIS (e.g. software, training)			
	Others (please specify and scale them)			

<u>GIS projects in your organisation</u>

16	Please document some of the GIS projects in your organisation as examples.				
	Organisation	**Project/Program**	**Funding**	**Sector/ Application** (e.g land use)	**Status (**e.g. completed, planned, ongoing**)**

Factors Impeding the use of GIS in your organisation

17	Please scale these potential impeding factors as best as you can for your organisation	**Major problem**	**Minor problem**	**Not a problem**
	Organisational			
	The management of this organisation is not committed to GIS			
	The management of this organisation is not aware of the value of GIS			
	There is no clear GIS strategy in place			
	There are insufficient staff resources to implement GIS			
	There are insufficient financial resources to fully implement GIS			
	Insufficient motivation of staff from high-level management			
	There is not designated person to maintain GIS			
	There is insufficient GIS training and guidance			
	There is generally a lack of GIS skills in this organisation			
	Unclear project requirements			
	Staff turnover			
	Bureaucratic inertia			
	Others (please specify and rank)			
	Hardware and software			
	The hardware is insufficient and inappropriate			
	The GIS software used is inappropriate			
	Lack of proper systems management			
	Others (please specify and rank)			
	Data			
	Cost of data collection and capture			
	There is a lack of digital data in appropriate formats			
	Lack of compatibility of data sets			
	Incomplete data sets			
	Absence of national spatial data policy			
	Others (please specify and rank)			
	Any other factors not identified above?			

18	Please document the roles played by various actors in the implementation of GIS that impede the successful implementation of GIS in your organization. (*Feel free to use examples)*
	Senior management of this organisation:
	Donors:
	Consultants:
	Vendors and suppliers of various components of GIS:
	Government:
	GIS department/ project coordinators:
	Academia:
19	Please provide a detailed documentation of additional resources your organization would need in order to fully leverage GIS in your duties. (*Feel free to use examples)*

Appendix 3.2: The Questionnaire for the Top Management

Record of the interview
Code number _____________
Date of Interview __________

	General information of the GIS department/ project	
1	What is the size of the GIS department/ project staff?	nos ____________
2	What is the size of the budget?	N$ _____________
3	What proportion of the budget is for GIS activities?	☐ None ☐ 25% or below ☐ 25 – 50% ☐ 50 – 75% ☐ More than 75% ☐ No idea
4	Which year was GIS first introduced in your organisation?	
5	What were the justifications for adopting GIS?	
6	Is there current department-wide GIS strategy? Or is GIS implemented at project level?	☐ Yes ☐ No ☐ Being developed ☐ Yes ☐ No
7	At what level is GIS activities managed?	☐ Departmental level ☐ Project level
8	What is the approach towards management of the GIS department/ projects	☐ Completely centralized ☐ Completely decentralised ☐ Partly centralized and partly decentralised
9	What proportion of your organisation currently have access to GIS hardware and software?	☐ Only GIS department/ projects ☐ GIS department/ project, and other interested departments and individuals ☐ No idea
10	What proportion of your organisation currently have their own GIS databases?	☐ Only GIS department/ projects ☐ GIS department/ project, and other interested departments ☐ Each project in the organization has their own databases ☐ No idea

Actors in GIS adoption and implementation

11	To what extent did the following actors influence the development of GIS in your organisation?

Actors	Major influence	Minor influence	No influence
Government			
Senior management of the organisation			
IT managers of the organisation			
Government IT coordinators			
Donors			
Department/ project coordinators			
GIS champions			
Users of GIS products from different departments/ projetcs			
Other non-users who may have a vested interest in the development of GIS			
Counterparts in other organisations			
Academia			
Vendors and suppliers of various components of GIS (e.g. software, training)			
Others (please specify and scale them)			

Management issues		
12	Which of these sequences of events best describe the process of development of GIS in your organization?	☐ Continued development of separate GIS for various projects ☐ Development of one GIS department/ unit responsible for all GIS activities in the organization ☐ Following successful pilot projects, a GIS department/ unit was built ☐ A mixture of two or more of the above, (Please specify)___________________________________ ☐ Others (please specify)___________________________
13	Are there any activities in place to encourage use of GIS by staff?	☐ None ☐ GIS demonstrations ☐ Hands-on-experience ☐ Short training courses ☐ Promotional materials/ newsletter ☐ Attendance to GIS conferences, workshops and seminars ☐ Other (please specify)
14	Are there any organisational arrangements in place to encourage sharing of GIS data and products across departments/ projects?	☐ None ☐ Centralised identification of opportunities ☐ Centralised building of infrastructure ☐ Budgetary incentives ☐ Others (please specify) __________________________________

GIS projects in your organisation

15	Please document some of the GIS projects in your organisation as examples.				
	Organisation	**Project/Program**	**Funding**	**Sector/ Application** (e.g land use)	**Status (**e.g. completed, planned, ongoing**)**
16	Please document as much as you can, the advantages GIS has brought to your organisation. (*You are strongly encouraged to attach additional information materials to supplement your documentation*).				
17	In your view, to what extent does the following groups of stakeholders require GIS in conducting their duties?				

Stakeholders	**Very much required**	**Required**	**Can do without**
Senior managers			
Politicians			
Professional and technical staff			
General clerical staff			
General community			

Factors Impeding the use of GIS in your organisation

18	Please scale these potential impeding factors as best as you can for your organisation	**Major problem**	**Minor problem**	**Not a problem**
	Organisational			
	The management of this organisation is not committed to GIS			
	The management of this organisation is not aware of the value of GIS			
	There is no clear GIS strategy in place			
	There are insufficient staff resources to implement GIS			
	There are insufficient financial resources to fully implement GIS			
	Insufficient motivation of staff from high-level management			
	There is not designated person to maintain GIS			
	There is insufficient GIS training and guidance			
	There is generally a lack of GIS skills in this organisation			
	Unclear project requirements			
	Staff turnover			
	Bureaucratic inertia			
	Others (please specify and rank)			
	Hardware and software			
	The hardware is insufficient and inappropriate			

	The GIS software used is inappropriate			
	Lack of proper systems management			
	Others (please specify and rank)			
	Data			
	Cost of data collection and capture			
	There is a lack of digital data in appropriate formats			
	Lack of compatibility of data sets			
	Incomplete data sets			
	Absence of national spatial data policy			
	Others (please specify and rank)			
	Any other factors not identified above?			

19	Please document the roles played by various actors in the implementation of GIS that impede the successful implementation of GIS in your organization. (*Feel free to use examples)*
	Senior management of this organisation:
	Donors:
	Consultants:
	Vendors and suppliers of various components of GIS:
	Government:
	GIS department/ project coordinators:
	Academia:

Appendix 4: Specifications for 2001 Census Demarcation Database

Because the different EA types represented different settlement patterns, unique requirements were identified for the content of the documentation for fieldworkers for each of the settlement types. (Source: Devinso 2000)

Formal Urban

Name of region Name of constituency Name of town/city/municipality Name of surbub Streets Street names Plot numbers Erven House numbers Erf numbers Boundary description EA numbers	North arrow Scale bar Type of EA code Guide map Land use (e.g. church, school, shop, police) Estimated number of households Estimated population Details of supervisor Details of enumerator Page for recording on enumeration details

Formal rural

Name of region Name of constituency Localities (farm name) EA number Boundary description Recording (and location) of cuca shops, police stations, clinics Roads Aerial photo/ videography – scale 1:6000	North arrow Scale bar Guide map Location of communcal taps Estimated number of households Estimated population Details of supervisor Details of enumerator Page for recording on enumeration details

EA types

Formal urban
Proclaimed usrban areas for which cadastral data is available. Examples include urban surbubs and urban institutions.

Informal urban
Proclaimed urban areas for which cadastre is not available. The mmost common example is informal settlements within the boundaries of an urban area

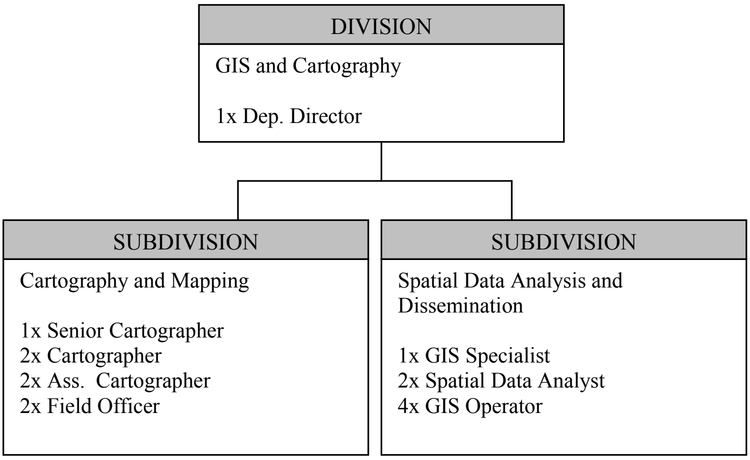
Formal rural
Rural areas for which cadastre is available. These are mainly commercial farmland areas and institutions in rural areas.

Informal rural
Rural areas for which cadastre is not available. These are mainly communcal farmland areas.

Appendix 5: Proposed Structure of GIS and Cartographic Division at CBS

Note: This version of the proposal may not be the final one, because during the compilation of the current thesis the proposal was still under review.

It is proposed that a GIS and Cartographic division consisting of two subdivisions, (i) Cartography and Mapping, and (ii) Spatial Data Analysis and Dissemination be established at NPC. A total number of staff members will work in the structure.



The proposed structure of the GIS and Cartographic division at NPC (Source: Rydén 2004)

The division is proposed to be lead by a deputy director who sits in the management meetings of NPC, and thus has influence on decisions taken related to the work of the division. The deputy director will work with data dissemination policies, copy right and regulations, standards, data exchange etc. He/she will also, together with the senior cartographer and the GIS specialist, coordinate the day-to-day work of the division. The deputy director should have at least a degree in geography or related field as well as a good understanding of issues related to spatial data infrastructure.

The Cartography and Mapping subdivision

The subdivision of Cartography and Mapping will be responsible for the maintenance and usage of the Master Sample Frame and provide the necessary support needed for the efficient usage of the frame and products thereof. The subdivision will primarily fill the needs of accurate map data for statistical surveys carried out by CBS or other organisations.

The main tasks will be the following:

- In liaison with the subdivision of Spatial Data Analysis and Dissemination, carry out day-to-day maintenance of the Master Sample Frame database. This involves the acquisition of field data as well as incorporation of captured data in the database.
- Produce maps needed for statistical surveys carried out by CBS and other stakeholders.
- Supervisory tasks in terms of national, regional and constituency boundary identification, GPS usage and general field logistics.
- Provide support in the preparation and execution of other surveys not carried out by CBS, such as training in map reading, boundary identification and GPS usage.

- In cooperation with the subdivision of Spatial Data Analysis and Dissemination, capture GPS points for NamPlan features as well as other features of interest for the maintenance of the division's different databases.
- Maintain locality lists/maps in cooperation with relevant local and regional authorities.
- In cooperation with the subdivision of Spatial Data Analysis and Dissemination, produce atlases, posters, etc of interest for the general public.

The senior cartographer will work in close cooperation with the GIS specialist to ensure that the databases are up-to-date and are structured according to the standards developed, and that the data is securely stored. He/she will be instrumental in the maintenance of the Master Sample Frame. He/she should at least have a degree in cartography or appropriate experience, specialising in GIS and digital mapping and be familiar with GIS software's particularly GeoMedia, Arcview and MapInfo.

The cartographer will work in close cooperation with the senior cartographer in order to keep the Master Sample Frame up-to-date ay ant point in time. He/she will also process any requests related to the production of the maps for various surveys. He/she should at least have a degree in cartography or related fields, specialising in GIS and familiar with GIS software's particularly GeoMedia, Arcview and MapInfo.

The assistant cartographer will work under the supervision of the cartographer and work together with the field staff to carry out any fieldwork required for the maintenance of the databases. He/she should have a degree in cartography or appropriate experience and be well familiar with the Microsoft Windows 2000 professional office suite. Previous experience with GIS software is an added advantage.

The field officer will work under the supervision of the cartographer and work together with the assistance cartographer to carry out any fieldwork required for the maintenance of the databases. He/she should have appropriate experience and familiarity with the Microsoft Windows 2000 professional office suite is an added advantage.

The Spatial Data Analysis and Dissemination subdivision

The subdivision of Spatial Data Analysis and Dissemination will be responsible for the various applications maintained by the division, such as the Regional Planning Tool, the Census Dissemination Tool and other Internet-based applications. The subdivision will also be responsible for the maintenance of the baseline and NamPlan data sets hosted by the division. The subdivision will primarily serve the need of accurate map data for issues such as poverty mapping are regional planning.

The main tasks will be the following:

- Day-to-day maintenance of baseline databases. This involves the acquisition of updates from main stakeholders and data producers as well as the integration of updates into the databases.
- In cooperation with the subdivision of Cartography and Mapping capture GPS points for NamPlan features as well as other features on interest for the maintenance of the division's different databases.
- Foresee that requests for data of different kinds are carried out to satisfaction.
- In cooperation with the subdivision of Cartography and Mapping, produce atlases, posters, etc. of interest for the general public.
- Perform spatial analysis on combined statistical and spatial data and disseminate the results of these analyses in the form of analogue maps, internet maps or posters.
- Develop and maintain applications of combined statistical and spatial data, e.g. Regional Planning Tool, the Census Dissemination Tool, etc.
- Provide support in technical matters related to the capture, usage and dissemination of digital spatial data, to the whole NPC as well as external stakeholders.

The GIS specialist will work in close cooperation with the senior cartographer to ensure that the databases are up-to-date and structured according to standards developed, and that the data is securely stored. The GIS specialist will also be instrumental in the development of new applications related to data analysis and dissemination. He/she should have a degree in geography or related filed, specialising in GIS and with experience of database management and spatial analysis. He/she must be familiar with GIS software's particularly GeoMedia, ArcView and MapInfo.

The spatial data analyst will work in close cooperation with the GIS specialist in order to process any requests coming in from the user community. He/she will also contribute to the development of the various applications used in the division. The requirement for this position is a degree in geography or related field, specialising in GIS and familiarity with GIS software's particularly GeoMedia, ArcView and MapInfo.

The GIS operators will work under the supervision of the GIS specialist and spatial data analysts. They should be well familiar with the Microsoft Windows 2000 professional office suite. Previous experience with GIS software is an added advantage.

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