Has GIS implementation in the 6 municipalities of South Africa been effectively utilized to address the free basic service delivery problem?

DISSERTATION

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Submitted in part fulfillment of the requirements for the degree of Masters Science in Geographical Information Systems (UNIGIS)

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ABSTRACT

Has the implementation of Geographic Information Systems (GIS) in South African municipalities been effectively utilised to address the free basic service delivery problem?

GIS as a decision making tool has become an important instrument to be utilized at local government level to improve the policy of free basic service delivery to poorer communities. Since most of the service data in municipalities are geographic, many municipalities and government agencies use computer and database technologies to store, process, and extract the data efficiently. "The technology that accomplishes this task is termed Geographic Information Systems (GIS)" as mentioned by Kubbara (1997, p.1).

It is important for South African local governments to create an integrated information resource using GIS and Global Positioning System technology that would provide the municipality with the necessary tools to collect and analyse relevant spatial data so as to facilitate planning and development and to be able to monitor the said policy.

It is within this context that the situation in South African municipalities needs to be determined with regards to the use and benefits of GIS, particularly in municipalities who attempt to use an integrated water, electricity and sanitation database to plan, maintain, and manage their work as well as monitor and evaluate the backlog and progress regarding free basic services.

Contents

ABST	RACT	i
DISCL	_AIMER	v
ACKN	IOWLEDGEMENTS	vi
1 F	RESEARCH OUTLINE	1
1.1	Introduction	1
1.2	Problem Statement	1
1.3	Aims	2
1.4	Objectives	3
1.5	Hypothesis	3
1.6	Research Methodology	3
2 L	LITERATURE REVIEW	5
2.1	Introduction	5
2.2	International case study: GIS and service delivery	7
2.2.1	Background	7
2.2.2	The implementation of GIS	7
2.2.3	GIS strategy	8
2.2.4	GIS application	8
2.2.5	Access to Spatial information	8
2.2.6	Relevant GIS Skills	9
2.2.7	Conclusion	9
2.3	The Regional Case Study: GIS as the Infrastructure Management tool in Botswana	9
2.3.1	Background	9
2.3.2	Implementation of GIS	10
2.3.3	GIS strategy	10
2.3.4	GIS application	11
2.3.5	Relevant skills capacity	12
2.3.6	Access to spatial information	13
2.3.7	Conclusion	14
2.4	National Case Study: Aligning GIS with the Developmental Objectives of a South African Municipality	15
2.4.1	Background	15
2.4.2	Implementation of GIS	16
2.4.3	GIS Strategy	16
2.4.7	Access to spatial information	19
2.4.8	Relevant GIS Skill	19
2.4.9	Conclusions of the three literature reviews	20
3 F	RESEARCH METHODOLOGY	26
3.1	Introduction	26

3.2	Subject Selection	28
3.3	Data Acquisition Techniques	29
3.4	Interview Technique	
3.4.1	Methodology	
3.5	Quantitative survey of six municipalities	39
4	ANALYSIS AND RESULTS	40
4.1	Introduction	40
4.2	Questionnaire development	
4.2.1	Implementation of GIS	43
4.2.2	2 GIS strategy	43
4.2.3	GIS application	
4.2.4	GIS skills capacity	44
4.2.5	Access to spatial information	44
4.3	Questionnaire Dissemination	45
4.4	Data verification process	45
4.5	Respondent type	45
4.6	Overview of Survey Responses	
4.7	Realities of GIS in three spheres of government in South Africa	47
4.8	Conclusion	
5	DISCUSSIONS AND CONCLUSIONS	50
5.1	Introduction	50
5.2	Summary	50
5.3	Conclusions	51
6	RECOMMENDATIONS	52
7	REFERENCES	53
8	APPENDIX	56

LIST OF FIGURES

Figure	2.3	Data overlays in GIS showing electricity supply in Gaborone central	14
Figure	2.4	The municipality wards and surrounding areas of the Buffalo city municipality	16
Figure	2.5	Application of GIS for service delivery	17
Figure	2.6	A GIS based system designed to monitor ongoing projects in the municipality	19
Figure	3.2	National map of SA displaying provinces	27
Figure	3.5	Eastern Cape Provincial map displaying Alfred Nzo municipality	32
Figure	3.6	Eastern Cape Provincial map displaying Buffalo City	33
Figure	3.7	Limpopo Provincial map displaying Capricorn municipality	35
Figure	3.8	Limpopo Provincial map displaying Polokwane municipality	36
Figure	3.9	North West Provincial map displaying Central District municipality	37
Figure	3.10	North West Provincial map displaying Rustenburg municipality	38

LIST OF TABLES

Table	2.1	Number of GIS Software at BPC in the workstations				
Table	2.2	GIS personnel in BPC and DWA	13			
Table	3.1	Municipalities participating in the research survey	27			
Table	4.1	Functions and core data set of municipalities	41			
Table	4.2	Municipalities in size, population and number of officials	41			
Table	4.3	The summary of response for survey	42			

LIST OF INSERTS

Inserts	1.1	Unavailability of Free Basic Water in rural communities	2
Inserts	2.3	Data overlays in GIS showing electricity supply in Gaborone Central	14
Insert	2.7	GIS officials teaching municipality councillors GIS	20
Insert	4.5	Unharmonised municipality systems	46

LIST OF CHARTS

3.3	3.3 The total population size per municipality						
3.4	The population size per municipality	31					
3.4	Income capita per municipality	31					
4.4	Municipalities that responded positively to the survey questionnaire	45					
	3.3 3.4 3.4 4.4	 3.3 The total population size per municipality 3.4 The population size per municipality 3.4 Income capita per municipality 4.4 Municipalities that responded positively to the survey questionnaire 					

DISCLAIMER

The results presented in this dissertation are based on my own research at the Faculty of Earth and Life Sciences of the Vrije Universiteit Amsterdam.

All assistance received from other individuals and organisations have been acknowledged and full references to all published and unpublished sources used in this paper have been supplied.

This thesis has not been submitted previously for any degree at any Institution.

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ACKNOWLEDGEMENTS

The following persons and organisations have been essential in the process of writing this thesis:

The UNIGIS Staff, for the positive input in writing up and finalizing the Thesis, Prof. Henk Scholten, Mr Bart Kusse MSc. & Dr. Jasper Dekkers. The admin lady Ms Anne Rooseboom responding quickly to my emails requests.

The Director: National Spatial Information Framework, Ms Abigail Thabethe, was of great assistance in the proofreading of the first draft of the thesis, whereas Mr Netshiukhwi Tshifhiwa was responsible for the final edits and quality assurance of this study.

Mr Jongikaya George, Mr Mgulwa Zama and Mr Magasa Mpho from the Directorate: National Spatial Information Framework played a valuable role in collecting data for this thesis.

Mr Mabuza Tilfred from the Department of Land Affairs in Limpopo Province has also assisted greatly with regard to data collection for the Limpopo Province survey.

I am also much indebted to Mr Mandia Lisho from UNIGIS, an MSc graduate, as well as Ms Sadjidha Hoosen from ESKOM, for the support that they gave me.

Mr Paul Strydom for proof reading the Thesis, and Dr David Levey for the editorial work on the thesis.

To my husband, Bafana Dhlamini, thank you for your continued support during the course of compiling this paper.

1 RESEARCH OUTLINE

1.1 Introduction

In recent years a growing interest amongst municipalities has been evident with regards to the use of GIS in daily operations as attested by Worrall (1990). This interest echoes the increased awareness that GIS is more than a distinctive technology, more than merely hardware, software and data ware. It is widely accepted that many different factors influence the successful introduction and deployment of GIS within a municipality.

Worrall (1990) argues that the effectiveness of GIS is dependent on how well it has been integrated within the operation of the municipality as a whole. The use of GIS technology should be integrated within the overall strategy of the municipality by using GIS as a vehicle to attain strategic benefits.

Government and municipalities utilize such technology to plan, maintain and manage their data. GIS databases assist in the integration of many types of data; specifically geographic data that are available in different types, formats, locations, sizes, etcetera.

The focus of this thesis is to determine how effectively South African municipalities have utilised GIS tools to implement and monitor delivery of free basic services.

1.2 Problem Statement

"In South Africa, government has committed itself to providing a basic amount of free water and electricity to the poor people" Department of Provincial and Local Government (2004).

"There is general agreement that due to their economic conditions, the poor majority cannot afford to pay the full price for essential municipal services. The adoption of the policy in 2000/1 was to provide a basket of free basic services to all, as entrenched within the South Africa Constitution (Act 108 of 1996). Since the introduction of the policy by government in 2001, the emphasis has fallen on free water and electricity" Education and Training Unit (2007).

"Local government is responsible for the implementation of free basic services in the form of electricity and water services with the aid of guidelines from National Government. Many municipalities have also developed indigents' policies to ensure that households with little or no income can be identified and can still receive basic municipal services" Education and Training Unit (2007).

Having outlined the background to free basic services, (03 February 2006), The State of the Nation Address of 2006, by President Thabo Mbeki, "Identified access to electricity and water services as being amongst the major challenges facing over 8 million South Africans". GIS in this regard is the most important decision making tool to assist government to visualize the impact of the policies and programmes proposed by government. Kriel (1994), on his research about the "spatial information needs of local authorities for the planning and decision making", Clearly prove that GIS has been in existence in the South African municipalities for over ten years.

Hence one may ask:

"To what extent has GIS implementation in municipalities in South Africa post 1994 been effectively utilised to address the free basic service delivery problem?"

Figure 1 below illustrates the current rural communities' situation in terms of access to free basic services; it shows the importance of free basic service implementation - for example water. Would GIS help municipalities locate household(s) without water access?



Insert: 1 Unavailability of Free Basic Water in Rural Communities. (Anonymous).

In the view of Ventura (1989,p. 825), many decisions that affect the successes of the GIS in the municipalities would be made during its initial implementation on the effective functioning of the GIS, that the GIS should involve more than just hardware/software. It should also address the data sources, users, institutional arrangements, data models, database design and so forth, that will affect the system's future effective operations.

The question that arises is: To date, have South African municipalities benefited from GIS services in their municipalities?

1.3 Aims

This study explores the effective utilisation of GIS to respond to the delivery of free basic services in certain municipalities' post 1994.

The term "effectiveness" in this study refers to "How the GIS tool is utilised to measure success/progress and backlogs in the free basic services programme or how the tool is ensuring the maximum benefit of money spent in a municipal environment". It highlights the extent to which the outcome of the effective process is dependent not merely on the availability of GIS in a municipality, but on whether it assists in responding to the issues at hand in local government. (Smith and Tomlinson, 1992) also distinguish the measurement of benefits from the use of GIS technology. They made a distinction between what they called "efficiency benefits" and "effectiveness benefits".

- Efficiency benefits result when a GIS is used to perform a task that was previously carried out without a GIS. The same quality of output is produced but for a lower cost and time.
- Effectiveness benefits result when a GIS is employed to improve the quality of the current output or to produce an output that was not previously available, that is, the GIS is used to achieve that which could not or would not be carried out without it.

1.4 Objectives

The objective of the study is to assess as to what extent has GIS implemented in South African municipalities been effectively utilized to address free basic services. In order to achieve this objective, five principles were identified: the implementation of GIS, GIS strategy, GIS application to service delivery, access to spatial information and relevant skills capacity. These principles will be utilized as a framework for the assessment of the effective use of GIS in municipalities. Why is GIS in municipalities unable to measure the progress and backlog of service delivery in water and electricity as a free basic service?

1.5 Hypothesis

More effective utilization of GIS can make a considerable distinction for the basic service delivery in municipalities.

1.6 Research Methodology

The research will employ qualitative method in order to evaluate if GIS implemented in six municipalities is being effectively utilized to address the free basic services delivery challenge.

For this purpose the most relevant literature has been investigated and summarized in this thesis in relation to the subject of effective utilization of GIS to address water and electricity in the organisations. The literature review will help to justify the methods to be utilized in this study.

A representative sample of subjects rather than the full 284 municipalities were selected for structured techniques such as questionnaire, telephone interviews etc;

Secondary methods of research - for example desktop research, internet research and local GIS magazines will also be utilized to collect information for the survey. Random selection criteria on participatory municipalities will be conducted in order to address the following points:

- What is the total number of household(s) dependent on government for free basic services, this is to evaluate the extent of problem on service delivery through GIS.
- Size of population in the municipality to test how many household(s) in the municipality do not need free electricity and water support from the municipality;
- Comparison of municipalities with same dynamics/challenges (urban vs. rural); to assume a comparative form where similarities and differences among the municipalities is analyzed.

- The municipality classification (category-A municipalities which are metropolitan municipalities in South Africa; category B which are local municipalities; category C which are district municipalities), as according to Local Government: Municipality Structures Act, 1998.
- The municipalities should have implemented GIS post 1994;
- The GIS section staff component or organogram supporting municipality with the use of GIS for service delivery;
- Application of GIS in the municipality in the context of service delivery;
- Does the municipality have an indigent registry database integrated/related to the GIS to address the free basic service delivery issues?

2 LITERATURE REVIEW

2.1 Introduction

GIS appears to be viewed as a significant and potential tool when it comes to assisting in managing the planning and maintenance of infrastructure within various municipalities. The proliferation testifies to the optimistic belief in this new technology's capabilities and prospective benefits. How GIS is applied to examine the equity in distribution of public services to various segments of the community is also important in the context of this study. The growing urban population (worldwide), increasing at a much faster rate than the population as a whole Worrall (1990d), has resulted in the promotion of sustainable development and hence led to an increased pressure on the urban environment. These changes in the population have a profound effect on the demand for services, not only in the metropolitan municipalities but just as importantly in the district and local municipalities in South Africa.

In order to sustain these municipalities, a high demand for resources and services from within the urban, rural and surrounding areas is being experienced as well as an urgent demand to improve the management of delivery of these services by municipalities. To meet this demand, systems and procedures that assist in providing the required resources and management in a more efficient and effective manner need to be developed.

According to (Godsschalk and Budic, 1996), local governments find GIS technology attractive for many reasons: (1) Spatially referenced data represent a large proportion (estimated at over 70 percent) of data processing in local government agencies Somers, (1987 cited in 1996 Godsschalk, Budic), (2) Information is considered a fundamental resource of government Howard (1985; Repo, 1989 cited in 1996 Godsschalk, Budic) especially in monitoring the impact of the government policies, and (3) Pressure for improving government performance Osborne and Gaebler (1992; Gore, 1993 cited in 1996 Godsschalk, Budic) has prompted governments to look for more efficient ways of doing their work, where GIS becomes an essential tool to assist municipalities in planning, implementation and monitoring of free basic services project.

This chapter will outline case studies of how GIS have been effectively utilized in different countries for service delivery as regards the implementation of water and power management; and the manner in which such a system addresses the developmental objectives of the particular municipality or organisation. The discussion will use the following five criteria as a measure of effective utilization in the case studies:

The aim of literature review is to analyse the justification of GIS implementation in the organisation, to discuss the related studies together, utilize the five criteria's to tie together the literature review and give conclusion arising from five criteria measured against literature reviews. The global case study will constitute a review of the value of corporate GIS in local authorities, while the regional case study review will focus on GIS as a management tool in the infrastructure management of water and power, and the

South African case study will review how the GIS is aligned to address the developmental objectives of the municipality.

A comparative form will be compiled where similarities and differences among the three case studies will be analyzed in terms of the five mentioned criteria. For the purpose of this study, an explanation on the following topics will be utilized to measure the effectiveness of GIS.

• Implementation of GIS;

The definition on implementation of GIS will use Campbell and Masser's (1995) definition who believes that the best method to implement GIS is on a corporate scale because it will yield the strategic benefits and efficiency embedded in GIS technology. The underlying rationale for the corporate approach to GIS implementation is that it will increase levels of data sharing within the organisation, thereby reducing duplication as well as leading to more informed decision making.

• GIS strategy;

The study will assess if the municipalities have a plan on how they are going to institutionalise the GIS from a corporate management perspective in the municipality, grow a GIS in one unit to benefitting the whole municipality. The information management plan of the municipality should address the sharing of information, and decentralization of the spatial databases within the municipality. The formalized method on updating of available spatial data, capturing of metadata for the available spatial data sets should be followed by the municipality on a daily basis as part of its service delivery function.

• GIS application to service delivery,

Is the GIS utilized to respond to policy issues in the municipality?

Is the GIS utilized to plan for the water and electricity services and routine maintenance of these services?

Are water services and electricity services units in the municipality being able to conduct advanced spatial analysis, for example able to display the number of households connected to water and electricity services? Is there a spatial database integrated and connected to different services within the municipalities?

Access to spatial information;

The study will assess the availability of free basic water services spatial data sets and free basic electricity services spatial data sets that cover the entire municipality. The spatial data sets should be as recent as possible to provide the municipality with effective decision making support. Are the municipalities having access to the fundamental data sets in the country as base data for their own feature specific data?

• Relevant skills capacity

How many GIS qualified official(s) are employed in the GIS unit in the municipality to maintain, collect and conduct advanced spatial analysis utilising the service delivery spatial database. Has the GIS unit been in existence for more than five years?

Moving from the explanation of how the five criteria have to be utilized in the case studies and the study as a whole, the case study will begin with a review from global, regional and South African perspectives, respectively, with regards to service delivery. The issues addressed in this chapter will not address specific aspects relating to free basic services as other countries, unlike South Africa, do not offer similar programmes for poorer communities in their municipalities. However, the core objective is to assess each case study against the five criteria mentioned above.

The international case study will focus on Birmingham City Council's corporate GIS pilot project. The regional case study will concentrate on the diffusion of GIS with regards to utility management in Botswana. Lastly, a South African case study will be reviewed with respect to how one of the South African municipalities, namely Buffalo City Municipality, has utilized GIS for effective implementation of programmes within this municipality.

2.2 International case study: GIS and service delivery

2.2.1 Background

According to Gault and Peutherer (1988: cited in Worral 1990) the Birmingham GIS Pilot Study began in early 1998 with two objectives: "the first was to assess the potential value of the development of GIS and digital mapping applications to the Authority as a whole and to individual departments in meeting both policy and operational objectives, and the second, to produce a framework for the future handling of GIS within the City Council". The pilot exercise progressed along two separate channels: The objective of the first was to identify and test a series of practical applications and that of the second, to systematically examine the potential for the development of GIS throughout the City Council (the second channel is essentially concerned with educating potential GIS users about the benefits of GIS). "The benefits of GIS to local government are potentially considerable since it has been shown that approximately 80 per cent of the information in local government is spatially related "Bromley and Coulson (1989, cited in Worrall, 1990). The objective in Birmingham was to quantify some of these potential GIS related benefits.

2.2.2 The implementation of GIS

In terms of the Birmingham GIS Pilot Study according to Gault and Peutherer (1988: cited in Worral 1990) "there are several issues which must be addressed if GIS is to be successfully implemented in local government. These issues can be grouped under the following four headings: developing a GIS strategy, information management, applications justification, and organisation and management. The study does not mention the type of GIS implemented in the municipality".

2.2.3 GIS strategy

Gault and Peutherer (1988: cited in Worral 1990) mentions that although it was stated that a corporate approach was essential for the Birmingham Council, this should not be confused with central control. The central control of information processing is perceived as being unresponsive, unwieldy and expensive. They further elaborate the distinction between the business processes which generate the information and the uses of that information by the organisation at large. A GIS strategy also emphasises the importance to allow departments to control their own administrative processes within a framework that is coordinated centrally. Gault and Peutherer (1988: cited in Worral 1990) also believe that, standards in information management cost money and are simply unnecessary constraints and irritants to many people. Consequently, standards should be kept to a minimum if widespread participation is desired. Content standards exist for geographic information as standardised by the International Organisation for Standardisation (ISO) Technical Committee 211 that could be selected and adopted by the municipality. With regards to GIS, it is critical that a convention concerning locational referencing is adopted and that rules with respect to the use and updating of the map base is accepted. The establishment of a basic data definition dictionary is crucial. Even these minimal standards will have to be presented in such a manner as to make it clear that all participants will benefit by adopting Gault and Peutherer's (1988: cited in Worral 1990) outline.

2.2.4 GIS application

The Birmingham GIS pilot study indicated that the following is an application of attributes for the GIS. GIS is utilised for census, Land resources, City Terrier, Bridges data base, Lightning data base, Sewers Data base, Educational transfers and library stock monitoring.

2.2.5 Access to Spatial information

As suggested by Gault and Peutherer (1988: cited in Worral 1990) it is essential that the information be viewed as an asset within the organisation in its own right. However, it is equally important that the processing of information, including its collection and storage, is viewed as a cost. Therefore, explicit consideration has been given to the balance of costs and benefits between the needs of the users and the providers of information. In the case of GIS, specifically, the relative roles of maps and text needed to be made explicit.

"The accuracy and currency of data is viewed as vital because this has determined the system's credibility and, ultimately, its degree of use and usefulness. The negotiations took place between the users of the information and the owners of it as to the level of access, degree of accuracy or tolerance and the currency of such information. These negotiations formed the basis of a clearly understood "contract" between the provider and the users. A distinct problem in this area was the generally poor quality or inappropriateness of nationally available statistical material for local authority policy-making" Gault and Peutherer (1988: cited in Worral 1990).

2.2.6 Relevant GIS Skills

The Birmingham GIS Pilot Study only mentions that the sophisticated management of information is required if a GIS approach is adopted. The issues must be addressed in terms of what is feasible given current skill, organisational and technical constraints.

2.2.7 Conclusion

The Birmingham GIS Pilot Study was selected for this study on the thinking that it will address all the criteria that has being mentioned for measure of an effective GIS in the municipality, instead the study took a slightly different perspective for examining the potential for GIS development in local government. The study examined the political, organisational, managerial and policy-analytical environment in which GIS will have to exist. The Birmingham GIS Pilot Study did not meet all the criteria that is utilised to measure the effective utilisation of GIS in municipalities.

The following case study is on regional GIS while the conclusion will refer to the final case study, the national one.

2.3 The Regional Case Study: GIS as the Infrastructure Management tool in Botswana

2.3.1 Background

Tembo (2005). "The power in Botswana is generated and supplied by the Botswana Power

Corporation (BPC)". Tembo (2005) further attested that water is supplied by the Water

Utilities Corporation (WUC) in urban areas, the Department of Water Affairs supplies the rural areas.

For the purposes of this study: The case study will review both the Water Utilities Corporation and Botswana Power Corporation agencies, and comparisons will be made where necessary in order to cover GIS diffusion or effective utilisation of GIS in both the water and power services.

Botswana Power Corporation

Tembo (2005). "The *Botswana Power Corporation* initiated its GIS and Mapping section in 1998. Management recognised the need to fit information to facilities and customers. The purpose of implementing GIS was to allow access to information about who had been connected to electricity as well as to the AutoCAD sketch plans showing the locations of the power connections. The system would also provide information regarding the exact location of the cables laid. Furthermore, it would also allow and support simultaneous users of the database".

Botswana Water Utilities Corporation

"The Department: Water Resource Information Systems (WRIS) implemented GIS in 1997. This system was meant to link databases and for users to access the databases via the intranet".

2.3.2 Implementation of GIS

DWA used the following approaches in implementation of GIS:

- An organisation was assessed regarding its readiness to implement GIS.
- There was an agreed programme for the development and monitoring of both GIS and business systems.
- There was an agreed mechanism by which the costs and benefits of developing the GIS infrastructure and business systems would be shared between an implementing department and the rest of the organization.

BPC implementation of GIS:

- The GIS system implemented at BPC is currently managing its data using
- Spatial Database Engine (SDE) which runs the GIS using Arc Info 8.1.
- "The success of implementation is very dependent on availability of data" Choi & Williamson, (1995 cited in Tembo,2005).

2.3.3 GIS strategy

DWA GIS Strategy

Some issues that were considered during this study with regards to implementing a corporate GIS

Strategy was as follows:

- It was a planned process;
- It was problem-oriented; and
- It reflected a systems approach.

BPC GIS Strategy

As suggested by FIG (2003 cited in Tembo 2005), the following framework, as illustrated in the Strategy adapted from FIG (2002 cited in Tembo, 2005), should be established:

- A responsible officer fully accountable for the strategy and implementation;
- A set of corporate information data standards and plans;
- Robust business case to underpin all planned investment in GIS. This should define the expectations of the senior management about the role and performance of the GIS within the organisation and its contribution to business practice Wyatt & Ralph(2003 cited in Tembo,2005)
- Revenue budgets are in place to support effective data maintenance, updating technology and human resource development;

- Creation of a metadata database to allow stakeholders to explore and share existing sources of information;
- All staff are an integral part of the human resources management strategy; and
- Web based GIS or desktop access to the information is available to the wide corporate organisation at all levels of decision making.

In terms of the above mentioned points, it does appear that no GIS strategy had been formulated by either of the agencies while implementing the GIS.

2.3.4 GIS application

DWA GIS application

In the DWA, the Operation and Maintenance, Design and Construction, Ground Water, Water Quality Departments, as well as the Computer Unit, utilize GIS. Tembo (2005) explains that GIS is mostly utilized for the operation and maintenance for example for meter reading and water billing. The GIS tool is utilized to optimize the routes when reading the water supply meters in the seventeen villages. A further advantage of the GIS system is that when a meter reader is not available, a map including the villages can be printed out from a GIS and used as a guide to whoever will carry out the meter readings.

Advanced spatial analysis is utilized in DWA - for example request the system to query information with regards to customer's water bill, an address is used to identify the necessary information, which can be easily updated with GIS.

GIS in DWA is also utilized for the following functions:

- To manage the water supply interruptions;
- Forecasting of maintenance work;
- Capture and manage customer complaints;
- Analyse water sampling; and
- Manage water networks.

According to Tembo (2005) GIS is mostly used for mapping and manage the flow of water. This is done by identifying and then tracking the water conditions in the mains, valves, hydrants, meters, storage facilities, and other components.

BPC GIS application

GIS is mainly in two departments in the BPC, namely, the Planning and Inventory Departments. This department utilized GIS mostly to i) Capture data regarding the facilities and ii) To plan for new services. Planning involves creating maps in order to locate future infrastructure, there is also inventory to keep records of site conditions.

Other functions of GIS in BPC include:

- Customer queries management;
- Fault management;
- Maintenance routine planning;
- Network extension and optimization;
- Network reconfiguration; and
- Revenue collection, for example, the current system can identify illegal connections Tembo (2005).

The GIS is also utilized for map making. Currently, BPC expects to introduce systems that would share the same database as well as communicate with each other Mashumba (2005,cited in Tembo,2005). A new management system and proprietary customer information system (PCIS) is expected to be developed to address power outages challenges efficiently.

The purpose of upgrading the GIS system with the SDE based system is to allow for easy detection of outages without the notification by the customer, provide accurate information about outages and reduce the costs of operations. The system will later be linked to the customer information system so as to allow the geographic location to be linked to the account information.

2.3.5 Relevant skills capacity

DWA Relevant GIS Skills

In order to allow for the adoption quicker utilization of GIS in the DWA, a consultant was appointed to train the staff to use the system. The DWA employs more qualified personnel in the GIS field than the BPC and, mostly, they are more qualified in terms of water related studies and have been exposed to GIS due to the nature of their work.

BPC Relevant GIS skills

BPC did not specifically employ anyone at management level to manage the GIS in the agency. Consequently, the IT section and all personnel involved in GIS were allocated to the planning department where the Planning Engineer (Manager) was the manager of the GIS team. The success of the implementation of the GIS therefore, to a great extent, depended on the interest taken by the planning manager Tembo (2005).

As Tembo (2005) mentioned in the case study, the corporate implementation of GIS requires a degree of strategy in order to be successful.

The system architecture afforded an opportunity not only for the core group of record clerks and draft persons using the primary application to perform data corrections and complete edits for work orders

that had been completed, but also allowed engineers, technicians and technical clerks to utilize the GIS system to design new transmission and distribution work orders.

Software	Number of terminals
ArcView 3.x	10
ArcGIS 8.x	4
ArcSDE (Server)	

Figure 2.1 Tembo, Emmanuel, 2005. Number of GIS Software at BPC in the workstations.

This figure demonstrates the number of GIS software's available per computer in the BPC offices Tembo(2005).

The dominant platform is the workstation; although personal computers installed with standalone ArcView 3x software are now common features. Apart from the software, an analysis of the peripheral devices available in the organization indicates that BPC possesses a high quality colour printer but not digitizers and scanners (for large scale mapping).

Organization	General Field		data	General GIS mapping			GIS analysis					
	COILE	Clion										
	MSc	degree	Diploma	Short courses	MSc	Degree	Diploma	Short courses	MSc	Degree	Diploma	Short Courses
DWA			3				4		4	5	3	
BPC		1	3	7		1	3	7				

Figure 2.2 Tembo, Emmanuel, 2005. GIS personnel in BPC and DWA

The figure depicts the number of skilled GIS officials with qualification in GIS field in the BPC and DWA offices Tembo (2005).

2.3.6 Access to spatial information

DWA Access to Spatial information

DWA continuously collects data for water management processes. The data is collected in the form of a built pipelines network, which includes details regarding the main line, size of the pipe, flow rates, and village networks collected by service providers. The other data set, (the water lines on the maps) is acquired from surveys and mapping Tembo (2005).

BPC Access to spatial information

"The success of the implementation of GIS is dependent on the availability of data" Tembo (2005). "Data is collected by using hand held GPS receivers which captures both spatial and attribute information about BPC facilities. The data collected includes mostly vector data which is divided into electrical reticulation and GPS surveyed cadastral plots. Most of the fundamental data is collected from the Department of Surveys and Mapping (DSM). The data sets mostly take the form of maps in terms of which BPC would position their infrastructure. Some components of the raw data sets are captured by consultants and private surveying firms. The data sets are kept updated by capturing all new aspects of infrastructure whenever a new one is being built".

The BPC database includes the following:

- Road boundaries and aerial photograph data;
- Country and municipal boundaries;
- Lines and polygons (landmarks, e.g. schools, hospitals);
- BPC properties and rights of way;
- Subdivisions and lots; as well as
- Electrical facilities.



Figure 2.3. Tembo, Emmanuel, 2005. Data overlays in GIS showing electricity supply in Gaborone Central

The figure 2.3 depicts the spatial analysis query conducted by BPC to show electricity supply in the Gaborone Central Tembo (2005)

2.3.7 Conclusion

In terms of the five criteria identified to measure the effective utilization of GIS in organization for service delivery the Botswana case study, the water services and electricity distribution has implemented corporate GIS for both DWA and BPC. Both corporations have plans on sharing of spatial information with other units in their corporations and setting of spatial data standards. The advanced spatial analysis

is utilized to address service delivery - for example DWA utilizes GIS to organise and manage the flow of water services. BPC also utilizes advanced spatial analysis for planning of routine maintenance and improvement of revenue management for service delivery. DWA and BPC have a proper structure and qualified GIS officials to maintain the GIS systems in their corporations. There is a continuous capturing, collection and maintenance of up to date spatial data to address service delivery. In this regard it has met all of the criteria. With reference to the above analysis the Regional case study has addressed all five criteria in terms of effective utilisation of GIS for service delivery. The case study shows the importance of introducing corporate GIS in the organisation and as mentioned by

Dangermond (2001,cited in Tembo,2005) how: "Geographic information systems are evolving to support a new network-based architecture. This architecture is multi-participant, collaborative, and will allow organizations to openly share and directly use GIS information from any distributed sources at the same time". This is also true with the regional case study.

2.4 National Case Study: Aligning GIS with the Developmental Objectives of a South African Municipality

2.4.1 Background

"Buffalo City is situated on the South Eastern coast of South Africa. It is an amalgamation of the City of East London, King William's Town, Bisho (the Eastern Cape Provincial capital) and the large rural areas. Whilst named a "city" the municipality is in fact mostly rural, comprising some 2500 km² of small villages and townships" Farrant(2001). According to (Statistics South Africa, Census 2001 cited in Municipal Demarcation Board, 2007), the total population of the municipality in the region is 1 million.

"The Eastern Cape has been neglected in terms of development and is the poorest region in South Africa, with an unemployment rate of approximately 60%. This in itself creates huge challenges in terms of service delivery and spatial planning" Farrant(2001).

GIS have been implemented in the former East London Municipality but have not gained any momentum as their strategic objectives were incorrectly defined, with the focus falling on replacing record keeping systems and not on aligning with the development of the city as a strategic planning tool.

Consequently the need to reintroduce GIS as a corporate support tool for managing spatial adaptation and developing appropriate decision support tools has received high priority.



Figure 2.4: Buffalo city municipality map: displaying different wards and surrounding areas

The figure 2.4 displays the wards and surrounding areas of the Buffalo city municipality, this is to show the coverage of the municipality area and number of wards the Buffalo city municipality has to service in terms of free basic services.

2.4.2 Implementation of GIS

Farrant (2001) believes that corporate approach is the best option to implement GIS in municipalities, corporate GIS helps to manage the spatial data and develop decision support tools for service delivery. Corporate GIS has being implemented in the Buffalo City municipality to ensure that integrated planning addresses strategic purposes in the municipality. The GIS is utilized to monitor service delivery and also for decision makers to correctly interpret information derived from the spatial data.

2.4.3 GIS Strategy

In order to address the GIS strategy in the Buffalo City, the following roles were defined as according to Farrant (2001)

- The GIS unit ensured that there is sharing of spatial information and collaborative analysis by different units in the municipality
- A web based GIS was developed to ensure that spatial and non-spatial data sets are accessible to everyone.
- Ensured that GIS as decision making tool is accessible to non-technical GIS officials and senior managers and to the technical GIS officials

- The GIS unit developed data standards for all spatial data sets within the municipality and ensured that newly captured spatial data has metadata captured too.
- Where there was spatial data gaps, the spatial data set(s) were acquired from other relevant government departments

Farrant (2001) further explains that GIS has been integrated into various sector strategy plans, giving an effective overview of what is planned in the municipality and where the development is scheduled to take place.



Figure 2.5: Farrant, Phil. 2001. An example of advanced spatial analysis utilized by municipality to aggregate data for suitable and unsuitable area for development .Red displaying unsuitable area for development for burial site selection.

2.5 Application of GIS for Service delivery

Farrant (2001) explains that one of the most important functions of the GIS in the Buffalo City municipality was to be able to visualise what was happening on the ground and to analyse spatial trends so that experts and laypeople alike can quickly analyse the information and make decisions based on these observations. In terms of service delivery it is essential that planners and managers know the services on which to focus on, as defined in the integrated development plan (IDP) agenda. The Buffalo City municipality utilized advanced spatial analysis to conduct the spatial comparison between the departmental master plans and spatial development frameworks (SDF). This was achieved through the integration of GIS and planning schemes, to assist the planners in the municipality to identify where the planning was out of synchronisation with the municipality and where isolated planning was being initiated or taking place.

An important key objective of integrated development planning is to address basic service delivery and identify service delivery shortfalls/backlogs using spatial analysis techniques to identify who benefits from services and who does not, this became an easy exercise Farrant (2001).

When a spatial analysis of service delivery components is conducted in an integrated fashion, gaps in service delivery areas are immediately highlighted. These, in turn, are compared with the departmental master plans as well as the SDF and planning priorities identified.

By interrogating both the spatial and attribute data, it was possible to identify not only the extent of service delivery but also the quality. For example, planners may know that a settlement is serviced by means of a water main, but without knowing the capacity of the water pipe servicing the area, the quality of the service cannot be determined.

Advanced spatial analysis is utilized to perform calculations based on distances, this type of analysis made it possible for the municipality to analyse basic levels of service. Once the positions of the services are known, for example, standpipes, distances from these points are easily calculated using land parcel layouts (in the formal areas) or (in the case of informal dwelling units) in the rural or informal developments and areas Farrant (2001).

2.4.5 GIS for infrastructure maintenance

Buffalo City utilizes GIS to identify high risk areas by using up-to-date asset registers and infrastructure layouts, to address the infrastructure maintenance backlog issues Farrant (2001)

The use of information integration strategies from the various management systems are consolidated into a layered representation of the service delivery infrastructure, to identify critical areas that affect service delivery. The process assist municipality to prioritize the high risk area for maintenance planning.

While GIS is integrated into other systems within the Buffalo City Municipality, the service departments has not yet reached the stage where the analysis capability of the GIS can be fully integrated into the planning their activities of the services departments. Once a determined effort is made by services departments to capture the spatial components of the infrastructure assets, these will be linked to the maintenance/management systems for these assets, effective spatial analysis can become a reality Farrant (2001)

2.4.6 GIS for monitoring process

Once the projects has been approved through IDP and budget allocation process, the planning unit in the Buffalo City municipality utilizes GIS for the selection, to facilitate prioritisation of the IDP projects; the analysis of the projects and monitoring of the project performance.

The GIS unit in the Buffalo City Municipality has developed an accurate base map depicting all individual erven (land parcels) as well as an accurate road network. All rural communities and villages have been identified and added to the base map. When viewed together with the aerial photography and service infrastructures, an accurate picture of what the municipality looks like is readily available Farrant (2001).

Figure 2.4.3 below illustrates the concept of project monitoring in a municipality through the use of GIS to spatially locate each project and to manage these projects.



Figure 2.6: Farrant, Phil. 2001. A GIS based system designed to monitor ongoing projects in the municipality.

2.4.7 Access to spatial information

Buffalo city municipality has developed a spatial database for the planning of rural development and for meeting service level goals objectives. The base spatial dataset is digitised directly from aerial photography, which accurately identifies the geographic location of some 250 rural communities (settlements) within the region. Together with the demographics of these communities (to a large extent they match the sub place areas defined by Statistics SA for the 2001 census), they provide a good overview of what is currently happening in the municipality Farrant (2001)

2.4.8 Relevant GIS Skill

As part of the municipality's GIS strategy and effective implementation of GIS Buffalo City continuously trained GIS staff, continues.

A key objective of the training was to attempt to eliminate the disparities between the departments and reach a level where all can gain similar experience.

Buffalo City Municipality, had extensive in-house training programmes that had been developed to address the three levels of the basic GIS training required in the organisation. The levels are as follows:

- Basic users;
- Data custodians; and
- Overview users (managers and politicians) Farrant (2001)

Then identified another two main groups for GIS training officials, one the staff that worked directly with GIS: two the skilled specialists (analysts and technicians) and GIS end users, typically staff who need geographic information in their daily work without requiring the necessary skills to be considered a GIS specialist. The customised training for councillors, and members of top and medium level management who need to know of the capabilities of the GIS without requiring specialist knowledge regarding how to use GIS, is also catered for Farrant (2001).



Figure 2.7: Farrant, Phil. 2001. GIS officials teaching the municipality councillors about the use of GIS

2.4.9 Conclusions of the three literature reviews

In conclusion the three case studies, the Global case study; the Regional case study and the National case study reviews how each country effectively utilized GIS for service delivery, this was assessed against the five criteria for effective utilisation of GIS with respect to service delivery.

• Implementation of GIS;

Birmingham county municipality:

Gault and Peutherer (1988 in Worral 1990) mention that although it was stated that a corporate approach was essential for the Birmingham Council, this should not be confused with central control."

In addressing issues such information management, application justification, organisation and management, the study does make mention of the corporate approach that is essential for the Council. The case study continues to mention information management which does cover the portion of data sharing in terms of the criteria Implementation of GIS.

GIS as a management Tool in Botswana

DWA

According to the DWA case study, the organisation implemented corporate GIS to ensure that there is proper planning for water services in the country; and to ensure GIS implementation is problem orientated, to addresses service delivery issues. Lastly the GIS reflect a systems approach, that GIS is integrated to other systems in the organisation for the whole organization to benefit from GIS services.

BPC

According to the BPC case study, the organisation GIS is currently managing its data using the spatial database Engine which runs the GIS using Arc Info 8.1.

In terms of the above analysis DWA and BPC has corporate GIS, the two organisations meet the above criteria.

Aligning GIS: South Africa Municipality

The Buffalo city as indicated in the case study has implemented a corporate GIS to manage spatial data and develop decision support tools to address service delivery in the municipality Farrant (2001).

There is a corporate GIS in the Buffalo city municipality that meets the above identified criteria.

• GIS strategy;

The three case studies as according to the definition of GIS Strategy "Assess if the municipalities have a plan on how they are going to institutionalise the GIS from a corporate management perspective in the municipality, grow a GIS in one unit to benefitting the whole municipality. The information management plan of the municipality should address the sharing of information and decentralization of the spatial databases in the municipality". The three case studies in relation to GIS strategy are described below:

Birmingham county municipality:

The case study does mention "the business processes which generate the information and use of that information by the organisation at large. With regards to GIS, it is critical that a convention concerning locational referencing is adopted and that rules with respect to the use and updating of the map base is accepted. The establishment of a basic data definition dictionary is crucial."

GIS as a management Tool in Botswana

DWA in the case study mentions that "There was an agreed mechanism by which the costs and benefits of developing the GIS infrastructure and business systems would be shared between an implementing department and the rest of the organisation."

Also BPC to the fact that "A set of corporate information data standards and plans was established" as illustrated in the strategy adapted from FIG (2002). "The creation of metadata database to allow stakeholders to explore and share existing sources of information."

Aligning GIS: South Africa Municipality

The role of GIS in the Buffalo City municipality have been clearly defined to address " promoting spatial information management techniques as a means of developing long term planning strategies; facilitation of data sharing and collaborative data analysis; Development of data and metadata standards; focus on data acquisition, including data from quasi governmental departments and provincial government departments."

GIS application to service delivery,

With reference to the definition of application of GIS to service delivery "Is the GIS utilized to respond to policy issues in the municipality?"

Is the GIS utilized to plan for the water and electricity services and routine maintenance of the services?

Are water services and electricity services units in the municipality being able to conduct advanced spatial analysis, for example able to display number of households connected to water and electricity services? Is there spatial database integrated to different units / services in the municipalities?" According to the three case studies

Birmingham county municipality:

GIS is utilised for census, Land resources, city Terrier, Bridges data base, Lightning data base, Sewers Data base, Educational transfers and library stock monitoring.

GIS as a management Tool in Botswana

DWA: GIS is utilized for water management "management of supply interruptions for planned work; Forecasting of maintenance work; Management of customer complaints; Water sampling and analysis management, and network event management."

BPC: GIS is utilized for "capturing data regarding the facilities and the ability to plan for new services. Planning involves utilizing maps in order to locate future infrastructure, inventory deals with keeping a record of site conditions."

Aligning GIS: South Africa Municipality

GIS is utilized to calculate and analyse basic levels of services for example infrastructure maintenance; monitoring of projects.

Access to spatial information;

With reference to the definition, access to spatial information is "the availability of free basic water services and free basic electricity services. The availability of spatial information that covers the whole municipality, should be as recent as possible, and should be provided from a reliable source, and should be required by the municipality to provide effective decision making support. Are the municipalities having access to the fundamental data sets in the country as base data for their own feature specific data?"

Birmingham county municipality:

"The accuracy and currency of data is viewed as vital because this has determined the system's credibility and ultimately, its degree of use and usefulness. The negotiations took place between the users of the information and the owners of it as to the level of access, degree of accuracy or tolerance and the currency of such information. A distinct problem in this area was generally the poor quality or inappropriateness of nationally available statistical material for local authority policy-making" Gault and Peutherer (1988 in Worral 1990).

GIS as a management Tool in Botswana

DWA: "Spatial analysis is easily conducted owing to the availability of an accurate spatial data set. DWA continuously collects dataset for water management. The other data set (water lines on the maps) is acquired from Department of Surveys and Mapping.

BPC: "Data is collected by using handheld GPS receivers which captures both spatial and attribute information. Secondary data set is acquired from Department of Surveys and Mapping".

Aligning GIS: South Africa Municipality

Municipality developed a spatial dataset; digitised directly from aerial photography, which accurately identifies the geographic location of rural communities. The municipality also acquired the Census 2001 data set from Statistic South Africa.

Relevant skills capacity

With reference to the definition on relevant skills capacity the study assessed each case study " Number of permanent officials to manage the GIS unit, is there a structure in place on number of officials to be employed in the unit? Has the unit being in existence for over five years?"

Birmingham county municipality:

The Birmingham county municipality mentions that "The issues must be addressed in terms of what is feasible given current skill, organisational and technical constraints".

GIS as a management Tool in Botswana

DWA employs more personnel qualified in GIS analysis than BPC *Aligning GIS: South Africa Municipality*

The municipality has two main groups of staff that worked directly with GIS: skilled specialists (analysts and technicians) and GIS end users.

The Birmingham Council case study outlines that the GIS was not focusing on technological and technocratic aspect of GIS. It rather examined the political, organisational, a managerial and policy-analytical environment in which GIS will have to exist, and most importantly mentions that "The benefits of GIS to local government are potentially considerable since it has been shown that approximately 80 per cent of the information in local government is spatially related" Bromley and Coulson (1989, cited in Worrall, 1990). The case study does not clearly elaborate on Birmingham County Council having implemented a corporate GIS. The other criteria are GIS strategy; and GIS application related to service delivery; Access to spatial information; and relevant skills capacities are clearly mentioned the municipality meet these requirements. In terms of the regional case study and the South African case study, the GIS matches with the

five criteria's outlined to measure the effective utilisation of GIS to address government programmes.

The commonality of the three case studies is that all agree that the corporate GIS option is the best in order to receive the return of investment. There is also a shared view among the three case studies that GIS should address the following issues:

- The GIS should yield an adequate response to citizens/politicians and non technical managers' requests;
- GIS should improve efficiency and productivity within the municipality or the agency;
- The users of the system should be able to generate accurate reports and maps in less time for reporting purposes;
- The managers should be able to identify and prioritise maintenance and capital projects
- GIS should assist in making better quality and more effective decisions; and
- GIS should be utilised to comply with the government legislation regarding service delivery.

In conclusion the above points and case studies reviewed confirm that the following criteria as mentioned in this chapter constitute the core of the effective utilisation of GIS:

- GIS implementation;
- GIS strategy;

- GIS application on service delivery;
- Access to spatial information; and
- Relevant skills capacity.

3 RESEARCH METHODOLOGY

According to the free basic water service and free basic electricity policies, "the local government is responsible for delivering these services to the poorer households in its municipal jurisdiction". The Department of Minerals and Energy (2007, free basic electricity section) states that the Free Basic Electricity is the amount of electricity that is deemed sufficient to provide basic electricity services to a poor household. The Department further states that this amount of energy will be sufficient to provide basic lighting, media access, water heating using a kettle and ironing, in terms of grid electricity, and basic lighting as well as basic media access for non-grid systems.

According to the Department of Water Affairs and Forestry (2007, Free Water Services/Sanitation), free basic water "refers to the amount of water that is deemed sufficient to provide basic water services to a poor household".

3.1 Introduction

In this chapter, the same criteria mentioned in the previous chapter will be utilized to assess how GIS can be effectively utilised in municipalities in terms of service delivery.

A stratified Random sampling will be utilised to select district and local municipalities that have already implemented GIS as well as the municipalities that are currently rolling out free basic services.

The reason for this type of sampling is to ensure proportional representation of different categories of municipalities. It is also critical to assign subjects in a way that ensures the groups are balanced in terms of important variables that could modify the effective utilisation of GIS in municipalities for service delivery.

Six municipalities will be selected for the sample of subject rather than the full 284 municipalities in South Africa. Different methods of collecting the information will be utilized for example the questionnaire will be prepared in a semi-structured protocol. The open ended questions are designed to allow the respondent to describe in his/her own words, the rationale, goals and problems of utilizing GIS in municipality to address service delivery. Secondary method of research, for example desktop research, internet research and local GIS magazines was also utilized to collect information for the survey. Figure 3.1.1 below is a table with the 6 local municipalities used for the study. Figure 3.1.2 is a map depicting the provinces where the municipalities in Figure 3.1.1 are located.

Municipality	Province	Nature	Category				
Alfred Nzo	Eastern Cape	Rural/Urban	District Municipality				
Buffalo City	Eastern Cape	Urban	Local Municipality				
Capricorn	Limpopo	Rural/Urban	District Municipality				
Polokwane	Limpopo	Urban	Local Municipality				
Ngaka Modiri Molema	North West	Rural/Urban	District Municipality				
Rustenburg	North West	Urban	Local Municipality				
Table 3.1: Six Municipalities participating in the research survey, displayed according to the Province, Nature and Category.							



Figure 3.2: National map of South Africa displaying the provinces participating survey coloured in yellow

As mentioned by the Municipal Demarcation Board (2007), "the structure of local government in South Africa takes three distinct forms. Category A refers to Metropolitan Municipalities, as according to (South Africa Info 2011) also known as Unicities, have exclusive municipal executive and legislative authority in their areas. There are currently six of these: City of Cape Town, Durban (Ethekwini), Ekurhuleni, City of Johannesburg, City of Tshwane and Port Elizabeth (plus two more that are planned: Buffalo City and Ulundi). They have a choice of two types of executive systems: the mayoral executive system, and the

collective executive committee; category B, the Local Municipalities; and category C, the District Municipalities. District and local councils are interdependent and involve a division of powers. A district council has municipal executive and legislative authority over a large area, its primary responsibility being district-wide planning and capacity-building. Within a district council's area are individual local councils which share their municipal authority with the district council under which they fall (South Africa Info 2011). South Africa contains a total of 284 municipalities: six metropolitan, 47 district and 231 local municipalities" Pelser (2005). The survey was conducted in six municipalities from categories B and C which is District and Local municipalities.

3.2 Subject Selection

The qualitative survey was conducted in six municipalities to assess the effective utilisation of GIS with the purpose of establishing the following information:

- When was the GIS implemented in the municipalities?
- Does the municipality have a GIS Strategy in place?
- What is the application of GIS in the municipality used for?
- Does the municipality have relevant access to spatial information in terms of water and electricity services?
- Is there sufficient GIS skills capacity in the municipality the nature of GIS systems that are in place? (i.e., organisational arrangements that have been made within different Municipalities – perceived benefits).
- What are the problems associated with the acquisition of GIS?
- Is there access to and availability of a spatial data set to address the free basic services policy?
- Choosing Category B and C municipalities
- Are municipalities targeting indigent's households as beneficiaries of free basic services?

According to Statistics South Africa (2001) Municipal boundaries were defined in mid-2000 when the new municipal structure replaced the old structure. The new structure consists of Category A municipalities, which are the metropolitan areas (Category A or Metropolitan municipalities), Category C municipalities, or district councils (Category C or DCs), District Management Areas (DMAs) and Category B or local municipalities (Cat B). All local municipalities and DMAs fall within a district council. In total, there are six metropolitan areas, 47 district councils, 231 local municipalities and 25 DMAs. Key considerations in redetermining local municipality boundaries included: settlement type, the rationalisation of municipalities, manageable size and functionality. Local municipalities and DMAs are the next spatial level up from the Statistics South Africa main place. There are 231 Category B municipalities. Among them are eight cross-boundary municipalities. These are areas with both district and local municipality features, where the establishment of a local municipality is not appropriate (does not meet a set of requirements). DMAs are areas of special interest e.g. deserts and semi-arid areas, state-protected and conservation areas and special economic areas. There are 25 DMAs, four of which are cross-boundary. Metros and DCs are a level above the DMAs and local municipalities in the geography hierarchy. In 1999, the MDB published redetermined metropolitan and district council
boundaries. Metropolitan areas are conurbations featuring high population density; intense movement of people, goods and services; extensive development; and multiple business districts and industrial areas. Other features include a complex and diverse economy, a single area where integrated development is desirable and strong interdependent social and economic linkages between its constituent units.

With reference to subject selection category B and C municipalities that were selected as part of studythe reason being majority of South African population reside in local and district municipalities, the government has focused the resource, capacity building and programmes like free basic services to the category B and C municipalities to eventually be able to sustain themselves. For example the Project Consolidate initiative which was led by the department of Provincial and Local government was for National departments and other spheres of government to work together to strengthen support in municipalities who have greatest need in addressing free basic services, and municipalities with 50% of population declared indigent (with monthly income of less than R1600 or lower) as outlined on Department of Provincial and Local government (2004 pp10). The question still remains: has GIS as one of the decision making tool, municipalities having paid high price to implement this system has they benefitted from this system in assisting to display impact of government programmes for example the Free basic services, been effective?

3.3 Data Acquisition Techniques

For municipalities to ensure that they deliver free basic services to poor households in their jurisdiction, the infrastructure must be in place and in working order. The municipalities should be able to utilize advanced GIS queries to identify number of households to receive free electricity and water services per municipality. Electricity and water services database should be captured and integrated into the municipal GIS database. Municipalities that have participated in the survey should have implemented GIS post 1994. They should have the infrastructure data available in a recognised and common GIS capable spatial file format.

The six municipalities should have already established an ongoing management of various utility networks utilised to deliver the various services, of which one is the electrical network. Others include the sewer, roads, and water and storm water networks. All of these networks are captured on the spatial information system: the maintenance thereof is carried out based on information received from the maintenance teams, indicating where reparations and/or upgrades of the networks need to take place.

A qualitative survey of municipalities was undertaken to provide data regarding the effective utilisation of GIS to address the issue of free basic services in municipalities and to highlight the challenges faced in addressing the five criteria. Secondary data, for example, books, journals, newspaper, the Internet, Arc View Software and presentations, was also employed to analyse data. The results of the research are presented in tables, graphs, charts, and maps within the text. Random sampling was selected to choose municipalities with the same character, for example, district municipalities comprise a mixture of urban and rural areas, while all local municipalities are urban.

3.4 Interview Technique

Six municipalities were selected for the survey. A well designed questionnaire was developed. Short, to the point, yet have a flow that the interviewer and respondent can use to get through it quickly and accurately.

The selection criteria for participatory municipalities took into consideration the following:

- Total number of household dependent on government free basic services as per income
- Size of population in the municipality;
- The municipalities with same dynamics/challenges (urban vs. rural) of the municipality;
- The municipality classification (category A, B or C) as according to Municipal demarcation board categories
- Whether the municipality has an operational GIS;
- The GIS section staff component or organogram supporting municipality with the use of GIS for service delivery;
- Application of GIS in the municipality;
- Does the municipality have an indigent registry database linked with GIS to address service delivery issues?

The graphs below display the selection criteria mentioned above about the participatory municipalities in the survey.



Chart 3.3: The total population size of municipalities participating in the survey





Chart 3.4 Income capita per Municipality Statssa (2001)

As mentioned in the research outline chapter the above graphs will assist in analyzing the data on participatory municipalities in order to address the following points:

• What is the total number of household dependent on government for free basic services, this is to evaluate the extent of problem on service delivery.

- Size of population in the municipality to test how many household in the municipality do not need free electricity and water support from the municipality;
- Comparison of municipalities with same dynamics/challenges (urban vs. rural); to assume a comparative form where similarities and differences among the municipalities is analyzed.
- The municipality classification (category-A municipality which are metropolitan municipalities in South Africa; categories B which are local municipalities; categories C which are district municipalities, as according to Local Government: Municipality Structures Act, 1998.

Eastern Cape Province (i) Alfred Nzo District Municipality

Background

According to the Municipal Demarcation Board (2007), the Alfred Nzo District municipality is located in the Northern part of the Eastern Cape. It consists of two portions with one section being an island within the Kwa-Zulu Natal Province, both of which are rural and urban in character.

It is a category C municipality. The population is 392 177 for a total area of 7870.2803 square kilometres.



Figure 3.5. Eastern Cape Provincial map in yellow, displaying location of Alfred Nzo Municipality in green.

• Implementation of GIS

In a personal communication, Zamuxolo Mgulwa explained that the GIS in Alfred Nzo Municipality was established in 2001 Mgulwa (2008).

• GIS Strategy

According to Mgulwa (2008) the municipality has not compiled a GIS Strategy to address the sharing of spatial information within the municipality sections, and how GIS would benefit the whole municipality.

• Application of GIS

The GIS unit is located in the Development Planning department of the municipality. Some of the GIS users in the municipality are employed in the Disaster Management Unit. The GIS is also utilized in the local municipalities, in the water services unit, electricity services and maintenance, according to Mgulwa (2008). The municipality has an indigents' registry in place which was pronounced as representing the most accurate indigence statistics and highest level of free basic water implementation, according to this source: Development of Models to Facilitate the Provision of Free Basic Water in Rural Areas Report No 1379/1/05: March 2005. The GIS is not linked to the billing system or any other municipal systems. There is no Internet mapping facility. The GIS is mostly utilised for map making and capturing data.

• Access to Spatial information

The Municipality collects some of the required spatial data sets; secondary is received from a National Department (For example Department of Water Affairs etc)

Relevant GIS Skills

There are two full time employees dedicated to the GIS in the municipality.

The Buffalo City municipality will be discussed next.



(ii) Buffalo City Municipality

Figure 3.6: Eastern Cape Provincial map in yellow, the green colour displaying Buffalo City

Background

Buffalo City, a category B municipality, is, as mentioned, situated on the Southern Eastern seaboard of South Africa Farrant(2001),. While it is named a "City" the municipality, in fact, comprises mostly rural, small villages and townships. According to the Municipal Demarcation Board (2007), the total area of the municipality is 2527.79 square km.

• Implementation of GIS

According to Farrant(2001), a corporate GIS was implemented in 1996 to manage spatial data and develop decision support tools.

GIS Strategy

As mentioned by Farrant(2001), the data integration, data standards and skills development have been part of the GIS strategy development. The service provider has also ensured that corporate GIS are mindful of the user departments and individual clients. GIS is integrated into various sector strategy plans giving an effective overview of what is planned in the municipality and where the development is scheduled to take place.

• Application of GIS

GIS has been integrated into various sector strategies, namely, the development planning department (deals with zoning and housing in the municipality); infrastructure maintenance; water and electricity services; transport; and the maintenance of the primary health care system. The GIS is located in the development planning department Farrant(2001).

Access to spatial information

The municipality collects spatial data sets. The secondary spatial data sets are acquired from other government departments. The municipality does have an indigents' registry in place.

• Relevant GIS skills

At the time of the collection of information for the study, there was only a GIS coordinator and a GIS Technician who are in full-time employment. The GIS coordinator is the acting Manager for the GIS unit.





Figure 3.7: Limpopo Provincial map in yellow Map displaying the location of Capricorn Municipality in green

Capricorn District municipality is a category C, located in central Limpopo. According to the census results of 2001, it serves a population of 1 154 682 and covers 23 688 square kilometres Municipal Demarcation Board(2007). It is both urban and rural in character.

• Implementation of GIS

In a personal communication, Tilfred Mabuza explained that the implementation of GIS in Capricorn Municipality was done in 2000, Capricorn municipality does not have Corporate GIS Mabuza (2007).

GIS Strategy

The municipality has not compiled a GIS Strategy to address the sharing of Spatial Information within the sections in the municipality.

Application of GIS

According to Mabuza (2007) the main services of the municipality are those of water and sanitation, energy, roads and storm water, infrastructure development and community services as well as economic development.

Some of the functions of district municipalities are designed to support local municipalities in their jurisdiction and to manage the plans for the whole district municipality. The GIS in the Capricorn Municipality is located in the Development Planning section.

Access to Spatial information

The municipality utilises secondary data sets from the National departments, for example Census Data from Statistics South Africa.

Relevant GIS Skills

The municipality has employed one GIS officer for the maintenance of the GIS system.

(iv) Polokwane Local Municipality



Figure 3.8: Limpopo Provincial map in yellow Map displaying the location of Polokwane municipality in green

Background

"The municipal area comprises an urban core (Polokwane Town) and a number of rural settlements. The Polokwane CBD is of regional importance, serving an area greater than the municipal area. The municipal area is 3765.9810 square kms with a population of 508 275" (Statistics South Africa Census 2001; & Municipal Demarcation Board (2007). The Polokwane Municipality is the province's capital, even though many Government departments are located at Lebowakgomo.

The Polokwane Local Municipality falls into category B Municipal Demarcation Board (2007).

• Implementation of GIS

According to the research conducted by Chief Directorate Spatial Planning and Information: (2008): The corporate GIS, in the Polokwane Municipality were established in approximately 1994 with a web mapping facility.

GIS Strategy

According to the GIS officer there was previously a GIS strategy developed a long time ago.

• Application of GIS

It is located in the Development Planning section and services the following users in the municipality: the finance department, the water services unit, the engineering and the planning departments.

• Access to spatial information

The GIS database in the municipality is integrated with most municipal systems, for example, the billing system, the indigents' registry for identifying free basic services. The spatial data set for the municipality is collected at municipal expense, for example, the municipality has collected Cadastre and Deeds information for the development of the Valuation Roll.

Relevant GIS Skill

The municipality has a staff component of one.

(v) Central District Municipality



Figure 3.9: North West Provincial map in yellow Map displaying the location of Ngaka Modiri Molema(Central District) Municipality in green

Background

The Central District, officially known as Ngaka Modiri Molema, is a category C municipality with regions that include the towns of Mafikeng, Zeerust and Lichtenburg. This municipality consists of five local municipalities and houses a population of 762 989 with an area of 27 854.2503 square kms, according to the Municipal Demarcation Board (2007).

• Implementation of GIS

In a personal communication with Malebo Makgale that the GIS in Central municipality, was implemented GIS in financial year 2005/06 Makgale (2008).

GIS Strategy

According to Makgale (2008), there is no GIS strategy compiled to address the sharing of spatial information with other sections in the municipality.

• Application of GIS

According to Makgale (2008) the GIS is being located in the Development Planning department, and employs one GIS official. While the GIS in the municipality services the Development Planning section, the GIS is not integrated with the free water services and free electricity databases. The municipality is currently implementing free basic water services, according to DWAF (2007).

Access to spatial information

The municipality utilises the services of a service provider for information and the secondary data set from other government departments.

Relevant GIS skill

The municipality has one official employed to manage the GIS system



Rustenburg Local Municipality

Figure 3.10: North West Provincial map in yellow Map displaying the location of Rustenburg Municipality in green

According to the Municipal Demarcation Board (2007), the municipal area comprises an urban core (Rustenburg Town) as well as a number of rural settlements. It contains a total population of 387 095 within an area of 3423.2310 square kms and is a category B municipality.

• Implementation of GIS

In a personal communication, Dave Gill explained that the GIS in the Rustenburg Local Municipality is still in its infancy, and is located in the IT section Gill (2008).

• GIS Strategy

An awareness campaign regarding the GIS needs to be conducted as senior managers are not yet aware of the potential of the tool.

• Application of GIS

It is not integrated with most of the municipal systems, for example, the billing systems and free basic water and electricity databases. The major users of this system in the municipality are those in the Development Planning section.

The municipality is implementing free basic water services, according to DWAF (2007).

Access to spatial information

The municipality has received list of fundamental spatial data sets from the National Spatial Information Framework, to use as base information for their GIS.

Relevant GIS Skill

The municipality has one dedicated GIS official.

3.4.1 Methodology

The study comprised the following elements:

- A questionnaire survey of municipalities was undertaken to furnish data regarding the implementation status of GIS in municipalities and to highlight the challenges faced with regards to the effective utilisation of GIS in them.
- A telephone based survey was adopted because of the limited time frame to complete the survey (See annexure B for the survey questionnaire).

3.5 Quantitative survey of six municipalities

A quantitative survey of the said municipalities was undertaken in order to provide data on the effective utilisation of GIS, and to highlight the challenges faced in utilising GIS as a decision making tool. As remarked, the survey was conducted by means of telephonic interviews with the GIS municipal officials. The result reflected in the research is based on these interviews (Capricorn District municipality, Polokwane Local Municipality), A 67% response rate for the sample of all the selected municipalities was achieved.

4 ANALYSIS AND RESULTS

4.1 Introduction

"As outlined in a previous chapter, it is clear that the local government is one of the most important groups of users of GIS, an indispensable decision-making tool that contributes directly to accomplishing the goals and objectives of each municipality" Heywood (1997:pp27). The effective utilisation of GIS in South Africa's local government will determine visual information with respect to the progress and / or backlog regarding free basic services in municipalities.

Owing to time and budget constraints, the research study was conducted in only six municipalities

The figure 4.1.1 depicts the typical municipality function and core spatial data sets found in most of the municipalities in South Africa which have implemented GIS as described by Fourie (2008). The green colour displaying the available and used spatial data in the municipality departments for example the first rows is all green from top to bottom, it means the most widely used spatial data set is cadastre in all the municipality departments. The town engineering section is where the issues of water and electricity services are dealt with, which means according to the table below most town engineering sections in the municipality would have all the core spatial data needed for service delivery except the engineering facilities spatial data and the environmental information. What is also interesting is that the table has no information on indigent database, which also confirms the hypothesis of this study.

The municipality function and core spatial dataset

	Cadastre	Base Map	Town Planning Scheme	Treasury information	Eng-Bulk	Eng-Reticulation	Eng-Facilities	Service-Usage	Land use information	Demographic/Socio economic	Environmental information	Signage & outdoor Advertising	Aerial Photography
Town Planning	1	1	1	1				1	1	1			1
Housing and Land	1		1	1	1			1	1				1
Town engineer	1	1	1	1	1	1		1	1	1		1	1
IDP officer	1	1	1	1	1	1	1	1	1	1	1		1
Parks	1	1	1	1		1	1		1	1			1
Treasury	1		1					1	1				
Engineering	1	1		1	1	1	1	1	1	1			1
Valuations	1		1					1	1			1	1
Building Control	1		1			1			1				1
Tourism and Local economic development	1	1		1					1	1	1		1
Health	1		1	1					1				1
Traffic	1	1	1						1			1	1
Fire Department	1	1		1				1		1			1
Safety and security	1	1											1

Table 4.1: Fourie, Werner. 2008. Displays the functions and core data set within the south African municipalities

4.2 Questionnaire development

A questionnaire was prepared to obtain accurate, and detailed answers (see attached Annexure B).

Municipality name	Province	Population size	Nature	Category	GIS implementati on (when?)	Staff compon ent	Hardware and Software
Alfred Nzo	Eastern Cape	392177	Rural/ Urban	District Municipality C	Yes: 2001	2	Yes
Buffalo City	Eastern Cape	702279	Rural/ Urban	Local Municipality B	Yes:1996	3	Yes
Capricorn	Limpopo	1154682	Rural/ Urban	District Municipality C	Yes: 2000	1	Yes
Polokwane	Limpopo	508275	Urban	Local Municipality B	Yes: 1994	1	Yes
Ngaka Modiri Molema	North West	762989	Rural/ Urban	District Municipality	Yes:	1	Yes
Rustenburg	North West	387095	Urban	Local Municipality	Yes: 2000	1	Yes

Table 4.2: Comparison of the municipalities participating in terms of size, population and number of officials employed

Figure 4.2 elaborates on the number of GIS officials in the municipality as part of assessment in terms of capacity to deliver on informing decision makers of municipality with progress and backlog of free basic service in the municipality.

To elaborate further, five criteria were used to assess the effective utilisation of GIS in municipalities.

These criteria that have been identified to measure the effectiveness of GIS in municipalities will be utilised to quantify whether the GIS in the municipality is able to respond to the following:

- Display number of households within municipalities that are qualifying for free basic services.
- Display households within the municipality that do not qualify but are benefiting from free basic services.
- Can GIS in the municipality display households which are benefiting but need to be reviewed after six months?
- Does GIS in the municipality have available accurate spatial data regarding cadastral, water pipes and electricity connections, to be utilised for spatial analysis?
- Does GIS in the municipality have the spatial database integrated with the indigents' registry? and
- Can the GIS in the municipality develop a report on the progress and backlog of free basic services to assess the impact of the policy?

Munic	Type	GIS implementat ion	When?	GIS strategy	GIS application(I ndigent)	GIS skills	Spatial info Access
Alfred Nzo	District	Yes	2001	No	Yes	2	Yes
Buffalo City	Local	Yes	1996	Yes	No	3	No
Capricorn	District	Yes	2000	No	No	1	No
Polokwane	Local	Yes	1994	No	No	1	No
Central-Ngaka MM	District	Yes	2004	No	No	1	No
Rustenburg	Local	Yes	2000	No	No	1	No
		100%		83%	83%	9	83%

Table 4.3: The summary of the responses of six municipalities.

Figure 4.3 has summarized the responses of six municipalities against the five criteria utilized to assess the effective use of GIS to address the free basic services programme.

4.2.1 Implementation of GIS

Of the six municipalities, the Alfred Nzo municipality is the only one that has integrated the free water basic services into its GIS system. Even though the municipality uses GIS for map making and the maintenance of water services, and not for advanced issues such as those mentioned above, Buffalo City has implemented a Corporate GIS for managing spatial data sets and developing appropriate decision support tools. GIS is aligned with the development of the city as a strategic planning tool. Only the Alfred Nzo municipality has integrated the GIS with one of the free basic services, that is, a water service.

Buffalo City, Polokwane and Capricorn municipalities have implemented a Corporate GIS, which is integrated with other municipal systems, such as the billing system for revenue collection and infrastructure management. However, the GIS is not integrated with the indigents' registry in order to assist in identifying who are the beneficiaries, how many there are, or where they are located.

4.2.2 GIS strategy

Of all the six municipalities, only Buffalo City has formulated a GIS strategy to bring about a paradigm shift towards effective spatial planning as well as to share spatial and attribute data between systems.

The sharing of data allows for more informed decision making as management can view and control information from several diverse sources in a single integrated application.

The Alfred Nzo District and Polokwane Local Municipality are in the process of upgrading the present GIS to a corporate one.

4.2.3 GIS application

Of the six municipalities, Alfred Nzo, Buffalo City, Capricorn and Polokwane have their GIS offering services in development planning. The Central and Rustenburg municipalities have their GIS located in their IT sections.

Besides the GIS being located in the development planning department, supporting the planning unit as regards zoning, the municipalities indicated that they utilise GIS for water and electricity services as well as infrastructure management.

4.2.4 GIS skills capacity

The six municipalities all employ full time dedicated staff to ensure that the GIS unit runs smoothly. Four municipalities: Alfred Nzo, Buffalo City, Capricorn and Polokwane, have indicated that it is a challenge to find GIS officers and retain them in the municipality for longer periods because municipalities do not offer attractive salaries.

4.2.5 Access to spatial information

The aim was to assess the availability of free basic water services and free basic electricity services, as well as the format of the data in addition to the coverage, source and currency of the spatial data.

Buffalo City acquires spatial data from quasi governmental departments and provincial government departments.

Alfred Nzo municipality has collected a spatial data set on free basic water services, part of which is received from DWAF.

Capricorn and Polokwane acquire spatial data sets from provincial government and national departments. Mostly the data sets are at general level and not at a household level.

According to the Directorate, the NSIF has also provided the Rustenburg local municipality with a fundamental data set (cadastral, DWAF data set, census data set, Demarcation Board data set, etc.) It is not known from where the Central Municipality acquired its spatial data sets. It has been realised that of the six municipalities that have participated in the survey, four have outlined that in addition to receiving data from other stakeholders, they use their own funding to collect new stand / land parcel level spatial

data sets. Mostly the spatial data sets that are collected by a municipality consists of cadastral data (parent farms, farm portions, erven, agricultural holdings, sectional schemes) and imagery (aerial photography which is flown at least every 2 to 3 years), which are used to monitor service delivery.

4.3 Questionnaire Dissemination

The survey questionnaire was disseminated to all six local and district municipalities by electronic mail addresses. Municipalities were given two weeks to complete and return the questionnaire.

4.4 Data verification process

Subsequent to the dissemination, each municipality was contacted telephonically to establish if the questionnaire had been received: confirmation was obtained from four municipalities.

The data recorded in the interviews with each municipality was sent back to the municipality's GIS officer for verification. All new information, clarification or corrections were collected and added to the database.

4.5 Respondent type

The questionnaire survey was composed of seventeen questions. Most questions required only yes/no answers. In a few questions the respondents had to choose or provide short answers. These questions were all answered. Questions relating to the existence of a spatial data set, number of staff, availability of base and planning maps, GIS and related data were answered.



Chart 4.4: A listing of the six municipalities that responded positively to the survey questionnaire.

Figure 4.4 lists the number of municipalities participating in the survey and the responses to the survey questionnaire. The figure shows that Rustenburg and Ngaka Modiri Molema have not returned the survey questionnaire sent to the municipalities. The interviews were conducted with municipality

personnel delegated to GIS operational work there by means of an emailed questionnaire which was followed up by the telephonic interviews with municipal officials. A secondary data set was searched through the website of the Department of Water Affairs and Forestry, The municipality GIS survey which was conducted by the Department of Land Affairs: Chief Directorate Spatial Planning and Information and also derived from studies conducted by the Department of Provincial and Local Government: Section of Free Basic Services.

4.6 Overview of Survey Responses

The survey has shown that of the six municipalities in South Africa that have participated in the survey, amongst other clients in these municipalities are utility sections that deal with water and electricity services. In six municipalities, the GIS unit is located in the development planning department to respond to planning issues, and all these municipalities have implemented GIS. However, only one of the six municipalities has free water services data set integrated into GIS while a free electricity data set is not integrated anywhere. 67% of the municipalities responded to the questionnaire and positively agreed to implement the policy for indigents where water and electricity services were concerned.

GIS is used in these municipalities to plan water and electricity services and routine maintenance of these. On the level of GIS application, the gap between actual and potential GIS use is even larger: there is 0.5% GIS application to the indigent registry, so the GIS does not respond to the policy issues at local level, at least 50% have implemented GIS. They simply have not yet reached the stage of advanced spatial analysis.

Through secondary data collection it became evident that the 33% of municipalities that did not respond to the questionnaire also made use of GIS and are also implementing the free basic services policy. Surprisingly, the largest municipalities, as well as local municipalities in the upper mid-range municipal sizes, are the most active in adopting GIS technology - but they utilise the system for map making rather than to address policy issues. There is also a difficulty regarding relevant spatial data sets at local level as outlined by the table above on the typical spatial data sets in municipalities in South Africa. The table does not show that GIS in most municipalities has an indigents' registry integrated into it, while a municipality participating in the survey mentioned the lack of funding for GIS activities especially with respect to relevant spatial data and the shortage of staff skilled in GIS as major problems.

According to Pelser (2005), figure 4.1.1 depicts the situation in South African municipalities in terms of their system integrations. This affords an example of most of the local and district municipality's situation in South Africa. Which also the same as the participating municipalities in the survey, it is only Buffalo city municipality as according to the research that the municipality has integrated GIS with other systems in the municipality.



Insert 4.5: Pelser, Martiens.2005. Displays unharmonised municipal systems in South African municipalities

Out of the six municipalities, only four (Buffalo City, Polokwane, Rustenburg and Capricorn) indicated a knowledge of the services provided by the National Spatial Information Framework (NSIF). The Directorate: NSIF has indicated that it administers the Spatial Data Infrastructure (SDI Act 54 of 2003) through the provisions of the Act. The Directorate also supports municipalities by offering technical advice on GIS implementation. It makes available the fundamental GIS datasets free to organs of state to assist municipalities with the development of spatial development frameworks and land use management schemes. The municipalities must lodge a formal request for the spatial information to the NSIF.

4.7 Realities of GIS in three spheres of government in South Africa

National Departments, Provincial Departments and local governments collect a large amount of spatial information to analyze spatial data sets and carry out their various mandates or implement policies. One of these policies is an indigents' policy, and has been discussed in this thesis. GIS is perceived as a new technology possessing the capabilities to assist in monitoring and evaluating the implementation of the various policies, leading to prospective benefits.

As Dueker (1987 and Guptill 1989 cited in Budic 1994) have mentioned, this technology enjoys an advantage when compared with other computerised systems such as thematic mapping or computer aided design with respect to storing, relating, and manipulating attribute and spatial data. "Expectations regarding the new technology are not limited to the automation of routine data handling. GIS technology could also assist with managerial tasks, policy design, decision making, and communication with the public Somers (1987; Rogers and Anderson 1993a, b; Brown and Brudney 1993 cited in Budic 1994)".

4.8 Conclusion

In conclusion, according to the results of the research survey, the challenges faced by the six municipalities result from a combination of issues. At the district and local level the following are inherent problems:

- The utility infrastructure is inadequate to render a service;
- Problems regarding service delivery are experienced; and
- Municipalities are unaware of certain townships within their area of jurisdiction that they are supposed to provide essential services to;
- Municipalities are unable to identify where and who the indigent people in the municipality are.

As shown by the table illustrating the availability of spatial data sets in municipalities, the reality is that the latter works on limited resources. They depend on the financial support of the national and provincial government and of external donors, e.g. the Development Bank of South Africa and international donors, to assist with data collection and budget for GIS implementation in the municipalities. Municipalities have indicated that they possess limited capacity and resources to attract the necessary skills Hendriks (1998:621-639)

Pelser (2005) points out that the boundaries of the district and local municipalities were re-determined after 1994; some were merged, the reason being to ensure better coordination with other spheres of government as well as to ensure better planning and resource allocation across the local councils. The goal of the Municipal Demarcation Board after 1994 was to create a wall-to-wall coverage of district and local municipalities for the whole country. New boundaries were needed to create logical district planning and development areas. All the six municipalities which participated in the survey have been affected by the redetermination of boundaries.

Pelser (2005) mentioned that the creation of the new boundaries resulted in the amalgamation of existing municipalities into single municipalities. This meant that all the roads departments within the previous municipalities were merged into the new roads departments in the new municipal entities. This was also the case for all the other departments such as electricity, town planning and finance.

In most cases, these previous departments used different systems and databases to carry out their functions. This resulted not only in differing systems and databases being used in the same department but also within the various departments in the new municipality. This has made it very difficult for the six municipalities surveyed to share data between departments. The latter operates independently from one another and do not share the available spatial data set.

The pattern emerging from municipalities is that there is an overall thin spread of available technical, human and administrative capacity. This reflection is found mostly in rural municipalities where the lack of technical and managerial skills is greater than in urban areas due to the shortage of pull factors.

In agreement with Tempo (2005), clearly it is not sufficient to possess GIS software and hardware in a municipality yet claim to have a GIS. As indicated earlier, the effective utilisation of GIS in a municipality to address the delivery of free basic services must comply with the criteria mentioned in chapter 3: GIS implementation, GIS strategy, GIS application to service delivery, access to spatial information and relevant skills capacity. The successful implementation and utilisation of GIS in a municipality is dependent on data availability at a level where the municipality would be able to utilise the data for spatial planning.

According to Wyatt and Ralphs (2003 cited in Tempo, 2005), a necessary condition for maximising the benefits of an information system is that departments and municipalities co-operate and pool their resources. It is also hoped that the effective utilisation of GIS will take cognisance of the information management structure within the municipality. The municipal environment is the best area in which to alter the perception of GIS being merely a mapping tool to regarding it as one that can be utilised to monitor and evaluate the impact of government policy as well as aid in decision making.

The effective utilisation of the GIS technology is embedded in the social and technical processes of the organisations (the relationship between individual, organisation and technology) and therefore, it provides a more interesting and insightful perspective on technology utilisation than is presently available.

5 DISCUSSIONS AND CONCLUSIONS

5.1 Introduction

According to the five criteria GIS implementation; GIS strategy; GIS application on service delivery; Access to spatial information; and Relevant skills capacity which was utilized in the study to assess the effective utilization of GIS in six municipalities is evident that, as is the hypothesis that the "More effective utilization of GIS can make a considerable distinction for the free basic service delivery in municipalities":

As mentioned in the previous chapters that more than ninety percent (90%) of information required for the administration of municipalities consists of a spatial component such as parcels of land, road networks, and infrastructure for utilities, with the result that GIS has been viewed as being an essential technology for urban/rural management" Bromley and Coulson (1989).

The above mentioned five criteria will be used to summarize and make recommendation of the findings of the surveyed municipalities to.

5.2 Summary

With reference to the hypothesis, the survey of the six municipalities is summarized as follows:

- In terms of <u>GIS implementation</u>, of the six municipalities participating in the survey Buffalo City, Polokwane and Capricorn municipalities have implemented a Corporate GIS, which is integrated with other municipal systems, such as the billing system for revenue collection and infrastructure management. However, the GIS is not integrated with the indigents' registry in order to assist in identifying who are the beneficiaries, how many are there, or where are they located. Due to GIS not integrated with indigent database the six municipalities cannot take full advantage of the analytical capabilities of GIS.
- In terms of <u>GIS strategy</u>, of the six municipalities participating in the survey, all of the six municipalities are aware of the indigent policy to be implemented by their municipalities but indigent databases are stand alone in nature and is not linked spatially to the GIS in the municipality, only Buffalo City has formulated a GIS strategy to bring about a paradigm shift towards effective spatial planning as well as to share spatial and attribute data between systems. Which means the six municipalities, without future plan of ensuring that GIS should be integrated with others systems in the municipality they would not be able to effectively plan and implement service delivery planning.
- In terms of <u>GIS application</u> Alfred Nzo, Buffalo City, Capricorn and Polokwane have their municipal GIS' placed in the realm of development planning or town and regional planning. The Central and Rustenburg municipalities have their GIS located in their IT sections.
- In terms of <u>GIS skills capacity</u>. The six municipalities all employ full time dedicated staff to
 ensure that the GIS unit runs smoothly. Four municipalities: Alfred Nzo, Buffalo City, Capricorn
 and Polokwane, have indicated that it is a challenge to find GIS officers and retain them in the
 municipality for longer periods because municipalities do not offer attractive salaries. Looking at

the graph that showed income capita per municipality, these municipalities requires more than one or two GIS officials to get the work done.

 In terms of <u>Access to spatial information</u>, the six municipalities have indicated their knowledge to Directorate: National Spatial Information Framework that could assist them with the country's fundamental data sets to be used as base spatial data sets for the planning of projects. The challenge is that the spatial data sets they receive from National departments are at a general level, while municipalities are in need of detailed spatial data sets and most current spatial data sets, and have budgetary issues on collection of the recent data sets.

5.3 Conclusions

Based on the results of the study, the hypothesis that "more effective utilization of GIS can make a considerable distinction for the free basic service delivery in municipalities" is proven to be true.

- From the six Municipalities only Buffalo city is able to utilize GIS for service delivery in other areas for example collection of revenue but all of the six are unable to monitor progress and backlog on the free basic services programme of government
- Of the six municipalities, all of them do not have access to relevant spatial data sets to conduct advanced queries in GIS to identify through GIS who are the beneficiaries of free basic services in the municipal jurisdiction
- The GIS systems in six municipalities have been established post 1994 but is still utilized for more on mapping and less for responding to policies of government.

6. **RECOMMENDATIONS**

Based on the results of the study, the following recommendations are made for the six municipalities to ensure effective utilization of GIS in addressing free basic services/government policies:

GIS Implementation

 Where possible, a corporate approach should be taken with regard to GIS implementation in municipalities as it will enhance the integration of municipal processes and systems, improve information management within the municipality, and create a knowledge management culture.

GIS Strategies

- The municipalities should move away from centralised GIS and more towards a distributed information system as a way of ensuring sharing of spatial data sets.
- The municipalities should integrate their GIS with other municipal systems for example the billing / financial system for revenue collection, the indigent database for implementation of government programmes and policies, development planning systems for municipal spatial development plan development.
- The municipalities need to integrate indigent databases with GIS so that non technical managers and politicians would be able to monitor the impact of the government programmes and policies.

Access to Spatial Information

• The municipalities should / must invest in up to date and accurate spatial information for example cadastral and aerial photography / images to provide effective decision support to municipal managers and engineers on free basic services programme.

GIS Application

- GIS can be used to calculate useful statistics and demographic information of indigent populations in municipalities and "cost to council" calculations can be made. The municipality can budget for indigent service delivery.
- Local government as an implementing arm of government policies and programmes requires to implement GIS to assist with managerial tasks, policy monitoring and implementation, decision making, monitoring of projects on the ground and planning and maintenance of infrastructure projects.

GIS skills capacity

 Develop a proper GIS structure in the municipality, located or reporting directly to Municipal Manager; improve the salary scales of GIS personnel in municipalities to ensure continuity and better levels of service delivery.

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8. APPENDIX

Annexure A for survey questionnaire

Questionnaire Response 1: Alfred Nzo District Municipality

Date: 03 May 2007								
1. <u>Masters science in GIS Dissertation Questionnaire</u>								
This survey is being conducted for the Msc. GIS with the Vrijie Universiteit-Amsterdam. This questionnaire will form an essential part of the research.								
The research focuses on the effective utilization of Geographic Information Systems (GIS) in								
municipalities in South-Africa post 1994 with regard to the free basic service delivery problem?								
It will take no longer than 10 minutes. All replies will remain confidential and anonymous, and only used for this research. Thank you for your time and co-operation.								
For each question please elaborate.								
2.2 SECTION A								
Province: Eastern Cape, Alfred Nzo District Municipality								
Department/Division/Unit: IT								
Respondent(s): 1								
Position: GIS Technician								
Phone: 039 254 5000								
Q. 1 Which category is your municipality A, B or C? B								
Q. 2 How long have you worked for the GIS unit? 4 yrs								
Q. 3 When was GIS implemented in your organization? 2001								
2.3 SECTION B								
Q.1 What are the key uses for geographically referenced information to your office's mission? Give example								
[Capturing and updating of water scheme infrastructure, Assist with disaster management centre to map all areas affected by disaster. Assist with spatial development framework in the IDP, To map all households identified as indigent i.e. people who qualify for free basic services, Assist other local municipality with their GIS implementation, Map the new roads being developed / constructed]								

Q. 2 What are the major limitations faced by your office in accessing geographically-referenced information that may be eased or eliminated with proper implementation of a geographic information system?):

Hardware e.g. Proper Server With enough storage space; Lack of skilled personnel (only one GIS technician and if not there then data can't be assessed

Q. 3 What technical ideas or observations do you have which impact GIS and related system implementation?

Map production; Image processing; Data capturing with GPS; GIS Software Installation; Database design etc

Q. 4 By whom are GIS programs or the results of GIS applications, used within your organization /departments? (Please choose with a • just ONE answer how often these employees work with GIS and if they use it themselves (directly) or just use the output from a GIS system of application (indirectly).

Use sort	Use	Use often Use incidental		Do not use	
	Directl Indirec	Directly Directly Indirectly Indirectly			
Counter clerk for instance Cadastral information or Environmental information.					
Policy employee					
Maintenance employee					
Head of the department					
Long term planning employee					
Management team					
Mayor					
Counselors					
Outside personnel (like surveyors,)					
Others (please specify)					

Q. 5 Which objectives/ Aims for introducing GIS technology or applications were set and which are reached, partly reached or not reached. (Please specify with a • what was searched for and if these goals are reached, partly reached or not)

Objectives / Aims	Searche d for		Not reac hed	PARTLY reached	Reach ed
Improved access to information sources.					
Better quality of information.					
Better informed decision.					
Quicker decision-making.					
Automation of existing methods of analysis.					
New forms of analysis					
To make more effective use of the means of the organization.					
Improved spread and distribution of information.					
Reducing expenses.					
Quicker service to the citizens.					

Improved information management or in the whole			
organization.			
Presenting alternatives by defining new policy proposals.			

Q.6 Are employees especially responsible for organizing, implementing, and maintaining GIS systems / applications and its data?

✓ Yes, Special person is especially responsible
 □ No, responsibilities are within the existing functions.

2.3.1 SECTION C

Q.1 Which objectives/Aims for introducing GIS technology or applications were set and which are reached, partly reached or not reached.

Establishment of GIS workstation; Software Installation; Datasets Collection; Data Management & Dissemination (All reached)

Q.2 Who was of the most importance in the decision making process to make use of GIS

technology? GIS Technician

Q.3 Which activities were done before the installation of the GIS system?

Hardcopy management of data e.g. Maps; As-built drawings etc

Q.4 is there in your organization a plan with a vision and/ or objectives defined in it?

Yes, integrated development plan

Q.5 Who was educated in the use of GIS software?

GIS Technician

Q.6 How was the GIS developed in the organization?

User requirements and needs analysis was conducted.

Clients were identified.

Systems (hardware & software) were identified and purchased.

GIS Technician skills development and Development of Web-based GIS for clients

Q. 7 Has GIS supported the free basic services delivery initiative? Identifying on a map which people or household qualify.

Q.8 Which Municipality systems(e.g. Indigent registry) are linked to GIS?

DIMS: District information management systems; We are in a process of establishing Indigent registry which will be linked to GIS.

Should you have any queries about the questionnaire or, if you are willing to take part in a more in-depth interview on the subject over e-mail, then please contact Oteng Dhlamini at <u>oteng@mighty.co.za</u> or <u>opdhlamini@dla.gov.za</u>

Questionnaire can be faxed @ (086) 5116673 or emailed Thank you.

Questionnaire Survey 2: Buffalo City

Date: 03 May 2007								
1. <u>Masters science in GIS Dissertation Questionnaire</u>								
This survey is being conducted for the Msc. GIS with the Vrijie Universiteit-Amsterdam. This questionnaire will form an essential part of the research.								
The research focuses on the effective utilization of Geographic Information Systems (GIS) in								
municipalities in South-Africa post 1994 with regard to the free basic service delivery problem?								
It will take no longer than 10 minutes. All replies will remain confidential and anonymous, and only used for this research. Thank you for your time and co-operation.								
For each question please elaborate.								
2.1 SECTION A								
Province: Eastern Cape Province (Buffalo City)								
Department/Division/Unit: Development Planning								
Nolusindiso Davids Position: GIS Technician								
Phone: 043 705 3921								
Q. 1 Which category is your municipality A, B or C? B								
Q. 2 How long have you worked for the GIS unit? 4 yrs								
Q. 3 When was GIS implemented in your organization? 2001								
2.2 SECTION B								
Q.1 What are the key uses for geographically referenced information to your office's mission? Give example								
[To monitor and manage service delivery projects for example GIS is utilized to conduct spatial comparison between the department master plans and Spatial Development Frameworks; GIS helps to manage the spatial data and develop decision support tools for service delivery]								
Q. 2 What are the major limitations faced by your office in accessing geographically-referenced information that may be eased or eliminated with proper implementation of a geographic information system?):								
Like any other municipality in the country, Buffalo city has to capture feature level spatial data as other government departments have general spatial data set.								

Q. 3 What technical ideas or observations do you have which impact GIS and related system implementation?

Q. 4 By whom are GIS programs or the results of GIS applications, used within your organization /departments? (Please choose with a • just ONE answer how often these employees work with GIS and if they use it themselves (directly) or just use the output from a GIS system of application (<u>indirectly</u>).

Use sort	Use often Use incidental		Do not use		
	Directl Indirec	y tly	Directly Indirectly		
Counter clerk for instance Cadastral information or Environmental information.					
Policy employee					
Maintenance employee					
Head of the department					
Long term planning employee					
Management team					
Mayor					
Counselors					
Outside personnel (like surveyors,)					
Others (please specify)					

Q. 5 Which objectives/ Aims for introducing GIS technology or applications were set and which are reached, partly reached or not reached. (Please specify with a • what was searched for and if these goals are reached, partly reached or not)

Objectives / Aims	Searche d for		Not reac hed	PARTLY reached	Reach ed
Improved access to information sources.					
Better quality of information.					
Better informed decision.					
Quicker decision-making.					
Automation of existing methods of analysis.					
New forms of analysis					
To make more effective use of the means of the organization.					•
Improved spread and distribution of information.					
Reducing expenses.					
Quicker service to the citizens.					
Improved information management or in the whole organization.					
Presenting alternatives by defining new policy proposals.					

Q.6 Are employees especially responsible for organizing, implementing, and maintaining GIS systems / applications and its data?

✓ Yes, Special person is especially responsible
 □ No, responsibilities are within the existing functions.

2.2.1 SECTION C

Q.1 Which objectives/Aims for introducing GIS technology or applications were set and which are reached, partly reached or not reached.

GIS is utilized to monitor service delivery and also for decision makers to correctly interpret information derived from the spatial data (All reached)

Q.2 Who was of the most importance in the decision making process to make use of GIS

technology? GIS Manager

Q.3 Which activities were done before the installation of the GIS system?

User needs analysis conducted.Spatial analysis was done, gaps identified and data set collected.

Q.4 is there in your organization a plan with a vision and/ or objectives defined in it?

Yes, GIS strategy to address sharing of spatial information and spatial data set standards

Q.5 Who was educated in the use of GIS software?

Basic users; Data Custodians and Overview Users (Managers and politicians)

Q.6 How was the GIS developed in the organization?

The municipality decided on corporate GIS, to ensure that integrated planning addresses strategic purposes in the municipality. The GIS is utilized to monitor service delivery and also for decision makers to correctly interpret information derived from the spatial data.

Q. 7 Has GIS supported the free basic services delivery initiative?

Yes. GIS in Buffalo city is currently utilized to address basic service delivery and identify service delivery shortfalls using spatial analysis techniques to identify who benefits from services and who does not.

Q.8 Which Municipality systems (e.g. Indigent registry) are linked to GIS?

Planning schemes (Integrated Development Planning, Spatial Development Frameworks). Infrastructure management systems and identify service delivery shortfalls using spatial analysis techniques to identify who benefits from services and who does not.

Should you have any queries about the questionnaire or, if you are willing to take part in a more in-depth interview on the subject over e-mail, then please contact Oteng Dhlamini at <u>oteng@mighty.co.za</u> or opdhlamini@dla.gov.za

Questionnaire can be faxed @ (086) 5116673 or emailed Thank you.

Questionnaire survey 3: Capricorn District Municipality

Date: 03 May 2007									
2. <u>Masters science in GIS Dissertation Questionnaire</u>									
This survey is being conducted for the Msc. GIS with the Vrijie Universiteit-Amsterdam. This questionnaire will form an essential part of the research.									
The research focuses on the effective utilization of Geographic Information Systems (GIS) in									
municipalities in South-Africa post 1994 with regard to the free basic service delivery problem? It will take no longer than 10 minutes. All replies will remain confidential and anonymous, and only used for this research. Thank you for your time and co-operation.									
For each question please elaborate.									
2.3 SECTION A									
Province: Polokwane (Capricorn District Municipality)									
Department/Division/Unit: Development Planning Section									
Respondent(s): 1									
Position: According to research conducted by Mr Mabuza on behalf of Department of Land Affairs									
Phone:									
Q. 1 Which category is your municipality A, B or C? C									
Q. 2 How long have you worked for the GIS unit?									
Q. 3 When was GIS implemented in your organization? 2000									
2.4 SECTION B									
 Q.1 What are the key uses for geographically referenced information to your office's mission? Give example [GIS is utilized for water and sanitation, energy, roads and storm water, infrastructure development and 									
 Q. 2 What are the major limitations faced by your office in accessing geographically-referenced information that may be eased or eliminated with proper implementation of a geographic information system?): Collection of relevant spatial data at municipality level. 									

Q. 3 What technical ideas or observations do you have which impact GIS and related system implementation? **Data capturing with GPS; and Database design etc**

Q. 4 By whom are GIS programs or the results of GIS applications, used within your organization /departments? (Please choose with a • just ONE answer how often these employees work with GIS

and if they use it themselves (directly) or just use the output from a GIS system of application (indirectly).

Use sort	Use often		Use incidental		Do not use
	Directl Indirec	y tly	Directly Indirectly		
Counter clerk for instance Cadastral information or Environmental information.					
Policy employee					
Maintenance employee					
Head of the department					
Long term planning employee					
Management team					
Mayor					
Counselors					
Outside personnel (like surveyors,)					
Others (please specify)					

Q. 5 Which objectives/ Aims for introducing GIS technology or applications were set and which are reached, partly reached or not reached. (Please specify with a • what was searched for and if these goals are reached, partly reached or not)

Objectives / Aims	Searche d for		Not reac hed	PARTLY reached	Reach ed
Improved access to information sources.					
Better quality of information.					
Better informed decision.					
Quicker decision-making.					
Automation of existing methods of analysis.					
New forms of analysis					
To make more effective use of the means of the organization.					
Improved spread and distribution of information.					
Reducing expenses.					
Quicker service to the citizens.					
Improved information management or in the whole organization.					
Presenting alternatives by defining new policy proposals.					

Q.6 Are employees especially responsible for organizing, implementing, and maintaining GIS systems / applications and its data?

✓ Yes, Special person is especially responsible
 □ No, responsibilities are within the existing functions.

2.4.1 SECTION C

Q.1 Which objectives/Aims for introducing GIS technology or applications were set and which are reached, partly reached or not reached.

Establishment of GIS workstation; Software Installation; Datasets Collection; Data Management & Dissemination (All reached)

Q.2 Who was of the most importance in the decision making process to make use of GIS

technology? GIS officer

Q.3 Which activities were done before the installation of the GIS system?

Identification of relevant spatial data set from other government departments and National Departments

Q.4 is there in your organization a plan with a vision and/ or objectives defined in it?

No

Q.5 Who was educated in the use of GIS software?

GIS officer

Q.6 How was the GIS developed in the organization?

Collection of Spatial data set from other government departments

Clients were identified.

Systems (hardware & software) were identified and purchased.

Q. 7 Has GIS supported the free basic services delivery initiative?

Yes in some instances, GIS is utilized in water and sanitation planning .

Q.8 Which Municipality systems (e.g. Indigent registry) are linked to GIS? No GIS is not linked to indigent registry.

Should you have any queries about the questionnaire or, if you are willing to take part in a more in-depth interview on the subject over e-mail, then please contact Oteng Dhlamini at <u>oteng@mighty.co.za</u> or opdhlamini@dla.gov.za

Questionnaire can be faxed @ (086) 5116673 or emailed

Thank you.
Questionnaire 4: Polokwane Municipality

Date: 03 May 2007						
3. Masters science in GIS Dissertation Questionnaire						
This survey is being conducted for the Msc. GIS with the Vrijie Universiteit-Amsterdam. This questionnaire will form an essential part of the research.						
The research focuses on the effective utilization of Geographic Information Systems (GIS) in						
municipalities in South-Africa post 1994 with regard to the free basic service delivery problem?						
It will take no longer than 10 minutes. All replies will remain confidential and anonymous, and only used for this research. Thank you for your time and co-operation.						
For each question please elaborate.						
2.5 SECTION A						
Province: Polokwane						
Department/Division/Unit: Development Planning						
Respondent(s): 1						
Position: According to research conducted by Mr Mabuza on behalf of Department of Land Affairs						
Phone:						
Q. 1 Which category is your municipality A, B or C? B						
Q. 2 How long have you worked for the GIS unit? 4 yrs						
Q. 3 When was GIS implemented in your organization? 2001						
2.6 SECTION B						
Q.1 What are the key uses for geographically referenced information to your office's mission? Give example						
[Capturing and updating of water scheme infrastructure, Assist with disaster management centre to map all areas affected by disaster. Assist with spatial development framework in the IDP, To map all households identified as indigent i.e. people who qualify for free basic services, Assist other local municipality with their GIS implementation, Map the new roads being developed / constructed]						

Q. 2 What are the major limitations faced by your office in accessing geographically-referenced information that may be eased or eliminated with proper implementation of a geographic information system?):

Hardware e.g. Proper Server With enough storage space; Lack of skilled personnel (only one GIS technician and if not there then data can't be assessed

Q. 3 What technical ideas or observations do you have which impact GIS and related system implementation?

Map production; Image processing; Data capturing with GPS; GIS Software Installation; Database design etc

Q. 4 By whom are GIS programs or the results of GIS applications, used within your organization */departments?* (Please choose with a • just ONE answer how often these employees work with GIS and if they use it themselves (directly) or just use the output from a GIS system of application (indirectly).

Use sort	Use often		Use incidental		Do not use
	Directly Indirectly		Directly Indirectly		
Counter clerk for instance Cadastral information or Environmental information.					
Policy employee					
Maintenance employee					
Head of the department					
Long term planning employee					
Management team					
Mayor					
Counselors					
Outside personnel (like surveyors,)					
Others (please specify)					

Q. 5 Which objectives/ Aims for introducing GIS technology or applications were set and which are reached, partly reached or not reached. (Please specify with a • what was searched for and if these goals are reached, partly reached or not)

Objectives / Aims	Sear d fo	rche or	Not reac hed	PARTLY reached	Reach ed
Improved access to information sources.					
Better quality of information.					
Better informed decision.					
Quicker decision-making.					
Automation of existing methods of analysis.					
New forms of analysis					
To make more effective use of the means of the organization.					
Improved spread and distribution of information.					
Reducing expenses.					
Quicker service to the citizens.					
Improved information management or in the whole organization.					
Presenting alternatives by defining new policy proposals.					

Q.6 Are employees especially responsible for organizing, implementing, and maintaining GIS systems / applications and its data?

- ✓ Yes, Special person is especially responsible
- $\hfill\square$ No, responsibilities are within the existing functions.

2.6.1 SECTION C

Q.1 Which objectives/Aims for introducing GIS technology or applications were set and which are reached, partly reached or not reached.

Establishment of GIS workstation; Software Installation; Datasets Collection; Data Management & Dissemination (All reached)

Q.2 Who was of the most importance in the decision making process to make use of GIS

technology? GIS Technician

Q.3 Which activities were done before the installation of the GIS system?

Hardcopy management of data e.g. Maps; As-built drawings etc

Q.4 is there in your organization a plan with a vision and/ or objectives defined in it?

Yes, integrated development plan

Q.5 Who was educated in the use of GIS software?

GIS Technician

Q.6 How was the GIS developed in the organization?

User requirements and needs analysis was conducted.

Clients were identified.

Systems (hardware & software) were identified and purchased.

GIS Technician skills development and Development of Web-based GIS for clients

Q. 7 Has GIS supported the free basic services delivery initiative?

Identifying on a map which people or household qualify.

Q.8 Which Municipality systems(e.g. Indigent registry) are linked to GIS?

DIMS: District information management systems; We are in a process of establishing Indigent registry which will be linked to GIS.

Should you have any queries about the questionnaire or, if you are willing to take part in a more in-depth interview on the subject over e-mail, then please contact Oteng Dhlamini at <u>oteng@mighty.co.za</u> or <u>opdhlamini@dla.gov.za</u> Questionnaire can be faxed @ (086) 5116673 or emailed

Thank you.

Survey Questionnaire 5: Ngaka Modiri Molema District Municipality:

Did not receive the questionnaire back, had to conduct telephone enquiry with Ms F Makgale.

Survey Questionnaire 6: Rustenburg Local Municipality:

Did not receive the questionnaire back, had to conduct the telephone enquiry with Mr. D Gill.