THE COST EFFECTIVE IMPLEMENTATION OF INTEGRATED SPATIAL MANAGEMENT INFORMATION SYSTEMS IN LOCAL GOVERNMENT

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by

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Declaration

Hereby I, Nico Michiel Elema, declare that this study project is my own original work and that all sources have been accurately reported and acknowledged, and that this dissertation has not been previously, in its entirety or in part, been submitted at any university in order to obtain an academic qualification.

N.M. Elema 13 January 2006

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Opsomming

Daar word al hoe meer van die bestuur in plaaslike owerhede verlang, om verslag te lewer oor verskeie ruimtelike projekte en inisiatiewe in hul owerheidsgebied. Met die ontwikkeling van Informasie Tegnologie word verskeie elektroniese stelsels ge-implementeer om nie net aan die verslaggewingbehoeftes te voldoen nie, maar ook die instandhouding, datavaslegging en stoor van data te ondersteun. Om ten volle aan die verslagewingbehoeftes te kan voldoen, word daar ook al hoe meer van stelsels verlang om te integreer, om sodoende toegang tot meer datastelle in die organisasie te gee. Maar terwyl die verslaggewingbehoeftes gewoonlik duidelik is, is die kostes om relevante stelsels te integreer gewoonlik onduidelik. 'n Rede waarom kostes onduidelik mag wees, spruit uit die behoefte vir implimenteerders van geïntegreerde stelsels om faktore wat kostes dryf te begryp, en sodoende kostes beter te kan bestuur.

Deur middel van 'n literatuurstudie is die ruimtelike behoeftes binne plaaslike regering ondersoek, gevolg deur 'n ondersoek na moontlike oplossings om dié ruimtelike behoeftes aan te spreek. As 'n oplossing, word 'n Geïntegreerde Ruimtelike Bestuursinligting Stelsel (GRBS) bespreek. Sewe primêre kostefaktore word geïdentifiseer en bespreek om 'n beter begrip te ontwikkel van die relevante kostefaktore. Hierdie kostefaktore sluit data, programmatuur, apparatuur, opleidingsbehoeftes, doelgemaakte programmatuur, instandhouding en tydsbeperkings in. Elke kostefaktor word in detail bespreek, en die potensiële impak wat dit op die totale koste van 'n projek mag hê, word ondersoek. 'n Metode om die sukses van 'n projek te meet, word ook bespreek, waarvolgens die totale koste om 'n GRBS te implementeer gemeet word teen die totale aantal aktiewe gebruikers van die stelsel, soos uitgedruk in koste-per-gebruiker. Die verwantskap tussen die verskillende gebruikers in 'n plaaslike munisipaliteit, hul funksies en die impak wat die kostefaktore kan hê op die gebruik en koste-per-gebruiker-berekening word ook bespreek. Om die impak te illustreer,

word drie verskillende voorbeelde bespreek, elk met veranderende kostefaktore. Daar is gevind dat die bestuur van kostefaktore die gebruik van die stelsel grootliks laat toeneem, wat sodoende die implementering van die GRBS meer koste effektief maak. Laastens word "koste-voordeel analise" as konsep bespreek, waarby koste teenoor voordeel gemeet kan word, om sodoende 'n GRBS te ontwikkel waar die voordele die kostes oortref.

Abstract

Management within Local Government are increasingly required to report on the various spatially related projects and initiatives within their jurisdiction. As Information Technology develops, various electronic systems are implemented within the organisations, not only assist in the reporting, but also to fulfil the data requirements in relation to maintenance, capturing and storing of data. In order to fully adhere to the reporting needs, systems are also increasingly required to integrate, and in so doing, provide access to more data in the organisation. But as the reporting requirements are often clear, the cost in implementing the required systems elude implementers. One of the reasons for costs being unclear stems from a need for integrated systems to help implementers to understand the cost factors which drive costs, and in so doing, enabling them to manage costs incurred in projects better.

By means of a literature review, the spatial information needs within Local Governments are investigated, followed by the investigation of solutions to address the spatial needs. As a solution, an Integrated Spatial Management Information System (ISMIS) is discussed. Seven primary cost factors are identified and discussed to assist in the better understanding of the relevant cost factors. These cost factors include data, software, hardware, training requirements, customisation, maintenance and time constraints. Each cost factor is discussed in detail, and the potential impact it might have on the total cost of a project investigated. A method measuring the success of a project is also discussed, whereby the total cost in implementing an ISMIS is related to the number of active users as expressed in cost-per-seat. The relationship between the different types of users within a local municipality, their function and the impact the cost factors can have on the use and cost-per-seat calculation are also discussed. To illustrate the impact, three different scenarios are discussed, each with variable cost factors. It is found, that the management of cost factors can greatly increase the

use of a system, and thereby make the implementation of the system more cost-effective. Finally the concept of cost-benefit analysis (CBA) is also discussed, providing a concept whereby the costs can be measured against benefits, where the aim is to implement an ISMIS where the benefits outweigh the costs.

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CHAPTER 1
INTRODUCTION AND STATEMENT OF THE PROBLEM

1.1 Introduction

It is increasingly required from Local Governments to render services, which are focused on reconstruction and development as stipulated by National Government policies. These policies are aimed at addressing economic growth, eradicating poverty, providing housing and good governance in organisations and the areas under their jurisdiction. In areas where unemployment and poverty are the norm rather than the exception, even more strain is placed on the financial burden of such Local Authorities. In a recent report (Project Consolidate, 2004:10) the Department of Provincial and Local Government estimates that 226 out of 284 municipalities have more that 50% households classified as *indigent households.* Indigent households are households with an income less than R1600.00 per month. Thus, with more than 79% of all Local Councils facing the reality of a smaller income base, the fine balance between receiving funds to finance economic growth, and the financial obligations of the organisation, need to be planned and managed effectively. In an effort to plan and manage resources effectively, a holistic approach is followed in addressing the root of poverty and unemployment. Projects are initiated which would benefit the region over a longer-period of time, and thus provide a better chance for sustainable development.

But projects that would provide sustainable benefits are fuelled by enormous budgets, and the need to effectively plan, apply, and manage funds, is an essential requirement in the success of the Local Government. Various systems and processes are implemented within Local Governments to assist in the day-to-day operation of the organisations, including financial-, human resource-, building control- and land use management systems. Until recently, these systems have been operating independently from each other, and when integration did exist, integration was mostly limited.

Developments in Information Technology and specifically Geographical Information technologies, has enabled the effective implementation of Integrated Spatial Management Information Systems (ISMIS). The ability of these enterprise systems to integrate different systems into a single data repository, from where information can be updated and disseminated, has enabled users from all levels in the organisations to access data. By enabling these users to visualise data on a map of the area, trends and scenario planning can be conducted, enabling these organisations to effectively manage and stimulate economic growth within their area.

1.2 Statement of the problem

As implementers of ISMIS embark on projects, the question is more often asked: “At what cost and what will the benefits be?” The implementation of an ISMIS could cost an organisation millions of Rands during the implementation phase of such a project. Further maintenance costs are also required to provide the backbone of the project, which, if neglected, could take the sustainable momentum from the project.

In a tender published at the end of 2004 by the Overberg District Municipality, an assessment of tenders by the prospective service providers indicated that from the six service providers offering their services and products, costs ranged from ZAR 2,821 million to ZAR 5,778 million with an average cost of ZAR 4,260 million. The various tender prices are tabulated in Table 1.1 below.

Table 1.1: Comparable tender prices of the Overberg District Municipality ISMIS tender

Company	Price
Company A	ZAR 3,146,150.00
Company B	ZAR 4,676,850.00
Company C	ZAR 5,778,905.00
Company D	ZAR 4,878,539.00
Company E	ZAR 2,821,878.75
Company F	Did not provide a total cost
Average	**ZAR 4,260,464.55**

Source: Overberg District Municipality, 2005

Many Local Governments would find tendered-cost an obstacle in the implementation of an ISMIS if the cost is too high and perceived in isolation. They do not, however, consider the added benefits in implementing an ISMIS. As costs are inevitably incurred, added benefits are also derived from the system. A recent report (*Guidelines for Best Practice in User Interface for GIS*, 1998:97) refers to how benefits in spatial related projects can be defined in direct, indirect and external benefits[1]. In essence, the goal in implementing an ISMIS is to achieve a greater benefit than the cost in implementing an ISMIS.

In recent years, many Local Governments have embarked on the development of an ISMIS. In many organisations, the expectations created by service providers through the demonstration of software packages with pre-setup data sets, are not met in reality.

[1] For a more detailed discussion on the different types of benefits, refer to par. 3.4.1.1 of this document.

In many cases, organisations are led to believe that the purchase of a specific software package will solve all their organisation's spatial needs, and after completing numerous software training courses, realise that the only knowledge they have gained, was the realisation of how little they actually know, and how dependant many organisations are on service providers.

Experience has indicated that many Local Governments have become disillusioned and disappointed with spatial systems and service providers. Many Local Governments have spent large amounts of financial and human resources in the development of spatial systems, just to end up with a proverbial "white elephant" - a system that is extremely valuable, but of which the maintenance places an enormous financial burden on the organisation. With scarce resources and the demand for better service delivery, Local Governments can ill afford to waste funds on systems that do not provide tangible benefits to the organisation. Where systems have been implemented and pressure is mounting for users to gain access, implementers need to be aware of the factors that hinder users to gain access to the systems, in order to open systems up to as many users as possible.

1.3 Objective of the study

Section 152 of the Constitution of South Africa (Act 108/1996) defines that the objectives of Local Governments in South Africa are to:

a. provide democratic and accountable government for local communities;
b. to ensure the provision of services to communities in a sustainable manner;
c. to promote social and economic development;

d. to promote a safe and healthy environment; and
e. to encourage the involvement of communities and community organisations in the matters of Local Government.

In an effort to achieve these common objectives, Local Governments are structured uniquely, thus leading to unique implementation strategies of ISMIS for every organisation. There is unfortunately no COTS (Commercial of the shelf) software available, which could, after a simple five minute installation process, solve all the organisation's needs. All aspects within the spatial system need to be considered which include hardware, software, people, processes, and data, and within each of these components, certain factors occur that would have an impact on the eventual cost of the project and need to be considered.

The main objective of this study is to provide an understanding of the different cost factors in the development and implementation of ISMIS in Local Government, and to illustrate how these factors can influence the cost of a project. With a better understanding of the different cost factors, cost-effective systems can be developed for Local Governments. Cost effectiveness does not necessarily refer to the project with the least cost, but the project with the most effective application of cost, providing the greatest benefit in relation to user needs, and where the benefits ultimately outweigh the cost.

In identifying and understanding these cost factors, project implementers (from Local Government and service providers) would, from the outset of a project, recognise those factors that impact on the development of an ISMIS. They would furthermore understand the advantages and disadvantages of the cost factors, and would be able to manage these cost factors in such a way that systems would be implemented as cost-effective as possible, and that the outcome of the project could be measured against a cost-benefit analysis, where the benefit in fact exceeds the cost.

1.4 Methodology

To achieve the objectives of the study, the following methodology will be followed.

1.4.1 Literature study

In order for implementers of an ISMIS to cost-effectively establish electronic systems within Local Government, a systematic literature study will be undertaken. The following key aspects will be investigated:

- In order to understand what the spatial information needs within Local Governments are, the different Local Government structures will be investigated. The different structures will provide input into the purpose and function of Local Government. Based on the different functions, spatial information needs will be investigated.
- Through the use of Information Technology, different electronic systems operate within Local Governments. The different systems will be investigated, to define an ISMIS.
- Having defined an ISMIS, the different cost-factors will be investigated, which have an impact on the cost-effective implementation of an ISMIS within Local Government.
- Once insight has been gained into the different cost-factors, methods will be investigated on the management of cost, when an ISMIS is implemented. The relationship between cost, software functionality

(based on user-function in the organisation) and the different types of users of an ISMIS will be investigated. Finally, the relationship between cost and benefit will also be investigated as an applicable measurement of cost-effectives of an ISMIS implementation in Local Government.

1.4.2 Empirical study

As this study is essentially a Literature study, little empirical data will be used. In cases where a point in the literature study needs to be supported by empirical data, such data will be used, which will include:

- Comparable tender prices of the Overberg District Municipality ISMIS tender;
- The comparable software prices of GIS software;
- The basic calculation of cost-per-seat; and
- Examples of cost-benefit analysis within a spatial context, for three fictitious Municipalities.

1.5 Delimitation

Due to the complexity in function within Local Councils, this study will focus on the systems associated with Land Use Management within Local Government. These systems would include Land Use Management Systems (Building- and Land Use Control), Engineering Services Management Systems, Geographical Information Systems and Financial Systems.

The geographical delimitation of the study will also focus on Local Government structures within South Africa, as affected by the legislations which form the Local Government Structures.

Furthermore, the study will introduce the following concepts without providing detailed calculations on each of the concepts:

- Tangible- and intangible costs in the implementation of an ISMIS;
- Cost-benefit analysis (CBA) and how the cost-effectiveness of an ISMIS can expressed; and
- Cost as expressed as cost-per-seat, and how it relates to the cost-effective implementation of an ISMIS.

1.6 Layout of the study

The study is presented in six chapters.

Chapter 1 provides the introduction, the statement of the problem faced by Local Governments, followed by the objective of the study. The assumptions and delimitation are also defined, providing the framework for the study.

In **Chapter 2** of this dissertation the spatial information needs within Local Government will be assessed. These needs stem from the purpose of Local Governments within the South African context, created by Governmental structures.

Chapter 3 of the study will investigate how these spatial needs can be addressed, within the existing systems operational within Local Governments. Systems such as Management Information System (MIS) and Geographical Information System (GIS) will be discussed, with the view of defining an Integrated Spatial Management Information System (SMIS).

Chapter 4 will aim to identify the factors that are responsible for driving costs within the development and implementation of ISMIS, for if these factors are misunderstood, unnecessary costs can be allocated to projects, making them cost-ineffective.

Chapter 5 of the dissertation will aim to provide insight into the types of users within organisations, and based on their functional requirements, how cost effective ISMIS can be implemented within Local Government. The cost-effectiveness of ISMIS can be calculated by means of a cost-benefit analysis, which will also be discussed.

Chapter 6 of this dissertation will summarise and conclude the study.

CHAPTER 2
THE SPATIAL INFORMATION NEEDS WITHIN LOCAL GOVERNMENT

2.1 Introduction

In order to understand the information needs within Local Government, a brief outline of the Local Government sphere will be provided. This chapter will focus on the broad background to the formation of the existing Local Government structures, through legislation. The purpose and functions of Local Governments will be discussed, followed by the information needs within these structures. Finally a discussion on the types of clients associated with a Local Government will be discussed.

2.2 Local Government structures in South Africa

Since the democratic election of a new multi-party government, headed by the African National Congress (ANC) in 1994, a transformation of Local Government has occurred. Following the approval of the Constitution of South Africa (Act 108 of 1996), on 4 December 1996, various White Papers and following Acts were passed through parliament providing input and affecting the structures and various functions within municipalities. To name but a few, these documents and legislations include:

- The White Paper on Local Government, March 1998;
- Spatial Planning and Land Use Management White Paper, July 2001;
- The Organised Government Act (Act 52/1997);
- The Cross Boundary Municipalities Act (Act 29/2000);
- The Municipal Systems Act (Act 32/2000 and amendment as Act 44/2003);

- The Municipal Demarcation Act (Act 27/1998);
- The Municipal Structures Act (Act 117/1998 and various amendments: Act 58/99, Act 33/2000, Act 20/2002 and Act 1/2003);
- The Municipal Property Rates Act (Act 6/2004);
- The Municipal Finance Management Act (Act 56/2003)

Based on these documentations and legislations, Local Governments are aligning themselves for better service delivery to the communities they serve. In order for Local Governments to do so, different categories of Local Government are defined in the Constitution of South Africa.

2.2.1 Categories of Local Government in South Africa

For Local Government to operate effectively, different categories are provided for in Section 155, paragraph 1 of the Constitution of South Africa. These categories include:

(a) **Category A**: A municipality that has exclusive municipal executive and legislative authority in its area.

(b) **Category B**: A municipality that shares municipal executive and legislative authority in its area with a category C municipality within whose area it falls. An example of such a Municipality is the Overstrand Municipality (WC032) in the Western Cape Province, which includes the towns of Hermanus, Rooi Els, Pringle Bay, Kleinmond, Stanford and Gansbaai.

(c) **Category C**: A municipality that has municipal executive and legislative authority in an area that includes more than one municipality. An Example of such a municipality is the Overberg District Municipality (DC3), which includes the Theewaterskloof Municipality (WC031), Overstrand Municipality (WC032), Swellendam Municipality (WC034), Cape Agulhas Municipality (WC033) and the District Management Area (WCDMA03)

These categories of municipalities currently form the basis of different functions, and thus of different information needs within the Local Government structure in South Africa.

2.3 Purpose and functions of Local Government

In order to assure sustainable service delivery, South Africa has adopted a Developmental Local Government framework, whereby Local Governments are committed to working with citizens and groups within communities to find sustainable ways to meet their social, economic and material needs and improve the quality of their lives. (Republic of South Africa. The White Paper on Local Government, 1998:17).

Within the establishment of a developmental framework, Local Governments (category A, B and C Municipalities) are provided with the support from National- and Provincial Government, to develop their own development strategies and frameworks. These strategies include the development of Integrated Development Plans (IDP's), with key elements. One of the key elements in an IDP is the development of Land Development Objectives (LDO's) which has a legal status and is a powerful tool for guiding and managing development in a Municipal area. Another key element of an IDP includes the development of action plans and budgets. These action plans and budgets would focus on Institutional plans for the re-organising and development of human resources, and Financial plans which aims at producing medium-term (five-year) projections of capital and recurrent expenditure (Republic of South Africa. The White Paper on Local Government, 1998:29). These medium-term financial plans will form the basis on which the annual budgets and key projects can be undertaken. Table 2.1 illustrates the relationship between planning and budgeting over a short, medium and long term within a Local Government.

Table 2.1: The relationship between planning and budgeting over a short, medium and long term period for Local Government

	PLANNING	BUDGETING
Long term (up to 25 years)	**Vision** ↕	
Medium term (up to 5 years)	**Integrated Development Plan (IDP)** Including LDO's ↔	**Financial Plan** (including infrastructure investment plan on capital side)
Short term (1 year)	↕ **Key Projects** (Annual Action Plan) ↔	↕ **Annual Budget**

Source: Republic of South Africa. The White Paper on Local Government, 1998:30.

A Local Authority would identify and plan its long term vision, based on a 25 year vision, and would provide the framework for planning the medium term (up to 5 years) IDP, and the budgets and financial plans to support the IDP over this period.

Over the short term (1 year) annual key projects can be planned and budgeted for, which would in turn feed back into the IDP and financial plan, based on the long term vision of the Municipality.

To assist in the fulfilment of its obligations in relation to service delivery, Local Municipalities have certain powers to perform certain functions at a local level of government. Based on Schedule 4 and 5 of the South African Constitution (Act 108/1996), Municipalities have power over air pollution; building regulations; child care facilities; electricity and gas reticulation; fire fighting services; local tourism; municipal airports; municipal health services; municipal public transport; municipal public works (only in respect of the needs of municipalities in the discharge of their responsibilities to administer functions specifically assigned to them under the Constitution or any other law); pontoons; ferries; jetties; piers and harbours (excluding the regulation of international and national shipping and matters related thereto); storm water management systems in built-up areas; trading regulations; water- and sanitation services (limited to potable (drinkable) water supply systems, domestic waste and water and sewage disposal systems), beaches and amusement facilities; billboards and the display of advertisements in public places; cemeteries, funeral parlours and crematoria; cleansing; control of public nuisances; control of undertakings that sell liquor to the public; facilities for accommodation, care and burial of animals; fencing and fences; licensing of dogs; licensing and control of undertakings that sell food to the public; local amenities; local sports facilities; markets; municipal abattoirs; municipal parks and recreation; municipal roads; noise pollution; pounds; public places; refuse removal; refuse dumps and solid waste disposal; street trading; street lighting and traffic and parking.

Under the Constitution of South Africa (Act 108/1996), Local Governments also may have powers and functions delegated to them from National- or Local Government, by way of agreement, where the local authority may have the capacity and are regarded as the most effective site to exercise a specific power.

Other powers are also defined in national and provincial legislation such as the Second Amendment Act of the Local Government Transition Act (Act 97/1996) which gives Local Government powers for Integrated Development Planning and are stipulated in the Municipal Systems Act (Act 32/2000) and amended as Act 44/2003.

In order for Local Authorities to be able to exercise their powers effectively, the need for access to relevant information becomes clear, and is highlighted by specific information needs within Local Governments.

2.4 Information needs of Local Government

As discussed in the previous section, the powers provided to Local Governments to perform their function effectively are wide ranging. The Local Authority is also generally the first point of call in obtaining local information, making the local authority a supplier of information.

Complementing the planning process of an ISMIS, a detailed User Requirement Survey (URS) can be undertaken with officials within the Local Municipality. The URS is typically undertaken in the form of interviews with officials in the organisation and with stakeholders outside the organisation.

During the URS, it is also important to assess and understand the dynamics within the municipality. Cassetarri (1993:86) mentions the identification of threats and benefits that integrated systems can bring to the organisation and how the organisation needs to be understood - in particular its philosophy and culture. By undertaking a URS such organisational philosophies, cultures and dynamics can be experienced, which would assist in the proper planning of the system.

Once a detailed URS has been completed, a detailed User Needs Assessment (UNA) would provide summarised supporting documentation on all the needs of officials and stakeholders to the Municipality.

As a supplier of information, a Local Authority has different clients, who can include internal and external clients of the Municipality.

2.4.1 Internal clients

Within Local Government internal clients can be defined as clients who require information on a readily basis to perform their specific function *within* the organisation.

In recent studies (GIS Global Image, 2005) officials from the Local Authorities of the Amatole District Municipality, Eastern Cape Province and the Overberg District Municipality in the Western Cape indicated the following requirements relating to information needs within Integrated Spatial Management Information Systems:

- **Adequate access** to information. Officials indicated that inadequate access to the most requested set of information was information pertinent to a specific cadastral entity. This information includes owner's details, address details, usage, town planning scheme zoning and other property relevant information. This information is mostly requested from treasury spending a lot of time to handle all the queries.
- Officials indicated a requirement for systems to **improve productivity**. Most of the front office officials' (those dealing with the general public in some or other form) time is taken up by queries from the public. The query initiates a search for information, which is often not accessible and removes the official from the work he/she is actually supposed to perform, leading to un-productivity.
- **Access to more electronic information**. Information in Council mostly consists of paper based copies and a lot of duplication needs to take place in order to share this information.
- **Fewer duplication** of Status Quo information in several formats implying that no other departments are able to use it.
- **Fewer inconsistencies** in the accuracy of the information. Inconsistencies hinder officials in performing a professional service to internal and external clients.
- The **dissemination** of information remains a high priority need within all the municipalities. Officials know that the information is available, but time is wasted to access the information from the various departments.

- The **management of information** related to properties. Systems are required to simplify circulation processes in council.
- Access to a **centralized electronic information system.** Officials indicated that Departmental datasets should be shared among functions. Access to information should, however, be as simple as possible. The ideal situation would be to share information though a web interface, thereby minimising software training.
- **One stop shop –** a central place for the public to lodge queries / obtain information in order to free up time for officials to focus on more important work.
- **Communication / information sharing portal**, through internet access.
- It was indicated that information should be on a Geographical Information System **(GIS based)** and related to the lowest geographical entity, namely the properties.
- Data should be **maintained** and provided on a current basis.
- Municipalities do not operate in isolation. An integrated system on **District Level** would provide insight and support current District wide Integrated Development Plans and Spatial Development Frameworks.
- **Existing systems** should be assessed and integrated into the system, without the need to replace existing processes.

2.4.2 External clients

External clients of a Local Authority can be defined as clients requiring information *external* to the organisation. These clients include rate-payers; land developers, other governmental or Non-Governmental Organisations (NGO's) requiring information to be able to satisfy their specific needs, or to enable them to perform their different functions.

The requirements from external clients can be diverse, and range from basic queries such as the status of a building plan application, to more complex queries such as the availability of land for housing development.

Through the development of internet technologies, external clients are also requiring more information to be available on the internet. To this extent, more Local Governments are publishing basic information, which does not infringe on the privacy of individuals or create a threat to security on the internet, by making use of internet GIS software. As municipalities understand the needs of individuals better, the systems are being upgraded, which cater for user-names and passwords in a secure internet environment.

Municipalities are also starting to make private information available to satisfy the needs of external clients to access information that are created in the Municipalities, without compromising the privacy of individuals or organisations. Local Authorities therefore need to take cognisance of the Promotion of Access to Information Act (Act 2/2000), which provides external clients with a mechanism to access information from organisations. The act gives "effect to the constitutional right of access to any information held by the State and any information that is held by another person and that is required for the exercise or protection of any rights; and to provide for matters connected therewith" (Promotion of Access to Information Act (Act 2/2000):2).

For the purpose of this study, a detailed assessment will not be undertaken on the Act and the impact that it has on Local Authorities. It is, however, clear that such legislation does require Local Authorities to have systems in place, which would enable the organisation to effectively access information, and furthermore to provide the information in a responsible way.

The Promotion of Access to Information Act (Act 2/2000) does make provision for the responsible dissemination of information, without providing external clients with *carte blanche* access to *any* information in the organisation . In the preamble of the Promotion of Access to Information Act (Act 2/2000:2), effect is made to the constitutional right to access any information, bearing in mind that

- "the State must respect, protect, promote and fulfil, at least, all the rights in the Bill of Rights which is the cornerstone of democracy in South Africa;

- the right of access to any information held by a public or private body may be limited to the extent that the limitations are reasonable and justifiable in an open and democratic society based on human dignity, equality and freedom as contemplated in section 36 of the Constitution;

- reasonable legislative measures may, in terms of section 32(2) of the Constitution, be provided to alleviate the administrative and financial burden on the State in giving effect to its obligation to promote and fulfil the right of access to information."

In order for a Municipality to provide information in a responsible manner to all clients, an ISMIS needs to be developed to such a level, that while security and data accuracy are not compromised, the ISMIS will still be available on a cost-effective basis.

2.5 Conclusion

It is evident from this chapter that the varying nature of structures and functions within Local Governments, lends itself for Information Technology to play a key role in the establishment of electronic systems to integrate data from various sources. The sources and demand for information can be from within a Local Municipality or from external stakeholders. These electronic systems are based on the purposes and functions of various departments, each system providing information to internal and external clients.

In recent years, spatial information has been increasingly generated by all levels of Government, making the integration and displaying of spatial related information from Local Municipalities more prevalent. The electronic systems within Municipalities are also diverse in function and are often based on requirements National Government set for Municipalities to function effectively. One such requirement include the effective management of financial resources as stipulated in the Municipal Systems Act (Act

32/2000) and amended as Act 44/2003 and the Municipal Finance Act (Act 56/2003), which in effect ensures that municipalities implement financial systems. Other requirements include the establishment of Integrated Development Plans (IDP's) as stipulated in the Municipal Systems Act (Act 32/2000) and amended as Act 44/2003, which led to the spatial representation of various property related information, including land uses, development nodes, corridors and transport infrastructure. As more information is being gathered through time, systems will be required to manage spatial information, which will provide users in the organisations with the means to update, maintain and report on data. It is evident that systems are required to be integrated, and where spatial information exists, this information needs to be presented to users.

CHAPTER 3
DEFINING AN INTEGRATED SPATIAL MANAGEMENT INFORMATION SYSTEM WITHIN LOCAL GOVERNMENT

3.1 Introduction

As discussed in the previous chapter, the ability of Local Government to spatially represent data, has assisted organisations to plan and fulfil their obligations towards service delivery to communities in South Africa. The Municipal Systems Act (Act 32/2000 and amended as Act 44/2003) also makes provision for the establishment of Spatial Development Frameworks (SDF's), which must include the provision of basic guidelines for a land use management system (Act 32/2000, section 26 (e) page 38). By implementing an ISMIS, Local Governments are enabled to fulfil these requirements and effectively report and manage various data sources.

The following chapter will define an Integrated Spatial Management Information System (ISMIS). To achieve this, various systems which are prevalent in typical Local Governments will be discussed, followed by a discussion on Geographical Information Systems (GIS) and Management Information Systems (MIS). The resulting discussion focuses on defining an ISMIS and how such systems can benefit Local Government.

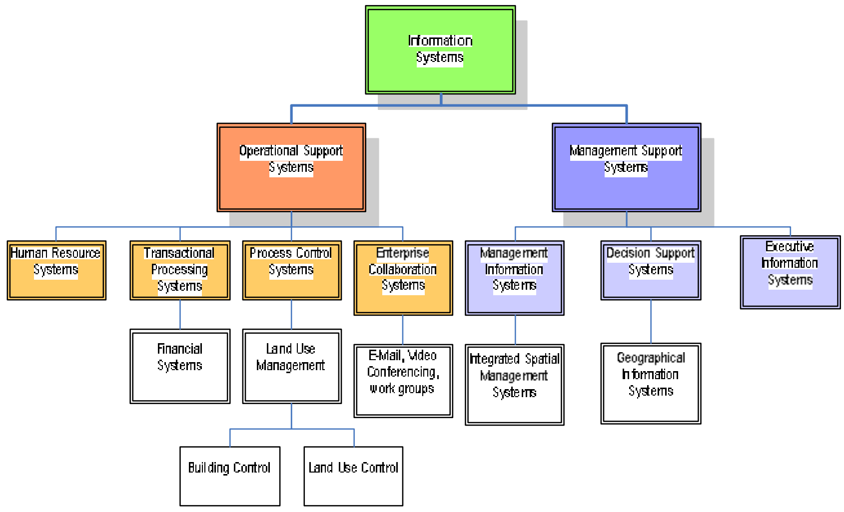
3.2 Information Systems within a Municipal Government

Developments in Information Technology have enabled Municipalities to implement various systems that would enable them to operate more effectively. Van Helden (1993:168) discusses how a hierarchical structure exists in information systems within the Municipal structures. At the top the integrated information system which consists of a collection of people, processes, data and technologies and at the bottom the individual information subsystems. The individual subsystems refer to systems implemented for a specific application such as the valuation role. Van Helden (1993:168) continues to discuss how the following terminology is used within Local Governments.

- **Municipal Information System:** The system which manages the information use within the Municipality
- **Departmental (such as the Town Planning Department) Information System:** A subsystem in the Municipal Information System, but also an information system on its own since it manages the use of information in a specific department. These subsystems can exist for various departments in the Municipality.
- **Information Subsystem:** The individual subsystem within different departments, to support the different operational functions of decision making within a specific department.

Various other information systems are operational within Local Governments. Since this study focuses on systems related to Land Use Management Systems, O'Brien (2004:23) provides a framework for the potential integration of systems. Based on Figure 3.1 below, different Information Systems support business processes as either *Operations Support Systems* or *Management Support Systems*.

Figure 3.1: Operations and management classifications of information systems for Local Government



Source: Adapted from O'Brien, 2004:23

The different information systems are discussed in more detail as follows:

3.2.1 Operational Support Systems

Within an organisation, the role of Operation Support Systems is to efficiently process business transactions and update operational databases with Transactional Processing Systems, control industrial processes through Process Control Systems and to support enterprise communications and collaboration with Enterprise Collaboration Systems (O'Brien, 2004:23). Human Resource Information Systems (HRIS) also update and manage personnel records. Within a Municipality, different systems are typically operational, to function as Operational Support Systems. These systems include the following:

- **Financial systems** update operational databases, these include debtors, creditors and budgets within the organisations. Information on tariffs, discount rates, as well as land and building valuation are available along with the amount of tax payable (Van der Merwe & Van der Merwe, 1989:19). Once a rate-payer has made a payment on an account, the financial application would update the account balance information real-time within the database. The management and reporting on debtors and creditors are effectively retrieved from the applications, and budget control can effectively be managed.

- **Land Use Management Systems** or sometimes referred to as Land Information Systems (LIS) is a specialised application of GIS technology that is concerned with issues of land ownership, land planning and management (Wyatt & Ralphs, 2003:9). The British DoE (1987) defines a LIS as “a system for capturing, storing, checking, integrating, manipulating analysing and displaying data about land and its use, ownership and development”. For this reason it includes Building Control and Land Use Control which manages applications related to building plans and land use applications. These applications include consolidations and subdivisions of properties and also rezoning, consent uses and land use departures on properties. These Land Use Management Systems enable the municipality to effectively manage- and report, on an operational level, to clients on the status of applications. Day-to-day queries from clients relating to land use, can be whether an application has been approved or denied, the type of application or the conditions attached to an approval of an application.

- As part of Human Resource Management (HRM), **human resource information systems (HRIS)** are designed to support (1) planning to meet the personnel needs of the organisation, (2) development of employees to their full potential, and (3) control of all policies and programs (O'Brien, 2004:154). According to O'Brien (2004:154), systems were originally used to produce pay checks and payroll reports, to maintain personnel records, and to analyse the use of personnel in the organisations operations. Many organisations have also gone beyond the original personnel management function, and are making use of HRIS to support recruitment, selection and hiring; performance appraisals; job placement employee benefit analysis; training and development and health, safety and security within the organisations.

- To further support the operations of the municipality, **e-mail** has become virtually standard in all municipalities. Although official data are not available to indicate to what extent Local Governments have introduced e-mailing facilities, experience has shown that is not uncommon for officials in the Municipality to communicate in e-mail format both among each other and to external clients.

3.2.2 Management Support Systems

On the other hand, Management Support Systems (MSS) refers to the "application of any technology, either as an independent tool or in combination with other information technologies, to support management tasks in general and decision making in particular" (Turban & Aronson, 2001:10).

MSS provide information through three different types of systems (O'Brien, 2004:24). **Management Information Systems** in the form of predefined reports and displays, **Decision Support Systems** through the provision of interactive ad-hoc support for decision-making processes and **Executive Information Systems** which provide critical information from many sources to executives. O'Brien (2004: 264) furthermore discusses the characteristics of these Management Support Systems, all of which are available to local Municipalities.

- Within Local Government, large volumes of information are generated on a daily basis. In order for organisations to function effectively, managers require summarised information that is readily available from the various departments. O'Brien (2004:264) describes a **Management Information System (MIS)** as a system where "predefined information products satisfy the information needs of decision makers at the operational and tactical levels of the organisation who are faced with more structured types of decision situations." This ability of decision makers at different levels in the Municipality to have access to tactical information can assist the municipality to respond effectively to various situations that may occur in the functioning of the organisation.

Management Information Systems have four major reporting alternatives which are available to managers in the organisation.

- **Periodic scheduled reports** provide information to managers in a pre-specified format on a regular basis. Examples of periodic scheduled reports include monthly financial statements, or the number of building plans submitted to the municipality per month, as required by the Central Statistics Bureau.

- **Exceptional reports** are generated only when exceptional conditions occur. An example of an exceptional report to management can be where a report is generated of rate payers who have exceeded a predetermined credit limit. The aim is to reduce the amount of information to decision makers which can be overwhelming with detailed periodic reports.

- **Demand Reports and Responses** where information is available to managers whenever a manager demands it. Managers are able to generate customised reports as and when they require it through report generators available on their PC's.

- **Push reports** enable relevant information to be *pushed* to managers' workstations as and when the pertinent information is generated.

- **A Decision Support System** is a content-free expression, in that it means different things to different people (Turban & Aronson, 2001:13). Although many definitions can be found for the term DSS, Turban and Aronson (2001:98) furthermore describe a DSS as "an approach (or methodology) for supporting decision making. It uses interactive, flexible, adaptable Computer Based Information Systems (CBIS), especially developed for supporting the solution for a specific non-structured management problem. It uses data, provides an easy user interface, and can incorporate the decision maker's own insights. In addition, a DSS usually uses models and is built (often by end users) by an interactive and iterative process. It supports all phases of decision making and may include a knowledge component. Finally, a DSS can be used by a single user on a PC or it can be Web-based for use by many people at several locations."

O'Brien (2004:267) also describes how a DSS use analytical models, specialised databases, a decision maker's own insights and judgements and an interactive computer-based modelling process to support structured and semi-structured decisions. In order to better understand the difference between Management Information systems and Decision Support Systems Table 3.1 is provided below.

Table 3.1: A comparison between Decision Support Systems and Management Information Systems

	Management Information System	Decision Support System
Decision support provided	Provides information about the performance of the organisation	Provides information and decision support techniques to analyse specific problems or opportunities
Information form and frequency	Periodic, exceptional, demand and pushes reports and responses	Interactive inquiries and responses
Information format	Pre-specified, fixed format	Ad hoc, flexible and adaptable format
Information processing methodology	Information produced by extraction and manipulation of data	Information produced by analytical modelling of data

Source: O'Brien, 2004:267

- **An Executive Information System (EIS)** is "a computer-based system that serves the information needs of top executives. It provides rapid access to timely information and direct access to management reports. EIS is very user-friendly, is supported by graphics and provides exceptional reporting and drill-down capabilities. It is also connected to the Internet, intranet and extranets" (Rockart & De Long, 1988). The first goal of an EIS is to provide top executives with immediate and easy access to information about the municipality's *Critical Success Factors* (CSF's), or factors that are critical to accomplish the organisation's strategic objectives (O'Brien, 2004:274) If a municipality's CSF is to improve revenue, EIS can be used to provide information on revenue-collection initiatives that might be undertaken within an area, or the processing of housing applications in a specific area, if the CSF is to provide housing before a specific deadline.

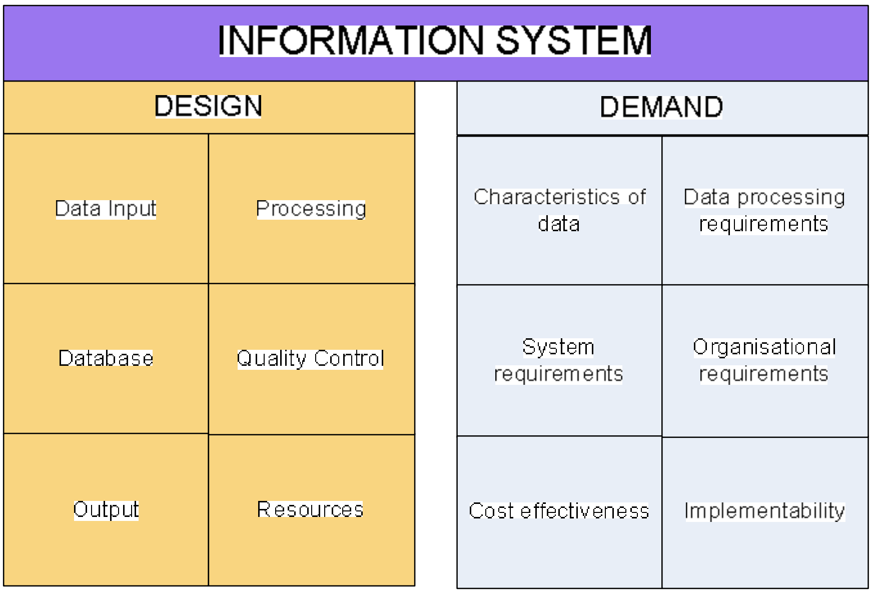
3.3 Defining a Geographical Information System

As indicated in Figure 3.1, Geographical Information Systems (GIS) are grouped within Decision Support Systems (DSS). Since this study focuses on the spatial representation of Integrated Management Information Systems, GIS will be discussed under a separate heading.

Many different definitions can be found defining a Geographical Information System (GIS). Laudon and Laudon (2002:413) define GIS as a "DSS that can analyse and display data for planning and decision making using digitised maps. The software can assemble, store, manipulate and display geographically referenced information, typing data to points, lines and areas on a map".

Much like most Information Technology Systems, a GIS consists of different components or building blocks. Based on Burch, Strater and Grudnitski, Van Helden (1993:49-55) illustrates how an Information System consists of building blocks (refer to Figure 3.2 below).

Figure 3.2: The building blocks of an Information System



Source: Van Helden, 1993:50

Based on Figure 3.2 above, the design blocks can be categorised into two main groups.

- The one group being the **design blocks** such as data-input modules, databases, data-processing, output modules, quality control and resources such as hardware, software and people.
- The other group being the **demand blocks** such as the characteristics of data, system requirements, cost-effectiveness, data processing requirements, organisational requirements and implementability of a system

In essence, it can thus be derived that an information system consists of a collection of people, processes data sets, software and hardware which collect, process, store and communicate data as information in support of operational tasks and decision making (Van Helden, 1993:168).

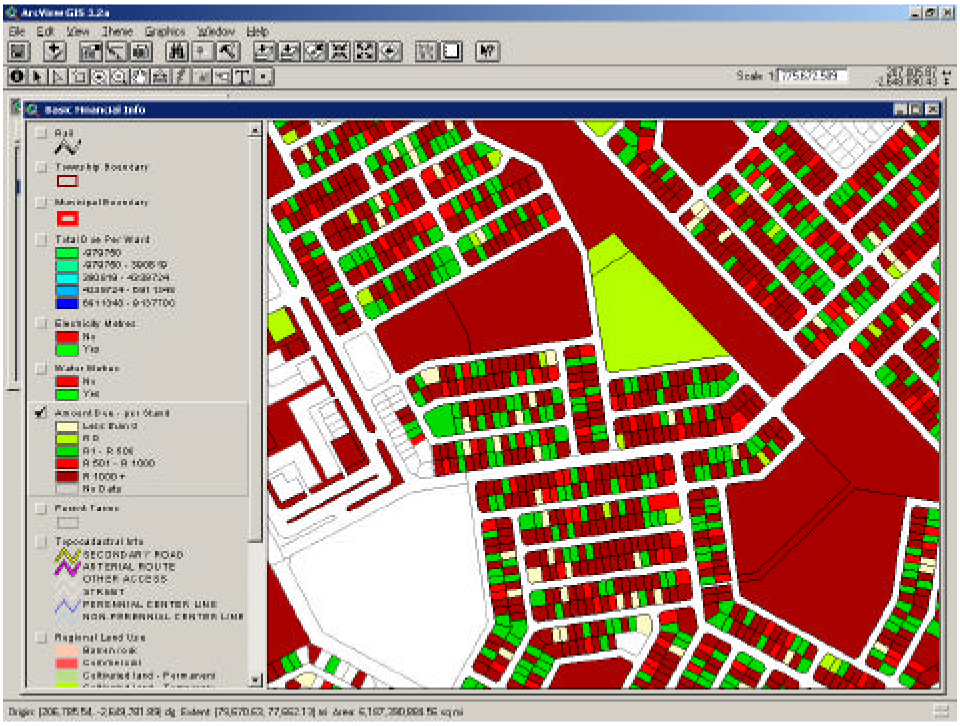
The most visual representation of the entire GIS is the production of a map with specialised computer software, depicting a representation of the real world either on a computer screen through a Graphical User Interface (GUI) or on a paper map. Maps produced by a GIS are linked to databases containing data on the map entities, which enables a user to visualise patterns, relationships between entities and patterns within the real world.

Van Helden (1993:65) explains how a GIS has a basic *purpose*, *functionalities* and *applications* within the organisation. The basic purpose of a GIS is the ability to distribute spatial data and information to a variety of users. In order to fulfil this basic purpose, a variety of functions are available within software packages which include data capturing, storage, processing and analysis. Different requirements of GIS have also given rise to the development of GIS applications, which include management and decision making.

3.3.1 The purpose and advantages of Geographical Information Systems

The purpose of a GIS is to assist a user in making more informed decisions. A GIS achieves this, by visualising tabular and spatial information on a map. "By integrating maps with spatially orientated (geographic location) databases (called *geocoding*) and other databases, users can generate information for planning, problem solving, and decision making, and increasing [sic] their productivity and the quality of decisions" (Turban & Aronson, 2001:154). In visualising tabular and spatial information on a map, a user has the ability to visualise trends and patterns that can assist in the decision making process. An example where a GIS representation would assist a local authority can be seen on Figure 3.3 below, where the financial system of a municipality is integrated with the property map of an area.

Figure 3.3: A GIS-based map



Source: GIS Global Image, 2005

The map Figure 3.3 indicates, in colour codes, the outstanding amount due per stand, in rates and taxes. The legend on the map indicates that the darker the colour scheme the higher the amount that is outstanding, and the lighter the colour scheme, the less the amount outstanding in rates and taxes on the property. If the map would indicate areas in the municipal area where exceptionally high amounts are outstanding on municipal accounts, the graphical representation would assist the municipality in identifying and focus resources effectively in these areas, to try and increase revenue.

3.4 Defining an Integrated Spatial Management Information System

In order to define an ISMIS, we need to understand why there is a requirement to integrate systems. In general, there are two major objectives for MSS software to integrate (Turban & Aronson, 2001:744):

- The enhancement of basic tools where the tools available in one system, are enhanced by the system tools of another integrated system. An example of such enhancements can be found where Expert Systems (ES) are often used to enhance other tools or applications.
- Increasing the capabilities of the applications where system tools compliment each other. An example of such increased capabilities of applications can be found where a financial system and geographical information system are integrated, to provide a spatial representation of outstanding accounts from the financial system.

The combination of a Geographical Information System (that has the ability to integrate and graphically represent data) and a Management Information System (that has the ability to integrate and provide predefined information to decision makers in report format), provides a system where most data that are generated, can be integrated and presented in a predetermined spatial format. This information can be accessible to all decision makers on a tactical and operation level within Local Government, to assist them in making more informed decisions.

Within the GIS literature, integration of GIS is often described as follows:

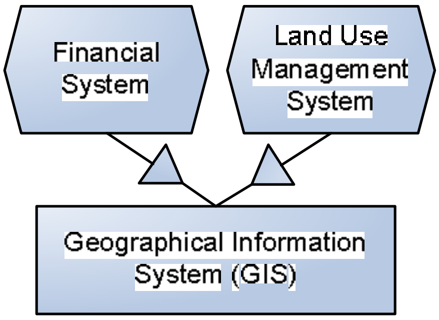
- The bringing together of spatial data from a number of sources, including maps, field survey equipment, photogrammetry, and remote sensors, within a single system (e.g. Aybet, 1990);
- The creation of a geometrical description of the earth's surface within a consistent topological framework (e.g. Marx, 1986);
- The inter-conversion of raster (i.e. image) and vector (i.e. map) models of the world within a single software environment (e.g. Jackson & Mason, 1986);
- The provision of a comprehensive set of geographical information handling functions within a unified software framework (e.g. Dangermond, 1986);
- The interlinking of both spatial and attribute data within a single, coherent representation or model (e.g. ESRI, 1990) and
- The synthesis of diverse spatial information by means of fundamental geographical operations such as spatial search and overlay (e.g. Cowen, 1988).

As this study focuses on the systems associated with Land Use Management within Local Government, the source of data for the ISMIS include Land Use Management Systems (Building- and Land Use Control), Engineering Services Management Systems, Geographical Information Systems and Financial Systems. Data from these data sources can be integrated into a single Database Management System (DBMS). DBMS permits an organisation to centralise data, manage them effectively, and provide access to the stored data by application software. Furthermore, the software enables individual applications to extract data, without having to create separate files or data definitions in the computer systems (Laudon & Laudon, 2002:209).

One example of the kind of function for which a municipality could make use of an ISMIS is to increase its revenue by identifying non-ratepayers in the municipal area. One of the challenges municipalities face, lies with the collection of debts that are in fact receivable. With 79% of municipalities (*Project Consolidate*, 2004:10) having large portions of indigent households (households having less than R1 600.00 per month), the collection of outstanding accounts should focus on those properties that have the financial means to pay for services such as businesses. A pre-defined report can be developed by making use of at least three different systems in the Municipality. These systems include the Financial System, which indicates the outstanding accounts (debtors), the Land Use Management System that indicates the land use on properties and the Geographical Information System (GIS), indicating the property map of the area. These three systems can be integrated as indicated in

Figure 3.4 below.

Figure 3.4: The integration of a Financial System and Land Use Management System with a Geographical Information System (GIS)



By integrating the combination of outstanding accounts (from the Financial System) and land uses (from the Land Use Management System) on a map (from the GIS), as indicated in Figure 3.4 above, clusters of businesses with outstanding accounts can be identified. Specific initiatives can then be undertaken in these geographical areas to collect outstanding accounts, and since these initiatives are focused, time and money are saved and additional funds are generated.

3.4.1 The benefits of integrating spatial information

It is evident from this chapter, that Information Technology can enable Local Governments to address the information needs of internal and external clients. Various systems can be implemented to capture, maintain and report on data, providing a Local Government with the foundation to effectively manage the organisation. With the further capability to integrate systems and present the data in its geographical context by making use of an ISMIS, middle and top management has the ability to make more informed decisions, in a user-friendly, customised format.

Shephard (1991) summarises the benefits for the individual or project team as follows:

- A broader range of operations can be performed on integrated information, than on individual sets of data;

- By linking data sets together, spatial consistency is imposed on them. This adds value to existing data sets, making them both more affective and a more marketable commodity;

- Through the integration of data which were previously the domain of individual disciplinary specialists, an interdisciplinary perspective to geographical problem solving is encouraged and

- Users benefit from the perception that they have access to a seamless information environment, uncomplicated by the need to consider differences in data sources, information types, storage devices and computer platforms.

Along similar lines, Bracken and Higgs (1990), discuss the advantages for organisations when they integrate data into a single pool. These advantages include:

- Data acquisition costs are reduced, due to the elimination of duplicate data collection and conversion activities;

- Organisations can draw on a broader base of information than previously, and are thus able to address issues that were previously beyond their individual data resources and

- Organisations can cooperate with one another within the context of shared information, and thereby make more effective management decisions.

For a Local Government to embark on the implementation of an ISMIS, the value or benefits need to be clearly understood and identified.

3.4.1.1 Types of benefits

Three formats of benefits are presented in a recent report (*Guidelines for Best Practice in User Interface for GIS,* 1998: 97), showing how benefits in spatial related projects can be defined as direct, indirect and external benefits.

- **Direct benefits** refer to those benefits that can be derived directly as a result of using the spatial technologies, rather than manual means.

- **Indirect benefits** are derived indirectly from the use of Spatial Technologies such as improved productivity through the application of user defined tools and processes.

- **External benefits** refer to those qualitative and quantitative benefits derived from outside the organisation, through the use of spatial technologies.

O'Brien (2004:349) also discusses how benefits can be tangible or intangible. Tangible benefits can be quantified, and where benefits are not quantifiable, these benefits are intangible. Clark (1991) states that *tangible benefits* can furthermore include *efficiency benefits* and *effectiveness benefits*.

- *Efficiency benefits* such as a decrease in salaries due to a reduction in personnel or an increase in income due to effective revenue collection from rate payers in the municipal area and
- *Effectiveness benefits* such as an improved quality of decision making by the local authority.

Intangible benefits can include examples such as better customer relations and public image through an increase in the access and reporting on property data, or the benefits derived through faster and more accurate information to management, such as the identification of suburbs where non-payment of rates and taxes are occurring. This would enable management to focus revenue collection strategies on specific areas, and not waste time and money in areas where non-payment is not an issue.

The access to integrated information also provides the organisation with a broader range of operations and uses than on different data sets and imposes a more consistent spatial consistency (Shephard, 1991). Shephard (1991) goes further and notes how the organisation can benefit from integrated information by having a more diverse view on data, and considering data use by other users in the organisation. Previously, information was in the limited domain of specialists who did not have a need to consider differences in data sources and information types. But in a domain where more users derive benefits through the access of seamless information, this specialist point of view might place an unnecessary burden on the users and a broader, interdisciplinary perspective would be beneficial.

Bracken and Higgs (1990) also believe that organisations can gain benefits from integrating information through a greater awareness of tasks being performed, and the information being used to perform the tasks. The greater awareness leads to a reduction in data collection costs and prevents duplication of capture and manipulation processes.

Further benefits include the undertaking of tasks with collective information, which would previously not have been possible, through the fragmented nature of information management (Cassettari, 1993:70). This benefit not only holds true for information within one organisation, but also inter-organisational departments, making use of each other's data sets. This may lead to an increase in productivity through a reduction in the duplication in the capturing of information.

3.4.2 Challenges facing Integrated Spatial Management Information Systems

As Integrated Spatial Systems advance from being "nice-to-have" applications to a necessity within organisations, the demand increases for the utilisation of spatial information and services. As the demand increases, the challenge facing an organisation, such as the City of Johannesburg GIS department, is managing organisational and technological change related to business processes and the integration of municipal legacy systems (Hattingh, 2005). Hattingh highlights other challenges including the management of resources for the capture and maintenance of the increasing number and size of data sets, such as street addresses, properties, informal settlements and imagery.

The organisational factors affecting the implementation of integrated systems can also not be overemphasised (Shepherd, 1991). Shepherd (1991) argues that the benefits of integrating systems can only be increased if there is consensus among participants of the integrated system. These participants include individuals, departments and organisations involved in creating the integrated system. Consensus can only emerge if the data users see a clear value in the integrated database. An important contributory factor in achieving success is that the database users should have a tradition of information sharing. Shepherd (1991) continues to argue that because different organisations collect data for different purposes, they assign contrasting meanings to their data. These purposes, therefore, need to be taken into account when decoding the meanings of specific data items. This highlights the value of metadata within the establishment of an ISMIS, where information such as the scale, accuracy and owner of data sets are documented.

3.5 The importance of Metadata

Metadata refers to data about data. The Spatial Data Infrastructure Act (Act 54/2003) refers to metadata as “a description of the content, quality condition and other characteristics of spatial information”.

Since a Local Authority has many users with different functions and needs (as discussed in Chapter 2) data sets are compiled from different sources. In order for users to interpret information in the correct context, it is necessary to document metadata on the data. Hattingh (2005) argues that the existence of Metadata also improves the understanding of the data by decision-makers, as in the case of the Corporate GIS department of the City of Johannesburg.

The importance of interpreting data in the correct context is specifically important in the case of some cost factors, which will be discussed later in this document. These cost factors include *data currency* (par. 4.2.1.1) and *data accuracy* (par. 4.2.1.2). As will be argued, both the currency and the accuracy of data could have an impact on the cost of a project. If data needs are different in exceptional cases with regard to the levels of accuracy or currency accommodated within the system, the users will need to interpret data accordingly.

Take, for example, a case of an aerial photography layer in the spatial system where, based on user needs, aerial photography was taken on a specific date (data currency) and the level of accuracy of the aerial photography was at a specific scale. The scale was at such a level that the aerial photography was useful for macro planning purposes (in theory the data must have cost less than more detailed photography). If the Municipality required identifying vacant land for housing due to rapid land invasion a few years after the aerial photography was taken, the aerial photography layer would be inappropriate and out of date in such an exceptional case. Users are then required to interpret the map in context, determine the reason for the data being out-dated and to an insufficient accuracy level, by making use of metadata.

The National Spatial Information Framework (NSIF) promotes software developed by the U.S. Geological Survey EROS data Centre's International Program. The software called Metalite conforms to the Federal Geographic Data Committee's (FGDC) content standard. The FGDC will in future adopt the International Organization for Standardization's (IOS) standard on geo-spatial metadata (What is Metadata?, 2005). Based on the Metalite software package, the following data is captured as metadata on spatial entities, which illustrate the diverse nature of data in a meta-database.

- The Originator:
  - Name
  - Publication data
  - Title of data
  - Edition of data
  - Geospatial presentation form
  - Publication information such as publication place and publisher
  - Online linkage
- Description:
  - An Abstract of the data
  - The purpose of the data
  - Supplemental information on the data
- Time and Status:
  - Time period of content:
    - Beginning date
    - Ending date
  - Currentness reference (referring to the publication date)
  - Status of data such as "complete", "in work" or "planned"

  - Maintenance and update frequency such as “daily”, “weekly” or “if needed”
- Spatial Domain:
  - Bounding coordinates (west, east, north and south)
  - Spatial reference method in terms of point, raster or vector format
- Keywords:
  - Theme keywords
  - Place keywords
  - Temporal keywords
- Constraints and graphics
  - Access constraints
  - Use constraints
  - Browse graphic details such as filename, file description and file type
- Distribution information:
  - Contact information of distributor
  - Resource description
  - Distribution liability
- Metadata reference:
  - Metadata date
  - Metadata contact information.

It is evident from the Federal Geographic Data Committee (FGDC) content standard, that extensive metadata can be compiled on geographic data, which will assist other users in interpreting data correctly when it is used.

3.6 Conclusion

It is evident from this chapter that Information Technology could enable Local Governments to implement electronic systems, which will provide the organisation with the ability to issue information based on the needs of internal and external clients. As a Municipal Information System, departmental- and information subsystems are being implemented, the specific functions in the departments of the organisation are being supported. These systems include Financial Systems, Land Use Management Systems, Human Resource Information Systems, and Geographical Information Systems, to name but a few.

Municipalities would further be able to maintain data in order to query and report on various aspects of the organisation. With the implementation of Management Information Systems, which are geographically represented such as an ISMIS, management at various levels of a municipality would be able to make informed decisions, in a user friendly, customised format, and reap the benefits of such systems.

Various challenges face the development of integrated spatial systems. Among them are technological change related to business processes and the integration of municipal legacy systems. Furthermore, consensus among users on the value of an integrated system is imperative. This can only be achieved if users can see a clear value in the integrated database.

For Local Government to implement ISMIS successfully, cost-effective systems have to be established. The challenge and further key success factor in establishing systems do not lie in the development of the least-cost ISMIS, but in the most cost-effective system. The following chapter will explore the factors that influence the cost in establishing an ISMIS, and what the related advantages and disadvantages are of cost factors.

CHAPTER 4
IDENTIFYING THE COST FACTORS IN IMPLEMENTING INTEGRATED SPATIAL MANAGEMENT INFORMATION SYSTEMS

4.1 Introduction

In order to implement an ISMIS cost-effectively, factors that influence cost need to be identified and understood from the outset of a project. In understanding these cost factors, implementers and service providers need to relate the cost factors to the needs of the organisation and thus consider the potential positive and negative impacts these cost factors might have on the financial- and operational requirements of the ISMIS implementation. The actual needs of the organisation are critical in assessing how cost factors would influence the level of benefits required by the organisation. For a detailed discussion on the *Information needs of Local Government*, refer to par. 2.4 in this document.

Much like benefits (discussed in *Types of benefits*, par. 3.4.1.1 in this document), O'Brien (2004:349) also illustrates how costs can be tangible or intangible.

- ***Tangible costs*** can be quantified, and where costs are not quantifiable, these costs are intangible. Examples of *tangible costs* include costs of hardware, software, salaries, training courses and other quantifiable costs incurred in the development of the Information System.

- ***Intangible costs*** are costs that are more difficult to quantify. When systems are implemented, initial resistance by personnel to change to a new system, might incur a loss in moral.

In order to identify these tangible and intangible costs, factors need to be considered that would influence costs in the implementation of Integrated Spatial Management Information Systems for a Local Government.

4.2 Factors that influence cost in the development of an ISMIS

Different factors influence the cost within the development and maintenance of an ISMIS. These primary factors include *data, software, hardware, training requirements, customisation maintenance and time constraints,* which will be discussed in more detail.

4.2.1 Data

Data is a key element of an ISMIS. In order to better understand data, Turban and Aronson (2001:131) explain how three terms, namely *data, information* and *knowledge* – all based on data, are sometimes used interchangeably.

- **Data** is about things, events, activities, and transactions that are recorded, classified, and stored but are not organised to convey any specific meaning. Data items can be numeric, alphanumeric, figures, sounds or images.
- **Information** is data that have been organised so that they have meaning to the recipient.

- **Knowledge** consists of data items and/or information organised and processed to convey understanding, experience, accumulated learning and expertise as they apply to a current problem or activity.

Through an operation called **extraction**, data can be captured from several sources. Extraction consists of importing files, summarisation, standardisation filtration and condensation of data (Turban & Aronson, 2001:103). Data can be derived from different sources, which include internal data, external data or personal data.

Related to data, three factors are identified, that impact on the cost of implementing an ISMIS within Local Government. The three data factors are *data currency, data accuracy* and *data availability* and are discussed in more detail.

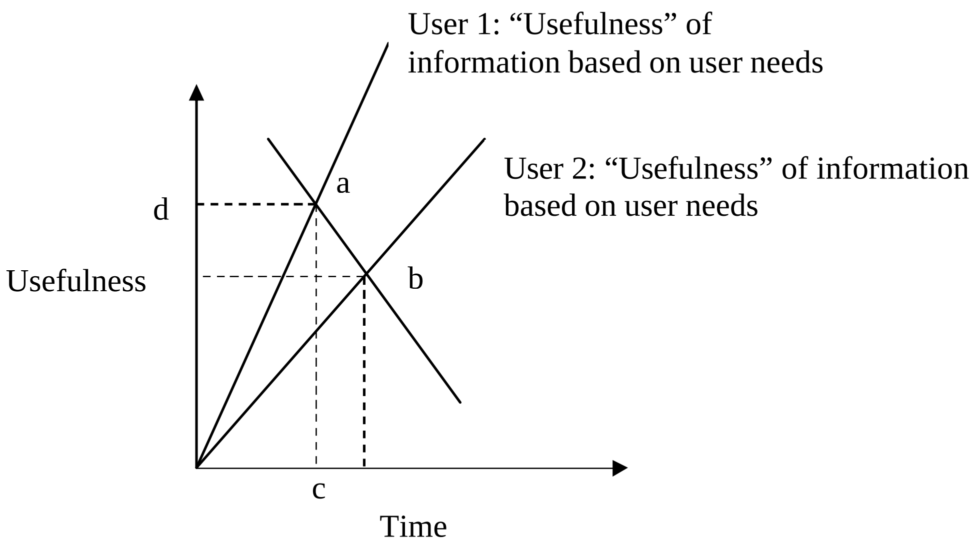
4.2.1.1 Data currency

Data currency refers to how up-to-date information is within the system. By making use of a database management system (DBMS), a municipality is able to constantly update and maintain data. A basis in deciding the "up-to-dateness" of data required within the system stems from the critical assessment of user needs. Based on the function of users in the organisation, data is required in different formats and at different time intervals in the organisation. The time interval determines the usefulness of the data to the user. The usefulness of data used within the organisation is described as "the quality of being suitable or adaptable to an end", according to Roget's II: The New Thesaurus (The Editors of the American Heritage Dictionary: 2005). This would imply that data reach a point at which the suitability of the data to perform a task ceases, and the data does not contribute to the function of the user anymore. Once user needs have critically been assessed, only then can be determined at which level information become either obsolete or useful,. This is based on time that has lapsed since the data was included within the system.

Most users will always answer that data is required the instance it is generated within a system. But the systems required to keep data as real-time as possible, require a lot of time to implement and maintain, which unavoidably adds time and cost to the system. A user will have to ask the simple question (and provide an honest answer): "How up to date does information *need* to be, in order to fulfil a function effectively in the organisation?"

Once the user has identified how up to date information need to be to be useful to a task or function, the requirements can be passed on to the system, which would then in turn ensure that the required data currency is provided to the user. In determining the optimum time of usefulness in data, implementers of an ISMIS can ensure that data is provided at the most cost-effective process possible. Refer to Figure 4.1 below, which illustrates the time-usefulness of information in relation to different user needs.

Figure 4.1: The time-usefulness of information in relation to different user needs



In Figure 4.1, two scenarios are provided in relation to the usefulness of information. Points "a" and "b" represent where information becomes useful to Users 1 and 2, to perform their respective functions effectively. User 1 requires information to be provided much sooner (Point "c") than User 2, thus placing a higher usefulness (point "d") on the "up-to-dateness" of information. An example is the critical assessment of knowing when a property's zoning has changed, from the system. If it is functionally critical that the information be displayed in real-time (or near real-time) within the system to relevant users (User 1), the system would have to cater for these requirements. On the other hand, if a 24 hour time lapse is sufficient for the system to process all amended zonings and then update the system, such information would address the needs of User 2.

In order for the system to provide real-time or near-real-time information, specific processes and data integrity procedures need to be in place, which could require a high level of data maintenance, resulting in an increase in cost.

4.2.1.2 Data accuracy

When system implementers develop an ISMIS, a distinction needs to be made between data quality and data accuracy. Since one of the major issues with data quality lies with data integrity (Turban & Aronson, 2001:133), users of data need to manage and understand the source of data sets they use. This brings to point the importance of metadata (or information on data), was discussed in more detail in par. 3.5. Metadata can form the basis to understanding the origin and key information related to a data set, thus increasing the data integrity. Turban and Aronson (2001:134) argue that in "data quality specific issues and measures depend on the application of the data" which would suggest that different applications of data require different levels of accuracy and by no means deter on the quality of data.

Implementers of an ISMIS can thus proceed and determine how accurate information needs to be within the system. Based on their function within the organisation, different users require different accuracy levels of data. The compilation of a User Needs Assessment (UNA) in the planning phases of a project will assist in determining specific needs of users in relation to accuracy requirements of data.

Within an ISMIS, different components of the data are represented as spatial entities on a map. These entities include points, and the accuracy of points is discussed as positional accuracy by Chrisman (1991:169). Chrisman (1991:169) distinguishes two levels of accuracy, namely *absolute positional accuracy* and *relative accuracy*, the latter being an identifiable quantity (standard deviation from the mean). However, due to well-placed opposition, the standard (as set by the US Proposed Standard (DCDSTF 1988:132-3)), reverted to a single measure of absolute accuracy (root-mean-square deviation from zero). Furthermore, he argues that much of the data in GIS do not fit the restrictive definition of well-defined points[2], and that there are approaches to solve this. The standard approach assumes that all features on a map can be categorised by the error in the position of the well-defined points, but this assumption can only be used as a lower threshold to accuracy. Another approach is to include an attribute alongside the position in a test for accuracy.

But how does absolute- and relative accuracy affect the cost-effectiveness of the implementation of an ISMIS? In order to answer this question, further descriptions of *absolute accuracy* and *relative accuracy* need to be considered.

- **Absolute accuracy**

  In order for the information to be useful and legitimate for a user to perform a function effectively within the organisation, the information needs to be 100% correct (or within a tolerance such as a generally accepted standard). Typical information is information that has negative legal consequences if it is inaccurate. An example would be information such as financial information where a ratepayer's current balance on the

[2] A "well-defined point" means that there is attribute ambiguity, and because it is a point, there is no dimensional ambiguity either (Chrisman, N.R., 1991:169)

account or a properties valuation is inaccurate and the ratepayer could have a legal claim against the municipality.

In order to maintain integrity of data, processes and personnel need to be in place to ensure the required accuracy, which makes this type of information more costly to maintain.

- **Relative accuracy**

In order for the information to be useful to the user, accuracy less than 100%, or outside a tolerance of a generally accepted standard is sufficient to perform a task or function. A characteristic of such data is that it should at least be accurate relative to other data within the system. An example could be the relative accuracy of a water pipeline, where the location of the water pipeline is relative to another entity in the database such as a property boundary - users can identify at least that the water pipeline are located on a specific side of a property boundary, approximately some distance, say 3m from the boundary.

Since the required accuracy is relative, the time to capture such relative information is much shorter, which in turn makes such data less costly to maintain.

4.2.1.3 Data availability

Along with data validation, data entry is frequently the most costly and tedious process of any GIS development (*Guidelines for Best Practice in User Interface for GIS*, 1998:70-71). As an element in the successful implementation of a GIS implementation, rigorous planning would highlight where existing data sets are available (Antenucci, Brown, Croswell, Kevany, & Archer, 1991). This would assist in avoiding the duplication in the capturing of data, and thus add unnecessary time and cost to the project. As with any database system, it is often more expensive to capture new data, than it is to purchase or source data from external sources.

4.2.2 Software

Within the software industry, different licensing models are found, under which software are made available to users. Each of the different software licensing options does have an impact on the cost of implementing an ISMIS and have their respective advantages and disadvantages.

Perceived advantages of the software package approach versus custom developed software, are discussed by Skidmore and Eva (2004:280). The following points are discussed:

- A reduced **cost** where the purchase of a software package is perceived as significantly cheaper than the development of a customised alternative.

- The development of custom made systems needs to be tightly specified, designed, programmed and tested which is very time-consuming. The software package is a product that already exists and can be purchased at a known cost and implemented almost immediately, **saving time** in the system implementation.

- It is perceived that software packages do have **quality benefits.** The software package is a proven product that has undergone system testing (in development) and user acceptance testing (by the users who have already bought and used the package). The result being that the software should be error-free, as well as fulfil most of the functional requirements of the application.

- In the software package approach, **documentation and training** is available, which can be inspected and evaluated before purchasing the product. The documents (such as user manuals and help systems), are usually of high quality, since they represent an important part of the selling process.

    - ✍ The same principle applies to training, where prospective purchasers of a software package can attend a training course prior to buying the product and so further evaluate the suitability of the package.

- Software packages are usually supported by formal maintenance agreements, which ensure **organised maintenance and enhancement** of the software. The agreement usually provides
  - o Unlimited access to a Help desk
  - o Upgrades that correct known faults and add new functionalities are provided to users which have maintenance agreements.
    - ✍ The cost of support and maintenance is spread across a number of users, and can so be offered relatively cost-effectively to customers. The cost of providing such as service would be extremely expensive, if the organisation would have developed customised software themselves.

- When an organisation purchases a software package, it has the advantage to examine the product in detail before purchasing it.

Skidmore and Eva (2004:282) also discuss the **perceived disadvantages** of the software package approach versus customised software as follows:

- When an organisation purchases a software package, the **ownership** of the software lies with the supplier, and not with the purchaser. Customers are licensed to use the software, which have the following implications:
  - o The supplier decides the future development of the software package. Hence future functionality is not in the control of the customer or the organisation
  - o The software supplier can make decisions about the ownership and support of the product. These decisions can have far reaching effects

for the customer. For example, the software supplier may decide to withdraw the support from earlier versions of the software. Hence customers may be forced into unnecessary (and potentially expensive) upgrades to hardware, adding to the cost of the ISMIS.

- o The software supplier may decide to sell the product to a third party. If the customer is negatively affected by such a move, this can result in the move to another system or rival product, which would inevitably add to the costs of the system, making the ISMIS less cost-effective.

- Internal Information System departments do not go out of business, whereas external software suppliers are subject to markets and management. If the supplier is **financially unstable**, there might be a risk that the supplier might go out of business, which could affect the quality of support and development. The risk can be limited through escrow agreements, but the disruptions to the organisations should not be underestimated.

- When organisations use software packages as supplied by a supplier, they loose their **competitive-edge** (if this is the reason for the organisation to use the specific software package), since other potential competitors also have access to that specific solution. If software suppliers are required to provide software exclusively to an organisation, cost would invariably increase to compensate for lost revenues elsewhere, thus decreasing the cost-effectiveness of the ISMIS.

- A common claimed disadvantage of software packages is that it **fails to fit the requirements** of the organisation. This means that either:
  - User will have to compromise and accept that they will not get all the functionality they require, or
  - Tailored amendments will have to be made to the software product to deliver the required functionality (see *par. 4.2.3 Customisation* of this dissertation)

- If a system fails to fulfil the user's functional requirements, the customer can as a last resort seek **legal redress** to resolve the failure. If a product was developed in-house by an internal IS department, this would not be possible. However, the legal responsibilities of a software provider are more complex, in that the licensing agreement is defined in favour of the supplier. In such an agreement there is usually a clause that states that the package may not support the functional requirements of the customer, and that it is the customer's responsibility to ensure that it does.

- **User requirements change** due to various factors in the lifetime of a system. These factors include the change of users and the business changes to adapt to new business environments. If software packages are not maintained, organisations will end up with products that are inappropriate in dynamic organisations and market-places.

Having discussed the advantages and disadvantages of purchased software packages in relation to bespoke packages, the different licensing options through which software is made available to Municipalities and organisations are as follows:

4.2.2.1 Licensed software

Licensed software is software where the ownership of source code is owned by an individual or business entity. Such an individual or business entity develops and maintains the software, and use of the software is managed by authorisation codes on which license fees are payable. Depending on the software product, different fees are payable. In Table 4.1, below a comparison is made between the software pricing of different GIS software packages that are available under a software licensing model.

Table 4.1: Comparable GIS software pricing per user license[3]

Software Provider	Software Product	Software use	Price
ESRI®	ArcView 9.x + Module	Desktop publishing	ZAR13,500.00
ESRI®	ArcIMS (to publish shape files only)	Internet Mapping	Single CPU ZAR65,000.00 Dual CPU ZAR87,600.00
MapInfo®	MapInfo Professional	Desktop publishing	ZAR17,581.00 + maintenance ZAR4,395.00
MapInfo®	MapInfo Discovery	Internet Mapping (No customisation possible)	ZAR37,000.00 + 25 % maintenance
MapInfo®	MapInfo Extreme for Windows ®	Internet Mapping (Customisation possible)	Server license per CPU ZAR97,000.00 + 25% maintenance
Autodesk®	Autodesk Map 3-D 2006 Including AutoCAD 2006	Desktop publishing	ZAR38,000.00 includes maintenance of 1 year
Autodesk®	AutoCAD MapGuide	Internet Mapping	1 user license : ZAR7,000.00* 10 user licence: ZAR63,000.00* 100 user licence: ZAR159,000.00* * Prices exclude VAT

Source: ESRI®, MapInfo®, Autodesk®

[3] Due to the variance in functionality available in different software packages, it should be noted that software cannot be compared purely on price per user licence.
Table 4.1 is provided purely as an indication of how software licensing can be applicable.

In Table 4.1 above, the different pricing options are presented from three GIS software providers. These GIS software providers are ESRI®, MapInfo® and Autodesk®. The different software packages are grouped based on the intended use of the software, which can either be as Desktop Publishing (DTP) software, or as an internet mapping software.

4.2.2.2 Proprietary software

The term proprietary means "privately owned and controlled". Proprietary software is software where the ownership of source code is owned by an individual or business entity. Such an individual or business entity develops and maintains the software, and use of the software is at no cost. The modification, use and redistribution are however prohibited, or where the use requires express permission from the owner of the source code. Proprietary software can also be released as:

- *Freeware* where the software is distributed at no cost, and carries a restrictive license such as the free distribution without resale or the restrictive use for commercial, governmental or military use.

- *Shareware* where software is distributed at no cost but functional for a limited period of time after which payment is required. Shareware can also be distributed as partially-functional software, where upon payment, full functionality is made available.

- *Abandonware* where the software is being distributed, but not sold or supported by the source code holder.

4.2.2.3 Open source software

In general, open source software refers to software which provides computer users with free access to its source code so that they can modify the code to fix errors or to make improvements (Laudon & Laudon, 2002: 179).

Closely related to software, is the ability of the organisation or service provider to customise a software package for the organisation, which is discussed as a separate cost factor.

4.2.3 Customisation

As in any organisation which strives to provide a service in addressing the information needs of internal- and external clients, users of spatial information systems require very specific applications to perform their function. Their interaction with the data base is generally by making use of a Graphical User Interface (GUI), which provides the user with icons, menus, windows, buttons, bars for selection within the software (O'Brien, 2004:474). The interface can also be described as the point at which the user and the computer system meet (Yeats, Shields & Helmy, 1994).

Through the continuous development of software, user-needs are generally addressed in standard software packages, but in order to address the specific needs of users, customisation of the software might be required. It is inevitable that as more customisation is required, the more time and costs are necessary, which would add to the total cost of the project.

Implementers of ISMIS need to assess user needs, and determine where the balance lies between using purchased software and customising software. If customisation is required, implementers need to determine the level of customisation in order to successfully address user needs.

4.2.4 Hardware

Implementers if ISMIS need to be aware of the different system requirements of the various software packages. These software packages are not only the GIS software, but would also include the Data Base Management Systems (DBMS) that would be required to store data within the system. Generally analysts divide system requirements into two categories: functional- and non-functional requirements (Satzinger, Jackson & Burd, 2004:119). ***Functional activities*** are the activities that the system must perform, and are based on the procedures and rules that the organisation uses to run its business. On the other hand, ***non-functional*** requirements are characteristics of the system other than activities it must perform. Many different types of non-functional requirements are stated by Sarzinger, *et al.* (2004:120), but hardware related requirements are as follows:

- **Technical requirements** describe the characteristics related to the environment, hardware, and software in the organisation. For example, where the server software is required to operate at minimum requirements related to memory, hardware space, operating system and processing speed.

- **Performance requirements** describe operational characteristics related to measures of workload, such as throughput and response time. In large organisations with many users and large data sets, these demands will be higher on the hardware requirements.

- **Reliability requirements** describe the dependability of the system – how often a system exhibits problems such as service outages and incorrect processing and how it detects and recovers from those problems. Reliability requirements are sometimes considered a subset of performance requirements.

While organisations need to ensure that the functional requirements are met, there are, according to Yeats, *et al.* (1994:190) two common problems that deter development estimates related to hardware costs. The one problem occurs where the final product turns out to be more complex and hence require more computing power than was originally envisaged. The other problem occurs when the hardware itself turns out to have less available power than the sales specifications suggest. The results are that initial estimates of the size of machine required almost always turn out to be too low in cost. If the server is somewhere in the low to middle range, it would be quite possible that more funds would be required to ensure that an adequate server is purchased in the first place. On the other hand, if the server is at the top of the range, the analysts should, according to Yeats, *et al* (1994:190), consider whether they shouldn't be proposing a more powerful environment in the first place.

It is important for implementers of an ISMIS to understand, and investigate the infrastructure requirements of various user software and DBMS. This will ensure that the organisation implements a cost-effective system, and that costs related to hardware do not spiral out of control, as the system attempts to address the organisation's functional requirements.

Development of hardware and software is not the only cost factor in the implementation of an ISMIS. Training is also required, a fact which needs to be considered by the implementers of an ISMIS.

4.2.5 Training

When new systems are implemented, personnel will probably be required to be retrained, since people's job functions might be changed by new systems. The organisation may also have to reconsider the type of people it will have to recruit in future, and the type of training they will require (Yeats, *et al.*, 1994:190). Where recruitment of new personnel is required, job specification, advertising, salary advance and interviewing will be required. Retraining of existing personnel will require planning and co-ordination (Skidmore & Eva, 2004:323).

For training to be effective, it must be clear what the training needs to achieve. This might be clarified through the setting of objectives, where three levels of objectives can be distinguished (Skidmore & Eva, 2004:323). The three levels of the training objectives are as follows:

- The first type of training demands the *recall of facts*;
- The second type of training requires *comprehension*; and
- The third type of training requires *application*, where the trainee has to use his or her knowledge in different situations of the same general application.

In practice, the objectives of a training course are a mixture of recall, comprehension and application.

According to Skidmore and Eva (2004:324) training is sometimes poorly planned, and presented at the wrong level of training objectives. This leads to users and operators who do not fully understand their tasks and roles which greatly reduces the effectives of the system. To overcome this, tasks of implementation should be clear and carefully co-ordinated. Where ill co-ordinated training takes place during the implementation phase of a system, users could end up having to be retrained, which adds unnecessary time and cost to the project, making the project less cost-effective.

In Yeats, *et al.* (1994:240-42) it is also suggested that a system be developed with menu systems that are structured hierarchically and with shortcuts within the Graphical User Interface (GUI), as opposed to using command language where the commands have to be syntactically correct in order to be accepted by the system. This would reduce the training requirement when preparing individuals to use the system, making the implementation of the system more cost-effective.

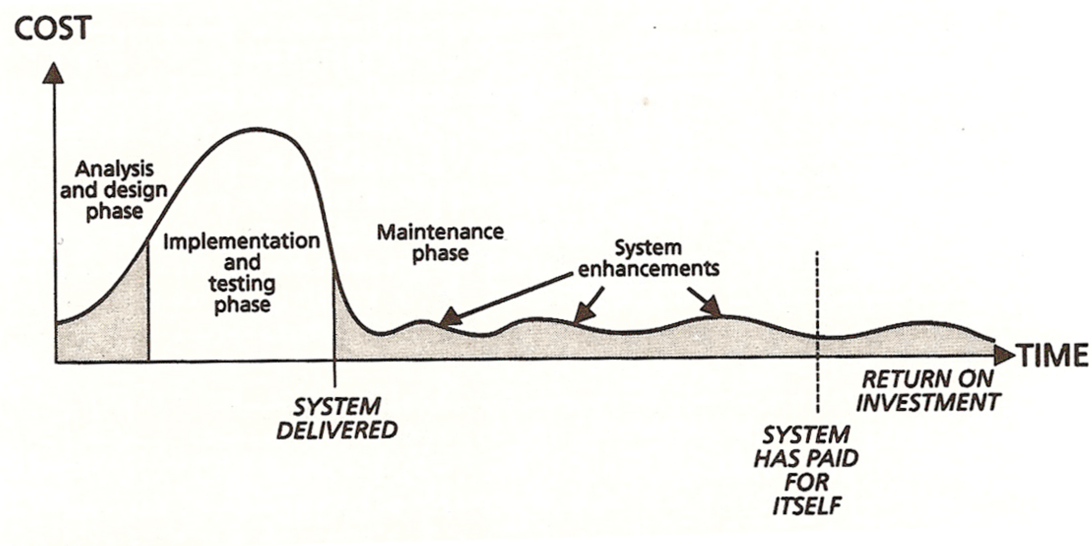
Apart from user training on how to operate the ISMIS effectively, system maintenance on hardware and software is regarded as a cost factor, in the cost-effective implementation of ISMIS.

4.2.6 Maintenance requirement

In order for the ISMIS to be effective over time, maintenance will be required. Maintenance will provide the sustainable momentum the project requires, after the system has been implemented and tested.

Yeats, *et al.* (1994:394) indicate that the maintenance cycle will be several times longer than the development period, which is indicated as the implementation and testing phase, as indicated in Figure 4.2 below. Although the cost of the maintenance phase is less than the implementation phase, the time period is far extended.

Figure 4.2: The lifetime system costs and returns

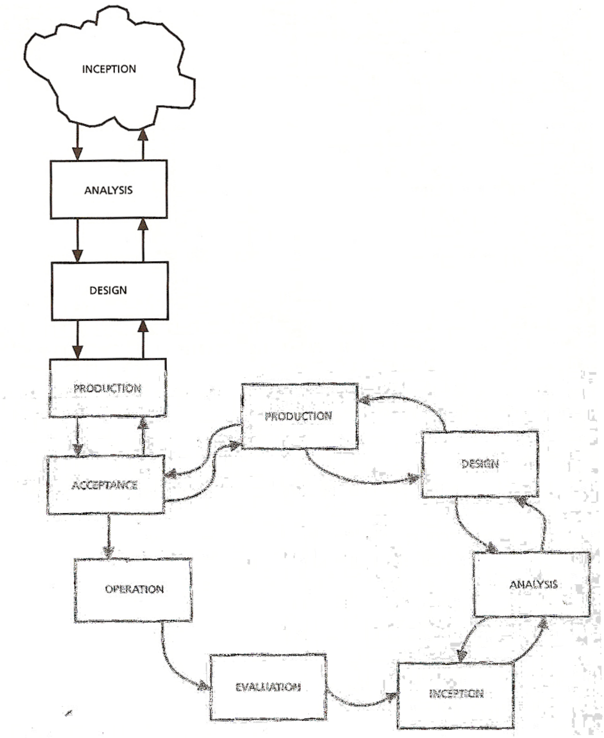


Source: Yeats, *et al.*, 1994:394

Initially the client and developers may negotiate a warranty contract which is similar to hardware guarantees, but with the difference that no work is done at no cost. Typically the client indicates the amount of support that will be required, which is agreed in the form of a monthly or quarterly maintenance agreement with payment schedules. If the client uses less than they contracted for, they are still liable to pay the full maintenance fee, although this is typically negotiated. If the system is relatively stable, the contract is reduced, and if the client requires more enhancements, the contract in increased.

Yeats, *et al.* (1994:394) furthermore explain that as users evaluate the system, and use it under business conditions, they might suggest improvements, additions or amendments. The maintenance phase would then lead to further development into a new inception phase, as illustrated in Figure 4.3 below, the b-model of system development.

Figure 4.3: The b-model of system development



Source: Yeats, *et al.*, 1994:110

The b-model of system development will not be discussed in detail, and serves to indicate that further costs are inevitably incurred though the life-cycle of any system, which add to the total cost of ownership of the project.

4.2.7 Time constraints

Time constraints are identified by the *BEST-GIS Consortium* (1998:100) as a cost factor in the establishment of a spatial system. The example is used where a project has to be finished in one year, with 12 man years of work. The cost for the software and hardware will be quite high, since 12 GIS seats will be necessary. If the project could be done in 3 years, the cost of services will remain the same, but the cost of hardware and software will drop substantially, since only 4 seats will be required. The *BEST-GIS Consortium* furthermore states that time constraints should not be confused with time aspects. Time constraints are the factors that cause a different division of the (standard GIS) components and time aspects are the considerations determining that a GIS should not be seen as a once-off purchase.

4.3 Conclusion

As is evident from the above discussion, various factors are responsible for the total cost in the implementation of an ISMIS. These factors include issues related to data such as data currency, data accuracy and data availability. Software, and the various types of software licensing options, is also cost factors. Software customisation may also be required, and with additional time constraints linked to projects, costs can easily escalate to well beyond initial expectations. Software often has specific hardware requirements, and with training required to operate the system, maintenance is also required to provide the sustainable momentum in the project.

All these cost factors could have a significant impact on the budget of a project, and if an organisation wishes to implement an ISMIS cost-effectively, the need of different users in the organisation should be understood. Particularly important is understanding how their needs differ, and how the respective functional requirements of different users can affect the cost of a system. The following chapter will outline these issues, and will also provide an indication of how cost can eventually be measured within a cost-benefit framework.

CHAPTER 5
MANAGING THE COST OF AN ISMIS

5.1 Introduction

In the second chapter of this dissertation, it was clear that due to the demands placed on Local Government to serve its communities, service delivery and systems to support service delivery are paramount to these organisations. Unique needs are found within these organisations, which can be addressed through the implementation of Integrated Spatial Management Systems (ISMIS), where various systems within the organisation are integrated into a data repository, and displayed on a map, which was discussed in chapter 3. Unique reports can be generated for all levels of the organisation, from front-desk personnel, dealing with daily public queries, to top management requiring strategic information from the ISMIS. Chapter four discussed how implementers of an ISMIS should be aware for certain cost factors, if not carefully assessed and understood, could provide the organisation with a system which does not address the unique needs of the organisation.

The costs associated with implementing these systems are also substantial, and as previously mentioned, the successful implementation of any system is not necessarily based on the implementation of a system at the lowest cost possible, but the system with the most cost-effective application of costs. For this reason, chapter 5 initially aims to provide an insight into the reasons why systems fail in general.

Further discussions will focus on why implementers of an ISMIS need to identify different levels of users in the organisation, as well as determine what the relationship is between the needs of these users, based on their function in the organisation, and the cost of implementing an ISMIS.

The final section of this chapter will focus on the relationship between cost and benefit, as this can provide a basis for determining how effective the application of any cost is within the organisation.

5.2 The failure of systems and the prevention of failure

With the background of the different cost factors that influence the implementation of an ISMIS (as discussed in Chapter 4, above), the following section will investigate why systems fail in general in organisations and how implementers can minimise the risk of failure.

In a recent article, "Why IT fails", which is based on his book "The Critical Factors for Information Technology Investment Success", Robertson (2005), discusses seven factors that cause IT systems in general to fail. These factors are also relevant in the implementation of an ISMIS within Local Government. He argues that nearly seventy percent of IT systems fail due to factors such as:

- **IT mythology**: the tendency to assign mystical or human attributes to computer systems. Systems are sometimes attributed with superhuman characteristics, and are perceived as having the ability to perform intellectual and creative functions which exceed the ability of human beings. A problem arises when there is a tendency to speak of integrated systems as though they will compensate for diverse human inadequacies.

- A second factor for IT systems to fail is a lack of **executive custody** and inappropriate policies, where top management do not take ownership of IT systems. This leads to a lack of support, which inevitably can lead to system failure.

- A third factor mentioned by Roberson (2005), is a lack of **strategic alignment.** A clear, robust definition is required of what differentiates the organisation in its core market and how it will be achieving growth and profit. Once a strategic definition is in place, the proposed improvements that a new IT investment will bring can be aligned in the context of every core operational functional area of the organisation.

- Often **"an engineering approach"** is required for systems to succeed. The engineering approach includes meticulous attention to detail, rigorous specifications, checking and double-checking of specifications, use of multi-disciplinary professional teams and acceptance of liability and accountability for failure. Cassetari (1993:86) also maintains that the failure to adopt a rigorous and well-constructed implementation process will inevitably lead to an unsatisfactory solution.

- In general systems also fail due to poor **data engineering**. It is important that the classification and arrangement of data is in such a way that codes that are used for validation data and master data, are highly structured and accurately reflect expert human understanding. According to Robertson (2005), this data classification starts with a strategic, highly structured design of the chart of the accounts, and extends to every code in the system.

- The sixth factor in the failing of systems are **“soft issues”** such as psychology, the management of change, training, motivation, leadership and other human characteristics.

- **Technology issues** can be regarded as the final factor according to Robertson (2005), where technology is far more advanced than the average organisation. Organisations need to ask “what technology is REALLY appropriate to the organisation and what does the organisation need to do to fit it effectively in the organisation”.

When a system fails or succeeds, the effect is far-reaching within the organisation, and affects various elements throughout the organisation. These elements include planning, user requirements, an appraisal of effort, staffing, funding, time and user expectation (Antenucci, *et al.*, 1991). The effects of a successful or failed system are summarised in Table 5.1, below.

Table 5.1: The elements of success and failure in a GIS implementation

Success		Failure
Rigorous	**PLANNING**	Short lived
Focussed	**REQUIREMENTS**	Diffused
Realistic	**APPRAISAL OF EFFORT**	Unrealistic
Dedicated, motivated, continuity	**STAFFING**	High turnover
Adequate financial plan	**FUNDING**	Inadequate, conjecture, speculative
Thoughtful	**TIME**	Rushed or prolonged
Balanced	**EXPECTATIONS**	Exaggerated

Source: Antenucci *et al.*, 1991

Based on Table 5.1 above, it is clear that the successful implementation of a spatial system can be achieved through rigorous planning, focussing requirements on user needs, an adequate financial plan, a thoughtful time frame and balancing user expectations. The result will be a dedicated and motivated staff component, which provides continuity within the system.

In order for the organisation to function effectively, officials are required to perform specific functions. As stated in paragraph 5.2 above, one of the reasons why systems fail, according Robertson (2005) is related to technologies that are ineffectively applied within organisations. In other words, users of an ISMIS end up with the incorrect software tools, in relation to their function in the organisation. It is thus important to understand users, their functions, functionalities required from the system, as these affect cost and the number of users using the system in the organisation.

5.3 Providing the correct software tools to the correct users

In order for implementers of ISMIS to provide users with the correct software tools applicable for their function in the organisation, the different types of users need to be understood. These different types of users, and the functionalities they require from the systems, have an impact on the cost and the number of users accessing the system, which will be discussed in more detail.

5.3.1 Types of users in an ISMIS

Organisations are, in the words of Handy (1993:23): "first and foremost, fascinating collections of people". It is thus important for implementers of an ISMIS to realise that different levels of users exist within the organisation. Different terms are used for the person faced with the decision that the MSS is designed to support such as *user*, the *manager*, or the *decision maker* (Turban & Aronson, 2001:109). However, these terms fail to reflect the heterogeneity that exists among users and usage patterns (Alter, 1980).

Turban and Aronson (2001:109) distinguish between two broad classes of users of an MSS: managers and staff specialists, such as financial analysts, production planners, and marketing researchers. In general, managers expect systems to be more user-friendly than do staff specialists. Staff specialists tend to be more detail-orientated than do managers, and use more complex systems in their day-to-day work, and are interested in the computational capabilities of the MSS. Often, staff analysts are intermediaries between management and the MSS.

If the user-model is based on a GIS system where specialists pass results of analysis to a decision maker, then a very different kind of interface is required from the model where relatively inexperienced GIS users access data as part of an integrated information strategy for solving complex problems (Cassettari, 1993:155).

For the purpose of this study, different types of users are identified, and are grouped *as super users, basic users* and *expert users*. The different types of users are described as follows:

- **Super user:** A super user can be defined as a user that have access to all information within the system related to his or her function in the organisation, and can add, edit, maintain and report on data. This type of user is typically at the operational level of the organisation.

- **Basic user:** A basic user has extremely limited functionalities available from the system, and can view, and report on data. The basic user does not have the authority to add, edit or maintain data. This type of user can often be at senior management level.

- **Expert user:** An expert user can be defined as a user who cannot add, or edit new data to the system, but do have the ability to view, manipulate and report on data. The expert functionalities within the system do allow the user to create complicated queries and analysis on the data, which would lead the user in creating new layers of data based on the existing data created by the Super Users. Typically this type of user can be found at the middle management level of the organisation.

Table 5.2, below provides a comparison between the user types, the user's function in the organisation in relation to the ISMIS, and the functionalities the user requires from the system.

Table 5.2: User profile in the organisation.

Type of user	Function in the organisation	Functionalities required from the system	Relative Cost	Relative number of users
Super user	Data Capture	Add, edit, maintain and report data	Most expensive	Fewest users
Expert user	Data Analysis	View, manipulate and report data	More than Basic user, but less than Super user	Fewer than Super users, but more than Basic users
Basic user	Data Publish	View and report data	Least expensive	Most users

In Table 5.2, the relative cost and number of users in relation to the different types of users is also provided, indicating that super users are typically the most expensive type of user and also the fewest number of users in the organisation. On the other hand, it is least expensive to provide basic users with access to the system, resulting in most users having access to the system.

A paradox can be found in this model, as the number of staff specialists (expert users) outnumber managers (basic users) 3 to 2 (Turban & Aronson, 2001:109). This can be even more for super users (data capturers) in relation to basic users (managers) in organisations. This is not to say that the statement is incorrect, but merely highlights the need for implementers to provide data capturers with applications that are custom made for their function, and not to attempt to provide COTS (Commercial off the shelf) software, which are inappropriate to the user. This is achieved by providing expert users with enough data capture functionalities (and no more), than is required for them to effectively function in the organisation. This is in line with the arguments of Robertson (2005). Costs can be managed and decreased, making the system more cost-effective.

5.3.2 The relationship between cost (cost per seat), functional functionality and user base

It is important for implementers of ISMIS to understand the relationship between user requirements, the associated functionality requirements from the system, and the impact these requirements have on the number of users accessing the system. Once implementers understand that different users have different functionality requirements, the correct set of software "tools" can be provided, which would assist in the cost-effective implementation of an ISMIS. Once again it is important to note that the term "cost-effective" does not necessarily refer to the project with the least total cost, but to the effective application of cost to meet user requirements in the organisation.

In order to clarify this relationship, the following terms are discussed in more detail:

- Cost-per-seat;
- Functional functionality; and
- User base.

Cost-per-seat: If the aim of the organisation is to measure its success in the publishing of spatial related information to as many users as possible at the least financial cost, the calculation of cost-per-seat would provide an indication of how successful the organisation was, in achieving its aim.

Cost-per-seat is calculated by calculating THE TOTAL FINANCIAL COST OF THE PROJECT (as discussed in chapter 4 of this document) divided by THE NUMBER OF USERS ACTIVELY USING THE SYSTEM.

$$COST\ PER\ SEAT\ ?\ \frac{TOTAL\ FINANCIAL\ COST\ OF\ PROJECT}{NUMBER\ OF\ ACTIVE\ USERS}$$

As the calculation of cost-per-seat involves the detail calculation of tangible and intangible costs (as discussed in par. 4.1, above), such an accurate calculation falls outside the scope of this dissertation.

However, to illustrate how different components within the development of an ISMIS can influence the cost-per-seat, three fictitious scenarios are presented in Table 5.3 below.

Table 5.3: The basic calculation of the cost-per-seat

	Scenario 1	Scenario 2	Scenario 3
Hardware	ZAR300,000.00	ZAR300,000.00	ZAR300,000.00
Data	ZAR20,000.00	ZAR20,000.00	ZAR20,000.00
Software	ZAR425,000.00	ZAR0.00	ZAR0.00
Training	ZAR225,000.00	ZAR50,000.00	ZAR100,000.00
System development	ZAR700,000.00	ZAR700,000.00	ZAR700,000.00
System maintenance	ZAR100,000.00	ZAR300,000.00	ZAR300,000.00
Total Cost	**ZAR1,770,000.00**	**ZAR1,370,000.00**	**ZAR1,420,000.00**
Number of users	**50**	**50**	**100**
Cost-per-seat	**ZAR35,400.00**	**ZAR27,400.00**	**ZAR14,200.00**

Within all three scenarios, the different organisations aim to develop an ISMIS which operates over an intranet platform. In the three scenarios, all costs are equal, except for software, maintenance and training fees. A brief description of each scenario follows:

- In scenario 1, the organisation decided to opt for a supplier who provides software on a per user basis. In order to maintain the data, 15 user licences are purchased, at a cost of ZAR15,000.00 per user to maintain the data. An additional ZAR200,000.00 license fees are payable, to enable the organisation to publish data on an intranet. Since the organisation is maintaining its own data, specialist training was required for the 15 users, at a cost of ZAR15,000.00 per user. A maintenance fee of ZAR100,000.00 was negotiated, to support the system.

- In Scenario 2, the organisation decided to opt for proprietary software, thus no software licensing was required. The organisation also outsourced the maintenance of the system, hence no specialist training was required. This has, however, increased the maintenance cost of the system, since an outside service provider is required to maintain the data.

It is at this point evident from the two scenarios, that when a cost-per-seat is calculated, scenario 2 presents a cost of ZAR27,400.00 per seat, as opposed to ZAR35,400.00 per seat in scenario 1. Both scenarios provide access to the system to 50 users.

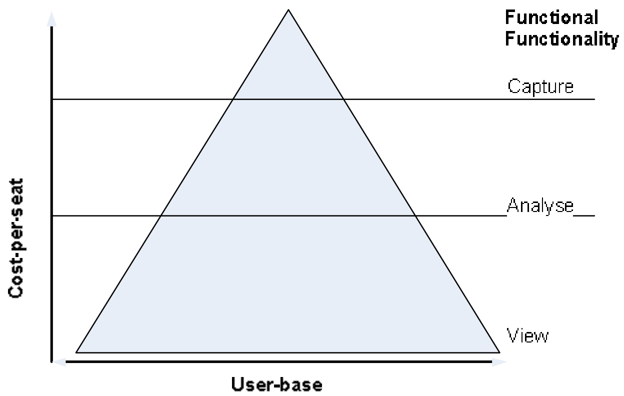
Scenario 3, however, is based on the same principles as scenario 2, but since no software licensing is required, the number of users has increased substantially, adding costs towards basic training. The cost of ZAR14,200.00 per seat, is still, however, substantially lower than both scenario 1 and 2, and provides probably a better indication on how software licensing can affect the cost-effectiveness in the implementation of an ISMIS.

Functional functionality: Within an organisation, different users have different functions. These broad functions, give guidance to actions the user need to perform in order to fulfil a function. Based on these functions, the user requires certain functionalities from the system, in order for the user to optimally perform a function effectively. This is in accordance with Van Helden (1993:169) who states that the role of information systems in the organisation is determined by the different functions. If the user has too little functionality within the system, the user would not be able to perform his/her tasks, or if the user had too much functionality within the system, the system would be too complex. This is further affirmed by Robertson (2005), who argues that technology is sometimes far more advanced than the average organisation; a case where "too many options clutter the mind". As discussed in previous chapters, different users require different software applications with different functionalities from the same system in order for them to perform their respective function effectively.

User base: The total number of users who actively access the system. If the system is intranet- or extranet based, these users could be from within the organisation, or if the system is internet based, these users could be from outside the organisation.

Based on Table 5.2 above, the relationship between cost (calculated as cost-per-seat), functional functionality and user base is illustrated. In Figure 5.1 below, users typically require specific functionality from the ISMIS, based on their function in the organisation. These functionalities are typically collected during the User Requirement Survey (URS) in the initial phases of the project.

Figure 5.1: The relationship between cost (cost per seat), functional functionality and user-base



The functionality requirements can be categorised into three levels, namely the requirement to capture data, the requirement to analyse data or the requirement to view published data.

- The first level of users can be grouped as the *Capture users*. Due to the higher costs associated with the capturing of data (through the use of super users, time associated to clean data and higher software licensing costs), the costs-per-seat is relatively the highest. Due to the higher costs, the relative number of users is also limited to only a few users in the organisation, which leads to the highest cost-per-seat calculation.

- The second level of users can be categorised as the *Analysis users*. Training requirements are normally not as extensive as the super users, and since the data have already been captured and cleaned, the time associated to analyse data are also relatively less than the Capture users. As mentioned earlier in this study, staff specialists (expert users) outnumber managers (basic users) 3 to 2 (Turban & Aronson, 2001:109). Since more users have access to the ISMIS, there is a positive impact on the cost-per-seat associated with the implementation of the project. (Refer to scenario 3 in the example presented in Table 5.3, above)

- The third level of users can be categorised as the *Viewer Users* in the publishing platform. Viewer user's requirements indicate that they require basic mapping functionality to simply view data. These users might simply want to search for and map a property on a map, and as easy as possible view information on the property which could include ownership, land use, zoning or any other information available from the system without analysing the data. Management reports are also readily available which generates updated reports as required from already updated data. Training requirements are also basic, and due to the easy accessible data, most users access the ISMIS at this level. Since more users access the system relative to the analysis- and capture levels, the lowest cost-per-seat can be expected from this level.

With a better understanding of the types of users and the impact the correct set of application software can have on the cost-effectiveness of an ISMIS, the relationship between cost en benefit can be discussed.

5.4 The relationship between cost and benefit

With a better understanding of the relationship between costs, (as expressed in cost-per-seat), different functions of users in the organisation, and the impact this relationship has on the number of users using the system within the organisation (as discussed in par. 5.3), the relationship between cost and benefit can be explored. It is important to note that the aim of this study is not to provide an in-depth analysis of the theories related to cost-benefit analysis in GIS projects (e.g. Born, 1992), or to provide a detailed cost-benefit analysis for a municipality, since such a analysis would lie outside the scope of this study, but to provide an overview of the relationship between cost and benefits within systems.

As previously stated, the aim of a cost-effective implementation of an ISMIS would not necessarily imply the implementation of a system with the *least* cost, but in fact a system where the benefits outweigh the costs of implementing the system.

As financial reporting by Local Government to National Government are required under the Municipal Finance Act (Act 56/2003), the application of cost-benefit analysis (CBA) provides municipalities with measurements of economic benefits and costs of projects not only to National Government, but to consumers and society as a whole (Galt, 1973). Galt (1973:3) argues that decisions on investments in projects are often made in a subjective way, and that real costs and potential benefits of some straightforward projects are by no means evident and that the consequences for cost and benefit are extremely wide.

The BEST-GIS Consortium defines CBA in a report (*Guidelines for Best Practice in User Interface for GIS,* 1998:93) as “a method to reduce uncertainty during decision making and planning by replacing options, believes and emotions, by a framework for identification and determination of the benefits and cost, respectively of each alternative GIS” and where a well-planned system can achieve a long-term, fully discounted, cumulative return of 2,5:1 (*Guidelines for Best Practice in User Interface for GIS*,1998: 94). This translates that for every monitory unit spent on hardware, software, data automation, system implementation, application development and operation costs can yield 2,5 monitory units in benefits due to efficiencies, avoided costs and other benefits. This is in line with Anderson and Settle (1977:14), who state “that the basic criterion to be satisfied is that the value of goods and services produced be increased".

It has been proven in a study undertaken by The Joint Nordic Project (1987), that benefits can be derived through the implementation of a spatial system. Through the analysis of sixteen GIS projects in North America and Italy (which ranged from automated mapping programs to fully integrated corporate systems), cost and benefit ratios were compiled. The results indicated the following:

(a) A digital system used only for computer-aided mapping and updating, produced a return on investment (C/B ratio was 1:1).
(b) If the system is also used for planning and engineering, benefits are doubled (C/B 1:2).
(c) Automation of conventional maps can bring a benefit of treble the investment (C/B 1:3).
(d) If the system permits the sharing of information among different organisations, this can result in a benefit of up to four times the cost (C/B 1:4).
(e) Where manual map production processes were inefficient, the benefits of automation gave a C/B ratio of up to 1:7, with an average reduction of 50 percent in map production time.

Boardman, Greenberg, Vining and Weimer (2001:3) distinguish two major types of CBA, namely *Ex ante* CBA and *Ex post* CBA.

Ex ante CBA is the standard CBA commonly used and is conducted while the project is under consideration, thus before it is implemented. *Ex ante* CBA provide a basis to assist the decision makers in determining whether scarce resources should be allocated to a project. In the case where alternative implementations are considered, each alternative is assessed in terms of its monetary costs and the monetary values of its benefits, each alternative can be considered on its own merits to see if it would be worthwhile (Levin, 1983: 21). Levin (1983) furthermore argues that in order for an alternative to be considered for selection, any alternative must show benefits in excess of costs.

Ex post CBA, on the other hand, refers to a cost-benefit analysis undertaken at the end of a project. All cost is calculated since the costs have already been incurred to implement the project. Such a type of CBA is less immediate than an *ex ante* CBA, since its purpose is to provide the organisation with inputs to whether such projects are worthwhile or not.

Where CBA studies are undertaken during a project, it is referred to as *in medias res*. Some elements of such studies are similar to *ex ante* analysis, where others are similar to *ex post* analysis.

The values that the organisation requires to extract from the different types of CBA are compared in Table 5.4 below.

Table 5.4: The value of different types of CBA

Value	***Ex Ante***	***In Medias Res***	***Ex Post***
Resource allocation decision for the project.	Yes - helps to select best project or make "go" versus "no-go" decisions, if accurate.	If low sunk costs, resources can still be shifted. If high sunk costs, continuation is usually recommended.	Not applicable. The project has been completed.
Learning about the actual value of a specific project.	Poor estimate – there is a high uncertainty about future benefits and costs.	Better – reduced uncertainty.	Excellent – although some errors may remain. May have to wait for a long period of time for the study.
Contribution to learning about actual value of a similar project	Unlikely to add value.	Good – contribution increases as the assessment is performed later in the project. There is a need to adjust for uniqueness.	Very useful – although there may be some errors and a need exist to adjust for uniqueness. May have to wait long for the project to be completed.

Source: Boardman, *et al.*, 1994:71

As the aim of the municipality would be to implement a cost-effective ISMIS, *ex ante* analysis will add value to the project in resource allocation towards the project in the planning phase of the project. On the completion of projects *ex post* CBA will assist the municipality in learning about the actual value of a specific project, and what contribution such specific project may have on similar projects or components in the ISMIS project.

5.4.1 Examples of cost-benefit analysis

According to Levin (1983:24), benefits are calculated as a ratio of costs, in order to complete a basic cost-benefit analysis. He goes further, and states that the benefits must at least equal the costs, and in a case where the costs are greater than the benefits (for example of ratio of 1:0,8), it would indicate that the project is not worthwhile. On the other hand, if the benefits are greater than the costs (for example a ratio of 1:1,2), it can be derived that the project was more cost-effective.

In a report published by the Best GIS Consortium (*Guidelines for Best Practice in User Interface for GIS*, 1998:101), three examples of *ex-post* CBA are provided of how a cost-benefit analysis can be applied within a spatial context[4]. The three fictitious examples (Case 1, Case 2 and Case 3) are rated as Case 1, a cost-ineffective project (Figure 5.2 below), Case 2, a medium cost-effective project (Figure 5.3 below) and Case 3 a cost-effective project (Figure 5.4 below).

For each of the case studies, the costs have been indicated (in KECU) for hardware, software, yearly maintenance, service costs, training, external data costs, personnel and other costs. To complete the cost-benefit analysis, the benefits have been indicated (in KECU) for services rendered, products (such as maps and applications), new internal services performed and the benefits from research projects.

Each case is discussed in the following paragraph.

[4] Note: Within the report, Case 3 is indicated as a cost-effective project. Within the analysis of the data, it was however found that the costs outweigh the benefits, with a ratio of 1:0,66 which would indicate a cost-ineffective project.
Due to the fictitious nature of the original data in the literature, and because the cases are provided as examples to illustrate the relationship between cost and benefits, the benefit data for Case 3 has thus been amended and reflects the benefit data of Case 2.

5.4.1.1 Case 1 – a cost-ineffective project

Based on information provided in Figure 5.3 below, the implementation of a spatial system for Municipality A is regarded as a cost-ineffective project.

Figure 5.2: Case 1 – The cost-benefit analysis of fictitious Municipality A

COSTS (KECU)

	1992	1993	1994	1995	1996	1997	Total
Hardware price	47	21	0	0	28	16	112
Software price	40	6	0	0	13	0	59
Price for yearly maintenance	2	2	2	2	2	2	12
Costs of service	8	5	15	12	13	13	66
Training	2	2	3	4	1	2	14
External data	0	0	3	26	16	16	61
Personnel	35	36	23	37	38	39	208
Other Costs	1	1	2	2	2	1	9
Total	**135**	**73**	**48**	**83**	**113**	**89**	**541**

ESTIMATED BENEFITS (KECU)

	1992	1993	1994	1995	1996	1997	Total
Services	0	0	0	0	0	0	0
Products (maps, applications)	0	0	0	0	0	22	22
New internal services performed	0	12	23	27	34	22	118
Research projects	0	24	24	0	0	33	81
Total	**0**	**36**	**47**	**27**	**34**	**77**	**221**

Source: Guideline for best practice in user interface for GIS, 1998:101

Based on the analysis of the data in Figure 5.2 above, a ratio of 1:0,41 is calculated for the cost-benefit analysis in the project. This can be translated as for each KECU spent on the project, the returned benefit was only KECU0,41, thus less than the costs incurred.

5.4.1.2 Case 2 – a medium cost-effective project

In Figure 5.3 below, the information from Municipality B, which is regarded as a medium cost-effective project, is displayed.

Figure 5.3: Case 2 - The cost-benefit analysis of fictitious Municipality B

COSTS (KECU)

	1992	1993	1994	1995	1996	1997	Total
Hardware price	51	25	61	15	26	11	189
Software price	46	5	24	15	12	5	107
Price for yearly maintenance	26	3	3	3	3	3	41
Costs of service	10	5	3	4	2	2	26
Training	26	2	4	4	2	2	40
External data	5	11	2	3	14	15	50
Personnel	31	32	45	60	120	133	421
Other Costs	5	3	3	2	3	4	20
Total	**200**	**86**	**145**	**106**	**182**	**175**	**894**

ESTIMATED BENEFITS (KECU)

	1992	1993	1994	1995	1996	1997	Total
Services	0	0	0	60	65	14	139
Products (maps, applications)	0	0	10	0	0	82	92
New internal services performed	0	21	46	60	81	20	228
Research projects	0	70	85	85	25	125	390
Total	**0**	**91**	**141**	**205**	**171**	**241**	**849**

Source: Guideline for best practice in user interface for GIS, 1998:102

Based on the data presented in Figure 5.3 above, a ratio of 1:0,95 is calculated as the CBA for Municipality B. In this case, the costs exceed the benefits by KECU45, and if compared with case 1, would still be a better project.

5.4.1.3 Case 3 – a cost-effective project

In Figure 5.4 below, the information from Municipality C, which is regarded as a cost-effective project, is displayed.

Figure 5.4: Case 3 - The cost-benefit analysis of fictitious Municipality C

COSTS (KECU)	1992	1993	1994	1995	1996	1997	Total
Hardware price	0	46	11	23	8	17	105
Software price	0	56	11	5	8	10	90
Price for yearly maintenance	0	2	3	3	3	3	14
Costs of service	0	5	2	11	3	4	25
Training	0	3	0	2	2	2	9
External data	0	11	5	0	6	11	33
Personnel	0	62	76	103	120	125	486
Other Costs	0	1	1	1	2	2	7
Total	**0**	**186**	**109**	**148**	**152**	**174**	**769**

ESTIMATED BENEFITS (KECU)	1992	1993	1994	1995	1996	1997	Total
Services	0	0	0	60	65	14	139
Products (maps, applications)	0	0	10	0	0	82	92
New internal services performed	0	21	46	60	81	20	228
Research projects	0	70	85	85	25	125	390
Total	**0**	**91**	**141**	**205**	**171**	**241**	**849**

Source: Adapted from Guideline for best practice in user interface for GIS, 1998:102 (Refer to footnote [4])

In the final case, the costs are less than the benefits, with a ratio of 1:1,10, as indicated in Figure 5.4 above. This would indicate that for each KECU1, the returned benefit was KECU1,10, and that the project was completed cost-effectively. Compared with the previous two cases above, Case 3 would be the better project.

5.5 Conclusion

With an increased understanding of users within the organisation, and how their functional requirements can affect the total cost of a project, users can be evaluated and categorised, within the organisation. Specific software applications can be provided to these users, which would suit their requirements, and make them effective within the operation of an ISMIS.

The Local Governments can furthermore evaluate the cost-effectiveness of ISMIS by means of a cost-benefit analysis, and by deciding when such as CBA should take place, either in the initialisation phases of the project, during the project or as a final step of the project, the organisation can determine how effectively funds have been spent.

CHAPTER 6
SUMMARY AND CONCLUSION

6.1 Introduction

Various systems and processes are implemented within Local Governments to assist in the day-to-day operation of the organisations, including financial-, human resource-, building control and land use management systems. Developments in Information Technology and specifically Geographical Information Technologies have enabled the effective implementation of Integrated Spatial Management Information Systems (ISMIS). The ability of these enterprise systems to integrate different systems into a single data repository, from where information can be updated and disseminated, has enabled users from all levels in the organisations to access data.

As costs are inevitably incurred, added benefits are also derived from the system. Where systems have been implemented and pressure is mounting for users to gain access, implementers need to be aware of the factors that hinder users to gain access to the systems, in order to open systems up to as many users as possible.

The main objective of this study was to assist in the identification of cost factors in the development and implementation of ISMIS in Local Government, with the goal of developing cost-effective systems. Cost effectiveness does not necessarily refer to the project with the least cost, but the project with the most effective application of cost, providing the greatest benefit in relation to user needs, and where the benefits ultimately outweigh the cost.

6.2 Integrative summary

Following the transformation of Local Government since the approval of the Constitution of South Africa in 1996, various white papers and acts were passed, defining the structure and purpose of Local Governments in South Africa. Various categories of Local Government were identified, namely category A, B and C. Based on their functions to society, and the requirements of internal- and external clients to the municipality, certain information needs have evolved in Local Government. The needs are determined by a detailed User Requirement Survey (URS).

Complementing the planning process of an ISMIS, the detailed URS can be undertaken with officials within the Local Municipality. Based on studies undertaken within various Local Governments in South Africa, general needs have been identified, which include inadequate access to information; a need for improved productivity; access to more electronic information; fewer duplication and inconsistencies of information; information needs to be disseminated; information needs to be managed and be centralised through a information sharing portal; information needs to be spatially based in a Geographical Information System (GIS); information needs to be maintained and the existing systems need to be integrated.

The electronic systems within Municipalities are also diverse in function and are often based on requirements by National Government for Municipalities to function effectively. As more information is being gathered through time, systems are required to manage spatial information, which will provide users in the organisations with the means to update, maintain and report on data. It was evident that systems are required to be integrated, and where spatial information exists, this information needs to be presented to users.

Developments in Information Technology make it possible for Municipalities to implement various systems that would enable them to operate more effectively. A hierarchical structure exists in information systems within the Municipal structures. At the top the integrated information system consists of a collection of people, processes, data and technologies, with at the bottom the individual information subsystem. These information systems include Municipal Information System, Departmental Information systems and information subsystems in a department.

Various other information systems are operational within Local Governments. These systems support business processes as either *Operations Support Systems* or *Management Support Systems*.

Within an organisation, the role of Operation Support Systems is to efficiently process business transactions and update operational databases with Transactional Processing Systems, control industrial processes through Process Control Systems and to support enterprise communications and collaboration with Enterprise Collaboration Systems. Human Resource Information Systems (HRIS) also update and manage personnel records. Within a Municipality, different systems are typically operational, to function as Operational Support Systems. These systems include Financial Systems, Land Use Management Systems, Human Resource Information Systems (HRIS) and e-mail systems.

Management Support Systems provide information through three different types of systems. Management Information Systems in the form of predefined reports and displays, Decision Support Systems through the provision of interactive ad-hoc support for decision-making processes and Executive Information Systems which provide critical information from many sources to executives.

In order to present information spatially, municipalities implement a Geographical Information System (GIS). Much like most Information Technology Systems, a GIS consists of different components or building blocks. The one group being the design blocks such as data-input modules, databases, data-processing, output modules, quality control and resources such as hardware, software and people. The other group being the demand blocks such as the characteristics of data, system requirements, cost-effectiveness, data processing requirements, organisational requirements and implementability of a system.

The combination of a Geographical Information System (that has the ability to integrate and graphically represent data) and a Management Information System (that has the ability to integrate and provide predefined information to decision makers in report format), provides a system where most data that are generated, can be integrated and presented in a spatial format. Data from these data sources can be integrated into a single Database Management System (DBMS). A DBMS permits an organisation to centralise data sets, manage them effectively, extract data and provide access to the stored data by application software.

As Integrated Spatial Systems advance from being "nice-to-have" applications to necessary applications within organisations, the challenges that face an ISMIS increase with the demand for the utilisation for spatial information and services. These challenges include the managing of organisational and technological change related to business processes and the integration of municipal legacy systems. Further challenges that are faced by organisations occur where different organisations collect data for different purposes, and where contrasting meanings are assigned to their data. This highlights the value of metadata within the establishment of an ISMIS, where information such as the scale, accuracy and owner of datasets are documented. In order for users to interpret information in the correct context, metadata need to be documented on the data. If data needs are different in exceptional cases to the levels of accuracy or currency accommodated within the system, the users need to interpret data accordingly.

The National Spatial Information Framework (NSIF) promotes software developed by the U.S. Geological Survey EROS data Centre's International Program. The software captures information such as the title of data, edition of data, an abstract of the data, the purpose of the data, supplemental information on the data, contact information of distributor, metadata contact information.

6.2.1 Cost factors which influence the development of an ISMIS

In order to implement an ISMIS cost-effectively, factors that influence cost need to be identified and understood from the outset of a project. In understanding these cost factors, implementers and service providers need to relate the cost factors to the needs of the organisation and thus consider the potential positive and negative impacts these cost factors might have on the financial- and operational requirements of the ISMIS implementation.

Cost factors can be categorised as *tangible costs*, which can be quantified, and where costs are not quantifiable, these costs are intangible. In order to identify these tangible and intangible costs, factors need to be considered that would influence costs, in the implementation of Integrated Spatial Management Information Systems for a Local Government.

Different factors influence the cost within the development and maintenance of an ISMIS. These factors include *data*, *software*, *hardware*, *training*, *customisation*, *maintenance requirement and time constraints*, and can be summarised.

6.2.1.1 Data

Data is a key element of an ISMIS. Data can be derived from different sources, which include internal data, external data or personal data.

Related to data, three factors were identified that impact on the cost of implementing an ISMIS within Local Government. The three data factors are *data currency* (which refers to how up to date data needs to be in the system), *data accuracy* (the level of accuracy can affect the cost of implementing a system) and *data availability* (by making use of existing data sources, cost can be positively affected in a project).

6.2.1.2 Software

Within the software industry, different licensing models were found, under which software are made available to users. Each of the different software licensing options does have an impact on the cost of implementing an ISMIS and have their respected advantages and disadvantages.

Where software is made available as software packages, perceived advantages include reduced cost; the saving of time since the software already exists; quality benefits, since the software has been tested; documentation and training do exist and software packages are usually supported by formal maintenance agreements, which ensure organised maintenance and enhancement of the software.

Perceived disadvantages of software packages also include

- the fact that the ownership of the software lies with the supplier, and not with the purchaser;
- if the supplier is financially unstable, there might be a risk that the supplier can go out of business, which could affect the quality of support and development;
- when organisations use software packages as supplied by a supplier, they loose their competitive-edge;
- the purchased software fails to fit the requirements of the organisation;

- if a system fails to fulfil the user's functional requirements, the customer can seek legal redress to resolve the failure. If a product was developed in-house by an internal IS department, this would not be possible; and
- since user requirements change, maintenance is required at a cost which can be perceived as a disadvantage to the organisation.

The different Software licensing options that are available, include licensed software, proprietary software and open source software.

6.2.1.3 Customisation

Closely related to software, is the ability of the organisation or service provider to customise a software package for the organisation. Implementers of ISMIS need to assess user needs, and determine where the balance lies between using purchased software and customising software. If customisation is required, implementers need to determine to what level of customisation in order to successfully address user needs.

6.2.1.4 Hardware

Implementers of ISMIS need to be aware of the different system requirements of the various software packages. These software packages are not only the GIS software, but would also include the Data Base Management Systems (DBMS) that would be required to store data within the system. In large organisations with many users and large data sets, these demands will be higher on the hardware requirements.

6.2.1.5 Training

Where ill co-ordinated training takes place during the implementation phase of a system, users could end up being retrained, which would add unnecessary time and cost to the project, making the project less cost-effective. Apart from user training on how to operate the ISMIS effectively, system maintenance on hardware and software is regarded as a cost factor, in the cost-effective implementation of ISMIS.

6.2.1.6 Maintenance requirements

In order for the ISMIS to be effective over time, maintenance will be required. Maintenance will provide the sustainable momentum the project requires, after the system as been implemented and tested

6.2.1.7 Time constraints

Time constraints were identified as a cost factor, in the establishment of a spatial system. Where projects are required to be completed in a short period of time, more hardware and software are required, thus increasing the cost.

6.2.2 Managing the cost of an ISMIS

Different types of users also have different needs which are one of the driving forces for the development of applications.

Three different types of users have been identified. The first being *super users* who have access to all information within the system related to their respective functions within the organisation, and can add, edit, maintain and report on data. The second group comprises the *basic users* who have extremely limited functionalities available from the system, and can view, and report on data. The last group, the *expert users* consists of users who cannot add, or edit new data to the system, but do have the ability to view, manipulate and report on data. The expert functionalities within the system allow the user to create complicated queries and analysis on the data, which would lead the user in creating new layers of data based on the existing data created by the super users.

In general super users are typically the most expensive users and also the fewest number of users in the organisation. On the other hand, it is the least expensive to provide basic users with access to the system, resulting in most users having access to the system.

It is important for implementers of ISMIS to understand the relationship between user requirements, the associated functionality requirements from the system, and the impact that these requirements have on the number of users accessing the system. This relationship is better understood in discussing the principles of cost-per-seat, functional functionality and user-base.

- **Cost-per-seat**: If the aim of the organisation is to measure its success in the publishing of spatial related information to as many users as possible at the least financial cost, the calculation of cost-per-seat would provide an indication of how successful the organisation was.

- **Functional functionality:** Within an organisation, different users have different functions. Based on these functions, a specific user requires certain functionalities from the system, in order to optimally perform a function effectively. If the user has too little functionality within the system, the user would not be able to perform his/her tasks. The same would be true, if the user had too much functionality within the system.

- **User base:** The total number of users who actively access the system. If the system is intranet based, these users could be from within the organisation, or if the system is internet based, these users could be from outside the organisation.

As different users who capture, analyse or view data, access the ISMIS, the user-base increases. As a result the cost-per-seat decreases as the number of users increase to a viewer user level.

With a better understanding of the relationship between cost, (as expressed in cost-per-seat), different functions of users in the organisation, and the impact this relationship has on the number of users using the system within the organisation, the relationship between cost and benefit were discussed. The application of cost-benefit analysis (CBA) provides municipalities with measurements of economic benefits and costs of projects not only to National Government, but to consumers and society as a whole.

Two major types of CBA were discussed, namely *ex ante* CBA and *ex post* CBA. *Ex ante* CBA is conducted while the project is under consideration while *ex post* CBA, on the other hand, refers to a cost-benefit analysis undertaken at the end of a project. Where CBA studies are undertaken during a project, it is referred to as *in medias res*.

When a cost-benefit analysis is undertaken for an ISMIS, the various cost factors are used in the calculations, as discussed in the document. The ultimate aim of a CBA is to achieve a benefit higher than the costs, associated with the project.

6.3 Results

Based on the literature study, the results are as follows:

- User needs in relation to Integrated Spatial Management Information Systems within Local Governments in South Africa are unique, and are based on the functions delegated to the Authorities through legislation, and the existence (or non-existence) of electronic systems to support their functions.

- Tangible- and intangible benefits to Local Governments can be derived through the integration of electronic systems in the form of an ISMIS.
- If the goal of Local Government is to make spatial systems available to as many users as possible in a cost-effective manner, certain cost-factors need to be understood, and the impact that such cost-factors can have on the implementation of an ISMIS.
- By understanding the relation between cost, functional requirements and the impact this relation can have on the number of users, cost-effective systems can be developed for vast numbers of officials in Local Government.
- The cost-effectiveness of ISMIS can be measured by making use of cost-benefit analysis, before during or after a project.

6.4 Recommendations

Based on this extensive literature study, it is recommended that more academic research be undertaken in scientific calculations of the actual benefits of Integrated Spatial Management Information Systems, to determine whether such Management Systems actually create greater value than cost to organisations.

It is furthermore recommended that Local Governments implement Integrated Spatial Management Information System in a responsible manner, by carefully considering all cost-factors in relation to their specific needs. User Need Assessments should also focus on the spatial related needs within the organisations when implementing an ISMIS, to ensure a clear Terms of Reference (TOR) for an Integrated Spatial System.

6.5 Conclusion

In conclusion, it is evident through this study that Local Governments have unique needs, in relation to the development of a Spatial Systems. The unique functions of different officials in these organisations also contribute to the need for customised systems which are integrated from various electronic systems which operate within Local Government. This leads to the development of Management Information Systems which represent data in a spatial (on a map) format.

But implementers of an ISMIS need to consider and understand the different cost-factors, which influence the implementation process, and would ultimately impact on the cost-effectiveness of the systems. These cost-factors include data currency, data accuracy, data availability, software licensing, customisation requirements, hardware, training, maintenance requirements and time constraints. It is also important for implementers of these systems to evaluate the cost-factors according to each organisation's specific needs, since cost-factors which apply in one organisation might no apply to another organisation.

Once implementers of an ISMIS understand the impact cost-factors can have on the cost-effectiveness of an implementation, users in the organisation need to be assessed, and based on their function in the organisation, specific software tools provided to perform their function effectively. This relation between cost and functional software applications can have a major impact on the number of users who have access to the ISMIS.

Finally, the cost-effectiveness of the system can be calculated by a cost-benefit analysis, where the aim is to achieve a benefit which is greater than the cost of implementing the ISMIS, and thus justify the implementation of an ISMIS in Local Government.

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