ASSESSING THE MOTIVATORS AND BARRIERS OF INTERORGANIZATIONAL GIS DATA SHARING FOR ADDRESS DATA IN SOUTH AFRICA

Mini-dissertation by

MALETE DANIEL SEBAKE
(29445036)

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Declaration

I declare that this research represents original work done by myself, and is hereby submitted in partial fulfilment of the requirements for the degree of Master of Information Technology (MIT) at the School of information and Technology, University of Pretoria. The works of other authors have been acknowledged and referenced accordingly in the research. Furthermore, the author obtained necessary authorization and consent to conduct this research.

This work has not been submitted for any additional degree or diploma to any other institution. But, its portions were submitted for publication as presentations or journal papers with full acknowledgement of the authors (see Appendix E).

Signed …….
M.D. Sebake

Abstract

Address data within geographic information systems (GIS) is used as reference data to link personal and administrative information, thus making it possible to locate and deliver goods and services to eligible persons. Preferably, every country must develop and maintain a single national address database (NAD) to eliminate data redundancy and provide a common point of reference across the board. In South Africa, the challenge is that there are separate address databases, which are developed and maintained by various public and private organizations – with little or no cooperation on data sharing. Currently, the establishment of a Committee for Spatial Information (CSI) which is tasked with the implementation of the South African Spatial Data Infrastructure (SASDI) and the publication of the South African Address Standard (SANS 1883) offer organizations an opportunity to collaborate towards the creation of a single address dataset. This research posits that the implementation of a successful data sharing initiative depends on the understanding of motivators and barriers of organizations participating in it. The research applied the case study method – with a semi-structured questionnaire – to assess the issues that motivate or obstruct GIS data sharing among three address organizations in South Africa. The results identified significant motivators that underlie the data sharing activities, e.g. reduced cost of data collection, improved data quality, and improved decision making and planning for service delivery; and equally identified significant barriers that make organizations reluctant to enter into a data sharing initiative, e.g. data copyright and ownership, high staff-turnover, and lack of financial and/or technical resources. Although the case studies focused on address data in South Africa, the research findings similarly apply to other spatial datasets and are therefore relevant to inform a successful implementation of the SASDI.

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List of Abbreviations

ANZLIC – Australian New Zealand Land Information Council
CSI – Committee for Spatial Information
FGDC – Federal Geographic Data Committee
GI – Geographic Information
GIS – Geographic Information System
G-NAF – Geocoded National Address File
IACG – Inter-Agency Committee on Geomatics
INSPIRE – Infrastructure for Spatial Information in Europe
NAD – National Address Database
NLPG – National Land and Property Gazetteer
NSIF – National Spatial Information Framework
OSD – Occupation Specific Dispensation
PSMA – Public Sector Mapping Agencies
SASDI – South African Spatial Data Infrastructure
SDI – Spatial Data Infrastructure
VGI – Volunteered Geographic Information

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Seo se sa felego se a hlola. *Every task must come to an end.*

Chapter 1: Introduction

1.1 Background

1.1.1 Interorganizational GIS data sharing

The use of quality geographic information for decision making and planning is critical to service delivery in both the public and private sector (Feeney 2003, Kok & Loenen 2006, Budhathoki and Nedovic-Budic 2007), particularly the use of spatial address data for emergency, mail or provision of utility services (Coetzee 2008). The belief in the capabilities and benefits of geographical information, caused a marked growth in the proliferation of geographical information systems (GIS) by both public and private sectors in the 1980s and 1990s (Juhl 1989, French and Wiggins 1990, Budic 1993, Masser 1993, Onsrud and Pinto 1993, Wiggins 1993). But, this scramble for geographic information resulted in costly duplication of efforts and disparate spatial data holdings, which made it difficult for organizations to reconcile and share spatial data. Later, most organizations realized that sharing of spatial data reduced redundancies in data development and management, thus engendering cost saving, improved data quality, and highest returns on investment (Eason 1998, Nedovic-Budic 1999).

Most of the countries started looking at information as an infrastructure, which led to the concept of a spatial data infrastructure or SDI (National Research Council 1993, Masser 1998). In a quest to attain the benefits of GIS data sharing, multi-participant GIS projects were initiated in Europe and the United States of America (Masser and Camphell 1994, Nedovic-Budic 2000, Masser 2007, Onsrud 2007, Vandebroucke et al. 2009, Masser 2010, Nedovic-Budic et al. 2011), and other countries in Asia and Australia (Masser 2002).

South Africa, as a developing country with limited GIS resources, established its South African Spatial Data Infrastructure (SASDI) in the form of the National Spatial Information Framework (NSIF) – “a national initiative to co-ordinate the development of infrastructure needed to support the utilization of spatial information in decision making” (http://www.nsif.org.za, accessed 15 August 2009). The NSIF advocated activities such as (a) standardization of geographic data formats and contents, (b) metadata creation, (c) development of data discovery facility, (d) surveying the needs for and availability of the common basic data sets that cut across regional, national and local geographies – the so-called 'framework data’ described by Frank et al. (1996) and Somers (1999). The implementation of the NSIF relied on the cooperation among spatial data producing

organizations (Wehn de Montalvo 2002, George 2010), which seems to be the most challenging task.

What lies at the heart of cooperation is the concept of spatial data sharing, which is defined as the transfer of spatial data/information between two or more organizational units (i.e. interorganizational) where there is independence between the holder of the data and the prospective user (Calkins and Wheatherbe 1995). This is enabled by an interorganizational GIS, which is a multi-participant setup achieved through coordination between various organizations (Nedovic-Budic and Pinto 2000, p.456). According to most researchers, the motivating factors (motivators) and barriers of spatial data sharing are dominated by organizational dynamics (Azad and Wiggins 1995, Masser 2007, McDougall et al. 2007).

These motivators and barriers which are inherent to the interorganizational cooperation and relationships in GIS data sharing environment, are identified and discussed in chapter 2, thus laying a foundation for their assessment in this research.

1.1.2 Spatial address data and national address database (NAD)

Originally, an address was defined as an entity that describes the location where a person resides for the purposes of delivering mail, e.g. house number, street or road name (Webster 1913). In recent times, the concept of address apply to any reference data to which an individual's information is linked, e.g. billing, utilities (e.g. water and electricity), and credit application (Coetzee and Cooper 2007, Coetzee et al. 2011). As mentioned in Paull (2003), most organizations have harnessed the power of GIS by geocoding the address data, i.e. relate the address to a point on the ground. But, getting the addresses to be spatially enabled was confronted by problems of lack of geocoded address data, multiple formats and styles, variable definitions of address features or elements, no definitive source to test against addresses during data entry (Paull 2003).

In a survey conducted by Levoleger and Corbin (2005), it had been shown that most of the European countries have a strong foundation with regard to the historical records and address databases. The address data are collected from local level in countries such as Netherlands, Norway, Austria and the National Land and Property Gazetteer (NPLG) in the UK; while other countries embarked on collating address data on national level, e.g. the GeoDirectory in Ireland and the AddressPoint dataset produced by Ordnance Survey in UK (Coetzee 2008). There are a number of European countries where address data is still

maintained at local level and not collated into a national level, e.g. Croatia, Portugal, Germany, France and Hungary (Levoleger and Corbin 2005).

In Australia, the Public Sector Mapping Agencies (PSMA) follow a semi-automated process of matching address data into the standard format of the Geocoded National Address File (G-NAF), which is distributed on a quarterly basis (Paull 2003).

In developing countries such as India and Brazil, there is lack of comprehensive address data that can be collated into an address database at national level (Coetzee 2008). According to Davis and Fonseca (2007), this paucity of address data is due to (a) large cities with slums and rural areas, which are characterized by irregular occupation; (b) areas without street signs or individual address signs at each dwelling; (c) incomplete addressing database due to lack of quality information or the cost of creating and maintaining a detailed database in the places with irregular growth.

In South Africa, which is a developing country with a lot of similarities with India and Brazil, there is no collated national address database. Instead, there are disparate efforts from both public and private organizations to produce national address datasets from local authorities' datasets, which are released at intervals (Coetzee 2008).

The advent of the South African Address Standard, SANS 1883 (SABS 2009), gave an opportunity to the GIS organizations - responsible for developing and updating address databases – to use a common terminology and elements in order to improve interoperability and data sharing. Normally, address databases are under the jurisdiction of separate local authorities (Coetzee and Bishop 2009), but there is a need for collation of these disparate databases into a common national address database (NAD). The NAD should bring to the fore private and public entities, which are developing address databases for different purposes, into a high level spatial data infrastructure (SDI) that aims to serve a wider audience.

Due to the haphazard and discordant proliferation of address databases in South Africa, there are different address data formats assigned by the South African Post Office, Statistics South Africa, national departments, national utilities and private companies (Coetzee et al. 2008, Coetzee et al. 2011); which can only be overcome by the use of the common South African Address Standard (SANS 1883). All the affected and interested organizations need to work together to achieve this interorganizational geographic information system (GIS)

activity, which could be valuable in providing a common national address database (NAD) for South Africa.

1.2 Research formulation

The use of quality spatial address data for decision making and planning is critical to service delivery (e.g. emergency services, mail delivery and provision of utility services) in the public and private sector. Currently, spatial address databases in South Africa are in the jurisdiction of separate local authorities, national agencies and private companies. The collation of spatial address data into a common national address database (NAD) would inarguably be a cost saving exercise (by eliminating data duplication), and further give the decision makers the benefit of using a single source of reference information. However, to achieve the goal of a single national address database requires sharing of spatial address data among public and private organizations, which is advocated by the National Spatial Information Framework (NSIF) of the South African Spatial Data Infrastructure (SASDI). This interorganizational GIS data sharing for a NAD can only be successful if the associated motivators or barriers are thoroughly assessed and considered when establishing the relationships among participating organizations.

Thus, the problem statement for the research is as follows: *as a consequence of the limited knowledge about the underlying motivators and barriers for spatial data sharing among organizations, the development of spatial data initiatives, such as the proposed national address database (NAD) in South Africa would prove to be a difficult task to undertake.*

The aim of this research is *to assess the motivators and barriers of interorganizational GIS data sharing in the development of a proposed national address database (NAD) for South Africa*, and thereafter discuss the implications of the results on the existing theory and practices of GIS data sharing frameworks and relationships among the public and private organizations involved in the production and maintenance of spatial address databases.

To achieve this aim, the research investigated the following questions:

1. Why will organizations share spatial address data for the development of the National Address Database (NAD)? What are the motivators?
2. Why will organizations not share spatial address data for the development of the National Address Database (NAD)? What are the barriers?
3. How will the understanding of motivators and barriers for sharing spatial address data

influence the existing theory and practices on interorganizational GIS data sharing frameworks?

1.3 Method

In order to study the motivators and barriers in interorganizational GIS data sharing for the NAD, a multiple case study was conducted to evaluate a selected number of organizations that are responsible for collecting and maintaining spatial address databases. A case study method was selected because it was appropriate to answer the “why” and “how” questions pertaining to the motivators and barriers for spatial data sharing among organizations.

The research approach consists of three phases that culminate in the comparative report of multiple case studies. Figure 1.1 illustrates the case study approach described by Yin (1994), which was applied in this research. These phases are outlined hereunder.

Phase one involves defining and designing the research problem and questions by a proper study of the theory (literature). The review of the existing theory - in the areas of spatial data infrastructure (SDI), interorganizational GIS, spatial data sharing, national address databases (NAD) - guided the researcher in the selection of the case studies and the design of a suitable data collection protocol.

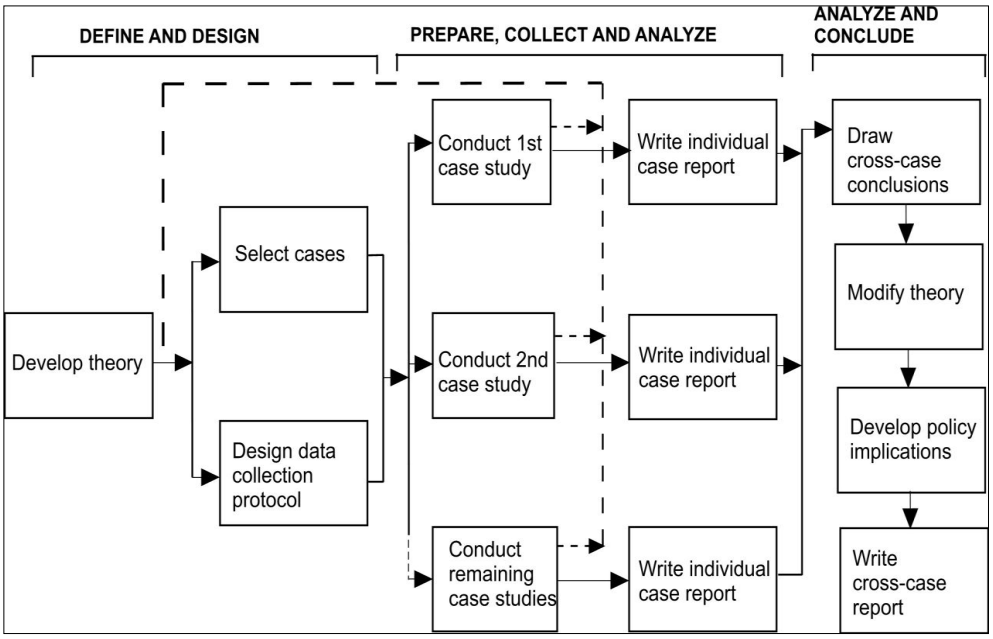


Figure 1.1: Case study method [after Yin (1994)]

Phase two comprised of preparation, collection and analysis of the case study data and results. The case studies were conducted on organizations that develop or maintain spatial address databases. The case study organizations were selected using a set of criteria to avoid certain research biases. A semi-structured interview approach was used to collect data about motivators and barriers for interorganizational GIS data sharing, with particular emphasis on spatial address databases. To supplement the semi-structured interviews, the researcher collected documents such as interorganizational agreements, internal reports, research papers and project reports, in order to get the full description of organizations' spatial data sharing operations.

Phase three collated the results of the individual case studies into a cross-case study report. This phase also presented the implications of the case study results on the existing theory and policies *vis-à-vis* the interorganizational GIS data sharing relationships in the development of the national address database (NAD) in South Africa.

1.4 Relevance

A functional national address database (NAD) will have a great impact on service delivery in a developing country such as South Africa. The critical part of delivering services (such as adequate housing, water, basic education, health care, food and other services stipulated in the Constitution of South Africa) is to know where these services are required (Coetzee 2008). Most of the government and private entities will benefit from a common NAD, which will save them time spent on validating the authenticity of address data for their customers, and they will be assured that they are providing services at the correct locations.

An extensive list of examples where NAD could be of benefit to both public and private sectors were mentioned by Coetzee and Cooper (2007), namely:

- goods delivery where courier, freight and logistics companies use spatial address databases to route their vehicles to a requested delivery address;
- credit application where the residential address of the applicant is verified against a spatial address database;
- household surveys where the spatial address database is used for the delimitation of enumeration areas, as well as the planning and execution of surveys;
- elections for the delimitation of voting districts and the identification of voting stations in the country; and
- emergency services to locate emergency, and route the relief team to the site.

The above-mentioned benefits will span the functions of government institutions (e.g. South African Post Office, Statistics South Africa, Independent Electoral Commission, state hospitals) and private entities (e.g. retail shops, commercial banks and logistics companies), who must leverage the address data for decision making and planning purposes.

This research on its own would not produce a working NAD, but it might lay a foundation in understanding the issues besetting the participants in the spatial address data initiatives. It would further improve the framework of GIS data sharing among different entities, and make use of the available infrastructure towards the development of a common NAD for South Africa.

1.5 Structure of dissertation

The dissertation is made up of four major parts as outlined in Figure 1.2. *First part* is the introduction, which comprises of the background to the research problem, the research aim and associated research questions. It also presents the relevance of the research and describes the research method. *Second part* is the chapters looking at the background to review literature on different aspects of the research. *Third part* covers the research method and the analysis of case studies. *Fourth part* is the synthesis, which comprises of comparative analysis of case studies, followed by discussions, conclusions and implications of the research. Hereunder is an overview of the chapters in the dissertation.

Chapter 1 introduces the background to the research problem. This chapter highlights the significance of inter-organizational GIS data sharing issues in the development of the spatial data infrastructure, viz. national address database. It presents the aim and questions to be answered in the research. Furthermore, it provides an overview of the research method, and discusses the scope and key assumptions.

Chapter 2 explores the existing literature on spatial data infrastructures (SDIs) in general, and identifies and discusses the motivators and barriers of interorganizational GIS data sharing.

Chapter 3 examines the concept of spatial address data and its applicability to the South African context. The chapter also looks at the theory and practices about the development of a national address database (NAD) and the significance of interorganizational GIS data sharing in realizing a functional NAD for South Africa.

Chapter 4 describes the research formulation, i.e. introducing the problem, the research aim and questions. A qualitative case study method is selected and justified as a means to study the motivators and barriers of interorganizational GIS data sharing as a basis for development of a national address database (NAD). The selection of case studies, the design of the semi-structured interview and data collection protocols are detailed in this chapter. The issues on the reliability (i.e. stability, accuracy and precision of measurement) and ethical considerations of the research method are discussed.

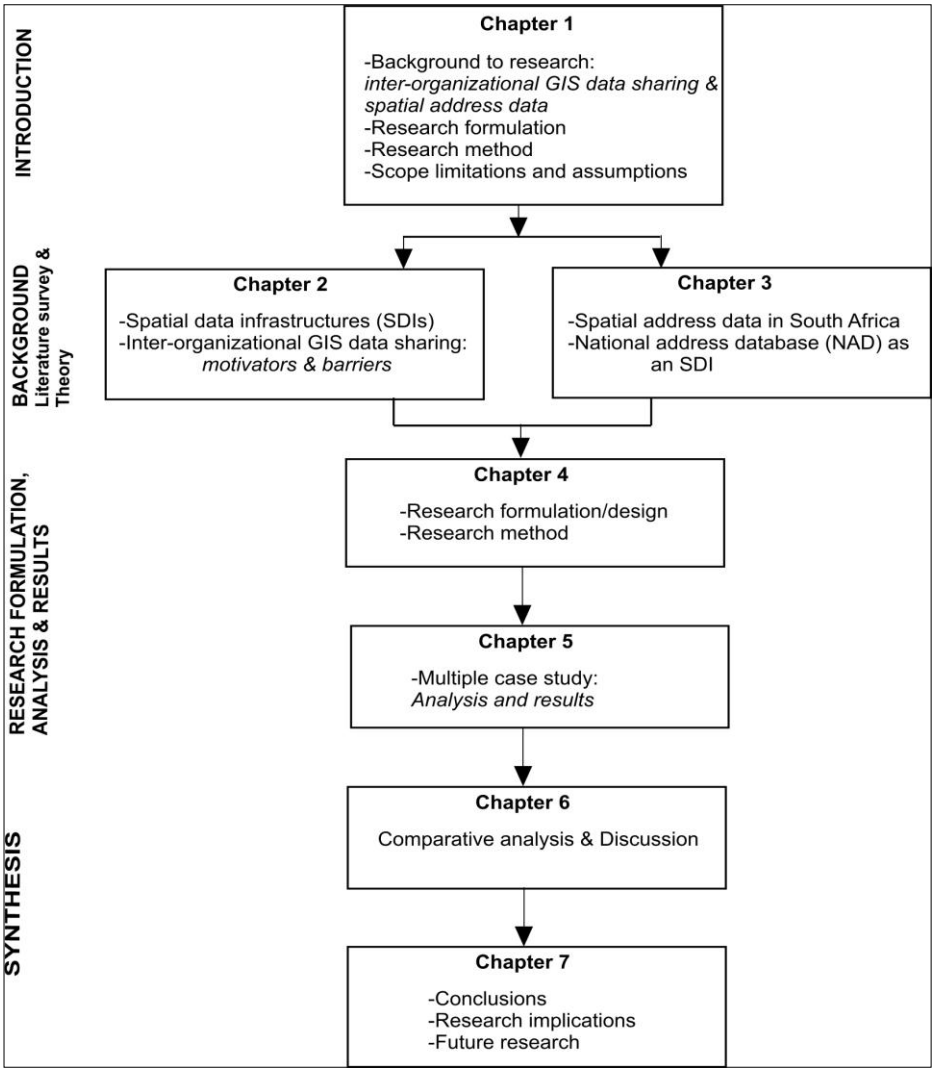


Figure 1.2: The structure of the dissertation

Chapter 5 describes and assesses the three case studies using a semi-structured questionnaire – which covers the issues of interorganizational GIS data sharing, SDI and address databases. Furthermore, the chapter analyzes and reports on the responses of the three selected case studies for this research.

Chapter 6 entails a comparative analysis of the individual case studies. This chapter critically assesses the differences and commonalities of the case studies with regard to motivators and barriers of interorganizational GIS data sharing for developing a NAD.

Chapter 7 offers the researcher an opportunity to conclude the arguments, highlight the implications of the research findings to the existing theory and practices, and provides recommendations for future research.

1.6 Scope limitations and key assumptions

The focus of this research was on motivators and barriers for interorganizational GIS data sharing initiatives, particularly among organizations that developed or maintained the spatial address databases. Thus, the case studies consisted of public and private organizations which possessed the *spatial* address databases and they were likely to have a significant impact (i.e. at national level) if their databases and knowledge were incorporated into the NAD.

Spatial address data has become critical to the activities of both public and private organizations. The integration of separate spatial address databases into a common national address database (NAD) should optimize the benefits, *inter alia*, delivery of municipal services (e.g. water and electricity), delivery of parcels, and bank credit application. So, this research *only* assessed the motivators and barriers experienced among organizations in their cooperation to develop the NAD as a type of an SDI.

Due to the sensitivities around data privacy and to ensure that organizations are not prejudiced in any way by the responses and submissions in the case studies, the names of the organizations in the study were withheld. Instead, pseudonyms such as "*Case A"* were used throughout the length and breadth of the research.

Although the dynamics of interorganizational GIS data sharing could change during the course of this research, it is worthy to note that the research did not have the luxury of updating or revisiting the case studies from time to time. So, the responses and documentation from the participating organizations will be valid at the time of data collection only, and any changes thereafter were not reflected in the current research.

Chapter 2: Interorganizational GIS data sharing

2.1 Introduction

The geographical information systems (GISs) have experienced remarkable growth since their development in the 1960s, and they were hailed as "the biggest step in the handling of geographic information since the invention of the map" (DoE 1987, par. 1.7). The main capabilities of a GIS, which entail capturing, managing, integrating, manipulating, analyzing and displaying spatial data (DoE 1987, Masser 2007) have grown in leaps and bounds to the extent that it is hard to imagine a modern society without GI technologies. To realize the full potential of the GIS, most researchers agree that some type of a multi-participant establishment is required to coordinate the spatial data sharing efforts of private and/or public organizations at local, national or transnational levels (Nedovic-Budic and Pinto 2000, McDougall et al. 2007), which was termed *interorganizational GIS* (Nedovic-Budic 2000). The interorganizational GIS could be seen as a precursor to the more matured, high-level spatial data infrastructure (SDI), which is the ultimate goal of interorganizational coordination and spatial data sharing.

This chapter will examine the advancement of interorganizational GIS and SDIs at local, national or transnational levels, and the evolution of the theory for spatial data sharing among organizations.

2.2 The context of interorganizational GIS

In this dissertation, some of the terms such as *interorganizational GIS* and *SDI* may be used in the same breath or interchangeably, as such it is important to define these terms upfront and clarify the context in which they are used here.

Geographical information system (GIS) is defined as a "*computer system for capturing, managing, integrating, manipulating, analyzing, and displaying data that is spatially referenced to the Earth*" (DoE 1987, p.132; Masser 2007, p.13). The tasks that may be undertaken using GIS are manifold and central to the business processes in both public and private sectors. The GIS data which are important for everyday functioning of the organizations include addresses, market research data, census data, environmental and natural resources data, descriptions of transportation and utility networks, information flows on goods, cadastral and land registration information, and remote sensing data (Masser 2007, p.11). The availability of GIS technology and data has resulted in the ease of data

exchange and integration across organizations, which in turn stimulate interorganizational partnerships in spatial data sharing.

It is these interorganizational partnerships that have given rise to the concept of interorganizational GIS, which is defined as "*a type of multi-participant setup … achieved through coordination between various organizations*" (Nedovic and Pinto 2000, p.456). In this multi-participant setup, public and/or private organizations at local, regional and national level are jointly involved in data acquisition and database development for a common purpose (Cash et al. 1994). Interorganizational GIS can be seen as having a limited scope and measurable goals, as compared to the high-level, cross-cutting nature of the spatial data infrastructure (SDI) defined hereunder.

The spatial data infrastructure (SDI) is an establishment that encompasses "*coordinated actions on policies, organizational remits, data, technologies, standards, delivery mechanisms, financial and human resources to support ready access to geographic information in the possession of both public and private organizations*" (Masser 2005, p.16). According to Thellufsen et al. (2009), the goals of an SDI are "to allow easy access, smooth sharing and seamless integration of data, both internally in the organizations and externally to other government institutions, private branches and ordinary citizens" (p.255). The SDI is sometimes described by words such as *system*, *infrastructure*, *framework, strategy* (Masser 1999, Masser 2007), which refer to the presence of coordinating mechanism for policies, standards and implementation purposes (Masser 1999).

From the definitions, it is apparent that interorganizational GIS operates at a lower level of the hierarchy and deals with basic coordination issues such as GIS data sharing agreements or contracts among participating organizations. On the other hand, SDI is applicable at a higher level as it addresses the framework for GIS data sharing, which comprises of policies, standards, or delivery mechanisms that provide interoperability for spatial data discovery and distribution. In other words, the interorganizational GIS denotes a couple of friends with manageable mutual interests, while SDI pertains to a community of persons with complex relations and rules guiding their interactions and co-existence. It can be argued that it is the issues in the interorganizational GIS arrangements, as buildings blocks, which determine the nature of SDIs emerging from them. As such, this dissertation will take a reductionist (bottom-up) approach by studying those issues found in the interorganizational GIS data sharing arrangements, in order to shed a light on the bigger picture of SDI arrangements.

This dissertation is mindful of the difference between the terms interorganizational GIS and SDI, and will use them in the right context as explained in the preceding sections, unless in the instances where their meanings converge to warrant them used interchangeably.

2.3 A short review of interorganizational GIS

2.3.1 Nature of interorganizational GIS

According to Nedovic-Budic and Pinto (1999), most organizations have moved in strides to adopt the use of GIS data to improve their every-day operations. As a result, the proliferation of GIS data and technology has grown exponentially into what Warnecke et al. (1998, p.24) termed a "growth surge". This "growth surge" in the adoption of GIS is characterized by organizations building and maintaining their own spatial databases, in many cases duplicating their efforts. The fact that GIS datasets are held by different organizations makes it essential for these organizations to cooperate and share data among themselves (McDougall et al. 2007), if the value of these data were to be fully realized. Although it is to the advantage of the public and private organizations to cooperate in the sharing of spatial data among each other, the interorganizational partnerships have proved to be difficult to sustain (Budhathoki et al. 2007, McDougall et al. 2007).

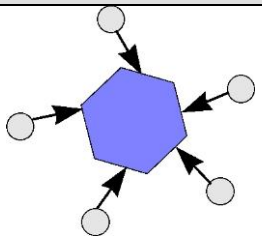
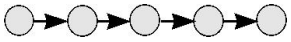
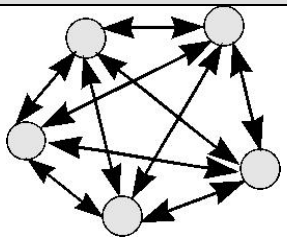
As explained in the preceding section, interorganizational GIS refers to a multi-participant establishment which is aimed at pooling the GIS resources to "perform applications and satisfy requirements of all participants" (Nabar 1998, p.9). The participating organizations in (a multi-participant GIS programme) may be separate entities bound by common GIS needs (Nabar 1998), for instance, the government departments and agencies, utility services departments, private organizations in the same or different areas of jurisdiction.

2.3.2 Types of interorganizational GIS programmes

According to literature on information systems, the organizational complexities increase further in interorganizational contexts, thus require different information systems development, management, and use practices (Williams 1997, Doherty and King 2001, Budhathoki and Nedovic-Budic 2007). The types of interorganizational complexities may be represented by organizational interdependencies, which were identified by Thompson (1967) as pooled, sequential, and reciprocal (Table 2.1). Meredith (1995) argued that the existing organizational interdependence tends to reduce resistance to interorganizational data

sharing. But, other authors countered that increased interdependence and a need for cooperation in networked organization may breed conflicts over authority, jurisdiction, and distribution of power (Kumar and van Dissel 1996, Ekbia and Kling 2005).

Table 2.1: Types of organizational interdependences [after Thompson (1967), Bhudhatoki and Nedovic-Budic (2007)]

Type of interdependence	**Pooled**	**Sequential**	**Reciprocal**
Configuration			
Coordination mechanisms	Standards and rules	Standards, rules, schedules and plans	Standards, rules, schedules, plans, and mutual adjustment
Technologies	Mediating	Long-linked	Intensive
Structurability	High	Medium	Low
Potential for conflict	Low	Medium	High
Type of interorganizational system (IOS)	Pooled information resource IOS	Value/Supply-chain IOS	Networked IOS
Implementation technologies and applications	Shared databases, networks, applications, electronic markets	EDI applications, voice mail, facsimile	CAD/CASE data interchange, central repositories, desktop sharing, video conferencing

Another argument on interorganizational interdependence was that a high degree of mutual resources tends to increase the number of nodes with power to make decisions, thus having a negative impact on prompt actions and successful implementation (Aiken and Hage 1968, Pressman and Wildavsky 1984).

Nabar (1998) identified two types of multi-participant GIS programmes, namely, the *multi-departmental GIS programme* and *multi-agency GIS programme*. The multi-departmental GIS programme is managed by a core departmental team which ensures that participants comply with the standards and policies, and also maintains communication channels among participants. The multi-agency GIS programme is composed of agencies with different policies and decision-making rules, which makes it difficult for the participants to reach consensus.

Despite the issues associated with multi-participant- or interorganizational GIS, most organizations are attracted to the multi-participant GIS establishments because of the benefits that might spring from such associations. Nabar (1998, p.10) mentioned such benefits of multi-participant GIS as follows:

- sharing of technology, costs and responsibilities;
- development of a centralized database, which eliminates redundancy of efforts and funds for collection, development and maintenance; and
- increased efficiency, productivity, profits and reduced cost for all participants.

These benefits of multi-participant GIS setup are influenced either negatively or positively by a nexus of data sharing issues (i.e. motivators and barriers) that are inherent to the interorganizational environment. The next section discusses these motivators and barriers associated with spatial data sharing.

2.4 Motivators and barriers for spatial data sharing

As much as there are motivators for spatial data sharing, there are similarly barriers that require attention when setting up interorganizational GIS programmes. In this section, the issues that motivate the organizations into action and those that bar them from participating fully into interorganizational GIS programmes are presented.

2.4.1 Motivators

The word motivator is derived from a verb motivate, which is defined as *to provide with an incentive*; *move to action*; and *impel* (The American Heritage Dictionary of the English Language 2000). In the promotion for sharing of GIS database, it is important to understand the drivers that motivate organizations, agencies, and government departments to engage in interorganizational partnerships (Nedovic-Budic and Pinto 1999, Nedovic and Pinto 2000, Masser 2005, Onsrud 2007). The motivators discussed hereunder form a large part of what is perceived by organizations to be the drivers of interorganizational partnerships.

Cost savings

When there is scarcity of resources in public or private organizations, it makes sense for organizations to share their databases as an act of distributing costs evenly among participating organizations (Azad and Wiggins 1995, Pinto and Onsrud 1995, Nedovic-Budic and Pinto 1999, Masser 2005).

Data quality problems

The problems of different data quality due to lack of common data definitions, formats and standards can be alleviated when participating organizations work together towards interoperability and same spatial data standards (Frank 1992, Nedovic and Pinto 1999, Budhathoki and Nedovic-Budic 2007).

Return on investment

The practice of sharing the costs of implementing spatial databases among participating organizations, and the exchange of information to improve productivity and decision making may yield good returns on investment for the participating organizations (Tveidtdal and Hesjedal 1998).

Reduced time on data collection

GIS data sharing may eliminate data redundancy, thus reducing time spent collecting data which has already been collected by other organizations (Nedovic-Budic et al. 2004). More and diverse spatial data are made available by participating organizations to boost decision making (Nedovic-Budic and Pinto 1999).

Incentivization

Cummings (1980) viewed the participation in interorganizational GIS database sharing as voluntary or mandatory. Although, “spontaneous interorganizational coordination is rare and monetary or other incentives may be necessary to stimulate joint projects” (Nedovic-Budic and Pinto 1999, p.185)

Improved user satisfaction

The findings by French and Skiles (1996) asserted that distributed and centralized multi-participant systems were perceived to be effective and satisfying to their users than in the case of single-agency systems.

2.4.2 Barriers

In this case, the more appropriate definition of a barrier would be *something immaterial that obstructs or impedes* (The American Heritage Dictionary of the English Language 2000). The section briefly discusses the barriers that obstruct or impede the sharing of spatial data among the organizations.

Organizational issues

While investigating issues which impede spatial data sharing among organizations, researchers regarded the organizational issues as most critical to the success of any interorganizational relationship (McDougall et al. 2007, Mansourian and Valadan-Zoej 2008). Some organizational issues were identified by Citera et al. (1995), namely, institutional disincentives, historical and ideological barriers, power disparities, differing risk perceptions, technical complexity, political and institutional culture.

Conflicting priorities among participating organizations

Organizations in an interorganizational GIS programme may have separate interests or levels of development depending on their priorities in a given moment (Mansourian and Valadan-Zoej 2008, Thellufsen et al. 2009). Masser (1995) identified issues such as, differences in GIS facilities, awareness and data-handling skills, concessions over access to information, leadership, data standards, equipment, and training.

Lack of resources

The GIS data sharing initiatives depend largely on the infrastructural and human resources available within organizations (Nedovic-Budic and Pinto 1999, Nedovic-Budic et al. 2004). The GIS data sharing programme can be impeded by a high staff turnover, lack of GIS resources, incompatible old systems, and lack of support from management (Sperling 1995).

Poor implementation of standards

Due to poor implementation of standards, the interorganizational GIS data sharing becomes difficult as organizations do not have common data definitions, formats and models (Frank 1992, Dawes 1996, Harvey and Tulloch 2006), which are the basis for interoperability among participating organizations.

Costs of coordination

The participants in GIS data sharing initiatives are likely to incur costs of coordinating their activities, such as investments in joint equipment, software, personnel, developing and maintaining a common database (Nedovic-Budic and Pinto 1999, Nedovic-Budic et al. 2004). Although it is an advantage that the participating organizations can share the cost of most of their activities, determining the contributions of individual participants in a GIS partnership and setting the price of access for a common shared database can be a point of disagreements (Nedovic-Budic and Pinto 1999).

2.5 Conceptual framework model for interorganizational GIS data sharing

In order to understand the interorganizational GIS data sharing phenomenon, it is important to identify the concepts and principles that guide the coordination and implementation of these multi-participant GIS programmes (Nedovic-Budic and Pinto 1999, Thellufsen et al. 2009). Nedovic-Budic and Pinto (1999) used the GIS data sharing factors and related literature to derive four theoretical constructs, which are the context, motivation, coordination mechanisms (structure, process and policies), and outcomes (Figure 2.1).

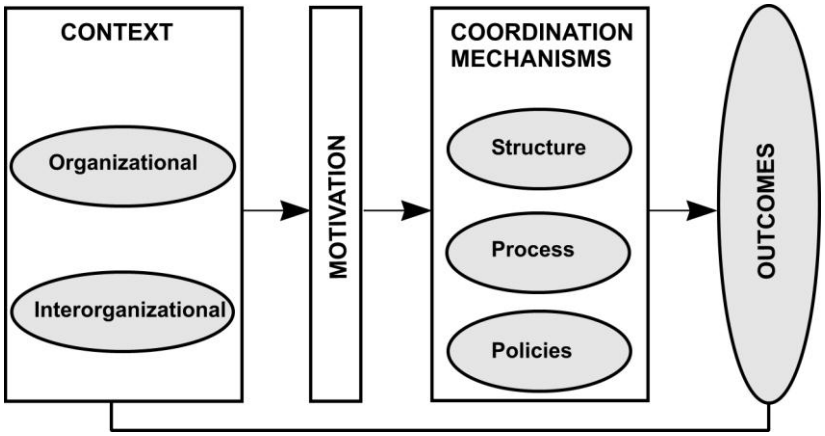


Figure 2.1: A conceptual framework for GIS data sharing [after Nedovic-Budic and Pinto (1999)]

2.5.1 Context

According to Nedovic-Budic and Pinto (1999), *interorganizational context* refers to "organizational factors and interdependencies that influence coordination and decisions about joint GIS and database activities" (p.55). As discussed in section 2.3.2, the organizations are involved in pooled, sequential and reciprocal interdependencies, which determine the nature of GIS data sharing among them. According to Meredith (1995), the existence of (cooperative) organizational interdependence reduces the resistance to interorganizational sharing; albeit, the increased interdependence and the need for cooperation can lead to conflicts over authority, jurisdiction, and distribution of power (Nedovic-Budic and Pinto 1999). The contextual factors that may influence the quality of interorganizational relations include organizational structure, resources, stability, culture, quality of relationships, bureaucratization of rules and procedures, incentives and leadership (Pinto and Onsrud 1995, Nedovic-Budic and Pinto 1999).

2.5.2 Motivation

The question of what motivate organizations to coordinate inteorganizational GIS data sharing is pertinent to the understanding of how the organizations are likely to react in multi-participant relationships. O'Toole and Montjoy (1984) identified the main factors that impel organizations to strive for coordination of interorganizational GIS, which involve (i) *authority*, i.e. derived from a sense of duty; (ii) *common interest*, i.e. valuing the same goals; and (iii) *exchange*, i.e. receiving something in return. The other motivating factors for organizations to interact in a multi-participant GIS programme include organizational needs, capabilities, cost, power relationships, appeals to professionalism, common goals, incentives, superordinate goals, accessibility, and resource scarcity (Calkins and Weatherbe 1995, Obermeyer 1995, Pinto and Onsrud 1995).

2.5.3 Coordination mechanisms: Structure, Process and Policies

In the centre of the conceptual framework (Figure 2.1) are the coordination mechanisms, which allude to the "interorganizational structures and policies employed, and the history and process undergone in coordinating multi-participant GIS and in establishing the sharing relationships" (Nedovic-Budic and Pinto 1999, p.57).

2.5.4 Outcomes

The efforts of participating organizations in interorganizational GIS programmes must expectantly be followed by acceptable outcomes, i.e. a measure of the value and social utility derived from the use of GIS (Onsrud and Rushton 1995). Theoretically, the interorganizational GIS should offer the following benefits, which were outlined by Nedovic-Budic and Pinto (1999): (i) efficiency – cost savings and productivity benefits form existing operations at lower per-unit cost; (ii) effectiveness – enhanced capabilities for the unit, new and better quality products, improved policy and decision-making; (iii) enterprise benefits – new responsibilities, broader mission, strengthen work relationships and morale, thus contributing to productivity, task completion and satisfaction of information users within and among organizations; and (iv) public benefits – data sharing benefits going beyond organizational boundaries to achieve broader societal outcomes, i.e. public service and equity.

2.6 Interorganizational GIS data sharing activities in the world

Interorganizational GIS data sharing requires an enabling environment in the form of high-level spatial data infrastructures (SDIs) to guide and support organizations participating in multi-participant GIS programmes (Masser 2005). An SDI serves as an underlying infrastructure in the form of *policies*, *standards* and *access network*, which allows data to be shared between and within organizations, states and countries (Figure 2.2).

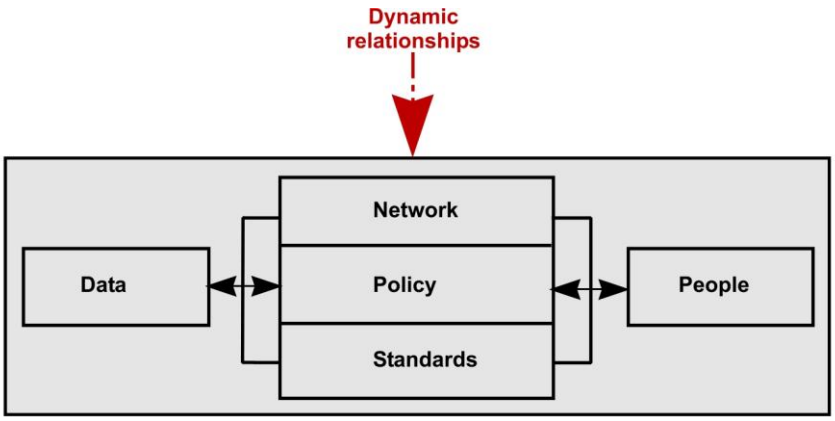


Figure 2.2: SDI components [after Rajabifard (2007)]

There have been marked changes in SDI over time, which have an impact on the policies, standards and access networks (Holland et al. 2009). These changes are generalized by some of the authors (Rajabifard et al. 2006, Willliamson et al. 2007, Masser 2009) as summarized in Table 2.2.

Table 2.2: The first and second generations of SDIs [(Rajabifard et al. 2006, Williamson et al. 2007, Masser 2009)]

1st generation SDI (started in mid-1980s)	2nd generationSDI (started in 2000)
Top-down, national level initiatives	Bottom-up, multi-participant initiatives driven by public and private organizations
Product-based SDI development model: data definitions, data collection, data integration, database creation, implementation	Process-based SDI development model: knowledge infrastructure, capacity building, communication, coordination
Centralized structures	Decentralized and distributed networks, i.e. world wide web(WWW)

In this section, the focus is on the literature that outlines the status of SDIs and interorganizational GIS relationships existing within and between countries in the world. The lessons learnt in the coordination and implementation of the SDIs and multi-participant GIS

programmes supports the theory about best practices of different countries in the world, and South Africa in particular.

2.6.1 International SDI activities

Australia

The SDI in Australia is coordinated by the Australian New Zealand Land Information Council (ANZLIC), which was established in 1986 with the goal of leading the community in defining the components of the national spatial data infrastructure, characteristics of these components, and provides a vehicle for the determination of national priorities and custodianship (Masser 2005). ANZLIC was aimed at coordinating, collecting and transferring land-related information (i.e. socio-economic data, natural resource information, environmental data, utilities and infrastructure) between different levels of government. The vision of ANZLIC was to create "a distributed network of databases, linked by common standards and protocols to ensure compatibility, each managed by custodians with the expertise and incentive to maintain the database to the standards required by the community and committed to the principles of custodianship" (Masser 2005, p.146).

The underlying problem for ANZLIC is that it is a consensus building agency, i.e. it can develop models, standards, and protocols; but lacks power to make the agencies implement them (Masser 2005). Moreover, lack of formal funding causes ANZLIC to depend on the meagre contributions of member agencies, which were not enough to run its activities (Clarke 2001).

Despite the above-mentioned problems, there were positive signs in favour of ANZLIC, which culminated in the formation of interorganizational Public Sector Mapping Agencies (PSMA) consortium to create an integrated national digital basemap to be used in the 1996 Census, which is the mandate of Australian Bureau of Statistics (ABS). After developing the Census basemap, PSMA made the data available to the private sector, which added value on the data to produce new geospatial products and services. The PSMA was credited with facilitating the development of key national data products as mentioned in http://www.psma.com.au/products (accessed on 29 September 2010), namely: (i) geocoded national address file (G-NAF), i.e. an authoritative index of all Australian addresses; (ii) administrative boundaries, i.e. boundaries in themes from electoral to suburbs; (iii) CadLite, i.e. Australia's 10.5 million land parcels, including suburb names; (iv) points of interest, i.e. everything from accommodation to banks, hospitals to museums; (v) post code boundaries,

i.e. official Australia Post's post code polygon and point data; and (vi) transport and topography, i.e. road, rail, rail stations and air infrastructure, parks and water bodies.

The success of the PSMA could be credited to its balancing act of ensuring that there is coordination of all datasets from state agencies which are critical for the Census basemap required by Australian Bureau of Statistics; while on the other hand allowing the private sector to leverage the datasets to create other innovative solutions and applications.

United States of America

The flagship national spatial data infrastructure (NSDI) was set up in the United States by Presidential directive in 1994. This directive provided for establishment of "a coordinated National Spatial Data Infrastructure to support public and private sector applications of geospatial data in such areas as transportation, community development, agriculture, emergency response, environmental management, and information technology" (Masser 2007, p.18). The directive gave impetus to the activities of the Federal Geographic Data Committee (FGDC), which coordinated the interagency activities of collecting and managing geographic information. Other matters contained in the directive include the creation of a national digital geospatial data framework of the core datasets, establishment of a national geospatial data clearinghouse for user awareness of available data and to facilitate accessibility to these data (Masser 2007). The FGDC Clearinghouse has been a key deliverable of the SDI initiatives, particularly the Clearinghouse Registry which lists approximately 500 registered nodes in its network from United States and other countries. In 2002, a Geospatial One-Stop portal was created with the aim of "building an interoperable system of systems that leverage standard and best practices" (http://www.geodata.gov, accessed 27 September 2010). Its bottom-up approach had emphasis on local data needs and practices, then move upwards with data integration at state/regional level up to national level.

Even after the establishment of the FGDC, issues were still raised about the poor SDI coordination and lack of formal authority by the committee chairperson over member agencies (Sietzen 2003). Most of the geospatial programmes were labelled as "unfocused, duplicative, underfunded, overpromised, poorly defined, and not easily accessed" (Lance et al. 2009, p.11). To remedy the non-compliance of agencies to coordinate their investments, the Office of Management and Budget (OMB) initiated a Geospatial Line-of-Business initiative, which pools funds from the budgets of respective agencies into the Geospatial One-Stop account to support their activities. The described funding mechanism was referred to as *coercion*, *heavy hand*, *extortion* or *strong-arming*, but it has played a major role in

changing the behaviour of agencies in support of a coordinated approach to SDI initiatives in the United States (Lance et al. 2009).

As it was mentioned by Giff and Crompvoets (2008), the performance and benefits of SDI initiatives should be assessed in order to justify their existence and the resources spent on them. To cover the assessment of inter-agency initiatives, the US established the Federal Enterprise Architecture (FEA) – a business-based framework that ensures that geospatial capabilities are documented and implemented in a systematic way, leading to cross-agency interoperability and potential cost savings (Lance et al. 2009). The FEA encompasses key areas such as "budget allocation, information sharing, performance measurement, budget/performance integration, cross-agency collaboration, e-government, and component-based architectures" (Lance et al. 2009, p.13).

Canada

In Canada, the Inter-Agency Committee on Geomatics (IACG) was founded in the 1980s as a vehicle to coordinate Canadian government geospatial investments and activities towards a Canadian Geospatial Data Infrastructure – CGDI (Lance et al. 2009). The CGDI oversees a national partnership initiative called GeoConnections, which has "to respond to challenges associated with advancing a culture and technology that supports the sharing and integration of geospatial data and services" (GeoConnections 2009, p.3). The emphasis of the GeoConnections was to develop a common goal, and streamline the strategies of geomatics communities, and implement core infrastructure and addressing key institutional and policy barriers to the sharing of data and interoperability of systems across organizations (GeoConnections 2009).

GeoConnections (2009) mentioned the notable achievements of GeoConnections initiative as follows: (i) implementing the GeoConnections Discovery Portal, a search engine for providers to catalogue their datasets and users to locate the datasets; (ii) establishing GeoGratis, a national repository where suppliers may place data for free distribution; (iii) developing GeoBase, a national suite of framework layers coordinated by the Canadian Council on Geomatics which include place names, national digital elevation model, a layer of satellite imagery, a national road network, survey reference points, and a national layer of administrative boundaries; and (iv) developing web-mapping standards in collaboration with the international Open Geospatial Consortium (GeoConnections 2009, p.3).

Another stage of GeoConnections's activities, after putting up the geospatial infrastructure, was to address users' needs and promoting the use of the CGDI by decision makers in four

identified priority areas, namely, *public health*, *public safety and security*, *sustainable development and environment*, and *aboriginal matters* (GeoConnections 2009).

The GeoConnections initiative was characterized by 2 stages: the first stage was represented by a *supply-push model*, which kept the industry occupied in the development of the geospatial infrastructure; and the second stage was represented by a *demand-pull model*, which was concerned with promotion of the CGDI and the integration of geospatial activities into four national priority areas and meeting the goal of a sustainable national SDI (GeoConnections 2009).

Europe

The member states of the European Union (EU) were at different stages of developing their national SDIs, but their individual efforts were undermined by lack of an infrastructure mechanism to outline and coordinate the geospatial activities across organizations and states (Masser 2007). According to Craglia and Annoni (2007, p.98), the major barriers for geospatial coordination were as follows: (i) inconsistent data collection, i.e. missing, incomplete or duplication of spatial data; (ii) inadequate documentation, i.e. description of existing spatial data is often incomplete; (iii) incompatible datasets, i.e. datasets cannot be combined with one another; (iv) incompatible geographic information initiatives, i.e. the infrastructures for accessing spatial data function in isolation; (v) and barriers to data sharing: cultural, institutional, financial, and legal issues that prevent or delay the sharing of spatial data.

To overcome the above-mentioned barriers of spatial data sharing, the EU deemed it fit to establish a framework mechanism to get its member states to coordinate and agree on a set of minimum standards and processes (Craglia and Annoni 2007). This resulted in the directive for the establishment of an Infrastructure for Spatial Information in Europe (INSPIRE), which was aimed at coordinating the activities of the existing national SDIs of the EU member states, and seek a common ground on identified elements of spatial infrastructures such as metadata, key spatial themes and services, network services and technologies, agreements on sharing and access, coordination and monitoring mechanisms, processes and procedures (INSPIRE NS DT 2008).

The activities of INSPIRE initiative are guided by the following key principles: spatial data should be collected once and maintained at the appropriate level; it should be possible to combine spatial data from different sources across the EU and share it between several users and applications; it is possible for spatial data collected at one level of public authority

to be shared between different levels of public authorities; spatial data are made available under conditions that do not unnecessarily restrict their extensive use; it is easy to discover available spatial data, to evaluate their fitness for purpose and to know the conditions applicable to their use (Craglia and Annoni 2007, INSPIRE NS DT 2008).

To carry out the INSPIRE initiative, two mechanisms had been put in place: the first was to engage national and subnational European organizations with the mandates for coordinating, producing, or use of spatial data; the second was to facilitate the self-organization of stakeholders, including data providers and users of spatial data into so-called spatial data interest communities (SDICs) by regional, societal and thematic issues (Craglia and Annoni 2007). The roles of SDICs were to identify and describe user requirements; provide expertise to INSPIRE drafting teams; review proposed implementation rules; develop, operate and evaluate pilot implementation projects; develop initiatives for guidance, awareness and training (Craglia and Annoni 2007). Among the SDICs there will be legally mandated organizations (LMOs), which fulfil a role of reviewing and testing proposed implementation rules, and assessing potential costs and benefits of SDI initiatives (Craglia and Annoni 2007).

Most of LMOs are national in nature and are constituted by producers of reference data; while on the other hand, SDICs are research organizations and GIS coordinating bodies, with each SDIC bringing together organizations with different views and interests (Craglia and Annoni 2007).

The INSPIRE initiative has witnessed a growth in the number of registered SDICs, LMOs, projects and reference materials as indicated on INSPIRE website (http://inspire.jrc.ec.europa.eu, accessed 02 October 2010). An example of the SDICs at regional level is the Germany's GDI NRW, which involves representatives from business, government and science communities in a public-private partnership as GIS data providers, enablers, brokers and users (Craglia and Annoni 2007). Other SDICs which are organized according to (themes) include: European Soil Bureau Network (ESBN) – for soil information in Europe; the EuroGeographics – for seamless access to national reference information (mapping, cadastral and land registry) for the benefit of European or cross-border users; and many others mentioned on the INSPIRE website.

Although INSPIRE seems to be an ambitious initiative, due to its vast scope, ever-changing political and technological environment, it has provided a legislative framework for EU member states to act on, and fostered coordination and implementation of SDI initiatives within and across member states of EU.

2.6.2 South African Spatial Data Infrastructure

Legislative framework

The South African Spatial Data Infrastructure (SASDI) was established through the Spatial Data Infrastructure Act (no. 54 of 2003), as the national technical, institutional and policy framework to facilitate the capture, management, maintenance, integration, distribution and use of spatial information. According to the SDI Act (no. 54 of 2003), the SASDI was established to fulfil the following objectives:

- to facilitate the capture of spatial information through cooperation among organs of state;
- to promote effective management and maintenance of spatial information;
- to promote the use and sharing of spatial information in support of spatial planning, socio-economic development and related activities;
- to create an environment which facilitates coordination and cooperation among all stakeholders regarding access to spatial information;
- to eliminate duplication in the capturing of spatial information;
- to promote universal access to such information; and
- to facilitate the protection of the copyright of the state in works related to spatial information.

The provisions of the SDI Act and the SASDI were to be administered by the Director General in the Department of Land Affairs (DLA), which is currently known as Department of Rural Development and Land Reform (RDLR). The RDLR established National Spatial Infrastructure Framework (NSIF) as a component of SDI which was responsible for developing an online metadata catalogue to allow the users to discover and access spatial data across organs of the South African government (http://www.gsdi.org/gsdiconf/gsdi12/papers/88.pdf, accessed on 04 October 2010).

NSIF as an implementation vehicle of SASDI

The National Spatial Information Framework (NSIF) is a component of the SASDI, with the goal of coordinating the development of infrastructure needed to support the utilization of spatial information in decision making (George 2010). To facilitate the favourable environment for SDI generation, the SASDI would possess the functionalities/components mentioned hereunder (George 2010).

- Electronic metadata catalogue or a *Spatial Metadata Discovery* (SMD) tool, which encourages the producers and custodians of spatial datasets to capture and publish metadata using the Metadata standards (e.g. ISO 19115, SANS 1878, etc).

- *New data collection register*, which is a tool used to publish and notify the Committee for Spatial Information (CSI) – a body provided for in the SDI Act (no. 54 of 2003) – about the specifications of the new spatial data to be collected by a particular organization. The new data collection register would assist the CSI to decide whether the data collection is a duplication of what has been collected already, or recommend public-private partnerships where such initiatives would be favourable for better data collection.
- *Spatial data fusion/integration*, a technology infrastructure that facilitates data sharing and integration of spatial and non-spatial data from disparate sources to create web-based services that will benefit a wider audience. The web-enabled GIS would enable the users to perform complex queries and geo-processing functions, without having to set up an expensive GIS infrastructure.

Although NSIF is in different stages of developing these components of the SASDI, its success hinges on finding the solutions to challenges that are inherent to the task of establishing a functional SDI.

Challenges of establishing the SASDI

In South Africa, the necessary legislative framework and strategies have been put in place for the establishment of the South African Spatial Data Infrastructure, and what remain are the challenges of coordinating efforts among spatial data organizations to achieve the goal of a sustainable SASDI. The challenges facing the SASDI include the willingness of participating organizations to cooperate with each other (Wehn de Montalvo 2002); data pricing policies, incentives and data restrictions; and continuous funding for infrastructure and development of required GIS datasets. These challenges are subject to investigation in this research, as it attempts to find out how the interorganizational activities impact on the establishment of the SASDI.

2.7 Volunteered Geographic Information as a new SDI trend

2.7.1 The context

Volunteered geographic information (VGI) refers to the act of using GIS tools to capture, collect and disseminate spatial data that is produced voluntarily by individual users (Goodchild 2007). VGI is part of the *neogeography*, which is described by Turner (2006) as “a set of techniques and tools that fall outside the realm of traditional GIS” (p.2). The

neogeography is characterized by any individual user creating and using their own maps by combining elements of existing datasets (Turner 2006, Liu and Palen 2010), which is an act that blurs the distinctions between producer, communicator and consumer of spatial information. As part of neogeography, VGI deals with the extensive use of the Web to manipulate and disseminate geographic information provided by individuals on a voluntary basis (Goodchild 2007, Liu and Palen 2010). This section will focus on the activities and examples of VGI, its impact on spatial data sharing and its use in spatial data infrastructures.

2.7.2 Activities and examples of VGI

The volunteered geographic information (VGI) has been largely facilitated by the ability of web platforms to accept and organize information in a widely accessible format (McDougall 2009). The spatial information may be provided as a read-only type access or be updated, changed or modified as in the Wiki environments, hence the term *wikification* of GIS (Sui 2009). According to McDougall (2009), the VGIs had been facilitated on two fronts, namely, geographic portals such as Google Earth, OpenStreetMap and Wikimapia; and geographic coordinates or locations generated through the Global Positioning Systems (GPS) which are found in most of the modern communication devices.

Unlike other projects that developed from *contributed content* such as Wikipedia, VGI is yet to be widely accepted as a valuable source of information (Kessler et al. 2009). The information in the VGIs is mostly provided by locals who post updates as frequent as possible. An important example of the potential of the VGI is OpenStreetMap project, which beats commercial mapping sites in terms of update frequency and thematic scope (e.g. hiking routes) in many regions (Kessler et al. 2009). However, some researchers have raised concerns about the accuracy, reliability and completeness of the information provided through VGI tools (Goodchild 2007, Zielstra and Zipf 2010).

Kessler et al. (2009) suggested a semi-automatic approach to include VGI in existing gazetteers such as GeoNames, which may help in updating and expanding the information in the gazetteer from the local level.

2.7.3 Impact of VGI on spatial data sharing and SDI

With the government agencies becoming more business-oriented and budget driven, and the demand for spatial data increasing, the VGI may present an opportunity for mapping

agencies and future development of SDIs by allowing the local users to volunteer spatial data such as street addresses and road networks, using the ubiquitous personal navigation devices (PNDs) (McDougall 2009). According to McDougall (2009), the street addresses and road networks would be a soft target for testing the VGI because of the following reasons:

- "street address and road networks are common systems of location which are used regularly by citizens", and
- "as the system of addressing is well-known and utilized the majority of citizens would have no difficulty in reporting corrections to the network" (p.7).

It has become a common practice for private data provider or value added resellers (VARs) to improve the base data from the public mapping agencies to be provided to the user through application packages, for instance those provided with personal navigation systems (McDougall 2009). McDougall (2009) suggested the *Closing the Loop* model (Figure 2.3), which would return the data from the user through the VAR, as the logical model to receive volunteered information such as street addresses and road networks data.

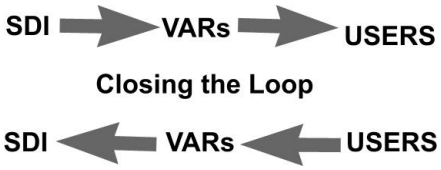


Figure 2.3: Closing the SDI Loop [after McDougall (2009)]

The technology to accept VGI is well-established through portals such as Google Earth and GeoNames, and the Closing the Loop model may ensure that there is a two-way exchange of data between users, VARs and mapping agencies (Kessler 2009, McDougall 2009).

The Closing the Loop model for volunteered geographic information would still be subject to a range of issues associated with coordination and implementation of SDIs, namely, "*the motivation for volunteering information*, *assessing the quality of volunteered information*, *privacy*, *liability*, *information rights* and *suitability of the information to various levels of SDI"* (McDougall 2009, p.8). Despite the above-mentioned issues that may concern organizations which utilize VGI, spatial data organizations should not dismiss the phenomenon of VGI merely as a passing technological fad, but they should look at it as a potential tool that can be harnessed to assist in spatial data collection at a local level (Sui 2008, McDougall 2009, Kessler 2009, Liu and Palen 2010).

Chapter 3: Spatial address data

3.1 Introduction

The preceding chapter dealt with the interorganizational GIS, spatial data sharing issues and the development of spatial data infrastructures (SDIs). This chapter will be a continuation of these themes, but with emphasis on address data as an instance of GIS/spatial data. This chapter will also define the concept of spatial address data, the standards governing the implementation of spatial address data, the National Address Database (NAD) in an SDI, and lastly the examples of functional NADs which provide the best practices.

3.2 Spatial address data

3.2.1 Definitions

An *address* is defined as *a description of the location of a person or organization, as written or printed on mail as direction for delivery* or *the location at which a particular organization or person may be found or reached* (The American Heritage Dictionary of the English Language 2000). The definitions point to the original purpose of the address, which was to ensure that letters and parcels (i.e. postal services) were delivered to the right location (Coetzee 2008). It is now widely accepted that an address does not only refer to the description of a location for a postal delivery, but it can be used for other services such as utility services, billing, emergency dispatch, property taxation, credit application and other functions that are critical for service delivery (Lind 2000, Morad 2002, Paull 2003, Farvacque-Vitkovic et al. 2005, Coetzee 2008). According to Lind (2000), addresses are reference systems based on identifiers, such as names for country, region, town, district, street name or house number (Figure 3.1).

Figure 3.1: An example of address identifiers showing the building, street, suburb and town names

The address system is characterized by some properties summarized in Table 3.1 below.

Table 3.1: Properties of an address system [after Lind (2000)]

Properties of address system	Description
It is well-known and widespread	Everybody is aware of the system. It must be the widely used method of localization when storing information of the location of a specific person or business
It is practical and logical	The hierarchical structure with town name, road name and house numbers, divided into equal and unequal numbers in rising order, makes it easy to find bearing when moving around or looking at a map.
It is suitably detailed	In the build-up area, the address system is fine-meshed to the extent that we can find our way to the right house or units, solely with the use of a road name or house number
It is visible	Signs with road names and house numbers mean that we can read and find our way around the address system, to arrive at the house number we are looking for. The combination of logical structure and visibility could the most special and valuable property of the address system.

As reference data, i.e. an independent entity to which other information about persons or businesses can be linked, address data could be geocoded (i.e. assigned a location such as latitude/longitude or census tract) so that it could play a pivotal role in spatial databases (Hurley et al. 2003, Coetzee 2008). The benefits of using geocoded address data as reference data in a spatial database is enormous, as large volumes of text-based records will be transformed into spatial information that can be queried, analysed or manipulated to support decisions in both public and private sectors (Lind 2000).

In this research, the geocoded address data will be referred to as *spatial address data*, which is the data that can be represented as an independent entity in the spatial database or on a spatially-enabled map. So, the author will carefully alternate between address data (i.e. text-based) and spatial address data (i.e. spatially-enabled) with adequate awareness of their different meanings.

3.2.2 Address data models

At a conceptual level, the pertinent question is whether the spatial address data is represented as an *attribute* or *entity* in a spatial database (Figure 3.2). As an attribute, the address data will be used as a characteristic of each of the entities such as a person,

property, or building; while as an entity, the address data will be used as an independent object related to these entities (Lind 2000).

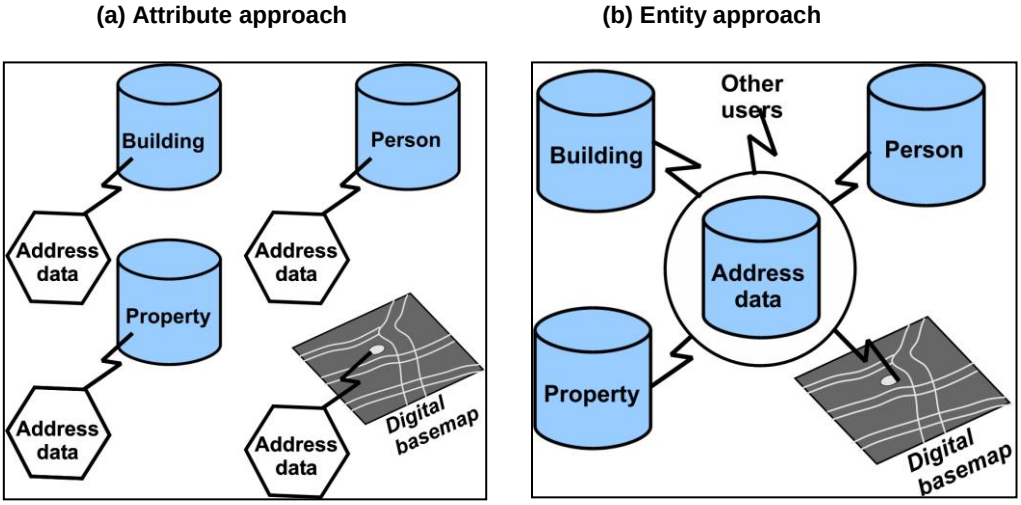


Figure 3.2: Diagram showing (a) attribute and (b) entity approaches of address data models [after Lind (2003)]

Lind (2003) noted that the trend for both public and private sector was to represent address data as an attribute rather than an entity, with the consequence that a building, person or property that should belong to the same address would have the address entered differently in each database [Figure 3.2 (b)]. In following an attribute approach for address data, each administrative function may be encouraged to create its own concept and definition of an address, thus resulting in address databases that cannot be linked or leveraged for nationwide applications. In South Africa, the attribute approach is prominent, as the municipalities, South African Post Office and Statistics South Africa and other organizations would have contradictory and ambiguous address data which apply only to their respective functions (Coetzee 2008).

An alternative to defining an address as an attribute is to define it as an entity, which implies that it would be represented as a separate object class to be treated the same as other administrative identifiers such as personal numbers, property or parcel numbers (Lind 2003). The benefits of representing an address data as an entity were described by Lind (2003) as follows:

- the address entity will exist on its own and not only as a characteristic of a building or property, thereafter the new addresses can be created and registered in a planning phase before a building is erected or plot is parcelled out; and

- the address entity can be registered and be assigned characteristics such as geographic coordinates, date of origin, etc., which can be reused in all data collections containing address information.

In the entity data model, an address should have three basic characteristics: (i) a *spatial location* indicated by coordinates or reference to at least one other identified spatial objects such as a building or property; (ii) a *reference* to a named road to ensure that the address can be fitted into the hierarchical order of the address system; and (iii) *a label* which should be an address number, assigned to indicate the place of the address in relation to the other addresses on the same road (Lind 2003).

3.2.3 Spatiality of an address data

In order to give the address data the spatial character – to be used in a GIS – the addresses should be geocoded, i.e. translated into a direct spatial reference based on geographic coordinates. The representation of the address data in the GIS can be categorized into three types, namely, polygon-based geographic representation, network-based geographic representation, and point-based geographic representation (as discussed in Table 3.2).

Table 3.2: Types of geographic representations for address data [(after Lind (2000)]

Types of geographic representation	Description
Polygon-based geographic representation	The polygon in the digital map represents a real world district with corresponding set of addresses, e. postal districts, parishes or constituencies. It is applicable where knowing the exact locality of each address appearance is not crucial.
Network-based geographic representation	The digital network representing the real world road system is linked to the information about which addresses belong to each line segment or a node in the network. If the road network has topology (i.e. rules on relatedness of features) so that it is intelligent to reflect the possibilities of motion in the actual road system. This can be applied in route planning, traffic optimization, etc.
Point-based geographic representation	Each individual address is linked to a point in the map which represents the geographic location (x- and y- coordinates) of the real-world object which is identified by the address. The point-based method could be regarded as a prerequisite in circumstances where an address must be located in a large scale map, aerial photo, etc.

3.3 Towards a national address database

3.3.1 Introduction

In most of the countries, the legislation provides for local authorities (municipalities and city councils) to be the custodians of address data, which involves assigning road names, house numbers and other address identifications (Lind 2000, Williamson et al. 2005, Coetzee 2008). Coetzee (2008) noted that "the challenge that faces many countries is the establishment of national datasets from these numerous local datasets" (p.30). Moreover, these address data were collected for different purposes, thus are represented in different formats and data models, which can be difficult to reconcile. Notwithstanding, these challenges have not stopped attempts to collate address data into databases for national and international SDIs, and make them available to a wider audience (Paull 2003, Coetzee 2008). This section will look at the SDI initiative for address data at a national level, which will be referred to as a *national address database* (NAD), its standards and best practices for implementation, and the prominent examples of NAD in the world.

3.3.2 The context for a National Address Database

Although the challenges of collating the address data from different organizations may seem insurmountable, most of the countries have gone forth to establish national address databases (NADs), also known as *address master files*, *registers*, *gazetteers* or *directories* (Lind 2000, Morad 2002, Lind 2003, Paull 2003, Coetzee 2008). The NAD puts the spatial address data (as an independent entity) at the centre of the database, to which personal, property or parcel information could be referenced.

As an address data reference system, a NAD should be subjected to the following requirements as outlined by Lind (2000):

- common standards and definitions;
- a responsible institution charged with ensuring custodianship of the system;
- a legal framework or legislation must be established to ensure best possible diffusion of the system, which include formal agreements between organizations; and
- the reference system must be well-documented, and the data and parameters which describe it must be as freely accessible as possible.

The implementation of a national address databases (NAD) may follow different data sharing models as described in Table 3.3 below.

Table 3.3: Data sharing models [after Lind (2000), Forster (2002), Coetzee (2008)]

Data sharing model	Description
Hub-and-spoke or data-harvesting model	Data from local organizations (spokes) is loaded into a single centralized single database to be coordinated and distributed by a major central organization, i.e. the hub. Data sharing between two other agencies would often go through the central agency (or hub).
Federation-by-accord model	A number of data producers who share their data with other data users in their network. Although there is often a central data producer or two cutting through the jurisdictions of many, they lack the strength of the hub.
Federation-by-mandate model	An agency (or group of agencies) is given special authority with regard to data production and sharing, for instance, a regional planning agency that is designated by the state as the official producer of specified data layers. Their authority may extend to requiring other jurisdictions to submit data to be incorporated into the official database.
Data grid model	A system that coordinates resources that are not subject to centralized control, delivers non-trivial qualities of service, and uses standard, open, general-purpose protocols and interfaces. A grid integrates and coordinates resources and users that live within different jurisdictions and addresses the issues of security, policy, payment, membership, and others that arise from these settings.

The suitability of the data sharing model depends on the nature of the interorganizational relationships and the scale (e.g. local, national, international) of a particular SDI initiative. Coetzee (2008) noted that “some of the implementations of address databases on a national scale … in Australia, the UK and Ireland follow the data-harvesting model where all the data is loaded into a single centralized database and published periodically” (p.30). Despite the success of the *data-harvesting model* of data sharing in those countries, Harvey and Tulloch (2006) found that its success is uncommon; instead, they recommended the *federation-by-accord model*, which may be more sustainable. As a follow-up to the assertion of Harvey and Tulloch (2006), Coetzee (2008) proposed a *data grid model*, which provides an enabling platform for “flexible, secure, coordinated resource sharing among collections of individuals, institutions and resource sharing among collections of individuals, institutions and resources spanning multiple administrative domains” (Coetzee 2008, p.30). This *data grid model* would provide an alternative to the centralized database approach and also be in line with the federation-by-accord model, while meeting the requirements for the future SDI (Coetzee 2008).

As it would be evident in the examples of national address databases in section 3.3.3, different data sharing models (or their combinations) were applied in the establishment of the NADs, with varying levels of success.

3.3.3 Standards for spatial address data

In order to enable the interoperability and interaction among participating organizations and systems for sharing spatial address databases, there is a need for a common standard to provide for both content (i.e. the data itself) and functionality (i.e. accessing and updating the data) (Coetzee 2008). This section will cover the rationale for spatial address standards, the examples of spatial address standards, and the significance of these standards to national address databases (NADs).

Rationale for spatial address standards

In South Africa, as in other countries around the world, large volumes of address-related datasets are held by different local authorities, public and private organizations. These address datasets are handled in an environment without common data quality standards, with poor consistency among them (Morad 2002). As illustrated in Table 3.4, the address datasets in South Africa occur in different organizations, variable data formats, different purposes for use, and different levels of coverage (Coetzee 2008).

Table 3.4: Different sources of address datasets in South Africa [after Coetzee (2008)]

Source	Type of data	Purpose	Typical coverage	Formats
Local municipalities	Land parcels, street names/numbers, property description(according to deeds directory	Support other municipal departments, property valuation	Municipality	Paper maps, CAD drawings, or GIS databases
South African Post Office (SAPO)	List of SAPO-approved place names and post codes; No spatial information included	Postal mail delivery	National	Comma-delimited text files
Statistics South Africa	Database of coordinates for dwelling locations	Household surveys	Per area as required for a survey	Proprietary GIS
Private entities	Source address data from different data producers, and aggregate them into a national database	Address-related service provision	National	GIS database formats

This situation of disparate address databases (Table 3.4), which is endemic throughout the world, calls for the establishment of address data standards to guide the address data producers towards interoperable and seamlessly accessible address datasets on national or international scale (Morad 2002, Coetzee 2008). According to Coetzee et al. (2008), a geo-enabled address standard should provide for the following:

- all kinds of address (not just those for postal delivery);
- systematic definition of all address elements and syntaxes that are required to decompose addresses into spatial features and/or normalized relational database tables, and to reconstruct address records from those spatial features and/or tables;
- a unique address identifier for each address;
- relating addresses to coordinates;
- address metadata, including record-level metadata such as the status (future, active or retired) and period during which the address was/is in use;
- systematic address data quality testing, error-trapping, and anomaly identification, including compilation of local address assignment rules into an address schema; and
- specification of encoding formats such as XML that enable electronic data exchange between different institutions.

A number of countries and international organizations have developed or currently developing standards for address datasets in order to benefit from the standardized address datasets (Coetzee 2008). The countries in the forefront of developing the national address standards include Australia and New Zealand (i.e. ANZLIC SDI initiative), Denmark, United Kingdom, USA and South Africa; while international organizations include Universal Postal Union (UPU), International Organization for Standardization (ISO), and others which are interested in international address standard.

Benefits of standardizing address datasets

The benefits of standardizing address datasets lie in the coordination and integration of those datasets into a national address database, which would provide the users with the quality address dataset and the ability to discover, access and update these datasets. Some of the benefits for address standardization are discussed in Table 3.5 below.

Table 3.5: The benefits of address data standardization summarized from Coetzee et al. (2008)

Benefits	Details
Economic benefits	– As a key to customer databases, standardized address data would allow business-customer interactions, which include sending invoices or goods, and direct debt collection. – The geocoded address data enable spatial analysis for economic decision making, such as in retail outlet planning, e.g. identifying where people shop in relation to where they live. – A standardized address system can generate downstream economic activities, e.g. production and maintenance of street maps/guides. – The creation of centralized address databases in Great Britain has resulted in cost saving across government departments, e.g. increased revenue from enforced local taxation.
Social benefits	– In South Africa, a unique, unambiguous standardized address data serve as a proof of a customer's residential address before opening an account with a financial institution or applying credit. – Farvacque-Vitkovic et al. (2005) regarded street addressing as the foundation on which civic identity can develop, i.e. as a prerequisite for the development of civic institutions. – Other social benefits from the use of standardized address datasets include disaster management activities (e.g. collecting fields reports of damaged sites, distress reports from home owners, producing maps for clean-up operations, etc.); and urban planning activities (e.g. zoning, construction planning, etc.).
Governance benefits	– The Independent Electoral Commission (IEC) in South Africa uses addresses in preparation for elections, i.e. addresses are used to ensure that the voting stations are within reach of voters, and for the analysis of voting patterns after elections. – Statistics South Africa (a body responsible for the census) use the address data to ensure that the census reaches all citizens and prepared maps to assist their agents in locating citizens. – Local, provincial and national spheres of government in South Africa would need to exchange service delivery data linked to common addresses in order to coordinate the planning and maintenance of service delivery across these levels of government. – The National Land and Property Gazetteer in the UK is used to audit other national datasets, thus supporting governance by ensuring better quality datasets (Nicholson 2007).

Examples of standards for address data

The standards for geocoded address data have been developed or presently developed by different countries and international organizations all over the world (Coetzee et al. 2008). For the purpose of this research, two foreign national standards and the South African Address Standard (Table 3.6) were looked at to give an idea of what is contained in these address standards.

Table 3.6: A summary of address standards

Address standard	Description of an address (spatial/non-spatial)	Components of the address database
United States Street, Landmark, and Postal Address Data Standard (formerly known as Street Address Data Standard) has been drafted by the Urban and Regional Information Systems Association (URISA) Address Standard Working Group for submission to the U.S. Federal Geographic Data Committee	Address: specifies a location by reference to a thoroughfare or landmark, or it specifies a point of postal delivery;	– *Part 1 - Data content*: defines the simple and complex data elements (e.g. address number, street name, place names, etc) that comprise an address and their attributes (e.g. address identifiers, geospatial coordinate systems and values, address descriptors, etc.) – *Part 2 - Data classification*: defines address classes by their syntax rather than semantics/meaning, i.e. allows the user of the standard to focus on record structures, without assuming about what the address locates – *Part 3 - Data quality*: checks the internal consistency (i.e.both tabular and spatial) of address elements, attributes, and classes – *Part 4 - Data exchange*: defines an XML schema document (XSD) to provide a template for the data and metadata needed for address data exchange
British Standard 7666 was published to articulate the general specifications of the national gazetteers of the United Kingdom	Address: a means of referencing an object for the purposes of unique identification and location	– *Part 0*: General model for gazetteers and spatial referencing – *Part 1*: Specification for a street gazetteer, i.e. each street is assigned a unique street identifier, and sometimes referenced geographically by its two end points – *Part 2*: Specifications for a land and property gazetteer, i.e. the land and property gazetteer consists of Basic Land and Property Units indexed to an agreed locational framework – *Part 3*: Specification for addresses (postal addresses) – *Part 4*: Specification for recording of public rights of way (footpaths)
South African Address Standard (SANS 1883) was developed to describe the data elements of different address types in order to enable address data exchange	Address: an unambiguous specification of a point of service delivery	– *Part 1*: Data format of addresses – *Part 2*: Guidelines for addresses in databases, data transfer, exchange and interoperability – *Part 3*: Guidelines for address allocation and updates

The major objective of these standards is to encourage interoperability so that address datasets held by different organizations (in different formats) could be exchanged easily among participants or users. By applying a common definition of an address and its elements across different address producers and users, the task of coordinating and integrating the address datasets for the development of a national address database (NAD) is made less cumbersome.

3.3.4 Development of NADs

Some countries have gone beyond the development of address standards towards the implementation of address databases at a national scale, i.e. the so-called national address databases or NADs for short. Some of the most prominent NAD initiatives have been documented by Paull (2003) and McDougall et al. (2005) for Australia, Morad (2002) for the UK, and Fahey and Finch (2006) for Ireland. A review of one of the successful NADs, e.g. Geocoded National Address File (G-NAF) (Table 3.7), would assist in understanding the nature of these initiatives and their best practices.

Table 3.7: Example of a NAD: G-NAF for Australia

Name	**G-NAF**
Description	The G-NAF was built and maintained with quarterly updates by Public Sector Mapping Agencies (PSMA) Australia. Geocoded National Address File (G-NAF) is Australia's official geocoded address file for the whole country, listing all valid addresses in Australia. It contains approximately 13 million physical addresses, each linked to a unique geocode (geographic latitude and longitude) of the address. The contributors to G-NAF include the Australian Electoral Commission, Australia Post, state, territory and Australian Government mapping agencies and land registries. To protect privacy, G-NAF does not contain any personal information such as names or business types.
Data Standards and Models	G-NAF implements the *AS/NZS4819:2003 standard for Geographic Information – Urban and Rural Addressing*. It follows a *data-harvesting model* with address data organizations pooling different address datasets from different address databases into the G-NAF, which validates the data and incorporates it into the national address file.
Data access	PSMA Distribution manages the distribution of the Australian' authoritative data. Access to the data is supported via a network of Value Added Resellers (VARs) – they combine their expertise and market knowledge with PSMA to develop and sell a wide range of mapping products, and business and location-intelligent tools. The Data Access and Pricing Policy will be determined in line with PSMA Australia policy, which ensures that price, access and licensing should not be a barrier to access.
Applications	G-NAF has delivered a national geocoded dataset, uniform data structure across all states, commitment to ongoing data improvements. These has enabled the development of applications for *business improvement* (i.e. location of direct delivery routes), *crime prevention* (i.e. confirmation of the validity of a submitted address to prevent identity fraud), *emergency response* (i.e. fast incident response to exact emergency sites), *personal navigation* (i.e. used in websites, mobile phones and personal navigation products to accurately locate an address), *improved policy* (i.e. accurate socio-economic and demographic analysis for government agencies).
References	Paull (2003) http://www.psma.com.au, accessed 26 October 2010

Some of the successful NADs such as G-NAF in Australia, National Land and Property Gazetteer (NLPG) in UK, GeoDirectory in Ireland have common attributes which would be summarized hereunder.

Data standards and models

The NAD should implement a standard that is recognized by all the participants, who would ensure that the data in their databases conform to the provisions of that standard. The use of a common standard ensures interoperability and integration, which are the tenets of data sharing towards the development of a NAD. Most of these successful NADs adopt the *data-harvesting model* for data sharing as a dominant model, as it is the case with G-NAF, NLPG and GeoDirectory (Morad 2002, Paull 2003, Fahey and Finch 2006). This could be attributed to the penchant for the NAD to manage and control the quality of the data through rigorous validation processes, which are inherent to the data-harvesting model of data sharing.

The other data sharing models (in Table 3.3) such as *federation-by-accord* model, *federation-by-mandate* model and the new *data grid* model [proposed by Coetzee (2008)] are still to make an impact in the implementation of the NADs. However, with local authorities adopting the address standards, improving capabilities in validating the addresses at the source, and growing concerns on data ownership, the federation and data grid models can become more relevant than the dictatorial *data-harvesting* model.

Data access

In the *data-harvesting* model or the *hub-and-spoke* model, the address data is provided by the local authorities and government agencies to be validated and incorporated into the central single database by the central organization (i.e. the *hub*). The *hub* would then be responsible for coordinating and distributing all the address data provided by the local authorities and agencies (i.e. the *spokes*). According to Coetzee and Bishop (2009), the *data-harvesting* model provides a platform-independent access to the address data for both application developers and service providers via online standardized NAD services. The *data-harvesting* model might result in different service providers using different releases of the address data, thus resulting in "conflicting views of the address data" (Coetzee and Bishop 2009, p.22).

Contrary to the single centralized database of address data in *data-harvesting* model, the federation model of the NAD has a federated database, with component databases contributing to the whole, that means, "if one of the component databases is off-line, the accessibility of the federated database is reduced, but the remaining parts of the federated database can still be accessed" (Coetzee and Bishop 2009, p.24).

Organizational issues

In the *data-harvesting* model, a single organization (i.e. a hub) should have a mandate and financial support to coordinate and update the single centralized database (Coetzee and Bishop 2009). According to Coetzee and Bishop (2009), if the central organization or hub is without a clear mandate or lack financial support, the data harvesting model will be a failure, as there will be no one committed to coordinating and maintaining the centralized address database.

For the *federation-by-accord* data sharing model (see Table 3.3), which is about a number of data producers who share their data with other data users and producers in their network, the model is resilient to abrupt collapse because "over time, this model builds thick networks of connections and relationships that help assure its longevity" (Harvey and Tulloch 2006, p.764). However, by using "accord" rather than "mandate" (or authority), some of the participating organizations may not commit themselves fully to the *federation-by-accord*, thus resulting in "significant inconsistencies in format, quality and presence of data across the jurisdiction of the federation" (Harvey and Tulloch 2006, p.764).

In the *federation-by-mandate* model, an agency (or group of agencies) is given special authority with regard to data production and sharing (Harvey and Tulloch 2006). The authority of these agency/group of agencies may "extend to requiring other jurisdictions to submit data to be incorporated into the official dataset" (Harvey and Tulloch 2006, p.764), but unlike the *data-harvesting* model, it would be a complex network with most of the participating organizations being major data producers who can hold their own outside the federation. The mandatory (authoritative) participation associated with the *federation-by-mandate* model may breed hard feelings and abuses of power, which may result in the withdrawal of some of the participating organizations (Harvey and Tulloch 2006).

Applications

The NADs are used as a platform for launching other applications for business improvement, crime prevention, emergency response, personal navigation, and improved policy for government agencies. With a well-functioning NAD, it is highly possible to establish an e-government which would ease the burden of the authorities by introducing electronic elections, coordinating census data, and generally expediting other service delivery tasks by local authorities and businesses.

Chapter 4: Research method

4.1 Introduction

The previous chapters in the study provided a theoretical background on the factors that motivate or impede the interorganizational GIS data sharing (chapter 2), which is a common feature in spatial data infrastructures (SDIs), and further highlighted the issues in the development of a specific national SDI for spatial address data or so-called NAD (chapter 3). This chapter outlined the research method used to respond to the research aim and questions posed in chapter 1 of this research. The justification of the research method and the details of its phases are presented and explained in this chapter.

4.2 Research aim

The review of literature in chapter 2, has laid bare the factors that play a critical role in the establishment of interorganizational GIS data sharing initiatives or SDIs in general. These factors which can act as either motivators or barriers in the life of an SDI were considered when studying the development of a NAD in South Africa – the focus of this research. Chapter 3 discusses the data sharing models, the organizational issues and benefits associated with the development of the NADs in different countries, and how these can be adopted for the development of a proposed NAD for South Africa.

To recap from chapter 1, the aim of this research is *to assess the motivators and barriers of interorganizational GIS data sharing in the development of a proposed national address database (NAD) for South Africa*, and thereafter discuss the implications of the results on the existing theory and practices of GIS data sharing frameworks and relationships among the public and private organizations involved in the production and maintenance of spatial address databases.

The proposed research method should investigate and answer the questions stated below in a satisfactory manner.

1. Why will organizations share spatial address data for the development of the National Address Database (NAD)? What are the motivators?
2. Why will organizations not share spatial address data for the development of the National Address Database (NAD)? What are the barriers?

3. How will the understanding of motivators and barriers for sharing spatial address influence the existing theory and practices of interorganizational GIS data sharing frameworks?

The research method should be in a position to answer the "why" and "how" questions, which are basically qualitative in nature. Thus, a case study method was selected as a suitable qualitative research approach – with more details on the justifications and the phases of this approach discussed in section 4.3 below.

4.3 Research method

This research will make use of a multiple case study method to assess the motivators and barriers of interorganizational GIS data sharing for the NAD, with the focus on a selected number of both public and private organizations which collect and maintain spatial address databases.

4.3.1 Relevance of the case study method

The case study method has been applied in the various investigations of the interorganizational GIS data sharing or spatial data infrastructure (SDI) issues (Nedovic-Budic and Pinto 2000, Nedovic-Budic et al. 2004, McDougall et al. 2007, Mansourian and Valadan-Zoej 2008). Benbasat et al. (1987) justified the use of the case study approach for investigating information systems and data sharing partnerships, by mentioning the following of its associated characteristics:

- it examines a phenomenon in its natural setting;
- it employs multiple methods of data collection (i.e. *construct validity*) to gather information from one or a few entities;
- it is used in situations where the boundaries of the phenomenon are not clearly evident at the beginning of the research; and
- it does not use experimental control or manipulation.

According to Yin (1994), the case study approach is recommended when the subject of the study is not easily distinguishable from its context, e.g. interorganizational partnerships or management information systems. Furthermore, Yin (1994) indicated that the case study method is applicable under three conditions: (i) the type of research questions posed should

be in the form of “how” and “why”; (ii) the investigator must not have control over the actual event; and (iii) the actual research should be based on a current event.

This research used the case study method to investigate the motivators and barriers of GIS data sharing initiatives among different address data organizations, which will lay a base for the development of a national address database (NAD) in South Africa. The suitability of the case study method is recommended for this study because of the following reasons:

1. the GIS data sharing initiatives among organizations could be investigated in their natural settings and gives the investigators an opportunity to study current events;
2. the case study method permits the “how” and “why” research questions, which sought to find out the frameworks for GIS data sharing initiatives and organizational dynamics;
3. the case study method allows the investigator to explore the GIS data sharing initiatives among the organizations as it is, without using experimental control or manipulation; and
4. the case study method employs construct validity, which uses multiple sources of evidence in the data collection process (e.g. interviews, documents and observations) to make the case study reliable in the sense of stability, accuracy and precision of measurements.

A case study is exploratory or descriptive (Yin 1994), which means it is capable of exposing new evidence about a phenomenon. The same would apply in this research, which aims is to explore and describe the motivators and barriers of interorganizational GIS data sharing initiatives, and how these could be used for development of the proposed NAD in South Africa.

4.3.2 Research design

The research design comprises of three phases, which are outlined in Figure 4.1 below. These three phases were described by Yin (1994) as follows:

- Phase 1: *Define and design* – involves selection of case studies and design of data collection protocol based on the theory.
- Phase 2: *Prepare, collect and analyze* – includes the process of conducting single or multiple case studies and compilation of each case study report.

- Phase 3: *Analyze and conclude* – comprises the tasks such as drawing cross-case conclusions, modifying theory, developing policy implications, and writing cross-case report.

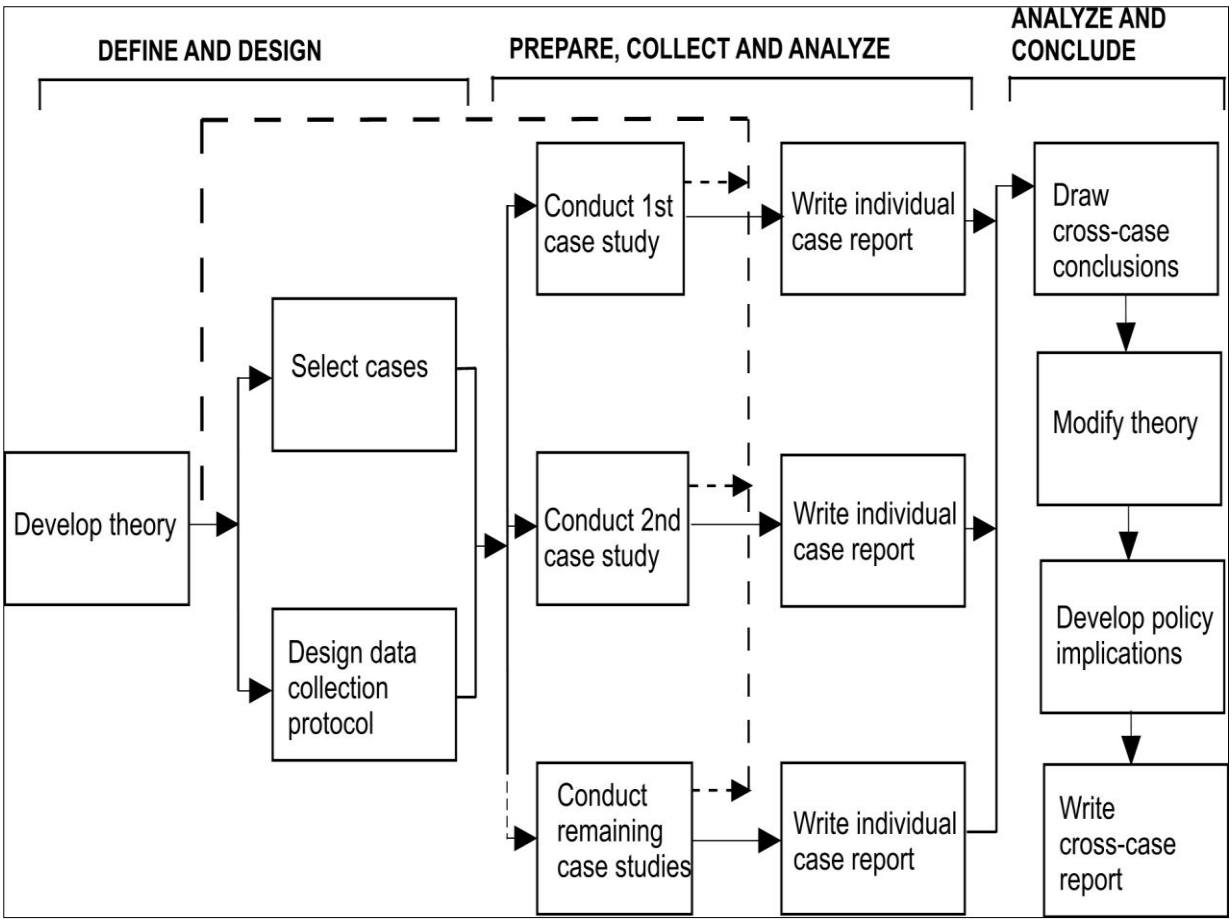


Figure 4.1: Case study method [after Yin (1994)]

More details about the phases outlined in the research design were expanded in the following sections, which indicate the methods and approaches employed in all the three phases of the research method.

4.3.3 Research methods/approaches

The research method will follow the three phases previously described in the research design section. The three phases that need to be employed in the case study research method are as follows:

1. Phase 1: Define and design
2. Phase 2: Prepare, collect and analyze
3. Phase 3: Analyze and conclude

Phase 1: Define and design

The first phase of the research involves defining and designing research problem and questions based on the theory in the areas of spatial data infrastructures (SDIs), interorganizational GIS data sharing, spatial address data, and national address databases (NADs).

Develop theory

The *first part* of the theory (chapter 2), addresses the characteristics of interorganizational GIS in an SDI, types of interorganizational GIS programmes, motivators and barriers for spatial data sharing, conceptual framework model for GIS data sharing, examples of GIS data sharing initiatives (or SDIs) in the world, and new trends such as volunteered geographic information (VGI) tools. The *second part* of the theory (chapter 3) aims to understand the instance of the interorganizational GIS data sharing initiative or SDI in the form of a national address database (NAD). The chapter defines the concept of spatial address data, the standards governing the implementation of spatial address data, the NAD as an instance of an SDI, and the examples of the functional NADs and their best practices.

Since the aim of this research is to assess the motivators and barriers of interorganizational GIS data sharing in the development of a proposed NAD for South Africa, the theoretical work was critical in designing and developing the framework for this analysis.

Selection of cases

The case studies will be conducted on three organizations that *develop or maintain spatial address databases*. The organizations chosen for the research are representative of key role players in the NAD, which include the *local municipalities*, *public organizations*, *private organizations*.

Data collection protocol

For the case study method to be reliable and repeatable, measures should be put in place to ensure that the procedures used are well-documented and can be repeated with the same results when conducted again. In this research, a protocol was observed and be recorded during the data collection as defined hereunder.

1. *Interview at least three informants for each case study. This is done for data validation purposes.*
2. *At least one informant should be a senior manager in their organization's GIS department.*
3. *Access informants through a trusted intermediary wherever possible.*
4. *Make the first contact with the case study organizations at the highest level possible.*
5. *Find someone to give guidance about the workings of the organization.*
6. *Tape record all interviews except in the cases where the distance is a limiting factor.*
7. *Support interview responses with corresponding documents where possible.*
8. *Secure multiple interviews per organization to save on travelling time.*

Phase 2: Prepare, collect and analyze

In this phase, there is preparation for conducting the case studies, by ensuring that the relevant cases are selected, the data collection procedures are in line with the data collection protocol and the schedule for data collection visits is set.

Conduct case studies

The data collection focuses on interviews and supporting documents, which are two main sources of evidence to ensure construct validity. The research uses a semi-structured questionnaire (Appendix A) to enable the informants to provide information on a wide range of issues that motivate or hinder organizations from sharing spatial address data. The interviews will be constructed in such a way that they offer leeway for informants to fully express themselves with minimal or no prejudice from the interviewer. The list of questions was developed to assist the interviewer whenever the interview requires some guidance.

The questionnaire consisted of the following three parts:

Part 1 – Particulars of the organization: This part of the questionnaire (which was rather structured) collects the information about the organization, such as its size (i.e. number of employees), spatial data sharing equipment and resources, and whether its GIS activities are for private or public consumption.

Part 2 – Motivators for spatial address data sharing: This part of the questionnaire consists of open-ended questions, which aims to establish the motivators for spatial address data sharing among organizations including issues of cost, data quality, return on investment, reduced time on data collection, improved decision making and incentives.

Part 3 – Barriers for spatial address data sharing: This part of the questionnaire comprises of a list of open-ended questions pertaining to the factors that may hinder spatial address data sharing initiatives among organizations, which include the impact on revenue-generating streams of the organization, priorities, accuracy and reliability of the data, copyright, data privacy and ownership issues, high staff turnover and lack of technical resources.

The other source of evidence for the case studies comprises of any documentation that has a bearing on the spatial address database activities of the organization or its activities in a NAD initiative. These documents such as interorganizational agreements, website pages describing the activities of the organizations, research papers (i.e. conference proceedings and journals), internal and project reports were used to corroborate and augment evidence from interviews in order to minimize biasness.

This phase will culminate in the drafting of individual case reports for each of the four organizations selected as case studies.

Phase 3: Analyze and conclude

In this phase of the research, the responses from the questionnaire are examined using different interpretations in order to find linkages between these responses and the research questions.

The individual case reports are assessed for commonalities or differences and *cross-case conclusions* are drawn. In all instances, the evidence was treated fairly to produce analytic conclusions that answer the “how” and “why” questions posed in the research.

This phase further assesses the implications of the case study results on the existing theory and practices – vis-à-vis the interorganizational GIS data sharing relationships in the development of the national address database (NAD) in South Africa.

Lastly, this phase produces a cross-case report that ties all the findings of the research, and gives conclusions about the data that has been presented.

4.4 Ethical considerations

The research involved the interviewing of among others, managers and other staff members close to different spatial data sharing initiatives in their organizations. Thus, it was important for the research to consider ethical issues and make provisions for that in the research

method and the presentation of the results. An approval to conduct research with human participants was granted by the Ethics Committee of the University of Pretoria.

All the data collected from the case studies through questionnaires and other sources of evidence (mainly documentation) was used for research purposes only. The confidentiality of informants was preserved and protected in the entirety of the research, and the names of participating organizations were withheld, instead pseudonyms such as “CASE A” were adopted throughout the research.

The participants were provided with information about the aim of the research and the limitations of use of the collected data before the commencement of the interview process. Finally, all the participants signed a consent form prior to interview sessions.

Chapter 5: Case study results

5.1 Introduction

This chapter describes and assesses the results of the three case studies using a semi-structured interview (Appendix A), which is based on the theory of interorganizational GIS data sharing and SDI, with particular reference to the national address database. The case study investigations sought to address the following objectives:

- to describe the nature of the organizations, i.e. particulars pertaining to its size, resources, private or public, etc;
- to investigate motivators for spatial address data sharing; and
- to investigate barriers for spatial address data sharing.

Prior to conducting the interviews, the background information of the selected organizations was collected from project reports, published papers, websites and any available sources. These information sources assisted the researcher to identify beforehand the potential informants in each organization. The suitable interview candidates were contacted and informed about the intention to interview. After the consent to be interviewed, the synopsis of the research and the semi-structured interview questions (Appendix A) were sent to them to allow them to prepare for the interview. Although the researcher targeted to interview at least three informants per organization, only one informant per organization could be attained; as some of the individuals did not feel empowered to speak on behalf of their organization. To avoid biasness of a single source of information, other sources of information such as organizational documents were collected to corroborate the evidence given in the interviews. All the interviews were recorded using a voice recorder, and later transcribed to ensure that all the information from the informants was captured accurately.

In this chapter, the results of the three case studies will be presented as individual case reports – addressing all the perceptions and issues on motivators and barriers of spatial address data sharing. The chapter will present the responses to the interview questions for each of the 3 case studies, and ultimately give concluding remarks about the findings of the research.

5.2 Individual organization report: Case A

5.2.1 Description of Case A

Case A is a statutory organization with a staff complement of more than 500 people. It is a public entity whose functions are guided by the Statistics Act No. 6 of 1999, which states its purpose as "to advance the planning, production, analysis, documentation, storage, dissemination and use of official and other statistics" (section 2) of the government of South Africa. The official statistics would assist organs of state, businesses, and other organizations or the public in planning, decision making, monitoring and assessment of policies.

The organization's level of infrastructure and capacity for GIS is adequate, with a dedicated GIS data management department consisting of at least ten permanent staff members. Case A does not have an e-business web portal for disseminating spatial data on dwelling units, but specific statistical data is available for download through the organization's official website. The organization is yet to make use of new technologies such as volunteered geographic information or VGI (e.g. OpenStreetMap), which encourages local users to volunteer the spatial address data to be validated and incorporated into the centralized spatial address database. In the author's opinion, the underutilization of VGI may be attributed to lack of awareness in the organization about the benefits of these technologies, or lack of mechanisms to validate the volunteered data before it got incorporated for public use.

5.2.2 Motivators for spatial address data sharing: Case A

Case A has been assessed using a list of questions pertaining to the motivating factors for spatial address data sharing among organizations. The responses to the interview questions are presented and discussed in this section.

Will sharing of spatial address data reduce the cost of data collection and maintenance for the organization?

Case A agreed that a collective effort of sourcing the spatial address data would result in significant cost reduction in the operations of the organization. The "assessments were made and it was found that only metropolitan areas had usable data" for census purposes, while the data in the rest of the areas did not meet their standards. The organization indicated in the interview that if spatial address data were available, "there was no need for the agency to

recapture the data", as it was the situation currently with the organization conducting the count of dwelling places (as coordinate points plotted on aerial or satellite imagery) for areas without address data.

Does the organization envisage improved data quality with the sharing of spatial address data?

In response to this question, Case A commented that "the limitation of the data was that it does not give indication of the number of households at the address points. If there were block of flats at that point, you would not know as the data is represented as points". This situation could be remedied by the organizations communicating their data requirements, so that the products are well-rounded and meet the quality standards agreed upon by the organizations.

How will a common national address database (NAD) contribute to the return on investment for organizations involved in spatial address data business?

Case A agreed that a lot of effort has been put in the development of public and private address databases; as such, a proportionate return on investment should be expected. In case of a public entity, Case A indicated that a return on investment would be denoted by the extent to which the national address database benefits the broader public. In support of a single national address database, Case A affirmed that there is "a need for a more efficient address repository and collection of address data that could be used by everybody".

Do you feel a common NAD will improve decision making and planning in service delivery?

In response to the question, Case A indicated that the common NAD would be invaluable in creating the sampling units for census, labour force surveys and business registers. In the absence of the NAD, the public agency developed its own sampling units called dwelling frames, which enabled the enumerators to conduct national census. There is a view that the common NAD would result in better quality of spatial address data, therefore improving the decision making and planning on service delivery by government and businesses.

If the organization is contributing its resources to the national address database (NAD) what incentives will it expect?

As a public organization, Case A did not expect incentives for their contribution to a common NAD. It would be desirable for them if "the private sector can make use of the address datasets to add value and make it useable in different applications, while the statutory agencies can maintain and safeguard the core data".

What other factors will motivate your organization to contribute to the common national address database (NAD)?

In the response, Case A mentioned the following factors that may motivate their organization to contribute to the common NAD, namely:

- It would be encouraging if the NAD was developed as an overarching structure, with a sizeable number of organizations contributing towards it, and emphasizing adherence to address standards;
- The regime of the NAD should be in such a way that address data would be accessible to a wider audience and "no one person pulls a lot of weight over others in terms of accessibility".
- The public-private partnerships should be established so that there would be shared responsibilities in terms of collecting and maintaining the address data. The public organizations would benefit from coordinated and validated address database, which would be critical for better decision making and planning in the public sector. Similarly, the private organizations would gain an advantage by focussing their energy on developing address applications and services; instead of spending a lot of time on collecting and maintaining their individual address databases.

5.2.3 Barriers for spatial address data sharing: Case A

Case A has been assessed using a list of questions pertaining to the barriers for spatial address data sharing among organizations. The responses to the interview questions are presented and discussed in this section.

Will spatial address data sharing have an impact on the revenue-generating streams of your organization?

In answering this question, Case A stated that their organization (as a public entity) does not focus on revenue-generating streams, because they had "no commercial interests at all".

How will your contribution to the common national address database conflict with the priorities of your organization?

As the organization which had vested interest in developing a database for their census purposes, the priorities of Case A were not in conflict with the development of the NAD. The only conflict cited was on the budget allocation for the maintenance of the NAD, as Case A

commented that “If money is available, it can be spent on maintaining the NAD, but if the budget is tight, it will take the back burner”.

Does your concern about accuracy and reliability of your spatial address data hinder your organization from sharing data with other organizations?

The organization was not concerned about the accuracy and reliability of their spatial data, because they made an attempt to use the methods that were statistically validated and they have been disseminating the data for public use for many years.

What is your view of copyright issues, data privacy and data ownership with regard to spatial address data sharing? How much of a concern will these issues be to your organization?

According to Case A, there were no copyright or data ownership issues that could hamper spatial address data sharing, because “if it is within the NAD, the copyright should be dealt with in terms of that structure”. With regard to data privacy, the only data that would be protected would be personal information, but “the address datasets should be made impersonal, so that it can be used widely across the public and private sectors”.

How will lack of common data definitions, formats and models influence your organization's efforts in spatial address data sharing? Which spatial address standards are used in your organization?

Case A had no serious concerns with regard to working within the standards, as they formed part of the committee for the development of the South African Address Standard (SANS 1883). But, the respondent cited the issue about the difficulty in getting the internal systems to adapt to the new standard, which may take a long time to address.

Will your organization have sufficient staff and technical resources to support a common national address database initiative?

In case of Case A, the staff retention was a concern for the organization. It was stated that after “getting the right people, when a lucrative offer comes along, they leave the organization”. So, the high staff turnover over the years has caused a loss of necessary skills needed for consistent spatial data sharing, thus it might have an impact on the support of the NAD in the future.

Do you feel that other organizations in a national address database initiative will offer the same kind of commitment and resources as your organization? Is there a sense of fairness in spatial data sharing?

Case A noted that the kind of commitment offered by other organization to the NAD initiative would depend on where the data sharing initiatives were discussed. The respondent stated that "if it is in a public forum, organizations might make promises; but when it comes to bureaucratic (organizational) structure, the sharing becomes difficult". Some organizations collect data to use it as a currency or a bargaining tool in the data sharing initiatives. Some of the public authorities which are responsible for collecting address data might find themselves having to generate revenue from the data, thus restricting the sharing of the data for public consumption. It was indicated that although the people were ready to share, they still need to see the value.

Will the sharing of spatial address data enjoy support from the strategic management plans and policies of your organization?

The agency does not have a hindrance with regard to participating in address data sharing initiatives. All the data can be shared with the public, except the personal information which may compromise the privacy of individual residents.

What other factors do you feel will strongly hinder the establishment of a national address database?

The response of Case A was as follows:

> "The fear is that the person or organization in charge of the national address database would be too strict around the theoretical detail and structure, and how it should be in the utopian world; while forgetting about the pragmatic application of it. They will want to decree that one cannot have a particular address in terms of naming conventions, hierarchies, etc. It is not necessary if you get the perfect address which is not usable; so, there must be flexibility in terms of other participants having a say in how the NAD is run. There is a fear of a single agency which would promise to put up an infrastructure, and solely collect and maintain the address datasets, and a few years down the line all is abandoned because of lack of resources and the NAD not seen as its core operation".

5.3 Individual organization report: Case B

5.3.1 Description of Case B

Case B is a private organization which described itself as "a leading and preferred supplier of spatial and other datasets to prominent public and private sector clients" (www.afrigis.co.za,

accessed 26 May 2011). The organization was founded in 1997, and it has approximately 150 staff members and contractors in its offices inside and outside South Africa. Case B specializes in location-based services such as geocoding, geo-marketing, mobile applications, transportation modelling, and any other GIS services as required by its clients. In order to provide these services, the organization required a quality spatial address database as base data for its applications. The lack of these base datasets prompted the organization to create its own spatial address database by sourcing the address data from the local authorities in paper or digital formats. These addresses were captured and geocoded to produce spatial address data, which is used for the development of location-based applications for their clients.

In more than ten years of providing geospatial services, Case B possesses what it described as 'excellent' ICT infrastructure for geographical information systems. The organization has a staff compliment of twenty members in the GIS data management department, which is well-equipped and well-resourced for providing support to their clients. Although the organization does not possess a web-portal for e-business activities or a volunteered geographic information (VGI) tool, it should not be interpreted as aversion to new technological advances. Case B does not mainly sell spatial address data; instead they provide customized services by adding value to the existing data, hence no need for an e-business portal. Furthermore, the need for a VGI tool is limited as Case B does not collect address data on its own; instead it captures address data collected by local authorities.

5.3.2 Motivators for spatial address data sharing: Case B

Case B has been assessed using a list of questions pertaining to the motivators for spatial address data sharing among organizations. The responses to the interview questions are be presented and discussed in this section.

Will sharing of spatial address data reduce the cost of data collection and maintenance for the organization?

Case B was pessimistic about the cost reduction, as it claimed that "there is no evidence that the cost of capturing and maintaining the address data will be reduced by a data sharing initiative". As the private agency, it is not their responsibility to collect and maintain the address data; so, it was not for the private sector to be concerned about the cost of data, but the public sector in the form of local authorities.

Does the organization envisage improved data quality with the sharing of spatial address data?

In response to this question, Case B acknowledged that data quality could improve if "the people responsible for capturing and maintaining spatial address data at the local level could be well-trained in terms of technical skills and GIS data standards and the address data standard which was published recently". The improved data quality may be as a result of educating and capacitating the people to do their work properly.

How will a common national address database (NAD) contribute to the return in investment for organizations involved in spatial address data business?

Case B agreed that the common NAD will spare the private agencies (*viz.* consumer databases) some efforts of developing their own address database, and instead focus on value addition on existing address data in the NAD.

Will the shared responsibilities of organizations save them time, resources and result in better spatial address data products?

The organization strongly expressed the view that the private sector should not be capturing and maintaining the address datasets, because it is the mandate of the public organizations. It also drew a comparison of South Africa and other countries in handling address data as follows:

> "in most of the countries, the address databases are sitting with the public agencies – responsible for maintaining the address datasets. Instead, the agency should be looking at ways of leveraging the value of the address data. There is a need for the citizens to have the address datasets, and it is ironic that the private agencies are supplying this data back to government".

Do you feel a common NAD will improve decision making and planning in service delivery?

Case B agreed that the common NAD, with validated address data, would improve decision making and planning for service delivery, e.g. emergency services. To illustrate the issue of lack of common NAD as a reference data, Case B stated that,

> "How do you direct the ambulance to get to the emergency scene? Do you say: 'travel up to the big tree, turn left, go on for two blocks until you get to the spaza shop, then turn right?'. When the local authorities talk about the service delivery at a certain point, they might not be talking about the same point because there is no common key identifier or reference point. Addresses are important for correct delivery of post, for validation of residential details by the banks (i.e. FICA) and

other economic and social benefits to make people feel proud about where they live".

If the organization is contributing its resources to the national address database (NAD) what incentives will it expect?

According to Case B, it would be fair to the private organizations if they were incentivized for developing spatial address databases, which is in essence the mandate of the government. As a private organization, Case B has been developing its spatial address database for use in its location-based applications and services, which are offered to both public and private sector. Case B suggested a model which would focus on public-private partnership – "whereby government can source the infrastructure and skills from the private sector in the collection and maintenance of the address data, while the government remains the owner of the process and the products".

What other factors will motivate your organization to contribute to the common national address database (NAD)?

In developing the spatial address database, Case B was inspired by the ubiquitous use of these data in everyday operations of the public and private organizations, for instance, banks to validate residency of a person to curb fraud, i.e. through the Financial Intelligence Centre Act (FICA); decision making and planning by businesses and government; location-based services to answer questions such as "I am here, what is in my surrounding?"; Pick 'n Pay home shopping for delivery of supplies.

5.3.3 Barriers for spatial address data sharing: Case B

Case B has been assessed using a list of questions pertaining to the barriers for spatial address data sharing among organizations. The responses to the interview questions would be presented and discussed in this section.

Will spatial address data sharing have an impact on the revenue-generating streams of your organization?

Although Case B has been developing its commercial address database over many years, it also did its fair share of supporting national data sharing initiatives. According to Case B, they will continue with developing spatial address database, as long as it is commercially viable. But, if there is a government initiative such as the NAD, they would support it, while looking at ways of leveraging the address data to develop commercial products.

Does your concern about accuracy and reliability of your spatial address data hinder your organization from sharing data with other organizations?

Despite Case B answering in the affirmative, it alluded to its suspicion on acquiring data from other organizations. Case B stated that "a lot of data out there from the custodians can be suspicious in terms of accuracy and reliability. There is lack of capacity building and training in data handling, as at times data management is not a priority of these organizations".

What is your view of copyright issues, data privacy and data ownership with regard to spatial address data sharing? How much of a concern will these issues be to your organization?

Case B has a data licensing agreement which specifies the restrictions on the use of the data purchased from them. Case B has stated that, "it is our data, we licence it to you for a period of time and you pay us for maintenance. It should not be copied or distributed to third parties". Nevertheless, Case B does not ask the customers to return the data when they decide not to renew the licence for the new updates of the dataset.

How will lack of common data definitions, formats and models influence your organization's efforts in spatial address data sharing? Which spatial address standards are used in your organization?

In handling the spatial address data, Case B stated that they were applying relevant standards, such as the SANS 1880 (South African Geospatial data dictionary), SANS 1878 (Geospatial metadata standard). Furthermore, the agency is looking forward to applying the address standard (SANS 1883) when it is adopted by their organization in the near future.

Will your organization have sufficient staff and technical resources to support a common national address database initiative?

Case B noted that there would be a need for capacity, i.e. skilled people who understand address elements, types of addresses and general knowledge about handling spatial data.

Do you feel that other organizations in a national address database initiative will offer the same kind of commitment and resources as your organization? Is there a sense of fairness in spatial data sharing?

Case B acknowledged that all members of the NAD initiative should show the same kind of commitment in making the NAD a success; otherwise "if some people are contributing a lot, and others are just using the data without showing any commitment, that sort of arrangement will not work". According to Case B, it would be ideal if all organizations, mainly the custodians of the address data at local level, could actively contribute to the NAD.

Will the sharing of spatial address data enjoy support from the strategic management plans and policies of your organization?

In response to this question, Case B cited the commercial model of their organization as an obstacle to sharing of spatial address data. Case B stated that,

> "if the agency is required to share the data without any incentive, then there will be a problem as that will conflict with the commercial model of the agency, i.e. to make money from the efforts they put in by providing resources and building the address database".

What other factors do you feel will strongly hinder the establishment of a national address database?

Case B felt that some of the factors that hinder the sharing of spatial address, thus the establishment of national address database, the following should be added:

> "It is not part of anybody's KPIs (key performance indicators), i.e. nobody is getting measured on it. There are few organizations which have the NAD as their (main) priority, and putting measures to get it off the ground. There is no (dedicated) budget for it and nobody is getting trained to make this a reality. There is a problem with the implementation of the SDI Act, in terms of finding an organization to account for the implementation of the NAD or any other national SDI, with support in terms of budget and resources".

5.4 Individual organization report: Case C

5.4.1 Description of Case C

Case C is a metropolitan municipality with a population size of 3 million – which is dependent on the municipality to provide services such as housing, water, electricity, refuse removal and other functions required by its mandate. In order to fulfil its functions, the metropolitan municipality would need impeccable property information, including spatial addresses and attributes of the inhabitants of these properties. In an attempt to develop and maintain the property information, the metropolitan municipality has a flagship project called land information system (LIS) – that is a sole source of property information in the custody of the metro municipality. The implementation of LIS ensures that if the property is not on the GIS system, the rezonings, and township establishments should not proceed, thus encouraging the registration of all properties within the municipality. Every registration of the property is geocoded before any attribute data is added to it; as a result, it is fully spatial.

This metropolitan municipality, which is a public entity that supports the government's initiatives, employs more than 500 staff to carry out its programmes. Case C has relatively good ICT infrastructure, with a well-equipped and well-resourced GIS department, constituted by approximately 70 permanent staff members. Despite the availability of volunteered geographic information (VGI) tools for crowd-sourcing of spatial address data or property information, Case C still relies on the property registration process to capture new data. Although the municipality does not have a web portal for e-business activities, the users can still access property data through conventional ways, such as browsing the catalogue and making an order directly.

5.4.2 Motivators for spatial address data sharing: Case C

Case C has been assessed using a list of questions pertaining to the motivators for spatial address data sharing among organizations. The responses to the interview questions are presented and discussed in this section.

Will sharing of spatial address data reduce the cost of data collection and maintenance for the organization?

Case C does not have a concern with regard to the cost of spatial data, because as the custodians of the street address data of the local municipality, they are "mandated to collect and register the new properties and assigning street addresses".

Does the organization envisage improved data quality with the sharing of spatial address data?

Case C commented that they do not accept addresses from third parties. Their need was to flood the market with the municipality's street address data, "so that everyone can use the same base data and standards … comparing apples with apples". According to Case C, in order to improve data quality and uniformity, they would ensure that their data is used by all the spatial address data users.

How will a common national address database (NAD) contribute to the return in investment for organizations involved in spatial address data business?

By eliminating duplication of efforts in collection and maintenance of the spatial address data, the NAD would reduce the cost of individual organization, thus ensuring good returns.

Will the shared responsibilities of organizations save them time, resources and result in better spatial address data products?

According to Case C, the compliance to the same address data standard, and the buy-in from address organizations would ensure that data is collected in the same manner across the board; thus, saving time, effort and cost for organizations which collect and maintain their own spatial address data.

Do you feel a common NAD will improve decision making and planning in service delivery?

As a metropolitan municipality, a common NAD would assist Case C in service delivery planning, such as in emergency services, policing, electricity, water, and others. On the other hand, the NAD would serve as a common base data linked to property valuations, rates, taxes, billing and revenue services; thus making it easy for Case C to bill and collect debt for its services.

If the organization is contributing its resources to the national address database (NAD) what incentives will it expect?

As a municipality, Case C would be ready to contribute to the NAD without regard to incentives, as it is already their mandate to collect street address data in their area of jurisdiction.

What other factors will motivate your organization to contribute to the common national address database (NAD)?

In terms of Case C, a common NAD would assist with standardizing the way addresses are captured. Case C commented that,

> "If everybody is using the same standard, one is going to talk the same language when it comes to street addresses. There are challenges with farm portions without street addresses, when we capture street addresses in predominantly rural areas. So, we assign street names for townships before they are developed so that there can be conformity".

5.4.3 Barriers for spatial address data sharing: Case C

Case C has been assessed using a list of questions pertaining to the barriers for spatial address data sharing among organizations. The responses to the interview questions would be presented and discussed in this section.

Will spatial address data sharing have an impact on the revenue-generating streams of your organization?

As a municipality, Case C is a custodian of the property and street address data in the area of its jurisdiction; as a result, it is expected of them to collect, maintain and share these data, whether it is generating revenue or not.

How will your contribution to the common national address database conflict with the priorities of your organization?

According to Case C, there should be no conflict of interest between the organization's priorities and its contribution to the NAD. As it is the mandate of the municipality to collect and register addresses in the area of its jurisdiction, they will be happy to contribute these data to a national initiative, such as the NAD.

Does your concern about accuracy and reliability of your spatial address data hinder your organization from sharing data with other organizations?

The issue of accuracy and reliability of spatial address data had not been a hindrance to the organization's sharing of these data over the past years.

What is your view of copyright issues, data privacy and data ownership with regard to spatial address data sharing? How much of a concern will these issues be to your organization?

Case C did not have any major copyright, data privacy or data ownership issues. Case C commented that "we make the data available freely; no licensing agreements required even for the private organizations. The organization would like to make the address data available to everyone without prejudice".

How will lack of common data definitions, formats and models influence your organization's efforts in spatial address data sharing? Which spatial address standards are used in your organization?

According to Case C, the organization is conforming to the address data standards when capturing the address data. It is in the interest of Case C to adopt the recently published address data standard in order to standardize the process of capturing the address data.

Do you feel that other organizations in a national address database initiative will offer the same kind of commitment and resources as your organization? Is there a sense of fairness in spatial data sharing?

In response to this question, Case C commented as follows:

> "If you think of public (government) organizations … there is no problem in sharing, but private organizations are profit-driven, so they might not share data. Government organizations should not have data sharing issues as they are mandated by legislations. Private organizations offering the same service are likely not going to share data, as it is viewed as currency".

Will the sharing of spatial address data enjoy support from the strategic management plans and policies of your organization?

Case C responded that the organization has a Balanced Scorecard, with every staff member in the organization expected to achieve certain targets which are revised every year. There is conformance to a set of criteria of what needs to be done, how it will be done, and how it will be measured. So, the spatial data sharing would appear as one of the criteria in the scorecards.

What other factors do you feel will strongly hinder the establishment of a national address database?

Case C perceived the different software platforms as a problem, as indicated by the response that,

> "Software platforms might be a hindrance. One organization will use the ESRI product while others are using other software; and different database platforms such as DB2, Oracle, SQL, etc. It would have been ideal if everybody was in an open-source environment where there are no issues of platforms, applications and formats".

5.5 Conclusion

This chapter presented the results of the case study assessment of three address organizations, which represents a government (public) organization, a private organization, and a local municipality. The questionnaire sought to determine the motivators and barriers of GIS data sharing among these address organizations, and emphasized the varied perceptions and issues encountered by each individual organization.

The views expressed in the interviews indicated that there is no one-size-fits-all solution to issues in the development of a successful data sharing initiative among organizations. All the SDI components of data, people, technology, standards and policies (Rajabifard 2007) should be taken into cognisance in order to create an enabling environment for spatial data sharing initiatives. The views also highlight areas of mutual understanding, such as applying similar standards, ensuring data quality, creating a single national address database and the cascading benefits among organizations. On the other hand, there are differing views in terms of data accuracy and reliability; copyright issues, data ownership and privacy; unequal commitment from organizations, and other issues that pertain to the seat of authority in the spatial data sharing initiative. The responses from the interviews can enable organizations to promote the commonalities among them, while resolving the differences that may occur in an interorganizational GIS data sharing initiative.

In Chapter 6, the results of the three case studies will be compared to understand the similarities and differences of these different organizations in terms of motivators and barriers of GIS data sharing among them.

Chapter 6: Results analysis

6.1 Introduction

This chapter gives a comparative analysis of the three case studies, i.e. the similarities and differences of the three address organizations with regard to motivators and barriers of interorganizational GIS data sharing. Secondly, it discusses the significance of these motivators and barriers in relation to the extent to which they impact on each of the case study organizations. Finally, it analyzes the implications of the results on the implementation of the South African Spatial Data Infrastructure (SASDI) by the Committee for Spatial Information (CSI).

6.2 Motivators

This section will give a comparative analysis of the responses by the three case studies (i.e. Case A, B and C) on the motivators which attract these organizations to participate in an interorganizational GIS data sharing initiative, particularly for spatial address data. The motivators would include these topics: *reduce the cost of data handling*; *improved data quality*; *return on investment, and improved decision making and planning; incentivization;* and *other motivators* covered in the interviews.

Reduce the cost of data handling

In all the three cases, the benefit of pooling resources to capture and validate the spatial addresses was recognized as a significant motivator to establishing a common spatial address database. The use of disparate databases was seen as duplicating efforts, and a waste of time and money as the data from different sources would still need validating before it is useable. Case B, a private organization, felt it was an unfair burden for them to be handling spatial address data from different sources; the cost should be borne by local authorities. Although Case B have doubts about the reduction in cost of handling data, the organization have a strong conviction that the cost of capturing and validating the spatial address data should be taken up by the local authorities, because it falls within their mandate. Nevertheless, the responses indicate that there was a role for both public and private organizations (i.e. public-private partnerships) in the management of spatial address databases.

Improved data quality

Both case A, B and C identified *improved data quality* as a significant motivator to establishing a spatial address data sharing initiative. The perception is that contributions to the same database would foster compliance to common definitions, standards, protocols and formats, thus improving the usability of the data. The improved data quality was also attributed to the availability of skilled personnel (in terms of GIS technical skills and data standards) in a spatial data sharing initiative.

Return on investment, and improved decision making and planning

According to the responses, the returns to be derived from a spatial address data initiative were manifold. A common spatial address database would enable public organizations to unlock potential for improving their functions, *inter alia*, collection census data, collection of rates and taxes, delivery of emergency and utility services, rezonings, establishment of townships/new developments and overall decision making and planning. Private organizations could focus their energy on developing new applications (e.g. location-based technologies), instead of wasting their time and resources recapturing and validating spatial address data.

Incentivization

The public organizations (Case A and C) were not keen on financial incentives, because it is their mandate to establish spatial address registers for their specific purposes. However, Case C uses key performance indicators, linked to participating in an SDI, in their Balanced Scorecard – a strategic performance management tool. Only Case B, as a private organization, considered financial compensation to be an appropriate incentive for recapturing and validating spatial address data. It is clear from the responses (on incentives) that organizations have not given enough thought to the benefits that a public-private partnership (e.g. ANZLIC-PSMA arrangement) could bring to an address data sharing initiative.

Other motivators

The three cases acknowledged that the participation in a common national spatial address database would create an enabling environment for organizations to use similar standards, e.g. South African Address Standard (SANS 1883), making it possible for public and private organizations to work from the same address dataset.

6.3 Barriers

This section will present the perceptions of the three cases in terms of the barriers that obstructs or impede the sharing of spatial address data among organizations.

Negative impact on revenue-generating streams

The public organizations are not expected to generate revenue from their address database efforts and this is thus not an impediment to contributing to a data sharing initiative. Although it is not a pronounced practice, the local municipality expressed that they are at times expected to fund their own operations; thus they are tempted to sell the data in their custody. On the other hand, the private organization has an inherent commercial interest, including selling their value-added data and products. This will make them reluctant player in any initiative where they are expected to contribute their services without consideration of their commercial interests, i.e. to make profit.

Priorities of the organization

The priority of the public organizations is to collect and register addresses for their own use. But, this priority depends on whether the budget is available to maintain the data sharing, i.e. “if money is tight, it will take the back burner” (Case A). In the private organization, the commercial priority comes first, but they alluded that they could participate in establishing a common spatial address database, despite their commercial interest.

Accuracy and reliability of spatial address data

Although the public organizations have used the same methods of collecting and validating address data for many years, data from custodians might still be suspicious in terms of accuracy and reliability. Lack of capacity building and training in GIS data handling are possible causes, because “data management is not a priority of these organizations” (Case B)

Copyright issues, data privacy and data ownership issues

For the public organizations with the mandate to distribute and share data, the copyright issues were not as pronounced as in private organizations. In public organizations, licensing agreements are not required and data is distributed for free. The private organization’s license agreement prohibits its clients to share their spatial address data. Privacy issues could be raised if personal/private information is attached to an address, but that was not a problem in all cases as it is easy to distribute the address data without private data.

Lack of common data definitions, formats and models

All three cases showed no reluctance to adhere to standards. They all participated in the formation of the South African Address Standard (SANS 1883). Case A mentioned that adapting their internal systems to the standard is a challenge that will take a long time to address. Although there is still a concern about common data definitions, formats and models, the three cases were positive about the future in which the national address standard would mandatory.

Staff turnover and technical resources

Case A, a public organization, mentioned that "attracting the right people and retaining them is a concern", as the organization experienced a high staff turnover for some time. Although both the public organization and local municipality appeared to be well-resourced, their budgets were not limitless. The high staff results in less technical skills, paralysing spatial data sharing initiative these organizations were involved in. Retention of GIS staff should be improved by the introduction of Occupation Specific Dispensation (OSD), which allows registered GIS professionals to advance on their career path, with appropriate remuneration, but only after predetermined periods based on specific criteria such as performance, qualification, scope of work and experience (Department of Public Services and Administration 2007).

Unequal commitment from organizations in an SDI

Because most public organizations are mandated to distribute and share data, they might feel obliged to make promises to multi-participant initiatives which are difficult to fulfil. Case A mentioned that "in a public forum, organizations might make promise, but the bureaucratic structures make data sharing difficult", by making it difficult to get required budget to support the spatial data sharing initiatives. There is a perception that some organizations (both public and private) use data as currency to elevate their importance and power base, thus creating unnecessary restrictions on data sharing.

Inadequate support from strategic management plans and policies

The strategic documents and policies of public organizations largely support building partnerships and creating an enabling environment for distributing and sharing data among organizations. Case C, the local municipality, uses Balanced Scorecard to align spatial data sharing targets with their strategy. So, it is important for organizations to ensure that their aspirations of contributing to the multi-participant spatial data sharing initiatives are included in their strategic documents in order to make them relevant to the organization as a whole. If it is not in the strategic document, it would risk being overlooked by decision makers.

Other barriers

The three cases raised other issues which they deemed as barriers to the sharing of spatial address data, which included the following:

- the fear of one organization dominating the spatial address data sharing initiative, thus denuding other organizations of their say (Case A);
- the risk of putting more emphasis on the theoretical details and structures, while neglecting the practical application of the data, e.g. rules that an address should follow a certain naming conventions or hierarchies, while overlooking the existing practices (Case A);
- the fear of an authoritarian or single agency promising to put an infrastructure for an SDI initiative, then in a few years time the initiative is abandoned as a result of lack of resources or the spatial data sharing initiative not seen as its core business anymore (Case A);
- the sharing of spatial address data not been part of the key performance indicators of the organizations, thus resulting in less commitment on the part of these organizations to implement the NAD (Case B); and
- the different GIS software platforms that make it difficult to share data among organizations (Case C).

6.4 Significant motivators and barriers

In the previous section, the responses from the cases about the motivators and barriers of interorganizational GIS data sharing were analysed. This section will take that further by identifying the motivators and barriers which play a significant role in the multi-participant GIS data sharing initiatives among the address data organizations. The motivators and barriers were assigned a significant (+) or not significant (**–**) status depending on how the cases have responded during the interviews (Table 6.1).

The motivators identified by all organizations as significant include *improved data quality, return on investment*, *improved decision making and planning* for service delivery. Although there was a consensus among the organizations that sharing spatial address data would lead to improved data quality, the organizations were still sceptical of data from other organizations. Each believed that their data was of high quality as it has been serving their purposes well; while they held a perception that people responsible for handling the GIS data in other organization were not well-trained or lack required skills for data management. Even

though reducing the cost of data handling was deemed significant by the public organization and local municipality, it was overlooked by the private organization, which argued that the cost of validating data might rise in a multi-participant setup. Incentives were considered by the private organization, which expected a financial compensation for doing the work of capturing and registering the address data, which is within the mandate of public or local municipality.

Table 6.1: The significant motivators and barriers in relation to cases

Motivators	**Case A: Public Organization**	**Case B: Private Organization**	**Case C: Local Municipality**
Reduce the cost of data handling	+	–	+
Improved data quality	+	+	+
Return on investment, i.e. saving time, resources and better spatial address products	+	+	+
Improved decision making and planning for service delivery	+	+	+
Incentives	–	+	–
Barriers			
Negative impact on revenue generating streams	–	+	–
GIS data sharing initiative vs priorities of the organization	–	+	–
Accuracy and reliability of spatial address data	–	–	–
Copyright issues, data privacy and data ownership issues	+	+	–
Lack of common data definitions, formats and models	–	–	–
Staff turnover and technical resources	+	+	+
Unequal commitment from organizations in an SDI	–	+	–
Strategic management plans and policies	–	+	–
Note: + sign denotes that the motivator or barrier has a significant impact on the organization; – sign denotes that the motivator or barrier has no significant impact on the organization			

The barriers that played a significant role for at least 2 of the cases include *copyright issues, data privacy and ownership*, and *staff turnover and technical resources*. In terms of the negative impact of spatial address data sharing on the revenue streams of the organization, the private organization would prefer a compensation for their contributions to the development of the spatial address database. Other barriers appeared to be not significant

for the public organization and local municipality but were significant for the private organization, namely, the *negative impact on the revenue generating streams*, *priorities of the organization*, *unequal commitment from organizations in an SDI, strategic management plans and policies.* The barriers which were not significant for all the cases include *accuracy and reliability of spatial address data* and *lack of common data definitions, formats and model*s.

These motivators and barriers, which were discussed in section 4.3 should be thoroughly studied and understood before organizations could embark on an uncertain journey of participating in an interorganizational GIS data sharing initiative.

6.5 Implications of results on the implementation of the SASDI

6.5.1 Motivators

The organizations in a multi-participant data sharing initiative can be motivated by issues such as reduced costs of collecting and maintaining the datasets and increased data quality due to subscription to the same standards. There is consensus among the case studies that an address data sharing initiative will foster standards compliance, improve usability of the data, assist the public sector to focus on developing their service delivery to citizens of the country, and allow private sector to focus on developing value-added products and services. Although not identified by case studies, standardized addresses can facilitate the development of tools for maintaining address data and also facilitate cross-border trade and commerce (Coetzee et al. 2011). Most of these benefits can also apply to all other spatial datasets in SASDI.

The case studies prove that the behaviour of public organizations differs from that of private organizations; the former is motivated by issues of public good, while the latter is driven by profit margins. Nevertheless, a middle ground is possible through public-private partnerships, which enables public and private organizations to collaborate on capturing and validating spatial address data; while at the same time allowing the private sector to develop commercial value-added products, e.g. location-based services. It is clear from the results of the case studies that none of the organizations had given enough consideration to the potential value of a public-private partnership. This finding can be invaluable to SASDI, because the study indicated that the cost of maintaining data is high. As such, the CSI should propose how spatial data is maintained within SASDI, and find sustainable financial

mechanisms to support its activities. One option is for private organizations to offer their data maintenance services at affordable rates in exchange for incorporating the address data into their value-added products. Another option is a public/private sector consortium establishing a company that builds and maintains the address database for a contracted period. This has proved to be a success in Australia, through the interorganizational Public Sector Mapping Agency (PSMA), which has produced an extensive Geocoded National Address File (G-NAF) – an address dataset that lists all valid addresses in Australia.

Address data is one of the core dataset for the SASDI; and if it is given priority, it will enable South Africa (as a developing country) to develop applications for *business improvement* through location of direct routes; *crime prevention* by confirming the validity of a submitted address to prevent identity fraud; *emergency response* to exact emergency sites; *personal navigation* through websites, mobile phones and personal navigation tools to accurately locate an address; and *improved policy* by providing unique reference for accurate socio-economic and demographic analysis for government agencies. These benefits are central to the development of South Africa, thus require CSI to encourage the relevant organizations to cooperate for the implementation of the single address dataset in the SASDI.

6.5.2 Barriers

The results of the case studies indicate that data ownership needs to be addressed to ensure that private organizations are not alienated by SDI initiatives that advocate data sharing at all costs or by the fear that data custodians will use their datasets as a bargaining tool in negotiations. Copyright and data ownership should also be resolved to allay fears of one organization taking control of all the data and distributing it without acknowledging the efforts of others.

It is significant that the targets of contributing to a multi-participant data sharing initiative are reflected in an organization's strategy. This will ensure that data sharing is not overlooked by decision makers who approve budgets. In addition, aligning performance measurements with the organization's strategy (in support of data sharing) encourages staff to carry out data sharing activities in their daily operations and decisions. CSI and SASDI have to find solutions to these issues by ensuring that strategies and performance measurements of participating organizations (or data custodians) reflect the expected data sharing targets.

The problem of high staff turnover and lack of technical resources must be addressed to prevent them from impacting negatively on the data sharing initiative in the long run. As discussed before, the introduction of the Occupation Specific Dispensation (OSD) in the South African public sector can be applied to ensure that the abilities and experience of the GIS professionals are recognised and remunerated accordingly, to stop them from job-hopping in search of a better pay.

The responses of the case studies indicate that despite the barriers that have been mentioned, the organizations are awaiting an action from the CSI to give direction and begin the implementation of the SASDI.

6.6 Summary

This chapter collated the results of the individual case studies into a cross-case report. It gave an insight into the significant motivators and barriers of interorganizational GIS data sharing across the three address organizations. The discussions in the chapter indicated that across organizations, there are common issues that motivate or hinder GIS data sharing; and the understanding of these organization-specific issues are a critical step towards building successful interorganizational relationships.

In the next chapter, the final conclusions of the research will be presented with emphasis on the research problem statement, the aim and associated questions. Thereafter, the implications of the research to the existing theory and practices of interorganizational GIS data sharing will be discussed and recommendations for future research will be put forward.

Chapter 7: Conclusions and recommendations

7.1 Introduction

In this research, the literature review indicated that the interorganizational relationships for GIS data sharing were the building blocks for the development of spatial data infrastructures (SDIs) at national level. There are complex issues that motivate or hinder the interorganizational GIS data sharing initiatives, and the successful implementation of an SDI depends on the understanding of those issues.

This research assessed the motivators and barriers of interorganizational GIS data sharing using the case studies of three address data organizations in South Africa. The results (presented in chapters 5 and 6) highlight the significant issues that motivate or hinder these organizations from participating in GIS data sharing initiatives, especially in developing a single national address database (NAD). The results indicate that generally those organizations acknowledge the benefits of a single NAD, such as reduction in the cost of data collection, improved data quality due to use of common standards, improved decision making and planning for service delivery, among others. But, their efforts are hampered by distinct organizational issues such as data copyrights and ownership, centre of authority, high staff turnover resulting in lack of skills, lack of financial and technical resources to support the address data sharing initiative.

This chapter will give conclusions on the findings of the research by highlighting its implication on the research problem, the aim and associated questions. Thereafter, the implications of the research to the existing theory and practices of interorganizational GIS data sharing will be discussed and recommendations for the future research will be presented.

7.2 Research aim and questions

7.2.1 Research aim

As presented in chapter 1, the research problem statement is described as follows:
As a consequence of the limited knowledge about the underlying motivators and barriers for spatial data sharing among organizations, the development of spatial data initiatives, such as the proposed national address database (NAD) in South Africa would prove to be a difficult task to undertake. Thus, the aim of the research was *to assess the motivators and barriers of*

interorganizational GIS data sharing in the development of a single national address database (NAD) for South Africa.

This research applied the case study method to assess the motivators and barriers of interorganizational GIS data sharing for the NAD, with the focus on three organizations that maintain spatial address databases. The case study method, as an exploratory or descriptive tool (Yin 1994), was useful in exploring and describing the motivators and barriers of spatial address data in these organizations. By merging the case study results (as presented in chapters 5 and 6) and collaborative evidence (e.g. project reports, conference articles, websites) from the address organizations, the new knowledge about the issues that motivate or impede interorganizational sharing of address data emerged. The comparative analysis of the case study results (chapter 6) highlighted areas of commonalities and differences among the organizations, thus providing invaluable lessons to organizations willing to engage in a multi-participant data sharing initiative.

7.2.2 Research questions

Why will organizations share spatial address data for the development of the National Address Database (NAD)? What are the motivators?

The responses presented in chapter 5 and 6 indicated that address data organizations generally appreciated the importance of data sharing, citing the benefits of reduced costs of collecting and maintaining the address databases, the improved quality due to the use of common data standards and other benefits associated with pooling of their limited resources. The issue of financial incentives was identified as significant for private organizations, as they expected financial compensation for capturing or registering address data on behalf of local authorities; while key performance indicators (KPIs) can be introduced in the public organizations to ensure that their participation in the spatial data sharing initiatives is part of their strategic plans.

Why will organizations not share spatial address data for the development of the National Address Database (NAD)? What are the barriers?

For private organizations, the significant barriers included the negative impact that the national address database would have on its revenue-generating streams; uncertainty on copyright and data ownership; high staff turnover and inadequate technical resources; unequal commitment from other organizations; and strategic management plans and policies (of private organizations) that do not support the NAD initiative.

The public organizations with a more primary role in capturing and registering address data had less restricting barriers than the private organizations. The revenue generation was not an issue for public organizations since they viewed the maintenance of address databases as fulfilling their mandate. The prominent issues raised as potential barriers involved the copyright and data ownership; and high staff turnover and inadequate technical resources which might negatively impact on the implementation of the NAD in the long run.

7.3 Implications of the research on existing theory and practice

Existing research about the national spatial data infrastructures (NSDIs) indicates that the first step in early SDI implementations was to establish an infrastructure, i.e. legislation, policies, standards, technology and procedures for effective and efficient use and maintenance of spatial data management for the community. This was a top-down approach initiated and driven by the government or state agencies, which characterized the beginning of most of the national SDIs (Masser 2007). Later on, it became evident that to implement a successful SDI, the collaboration and partnerships among government agencies, private sector, academia and community are of utmost importance. This manifested itself in the development of South African SDI whereby even with the framework (i.e. legislation, policies, and standards) in place, the challenge of participating organizations not cooperating with each other remains. It was discussed in the literature review (chapter 2) that collaboration and relationships among organizations in the SDI depended on particular motivators and barriers, which were made the basis of this research.

The research used a case study method to assess those motivators and barriers of the address data organizations participating in interorganizational GIS data sharing initiative, particularly the national address database (NAD) in South Africa. Based on the literature review, the case study method (with a semi-structured questionnaire) was deemed appropriate for this research because of its ability to ask the “why” and “how” questions required for a qualitative analysis of the interorganizational GIS data sharing activities. Furthermore, the corroborative evidence such as internal reports, research papers, internal project reports, website information and others from the organizations were used to validate the findings of the research.

The findings from the research questionnaire indicate that there are significant motivators that underlie the GIS data sharing activities among the organizations. As discussed in

chapter 5 and 6, all the participating organizations in an SDI can be motivated by issues such as reduced costs of collecting and maintaining the datasets, increased data quality due to subscription to same standards, and other benefits of shared responsibilities. But, from the research findings it was clear that the behaviour of the public organizations is not necessarily similar to that of private organizations; as the former is motivated by the issues of public good, the latter is driven by profit margins.

However, the middle ground seems to be possible, whereby the data sharing initiative (e.g. the NAD) can foster successful public-private partnerships in the mould of ANZLIC-PSMA type (as described in chapter 2). The public-private partnerships can allow the public and private organizations to work together in capturing and validating the core spatial address data, while giving the private sector opportunities to add value to the dataset and develop their commercial map products and location-based applications. The established Committee for Spatial Information (CSI) – the interorganizational body prescribed by the South African SDI Act – can explore the framework and guidelines to set up such public-private partnerships.

On the other hand, the findings presented in chapter 5 and 6 also indicated that there were potential barriers that faced organizations as contributors to a GIS data sharing initiative. The issue of data sharing at all cost, without considering the manner in which it impacts on the revenue-generating streams of mainly private organizations could discourage them from participating in the data sharing initiatives. The issues that affect copyright and data ownership should be resolved in order to allay fears of one organization taking control of all the data and distributing it without acknowledging the efforts of other participating organizations. The issues of high staff turnover and lack technical resources can be looked at to prevent them from impacting on the wellbeing of the GIS data sharing initiative in the long run. However, the introduction of the Occupation Specific Dispensation (OSD), which determines the career path of the registered GIS professionals in the government departments, can counter the job-hopping by government employees. The bureaucratic issues, which are characteristic to the government departments, can be dealt with by introducing KPIs (related to their spatial data sharing) in their strategic plans to ensure that they are budgeted for and carried out.

The findings of this research reflect the complexity of the issues of collaboration and relationships among organizations participating in the data sharing initiatives. Although it is always tempting for the government to prescribe a top-down approach to forge the relationships among organizations in an SDI, it would be desirable if an enabling

environment could be created (through the activities of the interorganizational CSI) to encourage the bottom-up synergistic activities from the participating organizations.

7.4 Recommendations

The findings of this research highlight areas that require further research of interorganizational GIS data sharing activities. These recommendations for future research areas are listed here.

- The scope of the research work did not allow for quantitative analysis of the motivators and barriers of interorganizational GIS data sharing activities. In taking the findings of this research further, a large survey of address data organizations could be undertaken to quantitatively assess the patterns that emerge from their complex relationships in an SDI initiative. This would result in better understanding of the dynamics of interorganizational relationships and their better management for lasting GIS data sharing initiatives.

- In the findings, the organizations indicated the fear of one organization dictating the terms of the data sharing initiatives, thus undermining the contributions of other participating organizations. This problem is encountered in the government setup whereby a hierarchical (i.e. top-down) structure is the norm, but held with suspicion by the private organizations who favour a bottom-up structure. Thus, an analysis of the efficacy of the top-down approach versus bottom-up approach in the establishment of the data sharing partnerships would be worthwhile in order to shed a light on the nature of this problem.

- The address organizations used as case studies in this research indicated that they had not yet adopted volunteered geographic information (VGI) tools to assist them in the collection and validation of address data from the local level. Their confidence in the use of the VGI tools could be improved by targeted research on the testing and optimization of these new technologies in real problems affecting them.

- The public-private partnerships, which have been explored in other interorganizational spatial data sharing initiatives (e.g. ANZLIC-PSMA), can be investigated for its suitability when applied to spatial address data sharing in South Africa.

7.5 Conclusion

As previously mentioned in this research, the use of quality geographic information for decision making and planning is critical to service delivery in both the public and private sector. This research made special reference to spatial address data, which is pivotal in the delivery of mail, provision of emergency and utility services. The development and maintenance of a single national address database (NAD) could be of great significance to a developing country such as South Africa, as it can be used as a reference dataset linking all personal and administrative information, with numerous benefits. The NAD will play a central role in making South Africa attain its development goals, i.e. the provision of running water, sanitation, electricity, and social grants to the residents (with addresses) across the country.

The collation of these address data into a national address database (NAD) would require an SDI or a GIS data sharing initiative, which is dependent on the interorganizational collaboration and relationships. This research posited that the implementation of a successful SASDI initiative hinges on the understanding of motivators and barriers of organizations participating in it. Thus, the research identified and assessed these motivators and barriers of interorganizational GIS data sharing using address organizations as case studies. The results of the assessment exposed some of the underlying issues that could either make or break the interorganizational partnerships, and subsequently providing the CSI with guidance for implementing a successful SASDI in the near future.

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Appendices

1. Appendix A: Research questionnaire and protocols

2. Appendix B: Audio and transcripts of questionnaire responses on DVD (for examiners only)

3. Appendix C: Consent form for informants

4. Appendix D: Research declaration for the author

5. Appendix E: List of presentations and publications related to this research

Appendix A: Research questionnaire and protocols

ASSESSING THE MOTIVATORS AND BARRIERS FOR INTER-RGANIZATIONAL GIS DATA SHARING FOR ADDRESS DATA IN THE SOUTH AFRICAN SDI

Malete Daniel Sebake (29445036)

Background of the research

The use of quality spatial address data for decision making and planning is critical to service delivery (e.g. emergency services, mail delivery and provision of utility services) in the public and private sector. Currently, the collection and maintenance of the spatial address data in South Africa is in the jurisdiction of separate local authorities. The collation of spatial address data into a common national address database (NAD) would not only be a cost saving exercise (by eliminating duplication), but it will also give decision makers and planners at local and national level the benefit of using a single source of reference information. However, to achieve the goal of a single national address database would require sharing of spatial address data among public and private organizations. This inter-organizational GIS data sharing for a NAD may prove to be successful if the motivators or barriers in this regard are thoroughly analyzed and considered when establishing the relationships among participating organizations.

The aim of this research is to analyze the motivators and barriers of inter-organizational GIS data sharing in the development of a proposed national address database (NAD) for South Africa, and thereafter discuss the implications of the results on the existing theory on GIS data sharing frameworks and relationships among the public and private organizations involved in the production and maintenance of spatial address databases.

The research will use semi-structured questionnaire to enable the informants to provide information on a wide range of issues that motivate or hinder organizations from sharing spatial address data. The interviews will be constructed in such a way that they offer the informants freedom to fully express themselves with minimal or no prejudice from the interviewer. However, a list of questions has been developed to assist the interviewer whenever the interview requires some guidance. The findings of the research will be presented in the form of a mini-dissertation, and will be accessible through other publications such as conference proceeding and journals. In the course of this research and the publication of the findings, the confidentiality of the informants will be preserved and protected. The names of the participating organizations will be withheld, instead pseudonyms such as "CASE A" will be adopted throughout the publications.

Thanking you in advance.

Malete Daniel Sebake
M.IT candidate
University of Pretoria
E-mail: dsebake@gmail.com

Part 1: Particulars of the organization

This part of the questionnaire evaluates the organization as a whole and the unit responsible for GIS management. The information in this part will be collected once from each of the case study organizations.

1A: What is the number of employees at your organization?

□<25 □25-50 □50-250 □250-500 □>500

1B: How will you describe the level of ICT infrastructure and capacity?

□Very poor □Poor □Adequate □Good □Excellent

1C: Does the organization possess a web portal for e-business activities on spatial address data?

□Yes □No □Under construction

1D: Does the organization use volunteered geographic information (VGI) tools to capture spatial address data?

□Yes □No

If yes, which VGI tool do you use? ….....

1E: Does the organization have a dedicated GIS/spatial data management department?

□Yes □No

If yes, how many permanent staff members are within your GIS/spatial data management department?….....

1F: The GIS/spatial data management department is well-equipped and well-resourced.

□Strongly disagree □Disagree □Neutral □Agree □Strongly agree

1G: Your organization's GIS operations can be described as:

□Private entity that provides commercial service to a number of spatial address data users

□Public entity that supports the government's initiatives

Part 2: Motivators for spatial address data sharing

This is a list of questions pertaining to the motivating factors (motivators) for spatial address data sharing among organizations.

2A: Will sharing of spatial address data reduce the cost of data collection and maintenance for the organization?

2B: Does the organization envisage improved data quality with the sharing of spatial address data?

2C: How will a common national address database (NAD) contribute to the return in investment for organizations involved in spatial address data business?

2D: Will the shared responsibilities of organizations save them time, resources and result in better spatial address data products?

2E: Do you feel a common NAD will improve decision making and planning in service delivery?

2F: If the organization is contributing its resources to the national address database (NAD) what incentives will it expect?

2G: What other factors will motivate your organization to contribute to the common national address database (NAD)?

Part 3: Barriers for spatial address data sharing

This is a list of questions pertaining to the factors that hinder spatial address data sharing among organizations.

3A: Will spatial address data sharing have an impact on the revenue-generating streams of your organization?

3B: How will your contribution to the common national address database conflict with the priorities of your organization?

3C: Does your concern about accuracy and reliability of your spatial address data hinder your organization from sharing data with other organizations?

3D: What is your view of copyright issues, data privacy and data ownership with regard to spatial address data sharing? How much of a concern will these issues be to your organization?

3E: How will lack of common data definitions, formats and models influence your organization's efforts in spatial address data sharing? Which spatial address standards are used in your organization?

3F: Will your organization have sufficient staff and technical resources to support a common national address database initiative?

3G: Do you feel that other organizations in a national address database initiative will offer the same kind of commitment and resources as your organization? Is there a sense of fairness in spatial data sharing?

3I: Will the sharing of spatial address data enjoy support from the strategic management plans and policies of your organization?

3J: What other factors do you feel will strongly hinder the establishment of a national address database?

Data collection protocol

1. Interview at least 3 informants for each case study. This is done for data validation purposes.

2. At least one informant should be a senior manager in their organization's GIS department.

3. Access informants through a trusted intermediary wherever possible.

4. Make the first contact with the case study organizations at the highest level possible.

5. Find someone to give guidance about the workings of the organization.

6. Tape record all interviews except in the cases where the distance is a limiting factor.

7. Support interview responses with corresponding documents where possible.

8. Secure multiple interviews per organization to save on travelling time.

9. Engage some of the employees of the case study organizations in informal conversations

Appendix B: Audio and transcripts of questionnaire responses on DVD (for examiners only)

Appendix C: Consent form for informants

INFORMED CONSENT FORM

(Form for research informant's permission)

(Must be signed by each research informant, and must be kept on record by the researcher)

1 Title of research project:
Analyzing the motivators and barriers for inter- organizational GIS data sharing: Towards a common National Address Database

2 I …… hereby voluntarily grant my permission for participation in the project as explained to me by
Malete Daniel Sebake (as a researcher)……..

3 The nature, objective, possible safety and health implications have been explained to me and I understand them.

4 I understand my right to choose whether to participate in the project and that the information furnished will be handled confidentially. I am aware that the results of the investigation may be used for the purposes of publication.

5 Upon signature of this form, you will be provided with a copy.

Signed: _____ Date: _____

Witness: _____ Date: _____

Researcher: _____ Date: _____

Appendix D: Research declaration for the author

RESEARCHER DECLARATION

Hereby I, …….**MALETE DANIEL SEBAKE**…… in my capacity as……**RESEARCHER**……., declare that

1 Research informants will be informed, information will be handled confidentially, research informants reserve the right to choose whether to participate and, where applicable, written permission will be obtained for the execution of the project.

2 No conflict of interests or financial benefit, whether for the researcher, company or organisation, that could materially affect the outcome of the investigation or jeopardize the name of the university is foreseen.

3 Inspection of the case study questionnaire and protocols may take place at any time by the committee or its proxy.

4 The information I furnish in the application is correct to the best of my knowledge and that I will abide by the stipulations of the committee as contained in the regulations.

5 Signed:  Date: **11.05.2010**

Appendix E: List of presentations and publications related to this research

Sebake, M.D. and Coetzee, S. *The sharing of spatial address data for SDI purposes: Perspectives of South African address organizations*, presented at the SDI Workshop organized by University of Pretoria and Department of Rural Development and & Land Reform, Cape Town, 30 May 2011.

Sebake, M.D. and Coetzee, S. 2011. On motivators and barriers of interorganizational GIS data sharing for address organizations in a South African SDI. *Proceedings of AfricaGEO Conference*, 30 May – 02 June 2011, Cape Town. Note: This paper will be reprinted in *PositionIT – The geo-informatics, surveying, GIS, GPS and location based services journal for Southern Africa (July 2011 Issue).*

Sebake, M.D. and Coetzee, S. 2012. Results of the three case studies for assessing motivators and barriers of address data sharing in South Africa. *South African Journal of Geomatics*, 1(1). In print.