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National Spatial Data Infrastructure Collaboration for the Kingdom of Saudi Arabia

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

AGI	Association for Geographic Information
AMIS	Al Moammar Information Systems (KSA)
ANZLIC	Australia and New Zealand Land Information Council
ASDD	Australian Spatial Data Directory
ASDI	Australian Spatial Data Infrastructure
ASDIDN	Australian Spatial Data Infrastructure Distribution Network
BPTF	Best Practices Task Force
BPEL	Business Process Execution Language
CCOG	Canadian Council on Geomatics
CGDI	Canadian Geospatial Data Infrastructure
CAP	Cooperative Agreement Program
CRCSI	Cooperative Research Centre for Spatial Information
DMLS	Deputy Minister for Lands and Surveying (KSA)
ESRI	Environmental Systems Research Institute
FGDC	Federal Geographic Data Committee
GCS	General Commission for Survey (KSA)
GEMINI	Geo-spatial Metadata Interoperability Initiative
GEOSS	Global Earth Observation System of Systems
GOS	Geospatial One-Stop
GIAC	Geomatics Industry Association of Canada
GII	Geo Information Infrastructure
GIS	Geographical Information Systems
GSDI	Global Spatial Data Infrastructure
HCDA	High Commission for the Development of Ar Riyadh (KSA)
HSR	Hierarchical Spatial Reasoning
IACG	Inter-Agency Committee on Geomatics
ICT	Information and Communication Technologies
IGGI	Inter-departmental Group on Geographic Information
INSPIRE	Infrastructure for Spatial Information in the European Community
KACST	King Abdulaziz City for Science and Technology (KSA)
KSA	The Kingdom of Saudi Arabia
KSU	King Saud University (KSA)
LBS	Location-Based Service
MOMRA	Ministry of Municipal and Rural Affairs (KSA)
NEMA	National Emergency Management Agency
NIMSA	National Interest Mapping Service Agreement
NGD	National Geospatial Database
NGDF	National Digital Geospatial Data Framework
NSDI	National Spatial Data Infrastructure
OMB	Office of Management and Budget

OS	Ordnance Survey
PCGIAP	Permanent Committee for GIS in Asia and Pacific
PME	Presidency of Meteorology and Environment (KSA)
PPP	Public-Private Partnerships
PSMA	Public Sector Mapping Agencies
SADC	Southern African Development Community
SD	Spatial Data
SDI	Spatial Data Infrastructure
USGS	US Geological Survey
WCED	World Commission on Environment and Development

ABSTRACT

Spatial data is a vital national resource necessary for a country's efficient and sustainable economic, social and environmental development, and so must be properly developed and managed. In the Kingdom of Saudi Arabia (KSA), there is lack of knowledge and no clear framework describing the optimal way for stakeholders, users, providers or administrators, to collaborate effectively in establishing a National Spatial Data Infrastructure (NSDI). Moreover, the complex, multi-layer and multi-jurisdiction system of government leads to competing interests and mandates in coordinating spatial activity.

Previous studies on NSDI in KSA focused on technical infrastructure strategy. However, there is a need to study institutional/organisational issues affecting collaboration in NSDI for KSA. This research presented in this thesis leads to recommendations for a best practice, collaboration initiative for Saudi NSDI, and contributes to advancing the goals and implementation of NSDI in KSA.

A mixed (triangulated) quantitative and qualitative case study research design was adopted to assist in achieving the research aims, utilising a questionnaire and semi-structured interviews. The data was analysed and elicited concepts to recommend the Saudi NSDI collaboration initiative.

A literature review was conducted in areas relevant to Spatial Data Infrastructure (SDI) and collaboration. The diverse definitions for SDI, its main components, and hierarchical nature were explored. Definitions for collaboration, motivational factors, and potential risks and costs were also reviewed. While a conventional NSDI is characterised by a top down approach, new technologies connected to social developments have led to a rapid, parallel development of commercial-, and consumer-led SDI, or dynamic 'GeoWeb', representing the potential next generation, Web 2.0 form, of NSDI.

Institutional and technical factors are key elements in the success of NSDI collaboration initiatives, which include organisational commitment, policies, and technological resources. The national initiatives for the UK, USA, Australia, and Canada are reviewed and compared, along five key themes: objectives and vision, coordination, datasets, standards, and access. This highlighted the evolving nature of NSDI, given the rapid pace of developments in technology-driven applications and tools, and that coordination and agreement among all stakeholders requires accurate and reliable datasets, widely accepted metadata and standards, and interoperable technology, and must include all government levels and jurisdictions, with greater private sector integration.

The current situation in KSA regarding the main SDI stakeholders, and their historical development, including legislation and policies and the barriers to sharing spatial data existing, facilitates background to understanding the issues involved in developing a Saudi NSDI. This is reinforced by primary data collected through a quantitative questionnaire survey of all 26 spatial data bodies in KSA, and qualitative semi-structured interviews of 72 key persons. The data includes themes, like types of spatial organisation and sphere of operations, data types and themes, standards and technical issues, and inter-organisational relationships and collaboration. The results revealed a lack of collaboration due to negative organisational cultures, and technical obstacles relating to a need for unified spatial data and metadata standards and specifications. In particular, there was an absence of appropriate legislation to deal with the two previous points, as well as providing protection for intellectual property; such legislation would outline a system within which collaboration would take place.

The historical development and current status of key, independent SDI initiatives in KSA, i.e. MOMRA, Riyadh, and Saudi National SDI, are presented using data from secondary and primary sources. Each initiative represents city, ministry, and national level SDI initiative for collaboration.

Finally, this research concludes by providing recommendations for best practice in collaboration among the various stakeholders forming a potential Saudi NSDI. It also outlines suggestions for future work.

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CHAPTER 1: INTRODUCTION

1.1 Background Information

Increasingly, the value of spatial data is being recognised by countries in the developed world as vital to their interests in the economic, social and environmental spheres. This has led to a demand for comprehensive, current, high-quality, and universally usable, spatially related information which can support decision-making and planning at strategic and other levels, in the context of management of disasters, security, the environment, and community preparedness, as well as economic and social development (ANZLIC, 2010). Moreover, the needs of sustainable development in the form of global initiatives, such as Agenda 21 and Habitat II (United Nations, 1994), has highlighted the need for access to spatial data, in the form of databases and efficient information exchange.

The availability and effective use of spatial data is dependent on a spatial data infrastructure (SDI) that involves government and the private sector in a collaboration including users and stakeholders. A Spatial Data Infrastructure (SDI) is built upon collaboration and relationships through which data and increasingly spatial data services can be shared, kept current, and integrated, and is best viewed as those policies, standards and procedures facilitating the interactions between organisations and technology for efficiently managing spatial data use and production (Ryttersgaard, 2001). Furthermore, an SDI is a framework consisting of a number of institutional elements whether policies, coordination mechanisms and standards, as well as data, networks, and data users and providers. As such, SDI is a vital resource supporting economic and sustainable development (Wiberg, 2002; Mohammadi et al., 2009).

The transition from paper to computer-based GIS laid the foundation for SDI development; following on from that information management replaced technology as the challenging element in further development of SDI (Lee, 2003). In a practical sense, the Internet and online applications, e.g. Google Earth, have led to a huge leap forward (Butler, 2006). However, a number of issues have been responsible for holding back progress in SDI development. In the interests of efficient information management, the concept of “collected once, then re-used many times” holds true. Yet, in reality, problems in sharing data whether within or among organisations, be they public or private sector entities, has been a difficult obstacle, unlike technology (Williamson et al., 2006). This is further complicated by the changing role of government from provider to regulator, autonomous jurisdictions, distributed information, and the varying needs of various layers of government, in terms of more detailed spatial data in lower operational levels, and less detail for upper levels. These multiple jurisdictions and information islands have led to wasted resources through duplicate efforts, lack of common standards, inconsistency between datasets held, and lack of proper accessibility. The solution is not principally technological, but resides in institutional measures whether policies, legislation, coordination mechanisms, and standards, which have so far lagged far behind (Craig, 2005; Mohammadi et al., 2009).

Collaboration in the area of spatial data began early in the 1990s. This collaboration was in the form of multi-partner GIS projects in Europe and the USA (Masser and Campbell, 1994; Nedovic-Budic, 2000). Moreover, it involved other regions like Asia and Australia (Masser, 2002), leading to development of the concept of SDI (ANZLIC, 2010; Coleman and Nebert, 1998; Masser, 1998b).

In a national infrastructure, collaboration between all stakeholders, i.e. users, providers, and administrators, is vital to better manage spatial data and stakeholders' interactions. This collaboration improves spatial data sharing and so realises the full potential of SDI. However, what is involved in creating a successful collaboration for establishing an effective and efficient SDI is not yet fully understood.

The world has changed, with respect to spatial data, from the highly centralised approach, where governments held uncontested control over data under the prerogative of the national interest. The spatial data field has witnessed massive change, represented by the steady commercialisation of spatial data driven by dominant global players, e.g. Google, with the reach, resources, and economies of scale to surpass most national government initiatives. As never before, mapping products and associated spatial data has been put in the public domain in a most accessible form. Even beyond that, the same consuming public are encouraged and empowered to contribute and share in the development of spatial data products in the Web 2.0 trend represented by crowd sourcing, and the Web 3.0 trend of domain ontology for spatial data to allow integration of formal and crowd sourced data, as well as ensuring interoperability, search, data mining, and analysis (Du et al., 2011). On the other hand, this emphasises the role of global metadata descriptors in successful spatial data infrastructure communication, domestically, regionally, and globally. In this era of openness and information sharing, NSDI initiatives must adapt to these powerful and highly enabling realities.

Within the Middle East, KSA is a key regional player (see Section 1.9). It has the largest area, economy, and population in the strategically vital Arabian Peninsula. As a key member of both the Gulf Cooperation Council (GCC) and the Arab League, KSA enjoys an influential position within that cooperative framework of Gulf countries, and beyond.

Therefore, the combination of land area, population, and geopolitical and economic factors reflects KSA's need for an effective NSDI, which couples seamlessly within a wider regional SDI that covers the Gulf area, and even the entire Middle East. Once KSA successfully implements its domestic NSDI initiative, given the recommendations of this research (see pp.237-240), with its experience, resources, and political power, it is the best-placed to lead such a wide and inclusive regional initiative for the good of the peoples of the area.

In the Kingdom of Saudi Arabia (KSA), a problem shared by other countries exists, where lack of collaboration has led to duplication in spatial data and systems in many areas. The consequences are potentially damaging to managing and responding to the environmental, social and economic needs of the public, and wasteful of resources.

This research focuses on this problem and aims to investigate how effective is Saudi spatial data sharing and collaboration. An attempt will be made to understand these collaborative arrangements, and identify the factors that could contribute to their success and sustainability.

1.2 Context of Research Problem

In KSA, there is lack of knowledge and no clear framework describing the optimal way for stakeholders, be they users, providers or administrators, to collaborate effectively in the interests of establishing NSDI. Moreover, in KSA, the government administration is distributed across multiple layers and jurisdictions, which frustrates spatial activity coordination due to the complexity caused by competing interests and mandates.

1.3 Research Problem

The majority of data available in most government and private bodies has a spatial data dimension, coupled to a rising need for treatment and use of such data to study environmental, urban, and security problems (Kubbara, 2007). Therefore, spatial data is a vital national resource necessary for efficient and sustainable economic, social and environmental development. In this context, SDI is part of a country's infrastructure that must be properly developed and managed to realise these ambitious goals. Hence, national SDI (NSDI) development is the solution adopted to facilitate shared information and common activities.

In KSA, it is recognised that there is waste of resources in the form of duplicated effort and unnecessary expenditure, as a consequence of the inadequate management of spatial data resources in the country, affecting all levels and jurisdictions. The situation is such that public and private sector stakeholders, unilaterally, and without coordination with the others, proceeded to develop their own base maps, and spatial databases. This has led to duplication in implementation, and obstacles to exchange of spatial data arising from differing standards and specifications for the data held by each body. In addition, there is a lack of appropriate legislation compelling these organizations to work as a team, by regulating the role of each, in regards to spatial data sharing.

Despite the passage of a significant amount of time, with accumulated documentation on NSDI benefits and technical aspects, the various stakeholders still lack the knowledge of how best to collaborate and effectively develop SDI. A template describing best practices in collaborating, and coordinating information and activities nationally in KSA is still lacking. Moreover, the effect of the country's distinct model of government on development of the NSDI is not well defined.

The extent of the problem is highlighted by the amount of duplication that occurs in spatial data among government bodies. Table 1.1 shows a number of government organisations that create spatial datasets based on their own perspective without regard to what other government organisations are doing. The duplication in spatial data projects in KSA is a significant problem.

This duplication of effort, and consequent waste of resources is emphasised in another example, where figure 1.1 shows the parcel layer produced by two different government organisations for the same area. This is further evidence of the lack of agreement and absence of collaboration between government bodies.

The cost of the current unsatisfactory spatial data situation in KSA can also be measured in human lives. A tragic consequence of this state of affairs was sadly highlighted in the events of Wednesday, 25 November 2009. Flash floods struck parts of the city of Jeddah, despite relatively moderate rainfall. This led to 122 deaths, and massive damage to roads, buildings, and transport (Figure 1.2), estimated at around SR6 billion (£1 billion pounds) (Humaidan, 2010; Hazzazi, 2010). The tragedy brought the problem into sharp relief, as each government department had developed plans and implemented projects alone, based on the spatial data in its custody, without attempting to benefit from the spatial data held by others. In this case, the result was randomly planned neighbourhoods, main roads routed through dry watercourses and flood plains, and inappropriate construction on ground that was not suitable for building (Humaidan, 2010; Hazzazi, 2010).

Table 1.1 Duplicated spatial data work in some government organisations

Spatial Dataset / Government Organisation	Geodetic	Road networks	Topography	Hydrology	Administrative boundaries	Utility information	Cadastral information	Geographical names	Transportation	Elevation and Bathymetry	Environment	Aerial or Satellite Imagery	Vegetation	Geology	Zip Codes	Population Census
Ministry of Municipal and Rural Affairs	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
High Commission for the Development of Ar Riyadh		*	*	*	*	*	*	*	*	*	*		*		*	*
General Commission for Survey	*	*	*	*	*	*		*	*	*	*	*	*			*
Saudi Electricity Company		*	*		*	*	*	*	*	*						
Saudi Commission for Tourism and Antiquities		*	*	*	*	*		*	*	*	*		*	*		*
Central Department of Statistics and Information		*						*	*							*
Ministry of Agriculture		*	*	*	*		*	*				*	*	*		
King Abdulaziz City for Science and Technology		*	*		*			*	*	*		*	*			
Saudi Geological Survey	*	*	*	*	*			*				*	*	*		
Saudi Post		*						*	*						*	*

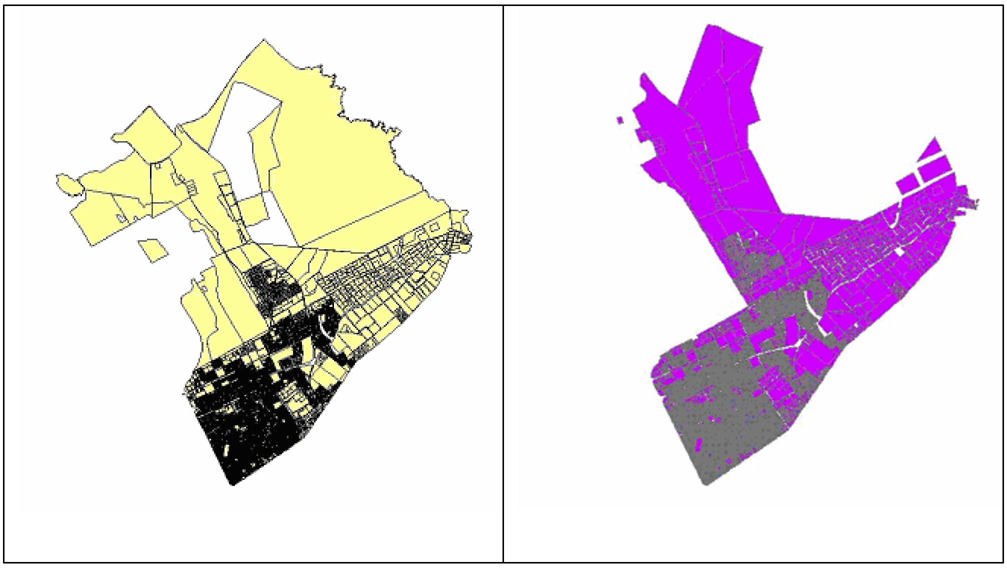


Figure 1.1 Parcel layer for the same area in Ar Riyadh city from two different organisations

Figure 1.2 Photograph showing a main road in Jeddah covered by flood water in 2009 (reproduced from Anaween Electronic Newspaper)

1.4 Research Aims

This research aims to recommend a collaboration initiative, which (i) supports spatial data sharing and maintenance activities (ii) properly describes and promotes collaboration between stakeholders across jurisdictions (iii) works effectively within the system of Saudi Arabia government, and (iv) can positively influence NSDI development in KSA. (Note: these recommendations for Saudi NSDI are presented in Section 10.2, pp.237-240).

1.5 Research Questions

A number of specific research questions were identified in light of the research problem in the context of KSA:

1. What are the spatial data and SDI concepts that are essential to developing NSDI?
2. In NSDI development, what relationships bind its components?
3. What is the experience worldwide in the best practice NSDI collaboration initiatives?
4. What is the current form of NSDI in KSA, and how far is it satisfactory to the needs of stakeholders?
5. What recommendations can describe a best practice Saudi NSDI collaboration initiative?

1.6 Research Objectives

The following objectives were identified to achieve the aims and answer the questions of this research project:

1) Review the current concepts and situation in spatial data sharing and infrastructure, as well as the nature of intra- and inter-organisational collaboration contributing to NSDI development.
2) Identify the key factors affecting collaboration in an NSDI.
3) Explore other countries' NSDI collaboration initiatives with a view to formulating the KSA NSDI.
4) Determine the current status of collaboration between stakeholders in Saudi NSDI.
5) Recommend a best practice Saudi NSDI collaboration initiative

1.7 Research Approach

According to Bryman (2008), research design defines the overall "*framework for the collection and analysis of data*" (p.31), while the research method is the technique used to gather the data. The following briefly introduces the methodological background to this research, which is critical if valid and admissible answers are to be derived from the research effort.

A case study design involves the deep and detailed study of one or a number of cases. The approach used may be qualitative, quantitative, or a hybrid of both, i.e. triangulation (Cresswell, 2002). In this work, a mixed (predominantly quantitative) case study research design was chosen to answer the questions and achieve the aims of this research that utilised two research instruments: a targeted questionnaire and semi-structured interviews. This mixed approach allows collaboration in SDI to be studied in depth and breadth, as each instrument would complement and reinforce the findings of the other. Analysis of the data yields the elements of the model for NSDI collaboration in KSA.

1.8 Implementation

The first stage included the research design, in which the research aims and objectives were clarified. This is accomplished by reviewing the extant literature to explore the areas of interest in the context of NSDI implementation: including SDI, spatial data sharing, organisational behaviour, collaboration, and intra-, and inter-jurisdictional relationships. The theory refined the research questions, and suggested the most appropriate methods of addressing them. Moreover, the research problem was more properly described, and gaps in the literature identified.

The literature review formed part of this first stage in the application of the research approach. This stage also involved a case study of NSDI in KSA. The case study is constructed of data gathered through the research instruments mentioned, i.e. semi-structured interviews and a targeted questionnaire, involving key persons in stakeholder organisations involved in handling, use and provision of spatial data in KSA.

In the second stage, the outcomes of the literature review and the data analysis, in addition to the learning from the four NSDI collaboration initiatives, UK, USA, Australia, and Canada, were used to develop a proposal for an NSDI collaboration initiative for KSA. The development is relevant to the centralised monarchical, hierarchical system of government found in KSA.

1.9 The Kingdom of Saudi Arabia (KSA)

As this research is undertaken within the context of KSA, with its attendant features, a brief presentation of the country is beneficial.

1.9.1 Brief Overview of History, Government, and Culture

The Kingdom of Saudi Arabia (KSA) was founded in 1932 by Abdulaziz bin Saud, who managed to unify the 13 emirates, and bring the entire country under his control. The discovery and subsequent exploitation of oil from the 1930s onwards marked a change in the fortunes of a previously poor nation. By the 1960s and through the 1970s, KSA witnessed a significant economic boom driven by high international oil prices. The economic boom saw phenomenal growth in infrastructure resulting in generations accustomed to a fast pace of technological change and adoption, in stark contrast with conservative, essentially Bedouin traditions (Al-Saud, 2000).

KSA is governed by a monarchical system, with the King as head of State (U.S. Department of State, 2010c). As the origin and birthplace of the World religion, Islam, the country's constitution is the Noble Quran (Horrie & Chippindale, 1994). Since reforms in 1993, a non-legislative, advisory body, the Shoura Council, was appointed, which is the means by which people have a say in their affairs in the context of Islamic governance (Al-Saud, 2000).

Saudi society is strictly conservative, and ruled by Islamic law, which lays down clear rules for religious observance as well as public behaviour, including segregation of men and women in education, work, and public functions (Al-Saud, 2000). At the same time, hospitality and generosity are quite characteristic of the Arab culture, and are extended to travellers and visitors in great measure (Horrie & Chippindale, 1994).

Figure 1.3 Map of Saudi Arabia emphasising desert character of the Kingdom (Source: Encyclopaedia Britannica, 2010)

1.9.2 Geography

KSA makes up a large part of the Arabian Peninsula, situated at the strategic crossroads of Africa, Europe and Asia. KSA is limited to the west by the Red Sea, and the Arabian Gulf in the East, as well as the Gulf States of United Arab Emirates, Qatar, and Bahrain, while its southern borders are with Yemen and Oman, and the northern borders with Jordan, Iraq, and Kuwait. In land area, it is as large as Western Europe, stretching over 1,960,600 sq.km, and lies between coordinates 16° 34' and 31° 52' N, 34° 05' and 55° 10' E (U.S. Department of State, 2010c).

As illustrated in Figure 1.3, KSA is mainly desert with an arid climate characterised by extreme temperatures in the interior, and high humidity in coastal areas. A large part of the southeastern part of the country is occupied by al-Rab' al-Khali (Empty Quarter). The desert nature of the Kingdom is highlighted by the fact that only 5% of the land is inhabited, and only 0.5% can be cultivated, while 98% is classed as desert (Encyclopaedia Britannica, 2010). This has presented serious and significant challenges on the road to development, and building the infrastructure of the country.

1.9.3 Population

In 2008, the country's population was estimated as 28 million, including a significant number of foreigners (5.6 million). In the wake of massive economic and urban development and growth, 95% of the population is settled in urban centres, in contrast to the nomadic lifestyle in the past.

Ar Riyadh, the capital, is home to 4.3 million people, while other key cities such as Jeddah, and Makkah have populations of 2.4 and 1.2 million respectively. Other important centres include Dammam/ Khobar/ Dhahran where 1.6 million people live (U.S. Department of State, 2010c). A number of key cities and urban centres are shown in Figure 1.4, and in terms of significance, the most important are: Makkah and Madinah, the spiritual and religious centres; Ryiadh, Jeddah, and Dammam as centres for commercial and economic activity; Jubail and Yanbu as the industrial hubs.

Figure 1.4 Major Commercial, Industrial and Religious Cities. Source: ABC Maps of Saudi Arabia (ITA, 2010)

Administratively, the KSA is divided into thirteen regions or provinces (Figure 1.5), which are: Ar Riyadh region and its capital, Ar Riyadh city; Makkah region and its capital, Makkah city; Eastern region and its capital, Dammam city; Assir region and its capital, Abha city; Al Baha region and its capital, Al Baha city; Najran region and its capital, Najran city; Jizan region and its capital, Jizan city; Madinah region and its capital, Madinah city; Qasim region and its capital, Buraidah city; Hai’l region and its capital, Hai’l city; Tabuk region and its capital, Tabuk city; Al Jawaf region and its capital, Al Jawaf city; and Northern region and its capital, Arar city. The major government and private spatial data organisations are located in Ar Riyadh, Makkah and Eastern regions.

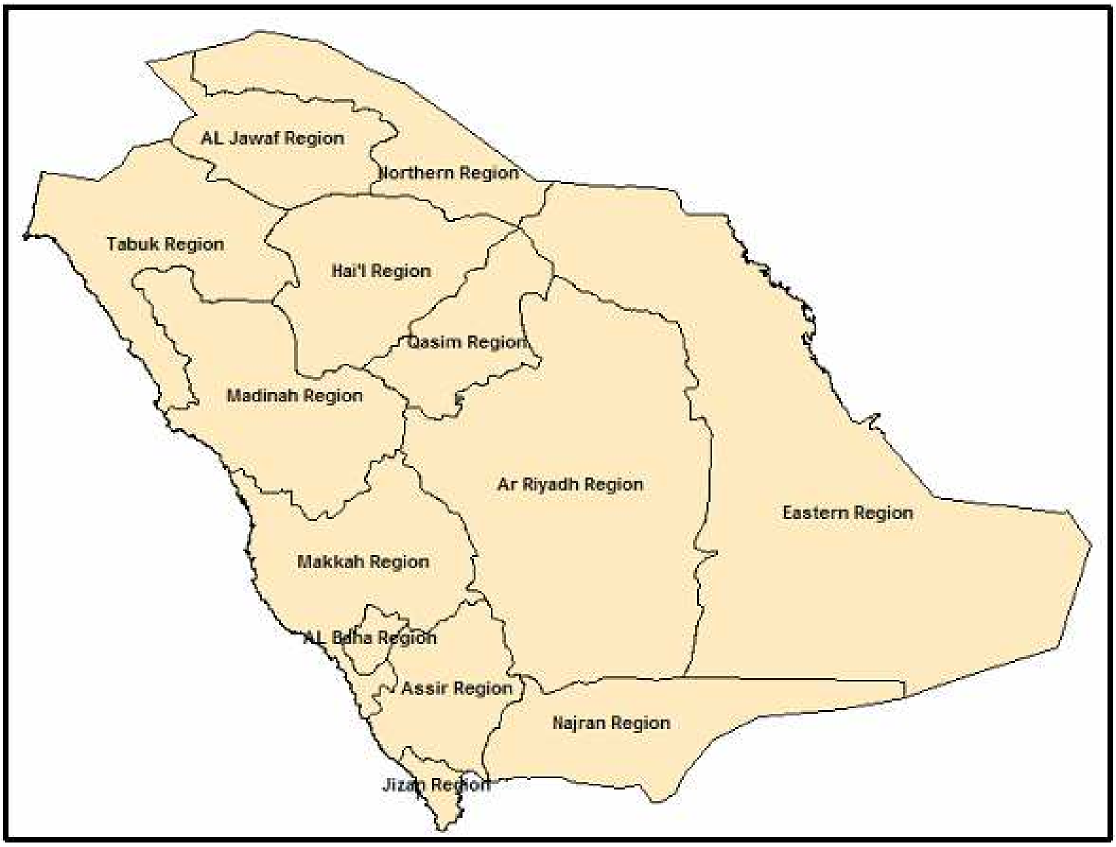


Figure 1.5 Regions of the Kingdom of Saudi Arabia

1.10 Thesis Outline

This thesis presents the investigation into “National Spatial Data Infrastructure Collaboration for the Kingdom of Saudi Arabia”. It is divided into ten chapters, and includes a list of references and appendices containing a fieldwork questionnaire developed for this research.

Chapter 1 provides an overview of the research problem, and discusses the research questions as well as its aims and objectives. A brief description is given of the methodology and research instruments chosen to address the research questions. The chapter highlights the unsatisfactory situation of lack of collaboration, and cooordination, as well as conflict among key SDI stakeholders. This has led to duplication of effort, and significant shortcomings, leading to one example of a national tragedy with regard to the flood disaster witnessed in Jeddah City in late 2009. The chapter also provides essential background introducing KSA, through its history, model of government, and culture, as well as its geography and population.

Reviewing the literature, Chapter 2 gives background on SDI from the historical development perspective, and explains the concepts underlying spatial data and information. Various considerations are presented, but principally that of information as infrastructure is elaborated. The vital nature of SDI as a powerful support in decision-making is highlighted, and the concept of e-government relevant to this issue is also described. A treatment of SDI concepts including definitions, components, and its hierarchical nature is provided as well, from the existing body of literature.

Chapter 3 continues with the presentation of NSDI by describing its nature, and its benefits, and coordination within NSDI. Collaboration whether within organisations and jurisdictions or stretching beyond that between organisations and jurisdictions (an important part of this thesis), is then presented. This includes definitions, why organisations collaborate, the nature of such collaboration, theories and strategies of organisational collaboration, its forms, outcomes and linkages to success. While the conventional form of NSDI takes a top down approach, a number of new technologies connected to social developments are presented. These have enabled a rapid, parallel development of a commerce-, and consumer-led SDI, in the form of a dynamic 'GeoWeb', giving insight into the next generation, Web 2.0 form of NSDI. The chapter ends with a brief summary of its main points.

Chapter 4 presents the NSDI initiatives of four developed countries, UK, USA, Australia, and Canada, which are considered to be quite advanced in terms of their NSDI implementation. The initiatives are presented within the frame of five main themes, namely NSDI initiative objectives and vision, coordination, datasets, standards, and access. A comparison between these country initiatives is then elaborated.

Chapter 5 provides the necessary background into the research methodology, by exploring the nature of case study research designs, and quantitative, qualitative, and mixed methods research. It relates the methodology chosen for this work to the research questions, and introduces the survey questionnaire and semi-structured interview as the instruments used. Moreover, a key aspect of academic research involves ethical considerations, which are reflected upon in the context of the research study.

Data collection undertaken in KSA is covered in Chapter 6, where the aims of the fieldwork are outlined, and the activities described. A breakdown of tasks leading to the conclusion of this stage in the research is presented, as well as the barriers encountered. The target organisations approached, which represent all the SDI stakeholders in KSA, and their responses, as well as interview schedule and questionnaire coverage are also treated in the chapter.

Chapter 7 provides in-depth coverage of the current situation in KSA regarding spatial data. The historical development of the SDI stakeholders in KSA is presented, as well as the policy and legislation defining and regulating their roles. The chapter concludes with barriers to spatial data sharing.

Chapter 8 presents an analysis of the data collected by questionnaire. This includes data on the organisations involved in spatial data in KSA, formats and standards, and organisational relationships defining existence or absence of partnerships and collaboration. The semi-structured interview data will be used to support, explain, and validate, i.e. triangulate, questionnaire quantitative data, and give it more depth.

Chapter 9 explores current SDI initiatives in KSA through the key initiatives by main stakeholders, such as MOMRA, Ar Riyadh Development Commission, and the Saudi NSDI initiatives. Data on these initiatives was collected both secondary and primary sources, including relevant reports, documentation, and legislation obtained directly from the stakeholder bodies and their websites, as well as through the questionnaires and semi-structured interviews.

Finally, Chapter 10 concludes the thesis by outlining its main findings (Section 10.2, pp.229-236), its contribution to knowledge, the recommendations (Section 10.2, pp.237-240), and suggests areas of future work.

1.11 Summary

This chapter has given an overview of the research problem in the context of KSA, supported by examples. It has mentioned key initiatives, MOMRA, Riyadh, and Saudi National SDI, which were developed independently of each other, and highlighted the distinct nature of each, in dealing with collaboration at city, ministry and region, and national levels respectively. It introduced the research questions as well as the aims and objectives. The methodology and research instruments chosen to address the research questions were described briefly. Key facts about KSA were also given in the chapter.

The following chapter will give necessary background on SDI in terms of its historical development. It will explain the concepts behind spatial data and information, particularly the consideration of information as infrastructure. SDI as a key support in decision-making is emphasised, and tied to the idea of e-government. Moreover, SDI concepts and definitions, its components, and its hierarchical nature will be outlined.

CHAPTER 2: BACKGROUND TO SDI

2.1 Historical SDI Background

In the 1980s, Geo Information Infrastructure (GII) as a term referring to the standards and protocols for spatial data exchange among mapping agencies, was introduced in Canada (Radwan, 1997). However, it was in the 1990s that awareness and interest in SDI pushed it into the mainstream. The 1992 Rio Earth Summit saw agreement of Agenda 21 as a plan for sustainable development actions; this signalled the need for high quality spatial data to respond to the needs of monitoring environmental trends (Nebert, 2004). In 1994, the US legislated and established a National Spatial Data Infrastructure (NSDI) arising from collaboration between stakeholders in federal, local government and private sector (Craglia, 2006; Harvey & Tulloch, 2006). This was followed by a number of initiatives to establish SDI at national and international levels: e.g. the Federal Geographic Data Committee (FGDC) in the US (Harvey & Tulloch, 2006), the Permanent Committee for GIS in Asia and Pacific (PCGIAP), the Australia and New Zealand Spatial Information Council (ANZLIC), the Global Spatial Data Infrastructure (GSDI) initiative, and most recently Infrastructure for Spatial Information in the European Community (INSPIRE) in Europe (Murray et al., 2007). International SDI activity was greatly enhanced by GSDI, seeking to coordinate activities and evolve common standards for global access to spatial data, and especially since the launch of its successful conferences in 1996 (Nebert, 2004).

2.2 Spatial Data and Information

A number of interchangeable terms have been used in the context of spatial information, i.e. spatial data, spatial information, geospatial data, and geographic information (Masser, 1998a; Groot and McLaughlin, 2000). All these terms refer to information that describes and characterises both geographical position, and natural and built forms. However, in the context of this research, only the term spatial data will be used to express this meaning.

In the past, spatial data has been represented in a number of forms such as by maps, survey plans and navigation charts. Throughout history, such information was vital to settlement activity, land registration, and to industry in terms of demarcating logging, mining, farming or other land use rights.

Ackoff (1989), Bellinger et al. (2004) and Clarke (2004) studied the relationship between data, information, knowledge and wisdom, as a progression from data as a raw representation lacking meaning to a highly personalised wisdom at the top of the understanding spectrum. Clarke (2004) considered data as facts arising from research, discovery, or gathering. Ackoff (1989) considered data as symbology or representation yet lacking meaning, while information was data collected in a context, giving meaning. In his view, knowledge arose from extracting the patterns and trends from data and information, and wisdom was a higher understanding based on previous knowledge and experience. These ideas are embodied in the knowledge hierarchy model presented by Ackoff (1989) (see Figure 2.1).

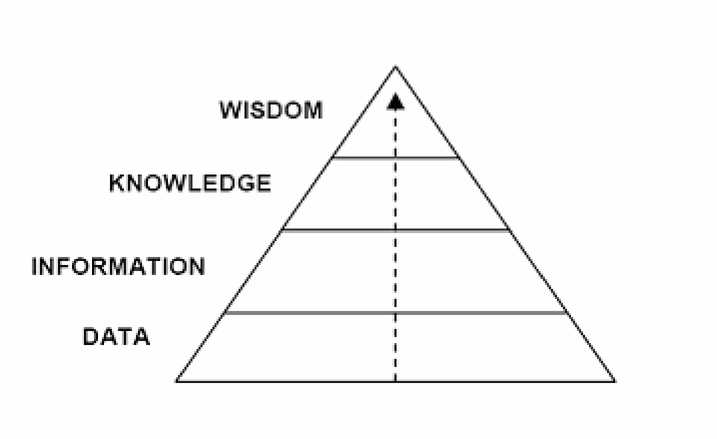


Figure 2.1 Ackoff's (1989) model illustrating hierarchy of knowledge

In extending this to geography, Masser (1998a) asserts that the combination of data and metadata is information. Moreover, understanding is implied by knowledge. In SDI, spatial data builds up into information, and this accumulates into knowledge through comparison and analysis. The ability to derive lessons and trends over time leads towards wisdom.

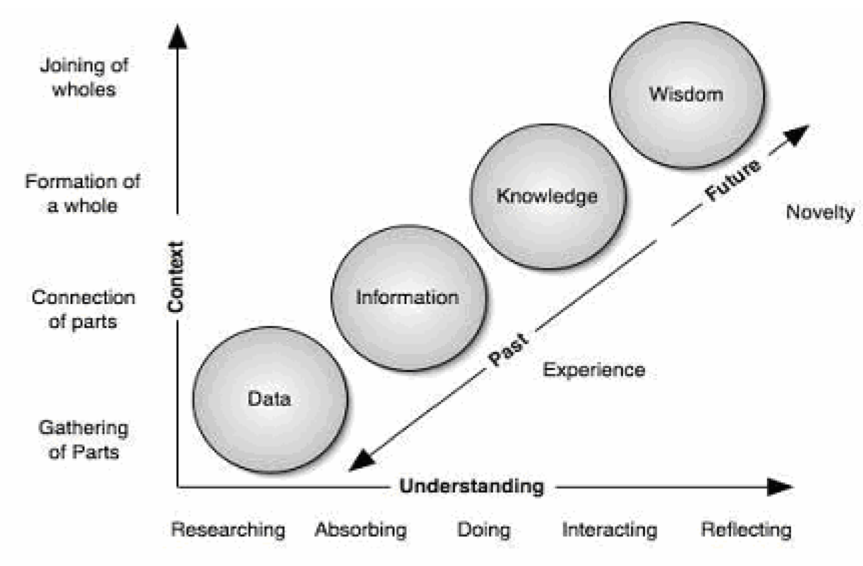


Figure 2.2 Relationships between data, information, knowledge and wisdom (Source: Clarke, 2004)

In Figure 2.2, Clarke (2004) reflects that data and information come from the past. This is when they are collected and given meaning by their context. In contrast, knowledge deals with the present. Wisdom, on the other hand, combines experience and ability to leverage understanding used to address the future.

2.3 Information as Infrastructure

There are two competing concepts of information: information as a commodity open to trading, and information as infrastructure. Each conception results in a different economic model for spatial information. The trade in digital information is seen as a pillar of an information economy, i.e. information is treated as a commodity (Goodchild, 2003a)—with the exception that the distributor does not surrender ownership (Masser, 1998a). On the other hand, the view of information as infrastructure began to take shape and was subsequently formulated in US policy on the National Information Infrastructure (Clinton, 1994). According to Clarke (2004), an information infrastructure consists of communications networks and software, and so includes existing and future information networks, i.e. Internet and all communications technologies. Information infrastructure has also been defined as "*a shareable, common, enabling, enduring resource that has scale in its design, is sustainable by an existing market, and is the physical embodiment of an underlying architecture*" by McGarty (1996, p.235). As can be seen, treating information as infrastructure depends heavily on regarding it as a resource; this can then be shared, transferred, expanded, compressed and is difficult to control, similar to material resources, and as such an asset (Masser, 1998a); moreover it has enduring and enabling characteristics (McGarty, 1996).

According to Carbo (1997), a national information infrastructure is seen to consist of the following elements, which are similar to elements of SDI:

- "people
- information content;
- hardware and other physical components;
- software and other electronic information delivery platforms;
- standards, codes, regulations, and other policies; and
- financial resources".

In addition, Murray et al. (2007, p.3) indicated the issues that are critical to implementation of SDI:

- "Organisation Issues;
- Legal Issues and Funding;
- Reference Data and Core Thematic Data;

- Metadata for Reference Data and Core Thematic Data;
- Access and other services for reference data, core thematic data and their metadata;
- Standards;
- Thematic environmental data".

Hence, information infrastructure consisted of both physical, and other supporting elements, such as education, legislative, and legal frameworks to address issues of privacy, security, and intellectual property.

This conception is fundamental to spatial information, which can be treated as an asset, and infrastructure, much like transport and education infrastructure, and hence vital for society to function properly, according to Masser (1998a). SDI integrates spatial data with other data, i.e. data on geodetic control themes and property boundaries make up the spatial reference, while topographic, administrative boundary and statistical data are some elements of the SDI.

Regarding spatial data as infrastructure opens up the discussion on regulation and financing. Given the need to safeguard the public interest—even though both the public and private sectors to varying degrees may be involved in developing, and managing SDI—regulation becomes important to prevent monopoly or damaging market practices (Masser, 1998a). In financing, argument centres on how to view SDI, and whether it is classic or network infrastructure (Williamson et al., 2003).

Classic infrastructure exists for the public good, and is not rivalled or exclusive; it is primarily financed with public funds, and to a small extent private investment. In contrast, the components of a network infrastructure are connected nodes, and the priority is attached to performance over time; funding in this case is mainly private sector, with little or no public sector involvement, and so no single model fits SDI, rather a combination best fits SDI economics (Williamson et al., 2003).

2.4 Importance of SDI in supporting Decision-making

Malczewski (1999) offered a broad definition of decision-making, as a choice between competing courses of action. Hence, it is not restricted to any particular area or discipline, and includes geographical information science. Accurate information is the pillar of good decision-making in every sphere of life, whether to do with public or corporate governance, or developing sound environmental policy, etc. Williamson et al. (2003) refer to the relationship between good governance and information as synergistic, such that good governance stimulates proper flow of information through instigating robust frameworks, legal, administrative, and socio-political, as well as economic; in turn, this information informs the decision-making process that results in good governance. SDI development encourages cross-disciplinary and cross-organisational classification of data to support decision-making (Feeney et al., 2001; Williamson et al., 2006; Carrera & Ferreira, 2007).

Sustainability involves a conscious decision, where "*Humanity has the ability to make development sustainable—to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs*" (WCED, 1990). In the area of sustainable development, the needs of implementing Agenda 21 and Habitat II Global Action Plan demanded the collation, classification of information, and definition of appropriate containers, and standards for exchange and interoperability (Ryttersgaard, 2001; Nebert, 2004). As depicted in Figure 2.3, sustainable development essentially involves decision-making that focuses on social, economic, political, and environmental conservation and resource management as inputs (Ting and Williamson, 2001; GEOSS, 2005). However, the legal, institutional, information technology and business system infrastructures have yet to fully emerge in concrete form (Ting and Williamson, 2001; Carrera & Ferreira, 2007).

Striking the balance between the needs of the present and safeguarding the future in the pursuit of sustainable development means decision-making is reliant on information, which is accurate, relevant, and presented in interactive and accessible form. The Rio Declaration indicated the necessity for geographic information to guide decisions and management of regional and global problems (Ting and Williamson, 2000), which is provided by SDI. Moreover, the Bathurst Declaration highlighted the vital importance of reliable information infrastructure comprising spatial data to support decision-making and resolving conflict, as well as a repository for social, environmental and economic rights (see Figure 2.4).

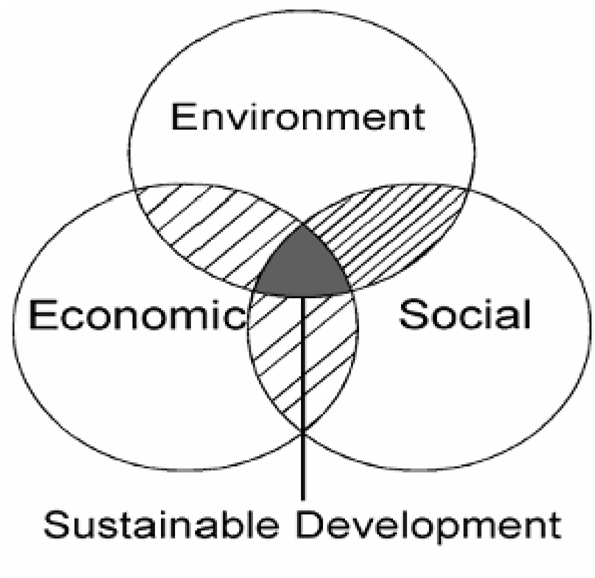


Figure 2.3 Sustainable development resulting from equilibrium between economic, environmental and social forces (Source: Ting and Williamson, 2000)

Spatial decision problems involve geographical data and information, and as such involve multi-criteria decision-making due to the significant number of alternatives that must be analysed with respect to multiple criteria (Massam, 1980). The complexity of the spatial decision problems is dictated by the number of participants in the decision process (Malczewski, 1996; Massam, 1988). The complexity lies in the values and preferences of the participants, which influence the process. Hence, any decision-making model must include values and preferences in the multicriteria analysis.

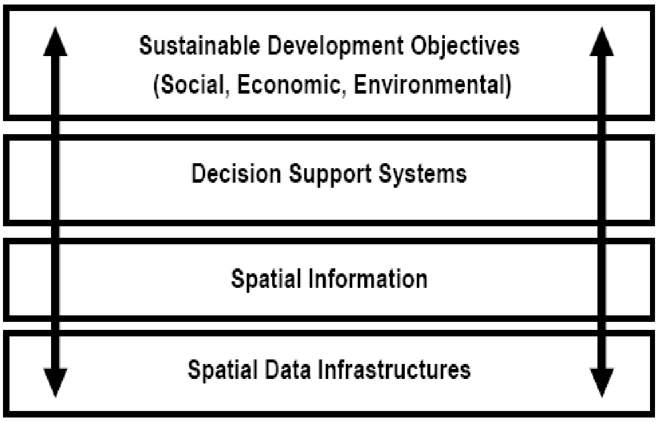


Figure 2.4 SDI supporting decision-making to achieve the aims of sustainable development (Source: Feeney et al., 2001)

Multi-criteria decision-making is a feature of sustainable development, which attempts to reconcile issues in the social, economic, and environment areas. This issue was highlighted in the 1999 UN-FIG International Workshop on Land Tenure and Cadastral Infrastructures for Sustainable Development regarding sustainable land-based resource use.

2.5 E-Government

E-Government is commonly understood to refer to the delivery of government information and services over the Internet (Williamson et al., 2003). This has been enabled by the huge progress in information and communication technologies (ICT), and especially the Internet, representing a global information network infrastructure.

E-Government offers a number of benefits to a range of stakeholders, in allowing round the clock access to government services and information. In addition, government agencies can consolidate their offerings through the single portal, with improved service and reduced operational costs, and of course greater convenience to users. Moreover, interfacing with government is eased, with less need for face-to-face processing. E-Government also enables enhanced processes for consultation, bringing it within reach of a broader audience, whether citizens, business or within government; this is dubbed e-Governance, where the relationship is more reciprocal and information flows are two-way enhancing participation in decision-making (Williamson et al., 2003). However, concerns about privacy and security require appropriate measures to be deployed. SDI is critical to the flow of information between stakeholders, representing an enabling mechanism and a technological framework.

2.5.1 Saudi e-Government Programme

The concept of e-government was adopted by the Saudi government as a prominent means of achieving transformation in services delivery and development of the national economy. The Ministry of Communications and Information Technology (MCIT) was directed by Royal Decree No. 7/B/33181, dated 7/9/2003 (10/7/1424AH) to set out a plan for the electronic delivery of transactions and services (KSA Royal Palace, 2003c). Yet, such an initiative requires a transition to an information society, which involves a significant collaborative effort to achieve it. The Saudi e-government initiative was setup in a partnership between the relevant ministries, Finance and MCIT, as well as the Communication and Information Technology Commission (CITC). The objectives of this initiative were: (Saudi e-Gov program, 2010)

- Improving efficiency and productivity of the public sector
- Improving the quality and accessibility of services for citizens and business
- Ensuring a higher return on investment (ROI)
- Ensuring the timely delivery of accurate information

The Saudi e-government initiative facilitates e-government implementation in a decentralised form, as far as practicable, and seeks to assure collaboration and coordination among government bodies. Implementation of the e-government initiative focused on several key principles (Saudi e-Gov program, 2010):

1. A single vision, agreed priorities, and uniform frameworks and standards
2. Going beyond mere technological solutions
3. Following a decentralised model
4. Embodying the concept of component re-use

2.6 Current SDI Concepts

There have been significant advances in the theory underlying SDI, and a number of concepts have been proposed. These were attempts to define, describe and create a classification for SDI, identify influential factors in development and application of SDI, as well as evaluate how far extant theories were relevant. A number of research trends have emerged, among them, applying Hierarchical Spatial Reasoning (HSR) to explain the hierarchy of SDI, applying innovation theory to SDI, studying SDI development using product and process approaches, and looking at the effect of GIS diffusion. However, despite these efforts, there is still a lack of definition of what constitutes SDI (Williamson et al., 2003).

2.6.1 SDI Definitions

A diversity of definitions have been offered for SDI by various authors, which in totality are a basis for understanding, yet none is capable of fully describing its dynamic and complex nature (Masser, 1998a; Rajabifard and Williamson, 2001; Williamson et al., 2003). While SDI is an innovative concept, ambiguity surrounding the concept (Chan et al., 2001; Rajabifard et al., 2000) and the lack of a unified definition has caused fragmentation in identities and nature of SDI as stakeholders pursued different goals (Rajabifard and Williamson, 2001), hampered its ability to evolve with the demands of technical and user environments, and failed to win the willing support of stakeholders (Rajabifard et al., 2000). This situation remains as the most serious challenge to the future development of SDI (Chan et al., 2001), since this contributes to the lack of a clear and comprehensive understanding of the concept by different stakeholders, whether in academia, different levels of government, business (Rajabifard and Williamson, 2001; Williamson et al., 2006), and even within the spatial data industry (Coleman and McLaughlin, 1998). This variety in views of SDI is perhaps reflected in the diverse forms in which it has developed (Masser, 1999). Therefore, it is essential to systematically classify and organise these diverse definitions and dimensions of SDI.

Table 2.1 presents the many definitions of SDI, and also highlights the common elements, such as data, people, access mechanisms, standards and policies, in addition to the need for sharing data and collaboration (Groot and McLaughlin, 2000; Rajabifard and Williamson, 2001; Williamson et al., 2006).

Table 2.1 SDI Definitions according to different sources

Reference (source)	Definition of SDI
Nebert (2004)	SDI denotes the relevant base collection of technologies, policies and institutional arrangements that facilitate the availability of and access to spatial data. The SDI provides a basis for spatial data discovery, evaluation, and application for users and providers within all levels of government, the commercial sector, the non-profit sector, academia and by citizens in general.
Clinton (1994)	NSDI defines as technology, policies, standards and human resources necessary to acquire, process, store, distribute and improve utilisation of geospatial data.

Radwan and Paresi (1995)	SDI is a set of institutional, technical and economic arrangements to enhance the availability, reliability and accessibility of correct, up-to-date, to-the-point and integrated geo-information, timely and at an affordable price to support decision-making processes related to a country's sustainable development.
FGDC (2010)	The U.S. Federal Geographic Committee defines SDI as a set of individuals, organisations, technologies and spatial data integrated to facilitate development and dissemination of spatial data and use of geographic information technologies.
INSPIRE (2003)	The relevant base of technologies, policies and institutional arrangements that facilitate the availability of and access to spatial data. Equivalent to Infrastructure for Spatial Information.
ANZLIC (2010)	The Australian Spatial Data Infrastructure comprises a distributed network of databases, linked by common policies, standards and protocols to ensure compatibility.
Coleman and McLaughlin (1998)	A Global Geospatial Data Infrastructure encompasses the policies, technologies, standards and human resources necessary for the effective collection, management, access, delivery and utilization of geospatial data in a global community.
Groot and McLaughlin (2000)	SDI encompasses the networked geospatial databases and data handling facilities, the complex of institutional, organisational, technological, human and economic resources which interact with one another and underpin the design, implementation and maintenance of mechanisms facilitating the sharing, access to, and responsible use of geospatial data at an affordable cost for a specific application domain or enterprise.
Rajabifard and Williamson (2001)	Viewing the core components of SDI as policy, access network, technical standards, people (including partnerships) and data, different categories can be formed based on the different nature of their interactions within the SDI framework.
Masser (1998a)	The National Geographic Information Infrastructure is a collection of policy, data sets, standards, technology (hardware, software and electronic communications) and knowledge providing a user with the geographic information needed to carry out a task.
CGDI (2010)	The Canadian Geospatial Data Infrastructure (CGDI) is the technology, standards, access systems and protocols necessary to harmonize all of Canada's geospatial data bases, and make them available on the internet.

2.6.2 SDI Components

Carbo (1997) identified a number of elements, which constituted an information infrastructure (discussed in section 2.6.1). Table 2.1 included these elements as proposed by a number of authors.

There are a significant number of SDI models applied around the world, and their common non-discrete components are briefly presented in Table 2.2. These models include NSDI in the US (FGDC, 2010), the Dutch National Geographic Information Infrastructure (Van Loenen and Kok, 2002), Asia-Pacific SDI (Holland et al., 2001) and ASDI in Australia and New Zealand (ANZLIC, 2010).

Table 2.2 Component elements of SDI (Source: Warnest et al., 2003)

Data	Fundamental datasets are themes of spatial data regarded as primary in supporting the key functions of a country or jurisdiction, providing the common spatial reference and context which underpins many other forms of business information. An individual agency may consider fundamental data in terms of the most important strategic spatial data that supports its business functions and processes. Themes commonly considered fundamental can include geodetic control, cadastre, administrative boundaries, geographic names and localities, street address, transportation, elevation, hydrology and orthophoto imagery. The list is not definitive and is dependent on the priorities of the responsible agency within each jurisdiction.
People	Includes the users, providers, administrators and custodians of spatial data and also value-added re-sellers. Users can be corporate, small or large business or individuals, public or private. The broad application of SDI beyond the traditional mapping and land administration role means users and administrators of spatial data have very different qualifications and professional backgrounds.
Institutional Framework	Includes the administration, coordination, policy and legislation components of an SDI. The institutional framework is reliant on successful partnerships and communication between agencies within and between jurisdictions.
Standards	Consistent standards and policy are required to enable the sharing, integration and distribution of spatial data; hence standards for data models, metadata, transfer and interoperability of storage and analysis software. Policy particularly needs to be consistent for the pricing and access to spatial data within and between jurisdictions.
Technology	Consists of the access and distribution networks, clearinghouse and other means for getting the spatial data or datasets to the users. Technology also involves the acquisition, storage, integration, maintenance, and enhancement of spatial data.

Strong relationships, and in cases overlap, exist between these SDI components and attributes, yet they are not unique in influencing SDI development. Moreover, together they do not constitute a fully structured model, but are classified to help study and discussion in order to determine the institutional factors affecting SDI collaboration.

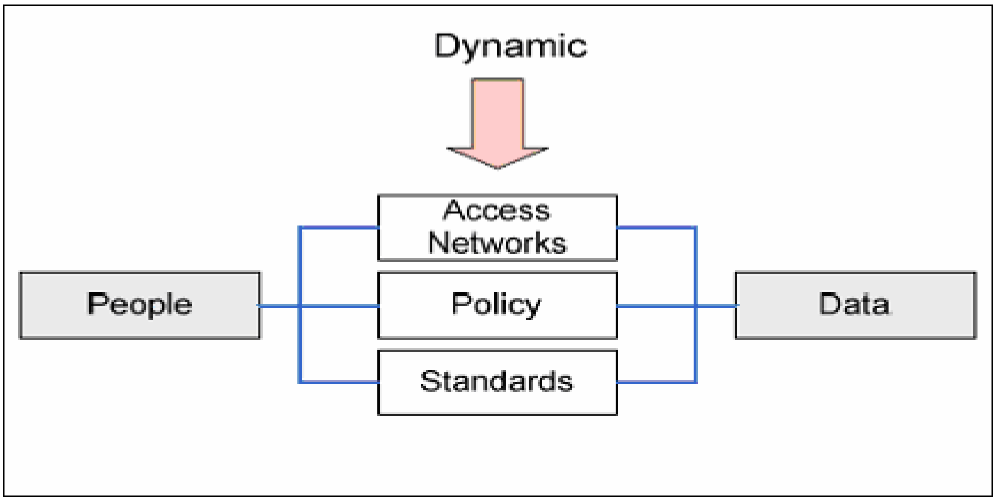


Figure 2.5 SDI components: nature and relationships (Source: Williamson et al., 2003)

The dynamic technological SDI components, comprising access network, policy and standards, control the interaction of people with data, according to Rajabifard and Williamson (2001). They proposed that the relationship is dynamic due to the steady advances in technology, as well as the evolving nature of user needs and expectations. First generation SDI frameworks were built on the components model shown in figure 2.5, and were focused on delivering products as the output. However, in later SDI framework generations, collaboration has been greatly emphasized, particularly at national level (Warnest et al., 2003; McDougall et al., 2005). SDI development is now based on sharing spatial data through formal mechanisms of collaboration, which clearly document the SDI component of institutional arrangements.

Spatial data, value-added services and end-users are not the unique constituents of an SDI framework, but are joined by interoperability, policies and networks as influential factors (Williamson et al., 2003; Williamson et al., 2006). The above reflects the rather older idea of an SDI being only about interoperability and provision of data whereas modern architectures for SDI, supported by OGC standards, increasingly sees SDI as interoperability of service components as well as data which can be chained together (e.g. using Business Process Execution Language or BPEL) to provide a wide diversity of powerful applications to be rapidly created from the multiple discrete data and service sources.

2.6.2.1 Data

Spatial data is the principal component in an SDI, and as such, fundamental or core datasets exist within all NSDI models. A fundamental dataset is defined as "*a dataset which more than one government agency requires consistent national coverage in order to achieve their objectives*" (ANZLIC, 2010). In the framework approach taken by FGDC in the USA, seven spatial data themes are used. Accordingly,

> "*The framework represents 'data you can trust' the best available data for an area, certified, standardised, and described according to a common standard. It provides a foundation on which organisations can build by adding their own detail and compiling other datasets*" (FGDC, 2010)

Fundamental or core data has been defined in a number of ways, yet specific datasets are seen to be fundamental within an SDI, for example, geodetic control. This key dataset is essential as it gives a spatial reference to any position with respect to specified vertical and horizontal datums, and assures a specified level of quality as appropriate to SDI datasets (Ryttersgaard, 2001).

The best of use of spatial data can be achieved through provision of metadata with clear instructions explaining the limitations and potential of the data available. Moreover, systems for accessing and distributing spatial data must be both efficient and user-friendly.

The choice of spatial data themes to be included in the fundamental datasets was based on a survey questionnaire circulated to a large sample of spatial data practitioners in the USA by the National Center for Geographic Information and Analysis (NCGIA) on behalf of the Federal Geographic Data Committee (FGDC). This allowed the most commonly used, and most demanded spatial data to be isolated from the large amount available, and thus collected by specific stakeholders and added into ‘core’ or ‘fundamental’ datasets (Frank et al., 1995). These fundamental datasets would be put in the public domain within the NSDI, and so realise significant cost, and time, savings to all stakeholders, as well as benefiting the US economy.

The survey of spatial data practitioners in the USA helped substantially in the development of the US NSDI initiative. Fundamental datasets, seven in all, make up the framework, which includes the guidelines and procedures needed to ensure integration and sharing of data, and that regulate relationships between stakeholders, and describe business practice aimed at appropriate measures to promote use, and assure maintenance of the spatial data (FGDC, 2010).

In Canada, fundamental datasets constitute the core of the Canadian Geospatial Data Infrastructure (CGDI). The fundamental data is called framework data in CGDI, and is made up of spatial data, which describes the Canadian context and gives reference information, in continuous and integrated form (GeoConnections, 2010). CGDI is built on a distribution node model, in which spatial data is created, provided, distributed, and maintained by various stakeholders. Fundamental data within CGDI is distinct compared to other NSDIs, in that it has additional identification and is resolved into regional or national spatial data. Spatial data at national resolution level is supplied by federal bodies, and typically comprises different demographic, environmental and physical themes, which are integrated with the Atlas of Canada-maintained 1:1M hydro base. The themes include Geodetic Reference System, elevation, imagery, national, provincial, municipal and electoral boundaries, road and transportation network, power transmission network, hydrography, parks, Indian reserves, defence and national security zones, toponymy, and structures (GeoConnections, 2010). Regional resolution spatial data is collected and provided by federal, provincial, and municipal level organisations, and as such a range of accuracies, 250 to 1 metres. The CGDI fundamental datasets are products of partnership between spatial data producers and resellers, covering the whole country, and at levels of detail appropriate for many different applications (GeoConnections, 2010).

Spatial data takes many forms, of which the commonest are raster and vector data, imagery, and digital photographs, grids, and triangulated irregular networks (TINs) (Frank et al., 1995):

- Vector data comprises geographic features defined in terms of geometry as point, line or polygon data, i.e. nodes, edges, or surfaces.
- Raster data comprises data in the form of normal or average geographic value at the nodes of each part of a space subdivided in regular rectangular patterns.
- Digital photographs comprise the pixel data defining geographical areas, such as digital orthophotos.
- Imagery comprises the pixel data as acquired by multi band sensors, such as images taken by Landsat, AHVRR, and SPOT.
- Grids comprise data on elevation collected on a pattern of squares or rectangles.
- Triangulated irregular networks (TINs) comprise data on elevation collected on irregular patterns; typically in areas of significant elevation change.

In addition, metadata may be considered a special kind of spatial data within an NSDI, but is best discussed with standards, with respect to facilitating access and dissemination of spatial data.

2.6.2.2 People

A wide range of stakeholders across various jurisdictions are involved in SDI at its different levels, whether international, national, or local, etc., including the private sector and end-users. Therefore, it is vital to classify stakeholders by organisation spatial data functions and business processes, spatial data requirements or provision, and the type of spatial data and activity flows that can be realised among these participating organisations (Nebert, 2004). This step allows a 'community' SDI initiative to be implemented to properly define collaboration opportunities, and the costs, savings and benefits that result in the wider context.

Management of spatial data requires the concept of custodianship, where authoritative sources of spatial data and services are identified, thus ensuring proper accountability, and from the user perspective, a degree of certainty and consistency, while assuring efforts are not duplicated. This concept of taking responsibility for spatial data, on behalf of others, is needed to create a robust SDI, allowing spatial data products to be created, acquired, and managed in a consistent manner (Thompson et al., 2003). Bodies chosen to act as spatial data custodians or ‘providers” act as trustees for the spatial data community, who integrate spatial data and products in collaboration with all the stakeholders, whether providers at national, regional, and local levels, or users. Therefore, spatial data custodianship concentrates responsibility at one body for all data and products needed by users, with the assurance of data possessing integrity, precision currency, and completeness (Thompson et al., 2003).

While SDI efforts in the past were mainly provider-driven, a significant change has occurred at the same time as the move to a digital environment. Given the fundamental business case of an SDI existing to meet user needs, SDI development has moved in the direction of being user-driven, and user-focused (Williamson et al., 2003).

2.6.2.3 Institutional framework

Traditionally, a central government monopoly existed in the area of mapping; a situation perpetuated over centuries. Thus, government mapping bodies exclusively undertook spatial data collection and distribution. This has had significant impact in modern SDI development, and spatial data management (Nebert, 2004).

Development of an SDI was at first conceived to be principally or solely the role of government (Williamson et al., 2003). However, as national datasets were accomplished, the private sector emerged with an increasing role in collecting, supplying, and maintaining spatial data and services. Thus the evolving roles of public and private sectors saw the former focused on developing the framework and policies, and adopting the role of coordinator and facilitator, while the private sector and wider spatial data community took over service provision, and other non-core activities (ANZLIC, 2010).

In a process of economic reform and rationalisation, mapping and land administration departments were downsized dramatically. The arrival of digitalisation and wide acceptance of GIS led to cadastral, transportation, and topographic dataset development. Yet, to a large extent government functions related to spatial data remained fragmented and processes mainly based on non-digital workflows. Through the 1990s, fundamental datasets were integrated into single, national cadastral databases with supporting Land Information Systems (LIS), at the same time attempting to involve the various bodies in collaborative effort (Chan & Williamson, 1999; Williamson et al., 1998). However, spatial data activity remained fragmented, where the various government bodies collected and maintained spatial data within their own databases to suit their activities, ranging from management of mineral resources and the environment to agriculture. Consequently, a unified approach across all government jurisdictions was needed to achieve a consistent framework consisting of spatial data standards, policies, and specific processes for collection, maintenance and distribution.

As an enabling factor, e-government initiatives have led to greater coordination among government bodies, facilitated by public sector bodies tasked with the same. Such e-government initiatives have ensured that common business processes and reusable services were identified, along with channels of digital information exchange between the bodies concerned. Moreover, this has happened within a new focus of satisfying citizens', commercial clients', and government users' needs (Nebert, 2004).

The traditional monopolies with regard to mapping had arisen due to the huge costs involved in collecting spatial data and translating it into map products, over time scales, which at times would span decades. Maps were principally not for the benefit of consumers but were linked to government functions in ensuring national security, conducting censuses, collecting tax, and carrying out national planning and development activity (Nebert, 2004). As such, spatial data types and formats were dicated by such uses, and so the common products that resulted were 1:100 to 1:5,000 scale cadastral maps, large 1:500 to 1:20,000 scale urban planning and development topographic maps, small to medium scale, 1:50,000 to 1:100,000, state topographic or 'base maps', and small scale 1:100,000 to 1: 250,000 national maps.

These maps became a common reference, and were derived from existing spatial data themes and applications, which were needed at regional, federal, state, and local jurisdictions. Furthermore, there are common needs across state jurisdictions in countries with a federal model of government, which meant that mapping products were basically interoperable across national administrative boundaries. The arrival of GIS was a significant advance in spatial data use, types, and nature, with the provision of a variety of spatial data products and services. This meant higher levels of accessibility, and functionality, such that end-users anywhere could create maps to suit their needs from their desktop using GIS, satellite imagery, GPS surveying, scanning and sophisticated software applications (Nebert, 2004).

Within this new environment, spatial data custodian bodies were involved in the essential tasks of developing the appropriate license and price arrangements and policies for the SDI institutional framework. Such measures are important in protecting the intellectual property, commercial, and legal rights of spatial data users and providers, and must be balanced with obligations to serve the community, promoting development of the spatial data industry, and making sure that price does not present an obstacle to use of spatial data. The management, and reduction, of risk associated with spatial data use is achieved by developing appropriate terms and conditions, and licensing arrangements (Thompson et al., 2003).

2.6.2.4 Standards

Spatial data standards are claimed to represent a key component in SDI development. The existence of standards, in particular international standards, facilitates discovery, exchange, and use of spatial data across the world.

A vital element allowing spatial data to be described, and products to be shared, is provided by technical standards. Such standards are developed with the aim of facilitating access, and contributing to greater integration and data quality, and include systems of reference, models for data, specifications relating to data quality, transfer protocols, and importantly, metadata (Eagleson & Escobar, 2003). While early standards focused on the spatial data delivery aspect, currently evolving standards grant greater emphasis to the user side with respect to access to spatial data, and so involving software and data exchange protocol interoperability. Development of standards is being undertaken by industry bodies and international standards organisations, such as International Organisation for Standardisation (ISO), Open GIS Consortium (OGC), Worldwide Web Consortium (W3C) and national coordination bodies in various countries. The aim of these efforts is to provide standards, schema, and specifications enabling spatial data sources to communicate effectively and ensure that diverse users enjoy access to the SDI.

2.6.2.5 Technology

In the area of spatial data, technology provides various opportunities, but at the same time, is not without challenges and limitations, in terms of how spatial data is collected, used, managed, and disseminated. The technical architecture of an SDI represents its physical nature and features, comprising clearinghouses, networks facilitating access and distribution, and whatever means that enables access to spatial data is granted to end-users. The main technical concepts relating to development of an SDI are presented in the following discussion, and as such it will be seen that SDI is not only a matter of housing all spatial data in one place in a central repository or server. The advances in ICT have allowed an SDI to be deployed in the form of a distributed network, where a huge amount of spatial data is held on remote servers. In this form, access is not limited by geographical location, but by access to the Internet, and bandwidth considerations.

In the context of SDI, the technology aspect involves standards, clearinghouses, and metadata. A clearinghouse is defined as "*a decentralised system of servers located on the*

Internet which contain field-level descriptions of available digital spatial data" (FGDC, 2010). As such, it represents a digital facility comprising a number of servers on the Internet, where spatial data acquired from various sources may be advertised, as well as made available to be searched, viewed, transferred, ordered, and distributed (Crompvoets & Bregt, 2003). Spatial data discovery, search and access is facilitated using metadata, which has a standard format, and describes the available spatial data. Metadata in standard form allows querying of spatial data held by all the bodies in an SDI. Therefore, a clearinghouse can be thought of as a large shopping centre where spatial data from participating suppliers is available to users (Crompvoets & Bregt, 2003).

In SDI development, the conceptual model based on a distributed network offers a robust and valid type of SDI technical component. Moreover, it is equally valid, regardless of whether it utilises a clearinghouse or not. In a simple illustration, an SDI may be thought of as a collection of rules and responsibilities applied to a cabinet with maps filed in it. In this scenario, responsibility for updating these maps, access policy to the maps cabinet, and price of maps is clearly defined. An SDI utilising a clearinghouse allows users access to spatial data at anytime, anywhere, and allows them to make informed decisions about suitability of the spatial data to their application before ordering or downloading it.

An example of a clearinghouse within an NSDI is that maintained by FGDC (located at http://www.fgdc.gov/clearinghouse/ clearinghouse.html) cataloguing national spatial data. The clearinghouse is built on Internet technology and uses the ANSI Z39.50-1995 (ISO 10163-1995) search and retrieve protocol, originally developed for bibliographic records of library holdings, and comprising a client and server software application. Spatial data on the clearinghouse may be queried, and searched, with the search results being presented to the Web client in any number of formats (FGDC, 2010). Node is the name given to a clearinghouse site in the network, consisting of host servers. Each node is expected to have links (hypertext) in the metadata records for direct download of spatial data in a particular format. If the spatial dataset cannot be downloaded directly due to size, details of the body holding the data is given, and the data may then be requested directly on appropriate storage media. As such, a directory listing spatial data providers is also available (FGDC, 2010).

The distributed network concept of SDI involves more than a metadata registry facilitating access to spatial data, which is searchable, and can be queried, and viewed, printed or downloaded in raster or vector format. The distributed network concept requires implementation of various protocols and standards for data exchange from the ISO TC211 geographic information working group, Open GIS Consortium (OGC) (see Figure 2.6), and Worldwide Web Consortium (W3C) (ANZLIC, 2010).

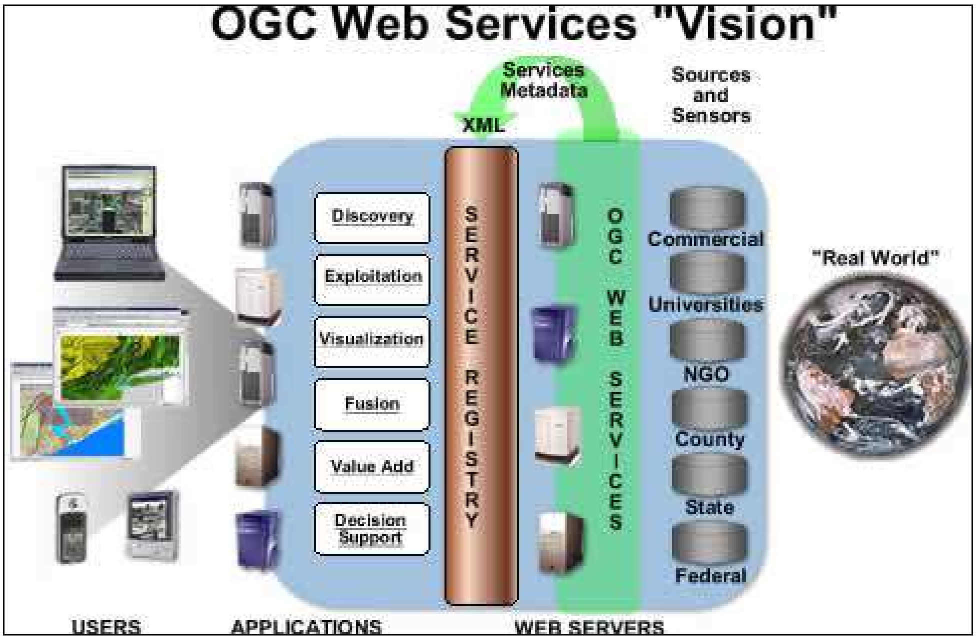


Figure 2.6 OGC Web Services (Source: OGC, 2010)

Therefore, in an SDI implementation, the clearinghouse is a powerful means to enable collaboration among stakeholders in making their spatial data available. In this implementation, servers can be located at any jurisdictional level, and configured as "peers" in the network without a hierarchy, and so users may query individual servers directly with negligible transactional processing (FGDC, 2010).

The next generation of technology underpinning clearinghouses is also being developed by OGC and others. These would replace the traditional "query" and then "retrieve" a graphics file via Web Mapping Services. In contrast, the same image would be assembled locally on the user's desktop through a small file with an instruction set downloaded via Web Feature Services. This would significantly reduce the bandwidth and communication capacity requirements, as large files need no longer be downloaded.

In this context, clients are distinct from distributed systems, in that: thin clients require other components to service requests, for them to function. The components may be servers, or middleware. Thick clients, in contrast, do not need other components to manage and handle data and metadata, and computations, but do so themselves. In this case, thick clients issue low-level data-access requests to acquire inputs they need.

Both thin and thick clients offer alternative advantages, where thin clients are normally configured with little RAM and low power CPUs requiring simple software providing limited flexibility and functionality, for example handheld devices and mobiles. Such a thin client is easily built, and can be simply embedded with general-purpose software components. In contrast, thick clients leverage significant power allowing them to process data retrieved from servers or server-side components, which consequently do not need much functionality (OGC, 2010).

These advances in Internet technology and services are influencing SDI development for the future. SDI is now being employed to cater for growing demand in provision of consumer location services through mobile devices, navigation systems, etc. SDI must also satisfy the need of communities for a robust system that promotes economic, and social development as well as safeguarding the environment.

2.6.3 Hierarchical Nature of SDI

Hierarchical structures exist nearly everywhere in nature and the man-made environment, e.g. taxonomies, organisations, databases, political systems and government, and parent-child human relationships. The properties of hierarchical systems include simplicity and complexity, upper and lower levels, and nested systems that diminish in strength; these properties have been adapted in some spatial data applications (Eagleson et al., 2002). In addition, great similarity can be seen between SDI development and that of political and administrative systems (Chan and Williamson, 1999). The hierarchy of SDI systems can be seen in a top down umbrella view, or a bottom up building block view (Rajabifard et al., 2000; Williamson et al., 2003).

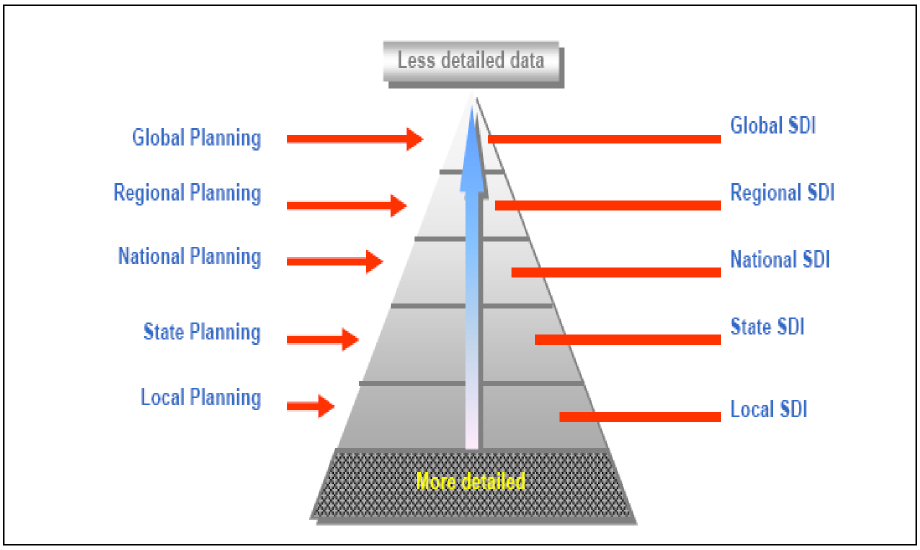


Figure 2.7 Degree of detail in data related to different SDI and planning levels (Source: Rajabifard et al., 2002)

Referring to Figure 2.7, Rajabifard et al. (2002) present a view of the various levels of SDI and their relationships, including data flows. More detailed information is gathered at state and local level for the purpose of delivering services and planning.

The hierarchical structure applied to SDI is important in developing consistent structures to hold data or databases, yet development and implementation are not appreciably affected by its absence (Masser, 2005). In practice, a national or federal body may elect to deal with the local level, short-circuiting the state level. Hierarchy in SDI is well understood in the relationships of administrative and political levels (Rajabifard et al., 2000; Williamson et al., 2003).

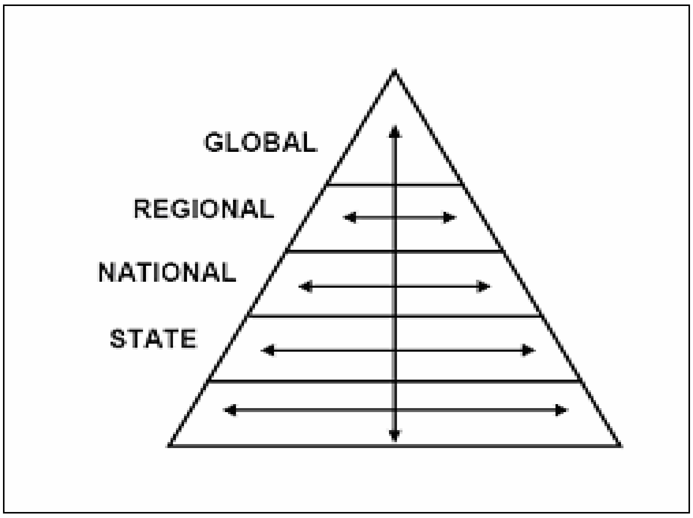
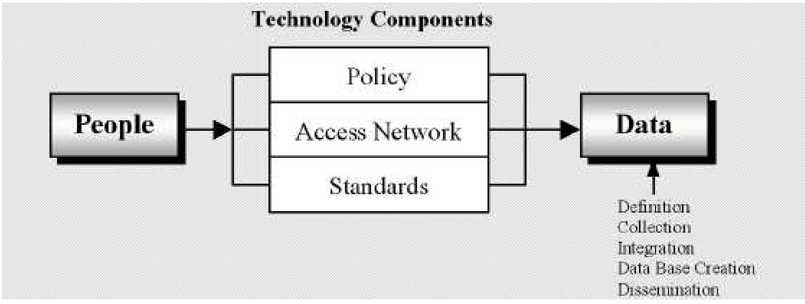


Figure 2.8 Hierarchy of SDI collaboration (Source: Rajabifard et al., 2000)

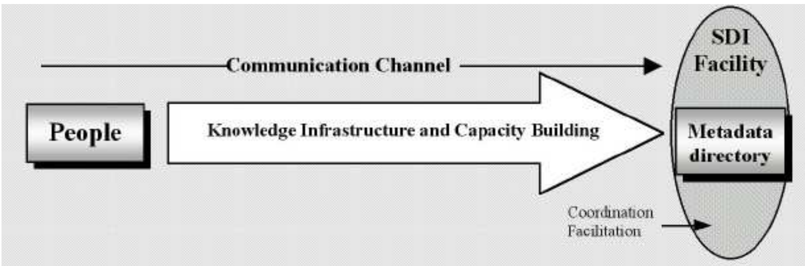
Figure 2.8 illustrates the complexity of the relationships, vertical and horizontal, tying these levels in SDI. The importance of such SDI hierarchy relationships lies in the sharing and flow of data and information that arise from collaboration between political/administrative levels. This view of collaboration can then be reflected in analysis of similar complex relationships between the public and private sector, as well as the individual stakeholder organizations involved in the SDI. However, this level of detail and complexity is beyond the scope of Figure 2.7, from which a lower ‘corporate’ level is notably absent.

2.6.4 Product-Based and Process-Based SDI models

Since SDI may be seen as an innovation, which results in different views of what an SDI is, and derived from this difference in views, different models result. As such, SDI development may be viewed from two main perspectives, namely product-based or process-based (Rajabifard et al., 2002). A product-based model of SDI development assumes a project-oriented approach with a focus on outcomes and achieving goals within the context of technical solutions. In contrast, a process-based approach is focused on development of spatial activity and data management systems, procedures and processes.



A) Product-Based Model



B) Process-Based Model

Figure 2.9 Product- and process-based SDI models (Source: Rajabifard et al., 2002)

These two perspectives or theories in the development of SDI are identifiable by looking at SDI initiatives with respect to their strategies, aims, objectives, and status at the various levels (Rajabifard et al., 2002). The product-based or process-based SDI development theories are illustrated in Figure 2.9a and 2.9b respectively. In the first model, a core aim of SDI developed according to the product-based approach is to connect all the spatial data databases at all political or administrative jurisdictions. In the other model, an SDI developed according to the process-based approach has as its key aim to properly define the framework within which spatial data assets and resources can be managed effectively. The emphasis, therefore, is to achieve good communication pathways for sharing within the spatial data community of stakeholders, and not merely to technically link databases. This view encapsulates the nature of an SDI as comprising technical and social aspects.

2.7 Summary

It is recognised that government policy and decisions are vitally supported by SDI, which contributes greatly to satisfying national social, economic and environmental needs and aspirations. Yet, even though the key nature of SDI is agreed, contrasting views exist regarding its nature and characteristics, and how best to ensure progress in this respect. While significant progress is being made in the technical or technological aspects of SDI, as well as in the area of standards, the management and institutional aspects of SDI have been somewhat ignored. By nature, SDI relies on multi-level, multi-jurisdictional interactions of great breadth and complexity between all stakeholders from all sectors; it brings together the public and private sectors, academia, and wider society. Management of such a diverse and wide-ranging stakeholder base falls to the public and private sectors, which represent the main spatial data producers and users.

This chapter has given the necessary background to SDI, including historical development. It has explained the concepts underlying spatial data and information, and presented information considered as infrastructure. SDI makes a powerful support to decision-making, especially when linked to e-government. SDI definitions, concepts, components, and hierarchical nature were also discussed.

The following chapter looks at NSDI and collaboration, generally, with respect to the different jurisdictions, sectors, and stakeholders. It gives a description of NSDI, and explores its nature, benefits, and organisational linkages. Collaboration is also explored in terms of the necessary inter-, and intra-organisational relationships. It also looks at the potential of new technologies to bring greater inclusiveness to NSDI models.

CHAPTER 3: NSDI AND COLLABORATION

3.1 Nature of NSDI

The hierarchical view of SDI illustrates that the relationships, both vertical and horizontal, between SDI stakeholders underpin the mutual dependence of the political and administrative levels. This research studies these relationships, principally the horizontal relationships, and how they affect NSDI. Williamson et al. (2003) argue that such horizontal relationships have not been properly addressed in the application of hierarchical spatial reasoning (HSR) to SDI. Moreover, while there is agreement on the constituents of SDI, the view of SDI at the national level is still inconsistent. At country level, ambiguity surrounds who is responsible for developing and managing NSDI. In the hierarchical view, whether NSDI is solely about national level actions of executive government, or whether it refers to the totality of contributions of all SDI stakeholders at all levels, is discussed in the literature. The whole view of NSDI, in terms of bottom-up and top-down contributions, is reflected by the Building Block and Umbrella views respectively (Rajabifard et al., 2000). In this sense, a useful definition is expressed in the 1994 Executive order by President Clinton, where:

> "*National Spatial Data Infrastructure means the technology, policies, standards, and human resources necessary to acquire, process, store, distribute, and improve utilization of geospatial data*" (Clinton, 1994)

In practice, developing NSDI is a challenging undertaking due to misconceptions surrounding the term, as mentioned in part previously. For example, in the US different views of NSDI are represented in different levels of the hierarchy (Harvey & Tulloch, 2006). At federal level, the agencies responsible for spatial data sharing view NSDI as the natural extension of their traditional mandate as custodians of spatial datasets to create consistent spatial data layers across a national hierarchy, while the local agency level considers that the proper approach would be to ensure greater resolution and more up-to-date spatial data in important locations, such as urban or environmentally sensitive areas (Tosta, 1999). This inconsistency in practice can be traced back to the wide variety of interpretations assigned to NSDI by stakeholders in different levels of the SDI hierarchy (Rhind, 1997). Inconsistent understanding of NSDI affects actions and therefore outcomes (Tosta, 1999), and so there is a need to develop SDI vision and a strategy for implementation (Cetl et al., 2009).

The notion exists that NSDI is a continuum, and so different countries may be found at different points on this continuum (Williamson et al., 2003; Cetl et al., 2009). There are countries leading in NSDI development, while others, mainly in the developing world, that are either only beginning to consider it, or confronting issues of capacity, and institutional and stakeholder relationships (Cetl et al., 2009). The difficulties facing KSA in this regard are presented in Section 8.9.4 (pp.194-199), based on the data gathered in this work. NSDI consists of a number of key elements: people, policy and technology, which by nature provoke conflicting perspectives.

Strategy, in contrast to infrastructure, consists of policy and institutional components that guide infrastructural development; properly applied NSDI strategy leads to continuous improvement and roadmap to the future. Yet, it is both national strategy and physical and non-physical infrastructure that bind a country's NSDI. In addition, NSDI concerns managing assets comprising spatial datasets and a portfolio of SI assets distributed nationally (Masser, 1998b; Williamson et al., 2006). National land and mapping agencies spearheaded first generation NSDI efforts, and dealt with cadastral and mapping information overlaid with census data (Masser, 1998a). This created a government-centric approach to NSDI. However, system of governance, and the allocation of responsibilities and actions, dictates the nature of NSDI development. There were significant differences between countries according to whether they were centralised or federal systems. This is reflected in Table 3.1 below from Masser (1998b) illustrates these differences and also the greater complexity in coordination as more levels/stakeholders are involved.

Table 3.1 A sample of NSDI strategy countries: responsibilities of each government level (Source: Masser, 1998b)

	Britain (incl. Wales)	**Netherlands**	**Australia**	**United States of America**
Central Government	Land titles registration, small and large-scale mapping, statistical data	Land titles registration, small and large-scale mapping, statistical data	Some small-scale mapping, statistical data	Small-scale mapping, statistical data
State/territory Government	N/A	N/A	Land titles registration, smalland large-scale mapping	Some land titles registration and small- and largescale mapping
Local government	None	Some large-scale mapping, population registers	Some large-scale mapping	Land titles registration, largescale mapping

In centralised government systems, the government assumes sole responsibility, while in a federal system contributions come from state and local government levels as well (Masser, 1998b). However, it is increasingly common nowadays for the private sector to have responsibility for what in the past was that of public mapping agencies. Moreover, overall responsibility for NSDI may be devolved from government, whether federal or central, to another entity. While first generation SDI involved land and mapping agencies as the prime, and sometimes sole, stakeholders, NSDI has now evolved to include a wide range of stakeholders.

Interestingly, Warnest et al. (2005) undertook studies of NSDI in Australia, from which a model for collaboration emerged. This model was stated to be applicable to countries with a federal system of government (Warnest et al., 2005). In terms of the present research focused on the monarchical and centralised system in KSA, it would be beneficial to explore the extent to which such a model could be applicable, if at all.

3.1.1 Benefits of NSDI

There are many benefits to be gained from an NSDI in many spheres, including the economy, environment, policy and planning, disaster management, and defence. In these areas, the availability of spatial data on a national infrastructural scale is crucial (Warnest, 2005). In fact, spatial data is now of such importance in a wide variety of activities and across disciplines that its impact is of huge significance in monetary terms, employee satisfaction terms, organisational improvement, creating new business services, and implications on transparency measures and greater openness yielding wider community participation in processes of governance (European Commission, 2006). In the developing world, NSDI is expected to help address issues critically affecting communities, such as HIV/AIDS, and food shortage (SADC, 2004b), as well as land use policy, and environmental information and decision-making (SADC, 2004a). Given the highly publicised and large-scale natural disasters recently, Hurricane Katrina, the Sichuan and Haiti earthquakes, the Indonesian and Japanese tsunamis, and large-scale flooding in Pakistan, and many other areas of the world, this is an area of crucial importance where NSDI promises to deliver tangible benefits. In time critical circumstances, NSDI can support collaborative decision-making for effective management of emergencies, e.g. through hazard mapping and more accurate representation of the situation (Rauschert et al., 2002), and also preparedeness for disasters (Farthing, 2010). An example of GIS in action comprised crowd-sourced online mapping, in the aftermath of the earthquake in Haiti in January 2010, where an OSM solution was used to map out emergency routes in the disaster zone in a collaborative effort by volunteers worldwide over a few days (Neis et al., 2010; Zook et al., 2010). The importance attached to this aspect has led the US to spend over $2.1 billion on emergency management measures in 2003 alone (NEMA, 2004). However, the scope for NSDI is not limited to the immediate needs of disaster relief and rescue efforts, but continues beyond that into the complex stages of planning recovery, and engaging in reconstruction, and recurrence prevention measures (Cutter, 2003). In this context, NSDI provides spatial data in a searchable and accurate form, and delivers it rapidly to address the incident in its location (Goodchild, 2003b).

In addition, NSDI is key to information regarding national infrastructure, including water sources, energy infrastructure, communications and transport, as well as digital information networks (Kelmelis & Loomer, 2003). Disruption to such infrastructure can have serious and potentially damaging long-term effects. Therefore, NSDI properly guides planning and implementation of measures to effectively guard against any eventuality affecting critical infrastructure.

In conclusion, the literature quantifying the benefits of NSDI is still evolving, as evidenced from European Commission (2006). The gains from NSDI can be assigned to areas of economic, social and environmental importance, event management, reduction in duplication, cost-savings due to ready availability of information for protection of infrastructure and disaster management, sustainable development and improved government policy-, and decision-making (Warnest, 2005).

3.1.2 Coordination of NSDI

By its nature, NSDI involves a diverse range of stakeholders, and as such presents a significant challenge in achieving proper integration and coordination. In the context of this study, a relevant research question is: …*how is executive responsibility mapped between the stakeholders? and who is responsible for NSDI overall?*

In management of NSDI, a number of choices are available: the central or top down approach enacted either by a centralised or federal government system, a non-governmental body with overall control, or a distributed effort of many aligned by a shared vision, aims, and interoperable standards (Tosta, 1999). The choice in many cases has been decided by the nature of the political system in place, and the definition of NSDI and perception adopted (Warnest, 2005). In many instances, independent bodies have been formally tasked with NSDI coordination (Masser, 1998b), and indeed umbrella organisations have maintained consistency by assuming this role at both national, and regional levels. Moreover, this has afforded scope for involvement of the private sector, perhaps in the form of public-private partnerships (PPP) (Murray, 2007). An example of effort to achieve a coordinated development of SDI, INSPIRE is a legislated framework for pan-European SDI (Murray, 2007).

3.2 Nature of Organisational Collaboration

A number of sources can be found related to collaboration between organisations, its forms, motives, risks, benefits, and determinants of success, etc., reflecting a wealth of approaches and ideas. In the area of spatial information, forms of collaboration such as multi-partner projects (Grant & Roeberge, 2001; Jacoby et al., 2002) have been studied. In recent years, collaboration transaction cost has fallen significantly, which can only serve to encourage greater organisational collaboration (Lank, 2006). Moreover, collaboration has become a feature of inter-organisational relationships (Child et al., 2005), and described by a variety of terms, such as partnership, network, coalition, alliance, association, co-operative, community, collective, forum, and consortium (Lank, 2006). Yet, it is notable that collaboration between organisations has been observed to be a product of necessity, provoked by "resource scarcity" or "performance distress" (Schermerhorn, 1975). In the development of NSDI, the diverse activities and stakeholders will ultimately lead to as diverse a set of forms of collaboration.

3.2.1 Defining Collaboration

Oxford University Press (2001, p.161) defines "collaborate" as "*work jointly on an activity or project*"; also to "*band together, **cooperate**, join forces;* informal: *pull together, team up, work together*", and collaboration as "*association, concerted effort, **cooperation**, **partnership**, tandem, teamwork*". Similarly, cooperate is defined as "*work together towards the same end*"; also to, "*act in concert, collaborate, combine, conspire, help each other*". While cooperation is given as "*assistance, collaboration, cooperative effort, **coordination**, help, joint action, mutual support, teamwork*. Opposites: ***competition***". Coordinate is given as "**1** *bring the different elements of (a complex activity or organisation) into an efficient relationship* **2** *negotiate with (others) in order to work together effectively*" (Oxford University Press, 2001, p.189).

Therefore, collaboration holds significant value to organisational relationships, where terms such as cooperation, partnership, coordination, and competition as an opposite, signify an efficient negotiated working relationship, to achieve an agreed objective in the midst of complexity.

Furthermore, Prefontaine et al. (2000) highlighted collaboration as support that is "reciprocal" and "voluntary" in providing services. Lawrence et al. (2002) included the element of negotiation in a relationship built on constant communication, where neither hierarchy nor market exerted control. While Gray (1989, p.5) described collaboration as a multi-participant process, in which the joint search for solutions takes them "*beyond their own limited vision of what is possible*".

3.2.2 Strategies and Theories of Collaboration

No single theory or approach has emerged to fully explain collaboration between organisations (Child et al., 2005). Attempts have focused on providing a view of collaboration on the basis of economic, organisation, strategic management, and game theories. In economic theory, inter-organisational collaboration has been explored in terms of market power, agency, transaction cost and value, and resource base theories. However, economic theory has been found to fail to account for trust among other elements in collaboration (Child et al., 2005). In a game theory perspective, collaboration is seen to offer better outcomes in the long term than competition and adversarial relationships. Yet game theory can only give satisfactory predictions of outcomes, and is inadequate in accounting for organisations as multi-person entities with all the complex interactions that can occur at the individual and day-to-day level (Axelrod, 1997). In strategic management, the objectives of sharing risk and costs, reducing overheads, and resource dependence motivate collaboration. This necessitates significant effort to properly align the strategic objectives of the collaborating organisations in order for all to achieve their goals (Child et al., 2005). From the view of organisation theory, the structure of the collaboration takes on vital importance, as it maps out the extent of control, dependence, and contribution of participants, as well as the tensions and conflicts that must be negotiated (Child et al., 2005).

3.2.3 Motivation for Collaboration

A number of factors have been proposed as motives for forming a collaborative relationship between organisations. Hence, organisations seek out collaboration in adversity due to resource scarcity or performance stress (Schermerhorn, 1975). In addition to the factor of “necessity”, other factors, such as “asymmetry, reciprocity, efficiency, stability, and legitimacy” are also ruled as essential (Oliver, 1990); especially, where the decision to collaborate is made consciously, and deliberately with clear perspective of its aims and causes (Oliver, 1990).

Collaboration is elaborated on a basis of shared interests and goals, and where a slight loss in control and autonomy has little effect on the organisations concerned. This “reciprocity” is based on exchange theory, in which the collaborators exercise the will to achieve balance, fairness, and are mutually supportive (Oliver, 1990). In seeking to mitigate uncertainty in the surrounding environment, organisations may turn to collaboration; Oliver (1990) refers to this as the “stability contingency”. Uncertainty may be the result of scarce resources, unclear picture of a changing environment, and uncertainty about future trends (Oliver, 1990). The strong interdependence that may exist between and within organisations is a powerful motivator for collaboration and pooled resources. This interdependence may be in areas of information needs and flows, policy-making outcomes, and management of economy or environment (Gray, 1989). Organisations may feel forced to seek to legitimise their existence or actions, and therefore seek out collaborating partners. The issues at stake may be to do with prestige and reputation, or simply to fit in with current fashions (Oliver, 1990). Moreover, collaboration may be the most appropriate answer to a situation where within a single jurisdiction there is significant fragmentation, as in the case discussed by De Vries (2008). In this case, intra- or inter-organisational collaboration allows more consistent and effective structures to be realised (Rogers & Mulford, 1982; Child et al., 2005). Confronting evolving legislative and regulatory pressures may exert overwhelming force on organisations to collaborate (Oliver, 1990). A shortage of resources, whether funds, materials, or manpower, etc. can force organisations to seek collaborating partners, with a view to improve efficiency and cut waste and inefficiencies (Rogers & Mulford, 1982). All these may make collaboration a more attractive proposition for organisations and intra-organisational jurisdictions. In the context of NSDI, collaboration between a range of stakeholders would be critical in ensuring compatibility of spatial information, and protecting and tackling shared interests and concerns, among others (Tait, 2003; Cetl et al., 2009).

3.2.4 Intra- and Inter-Organisational Nature of Collaboration

The existence of shared needs and responsibilities, and common business processes encourage collaboration of stakeholders across sectors, government and communities. This collaborative stance can take the form of communities of learning, which fulfil the need to share knowledge and learning both within and among organisational jurisdictions (Soekijad et al., 2004). Such example of communities of practice, take the form of networks with both dominant and equitable relationships co-existing, both within the same organisation and jurisdiction, and between organisations and jurisdictions (Wenger, 2004). Intra-organisational communities of practice work to bring together important knowledge residing in different parts of the organisation. Personnel networks function to maintain and develop the expertise of those in different parts of the organisation, who share common interests and perhaps activities, whether in temporary or permanent positions. Therefore, such communities cut across functional and administrative jurisdictions to disseminate, develop, and utilise valuable knowledge and expertise to the benefit of the organisation. Moreover, the communities of practice may cut across organisational lines, in an inter-organisational collaborative form, which ensures the benefit of shared knowledge and expertise is available to the parent organisations (Wenger, 2004).

Collaboration both within and between the stakeholders in NSDI is critical for its success (Williamson et al., 2003). Moreover, the horizontal relationships within each SDI level between and within stakeholder organisations are of great importance, as much as the vertical relationships between different levels, yet remains deserving of more attention in the literature. In its implementation, SDI is not bound by administrative or other boundaries, rather it acts as a unifying force bringing together the stakeholders within organisations, and stakeholder organisations themselves (Rajabifard et al., 2000). Collaborative relationships between government, industry, and academia are vital to NSDI, through shared responsibility for maintaining spatial information, defining policy for access, standards, and inter-operability (Tait, 2003). Hence, NSDI should meet the needs and expectations of all its community of stakeholders, and the wider world, where collaboration harmonises policies, approaches, and management issues relating to access, pricing, etc.

3.2.5 Collaboration Structures and Outcomes

The goal of collaboration is to achieve a set of preconceived outcomes for participants, whether quantifiable or not. Benefits gained from collaborating include:

- Gaining broader learning and capabilities, e.g. communities of learning;
- Acquiring a wider variety of resources;
- Reduced exposure to risk and better management of uncertainty, which is shared among collaborating stakeholders;
- Wielding greater influence in the area;
- More effective tackling of issues through a wider, expert base of collaborators (Alter & Hage, 1993).

However, collaboration also introduces risks and does not come without a price. In the context of information resources, a number of interdependencies have been identified: pooled, sequential, or reciprocal (networked) (Kumar & van Dissel, 1996). A pooled interdependency is identified with the risks of: overuse or misuse by one of the collaborators at the expense of the others, low quality contributions, and information or intellectual property theft. Collaborators contribute to, and share resources, while maintaining unit independence. In this mode of collaboration, standards play a critical role to ensure interoperability and sharing (Mulford & Rogers, 1982).

Sequential interdependency is identified with “transaction costs” of maintaining the collaboration and its transactions. It comes with its own risks to capital related to specific activities, in asymmetry of information where collaborators do not contribute equitably, and in surrender of control over the organisation’s resources. This is the supply chain model, where the output of one collaborating organisation is the input to the next, and so on (Kumar & van Dissel, 1996).

Reciprocal or networked interdependency by nature is very complicated in terms of costs and risks (Kumar & van Dissel, 1996). Furthermore, collaboration brings a loss of organisational autonomy, where outcomes are influenced by the external collaborators, organisational goals may have to be re-aligned in the context of a collaborative environment, and decision-making displaced to a sphere external to the immediate structure of the organisation. The organisation may also suffer instability, conflict and delay due to the negotiated nature of transactions in a collaboration with others (Alter & Hage, 1993).

Reciprocal or networked interdependency by nature is complex, based on the relative dominance (equi-partner or dominated) of member collaborators, and is built on a constant exchange of inputs and outputs. It is best coordinated through mutual adjustment or feedback (Mulford & Rogers, 1982).

Bearing in mind these risks and costs of collaboration, in its different interdependencies, stakeholders must decide on the proper balance to adopt, in order to benefit from the outcomes of successful collaboration.

Pooled and, particularly, reciprocal or networked interdependence seem suitable models supporting NSDI. Within the structure, the process of collaboration covers six stages involving evaluation, negotiation, and decisions; the stages are “start-up, search for partners, setting-up, implementation, operational management and cessation” (Prefontaine et al., 2000).

3.2.6 Collaboration and Success

Collaboration is a shared platform where consensus is formed regarding an issue of concern to participants, and suitable solutions negotiated, from which an agreed course of action can be mapped out and executed. In this sense, “*If collaboration is successful, new solutions emerge that no single party could have envisioned or enacted*” (Gray, 1989, p.16). However, for success to be measurable, a number of indicators must be agreed, and in many instances standard forms are inadequate. Criteria to measure outcomes, such as goal achievement, agreement durability, improved inter-organisational relations, participant satisfaction, and efficiencies in time and resource utilisation, were used to uncover factors determining success. Three main groups of factors were isolated: member, process, and resource (Dedekorkut, 2004). The member factors group covered stakeholder inclusion, provision of incentives, commitment to the collaboration, and exercise of leadership. The group of process factors dealt with maturity of the issue, decision-making protocols, mediation availability, and extent that collaboration was centralised and organised. The resource factors group encompassed financial, and political backing. Dedekorkut (2004) concluded that significant factors for a successful collaboration were existence of appropriate funding, included participants, firm commitment, prior agreement of collaboration rules, sound trust, and good personnel relationships.

In addition, Prefontaine et al. (2000) proposed a list of factors considered critical for success in collaboration (Table 3.2). These factors included characteristics of the surrounding environment, in the political, social and cultural dimension, as well as the institutional, business and technological. Moreover, they considered objectives and nature of the collaborating entities, the collaboration process itself, the model of collaboration adopted and the actual implementation of it, as further factors also determining success of otherwise of the venture (Prefontaine et al., 2000). These success factors may be compared with the barriers to collaboration revealed by this research, which exist in KSA (see Section 8.9.4, pp.194-199). Add "Lessons learnt from a post-mortem of a failed GIS" (Openshaw et al.).

Table 3.2 The factors influencing success of collaboration (Prefontaine et al., 2000)

Model Dimension	Success Factors
Political, Social and Cultural Environment	History of alliances Stability of government Role and nature of institutions Overall budgetary situation Overarching government Policies
Institutional, Business and Technological Environments	Policies, laws, regulation, procedures and standards; Business factors including sector's size, structure, delivery systems; ITC environment including nature of infrastructure, level, complexity, availability, security, accessibility, maturity
Partners Objectives and Characteristics	Nature of objectives, sharing of risk and cost, shared strategic development; Characteristics of partners including structure, ability to adapt, leadership, organisational strategies, past experiences with collaboration, profile, technological experience
The Collaborative Process	Roles in initiation, clarity of goals, level of innovation, scope of project, level of research, number of partners, complementary natures, presence of champion, project management, communication, support processes, agreement termination processes, problem resolution processes, climate of trust, risk management, power and control
Collaborative Model or Mode	Governance method, Responsibilities and roles, Management of the agreements, Monitoring
Performance of the Collaboration	Achievement of initial objectives, respect of agreement, reciprocity and trust, new products emerged, overall partner satisfaction, quality of service, innovation, service costs, efficiency, quality

3.3 Potential new technologies

In the current conventional form, NSDI emphasises the top down approach with strict control and management by government, and those concerns relating to metadata, clearinghouses or repositories, and exchange protocols for data coordination, among others. In contrast, a number of new technologies connected to social developments have enabled rapid, parallel development of a commercial-, and consumer-led SDI. These have gained ground in the form of a dynamic 'GeoWeb'. This commercial and consumer SDI development, contributed to principally by commercial Web interests comprising Google, Yahoo, and Microsoft, and the open source community, poses serious challenges to NSDI in its current form. Indeed, it is proposed that the next generation of NSDI will most likely take a Web 2.0 form with spatial data widely available and dynamically updated with consumer data, as part of a "*holistic location-aware ubiquitous computing environment*" (Jackson et al., 2009; Jackson et al., 2011). These disruptive SDI developments were built on images and maps at a level of detail and coverage to rival that available from government, and in contrast, are available free-of-charge and accessible to all, while leveraging the power of a huge base of users, and low cost or free tools for merging and checking user datasets. Location- and subject-specific spatial data can now be captured through the present-generation of location-enabled, high resolution image capture, and Internet-connected mobile devices, especially in instances where large numbers of users provide an opportunity for crowd-based data collection (Exel, et al., 2010; Jackson et al., 2009; Jackson et al., 2011).

The institutional form of SDI has also been found lacking in agility and flexibility in specific situations, such as disaster management. Here, the crowd-based approach to data collection allows a more rapid creation of a basemap and overlay themes, as was the case in the Haiti earthquake using OpenStreetMap (Zook et al., 2010). Moreover, the joint development of a Web 2.0 SDI, GeoNode, by the World Bank and OpenGeo arose from shortcomings in the conventional approach to SDI, such as lack of benefit from registering users, small numbers of actual users, contributions of data were not given recognition, and were not rewarded, compared to the open, user-participatory model of SDI (Jackson et al., 2009; Jackson et al., 2011).

Jackson et al. (2009) compared conventional and crowd-based SDI, and concluded that the latter was characterised by:

- Data collection and processing using Web services that were 'simple' and driven by consumers themselves
- Collection and input of data were almost 'real-time' enabling trend analysis
- Metadata and mashups were 'unstructured' and driven by the mass of consumers

- Mobile devices available to everyone, equipped with GPS and high resolution cameras, allowed unlimited spatial data capture and distribution

while conventional SDI was characterised by:

- Highly ‘complex’ GIS applications and involving a systematic institutional survey approach
- Map data although quality assured at great expense, was only ‘historic’ and ‘snap-shot’
- Inflexibly defined, ‘structured’ metadata
- Access and distribution strictly ‘controlled’ by licenses, policies, and asserted digital rights
- Comprehensive and systematic map coverage

This section will briefly examine some potential new technologies, which hold promise in helping GIS advance rapidly, and allow greater accessibility to spatial data, and its creation. These include the OpenStreetMap (OSM) initiative. The venture is an open collaboration with the aim of achieving a free and editable world map. Registered users add to the mapping database by uploading GPS track logs, and also editing the vector data using the tools provided (Wikipedia, 2009a). Such initiatives have important implications on the integration with NSDI, issues of custodianship, quality, and standards. As such, OSM is a good example of the difficulties of incorporating a significant grass roots development within an NSDI built on standards. Similarly, TomTom Map Share is an example of maintaining SD current by applying the idea of community successfully under a commercial umbrella. This gives users the ability to introduce corrections to maps, and making these available to the company and other users. This may prove to be the way forward incorporating the public’s contribution within an NSDI.

3.3.1 OpenStreetMap (OSM)

OpenStreetMap (OSM) is an example that can be studied to see whether standards cause loss of motivation and momentum, and rigidity versus flexibility, which may also result from organisation size and structure. The question is whether the public can be allowed to access the NSDI, and play an active part in building it, and creating or editing spatial data content. Moreover, is it worthwhile to integrate OSM into an NSDI, and how can that be achieved? This has obvious implications, and the issues here relate to organisation size, flexibility, interactivity, standards, open public access, etc. Relevant advances in technology, such as GPS, LBS, etc. need to be covered, as well as public and private sector spatial data organisations working in partnership.

3.3.2 TomTom Map Share™

This is a new development by TomTom, the GPS navigation and mapping company (owner of TeleAtlas). In 2007, TomTom released Map Share™, a technology that allows users to not only independently introduce changes to maps on their GPS devices, but also share these changes with other Map Share™ community members using content management software, TomTom HOME. This allowed the owners of TomTom GPS devices to edit their maps to more accurately reflect reality, and so roads could be blocked or unblocked, traffic direction modified, road names changed or new ones introduced, points of interest (POIs) added, deleted, or modified, and speed limits updated. The changes introduced by the community of users would be checked by TomTom, and then made available to all other users (TomTom, 2009; Wikipedia, 2009b). This development illustrates one way by which public access to the NSDI can be put to good use in a well-defined manner, and represents a model worth exploring.

3.4 Summary

Collaboration has been defined in the context of organisational relationships, using terms such as cooperation, partnership, and coordination. Collaboration has been described as a multi-participant process of joint search for solutions (Gray, 1989), which is “reciprocal” and “voluntary” (Prefontaine et al., 2000), with constant communication driven by the need for negotiation (Lawrence et al., 2002).

Collaboration is motivated by resource scarcity or performance stress (Schermerhorn, 1975), as well as “asymmetry, reciprocity, efficiency, stability, and legitimacy” (Oliver, 1990). Collaboration is founded on shared interests and goals, seeking to confront uncertainty, risk, and legislative interdependence, and for legitimacy (Dedekorkut, 2004), and in NSDI is necessary for compatibility and interoperability, and furthering common interests of stakeholders (Tait, 2003).

A collaboration aims to secure a successful outcome for participants, including broadened learning, expertise, and capabilities; access to greater resources and wider pool of expertise; jointly sharing and managing risk and uncertainty; and gaining market share or influence (Alter & Hage, 1993). However, collaboration is not risk-free and has a cost depending on the nature of interdependencies among collaborators, pooled, sequential, or reciprocal (networked) (Kumar & van Dissel, 1996).

No single theory or approach can fully explain collaboration between organisations, yet perspectives from economic, organisation, strategic management, and game theories have been useful (Child et al., 2005). In a collaborative structure, pooled, sequential, or reciprocal (networked) interdependencies can be identified (Kumar & van Dissel, 1996). Pooled and, particularly, reciprocal or networked interdependence seem suitable models for supporting NSDI, but, with a distributed architecture and with service chaining, a sequential model of interdependence is equally applicable. In a pooled interdependency, standards play a critical role to ensure interoperability and sharing, while reciprocal or networked interdependency (equi-partner or dominated) is built on a constant negotiated exchange of inputs and outputs (Mulford & Rogers, 1982). Finally, a large number of contributory factors play a role in achieving success in collaboration. These must be taken into consideration as critical factors by stakeholders. In this context, stakeholders in KSA have articulated the challenges to collaboration faced there (see Section 8.9.4, pp.194-199), and on this basis a set of recommendations was proposed to help achieve collaboration between KSA NSDI stakeholders (see Section 10.2, pp.237-240).

This chapter has looked at the nature of NSDI and national administration, as well as organisational collaboration, and the potential of new technologies to contribute to NSDI development.

The following chapter presents the NSDI initiatives of four developed countries, UK, USA, Australia, and Canada. The initiatives are presented individually according to their objectives and vision, coordination, datasets, standards, and access; these initiatives are then compared from which several conclusions are made.

CHAPTER 4: NSDI COLLABORATION INITIATIVES

4.1 Introduction

Progress in the area of spatial data infrastructure activities has encouraged many countries to develop their own spatial data sharing, access, and integration programmes. The rewards of implementing a usable spatial data infrastructure include enhanced efficiency, both direct and indirect, across all sectors of the economy. National programmes that were implemented in a number of jurisdictions, with regard to collection, management and sharing of spatial data, have aided the various types of users and producers in finding and accessing data in a cost-effective way. A national spatial data infrastructure (NSDI) has been envisioned in a number of countries, and on that basis the various instruments, including policy, technology, and spheres of responsibility, have been defined to make that a reality. In this chapter, the best practices in NSDI collaboration initiatives are presented embodied in the experiences of four countries, which enjoy a leading position in spatial data. These four countries are the UK, USA, Australia, and Canada, and it is expected that their experiences will yield insights into the issues, and identify areas of best practice.

4.2 The UK NSDI Collaboration Initiative

The United Kingdom (UK) with a population of roughly 62.2 million comprises England, Wales, Scotland and Northern Ireland, with a combined land area of 243,000 square kilometers (U.S. Department of State, 2010d). The UK's government model directly influences the form of regulatory and legislative tools regarding spatial data, and as such explains the absence of a governmental national spatial data sharing initiative. Rather, an initiative bringing together the private sector, academia, and private individuals, along with various government agencies, led to the launch of a national spatial database in 1995 under the umbrella of the National Geospatial Data Framework (NGDF) (Masser, 1998a). The NGDF was managed by a Central Management Team, and given funding through the 1998 National Interest Mapping Service Agreement (NIMSA) between the Ordnance Survey and the government.

4.2.1 Initiative objectives and vision

The NGDF sought to "*develop a United Kingdom framework to facilitate and encourage efficient linking, combining and widespread use of geospatial data which is defined by users as fit for purpose*" (Hobman, 1997, p.2). Accordingly, under its mission statement lay three key aims (Hobman, 1997):

1. To help achieve collaboration in spatial data with respect to collection, supply and use.
2. To promote the implementation of standards and good model practice.

3. To help achieve better spatial data access.

Achieving a commercial, single focal point for spatial data, i.e. one-stop shop, is the vision defined by NGDF, in which metadata is easy to access, and datasets are linked and integrated (Hobman, 1997).

4.2.2 Initiative Coordination

The UK is governed by a constitutional monarchy, which has in effect led to a unique government structure with attendant influence on the form of spatial data collection, sharing, and dissemination. In this context, NGDF is a voluntary body bringing together both public and private sectors, while no single body has overall responsibility for spatial data nationally. Yet, a key player, which has been instrumental in driving the development of national spatial data strategies, is the Ordnance Survey (Masser, 1998a). A recent development in the UK is the launch of the Gigateway project with central government funding (UK Location Programme) with the aim of facilitating access to metadata (Gigateway, 2010).

4.2.2.1 Ordnance Survey (OS)

The Ordnance Survey (OS) is a UK provider of spatial data and mapping, products and services (Masser and Campbell, 1996). The original plan for establishing the NGDF emerged from OS in 1995. Initially called the National Geospatial Database (NGD), this initiative involved linking the spatial databases belonging to OS to those of the different branches of government (Masser, 1998a). As such, OS was tasked with collating those resources, spatial research and information, necessary for the NGDF initiative to succeed.

4.2.2.2 Association for Geographic Information (AGI)

The objective of ensuring that maximum use is made of spatial data, in the interests of good governance, the private sector, and UK citizens, is upheld by the Association for Geographic Information (AGI). This not-for-profit body works to promote sharing and collaboration in the field of spatial data, as well as spreading awareness of NGD among practitioners. AGI took on the bulk of responsibility in providing national spatial metadata services in 2002, and operated the askGIraffe metadata search engine, which evolved into Gigateway.

4.2.2.3 UK Inter-departmental Group on Geographic Information (IGGI)

In 1993, fulfilling the aim of coordinating among the different government bodies in the context of land information, led to formation of the UK Inter-departmental Group on

Geographic Information (IGGI). This body was tasked with both identifying and removing those obstacles to effective and proper use of geographical information.

4.2.2.4 The National Interest Mapping Service Agreement (NIMSA)

In the UK, conditional on satisfying set criteria, funds for mapping and spatial data activities were made available through a service contract signed by the UK Deputy Prime Minister's Office with OS, termed the National Interest Mapping Service Agreement (NIMSA). In 1998, NIMSA provided the necessary financial resources to enable the mechanisms for accessing spatial data under NGDF. Currently, access to UK spatial metadata is through the Gigateway system, which benefits from NIMSA funding.

4.2.3 Datasets

A number of national spatial datasets relevant to the UK were developed, and made available, including a geographic reference base, maritime (coastal zone and offshore) features, address information, and a land and property register, as well as socio-economic, geological, and environmental information databases. These UK datasets are quite comprehensive, yet the national spatial data sharing strategy is still lacking in the definition and agreement of key relevant themes.

4.2.4 Standards

The importance of standards and their role in achieving success for NGDF has been recognized leading to a drive towards implementation of common standards for both spatial data and metadata. For this purpose, both an advisory group (with AGI as lead organisation), and a task force were formed in 1996 within the NGDF (Masser, 1998a). The development of appropriate metadata as well as application of the same in practice was undertaken by the NGDF Advisory Council and task force building on a significant research effort, publishing guidelines, and convening workshops to encourage member organizations to adopt common schema in developing spatial datasets. The development of these UK common standards took into consideration standards in use internationally, i.e. ISO/TC 211, European CEN/TC 287, and US FGDC/ ANSI.

In 2004, the Geo-spatial Metadata Interoperability Initiative (GEMINI) was introduced in the UK, as a national spatial metadata profile allowing new metadata to be created on the basis of two standards, the national E-Government Metadata Standard and ISO 19115 (Gigateway, 2010). GEMINI is the specification for a core metadata elements set designed to be used in a discovery spatial metadata service. In compliance with the Gigateway Discovery Metadata Specifications standard that replaced the former NGDF standard, a metadata creation tool, MetaGenie, was also introduced. The tool enabled spatial metadata to be created and then published on the Gigateway spatial data search engine (Gigateway, 2010).

Successive development cycles brought the 2004 GEMINI v1.0, to v2.0 in 2008, and on to version 2.1, which complies with the current technical guidelines issued by INSPIRE regarding rules on implementing metadata, and takes account of the accumulated experience from previous GEMINI implementations. This current version of GEMINI is to support the launch within the UK Location Programme of the UK geospatial discovery metadata service in 2010/11 (Gigateway, 2010).

4.2.5 Access

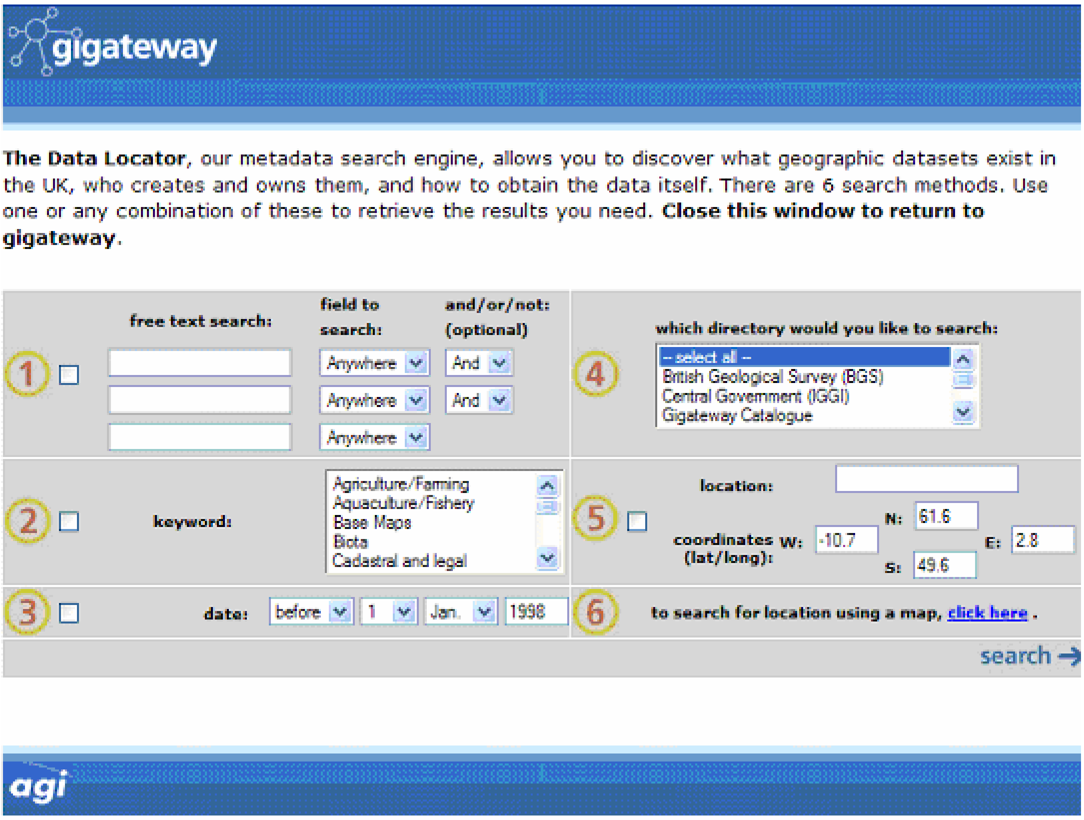


Figure 4.1 screenshot of the Gigateway Portal (source: Gigateway, 2010)

Access to spatial data is facilitated through two elements of the spatial data search service, the Data Locator and Data Integrator of askGIraffe, which was introduced in 2000. Following transfer of responsibility to AGI in 2002, the service was subjected to improvements, and later evolved into GIgateway, a web-based national portal for spatial data discovery. Through this portal, UK spatial data held by both public and private sector organisations is made available to users through metadata search functionality, containing filters for data by title, author, serial number, description, supplier, or price. This allows information on UK spatial datasets held in the data locator library to be effectively searched, to show what is available, from which provider, when the data was collected, for which geographical area, in what mode of access, and contact details for the dataset holder (Figure 4.1).

Within the UK Location programme, the GIgateway is due to be superseded by a new service based on GEMINI2, and implements both INSPIRE and the UK Location Strategy (Gigateway, 2010).

4.3 The USA NSDI Collaboration Initiative

The United States of America (USA) is a large country with a landmass of 9.2 million square kilometers and a population of 307 million people (CIA, 2010). With respect to spatial data sharing between the various levels in public and private sector entities, a number of recent and key initiatives have included the Geospatial One-Stop (GOS) web portal, National Digital Geospatial Data Framework, Clearinghouse, and the US Geological Survey National Map project (Nedovic-Budic et al., 2004b).

The aim of the US Geospatial One-Stop (GOS) project is to facilitate access to, and to integrate spatial data across many sources, with the end result that all spatial data resources held nationally become the responsibility of one focal point. In this sense, GOS in its current form is a product of continuing activities with regard to NSDI. In this context, the development of GOS was facilitated by the work of the Federal Geographic Data Committee (FGDC), which coordinated spatial data development, distribution, and usage. In particular, FGDC managed to:

1. build a wide partnership network among bodies;
2. build a framework with its associated spatial data content;
3. establish the standards needed for the spatial data content of the framework, following both ISO and ANSI standards;
4. develop the standard for content in Digital Geospatial Metadata, of note is that ISO 19115 actually arose from FGDC metadata;
5. build up the clearinghouse network through which spatial data is accessed using metadata;
6. fund various NSDI development programs at all government levels; and
7. thus establish GOS as the gateway through which spatial data access is facilitated for government bodies, companies, and private citizens.

GOS represents an e-government initiative aimed at improving efficiency in government and public services delivery, and is sponsored by the Federal Office of Management and Budget (OMB) (FGDC, 2010). It provides a single portal for all spatial data resources, which can then be accessed by both the public and the government. The goal underlying GOS is to provide the government with support in managing disasters and national emergencies, policy and planning, national security, protecting the environment, healthcare provision, etc., and to enhance inter-agency collaboration and coordination (GOS, 2010). These broad goals may be leveraged into the following tasks set to achieve them:

- Facilitate access to spatial data, and related services by maintaining a web-based portal (established in June 2003).
- Initiate a process of collaboration in the development of standards for data content.
- Keep an accessible inventory of current data held by Federal bodies.
- Build up a market in which planned investment can be made in spatial data (FGDC, 2010).

A one-stop, coordinated, national portal for spatial data presents significant challenges, which were reported by the Best Practices Task Force (BPTF) as:

- The involvement of federal, and local government bodies, as well as private sector bodies in evolving effective standards, collaboration in spatial data, and portal design is highly complex, and as is keeping true to the business case on which the concept is established.
- The issues of enhancing access and collaboration with respect to spatial data through the GOS portal and others.
- Defining in policy terms how the private sector may make use of the GOS portal.
- The issue of establishing portal interfaces that are interoperable in terms of online GIS and services, such as mapping, analysis, etc.
- The issue of tracking and predicting demand for spatial data by users using the GOS portal (GOS, 2010).

Therefore, as reported by the BPTF, cooperation and collaboration at all levels is key to success of GOS in the areas of developing standards for spatial data, building the spatial databases and archives, and achieving an interoperable portal. In this respect, the US provides an excellent study in the experience of collaboration among the various levels and sectors. Furthermore, implementation of the GOS concept across international, federal and state jurisdiction has also advanced the experience in both institutional and technical areas, such as those related to development of standards and open interoperability.

4.3.1 Initiative objectives and vision

The promotion and coordination effort with respect to availability of spatial data, its collection, access, usage, sharing, and quality, as well as its distribution between the various layers of government, and private sector and citizens was led by the Federal Geographic Data Committee (FGDC) (OMB, 2002). For this purpose, the FGDC national sharing vision was:

> "*current and accurate geospatial data will be readily available to contribute locally, nationally, and globally to economic growth, environmental quality and stability, and social progress*" (FGDC, 2010).

In it own right, GOS adopted a wider view, in that the vision was: "*to spatially enable the delivery of government services*", from which it derived specific tasks, including:

- Simplifying and integrating business processes.
- Providing an easily accessible, always available, spatial data service with up-to-date and accurate information.
- Bringing together the spatial data efforts at all levels of government along with the private sector.
- Adopting and implementing the efficiency measure of 'collect once, use many times'.
- Facilitating timely spatial data use and better decision-making in all activities related to government (GOS, 2010).

4.3.2 Initiative Coordination

The USA is a republic with a written constitution, run on a federal model comprising 50 states having 3000 counties, and including over 7000 cities. Circular A-16 (revised) was issued by the Office of Management and Budget (OMB); an interagency coordinating committee, the Federal Geographic Data Committee (FGDC) with political support at a high-level, was established tasked with NSDI implementation, enabling activities related to Circular A-l6, and wielding significant influence at federal government level. The 1994 Presidential Executive Order No. 12906 directed that a US NSDI be established as a key programme supporting efficient spatial data collection, management, access, and sharing (Clinton, 1994). All through the nineties, lead responsibility was taken by the FGDC in realizing this goal (Nedovic-Budic et al., 2004a).

4.3.2.1 The Federal Geographic Data Committee (FGDC)

As an interagency coordinating committee, the Federal Geographic Data Committee (FGDC) has prime responsibility for all efforts promoting spatial data availability, collection, access, sharing, quality, and use between government bodies, and in particular operating a Web-based searchable database system. The authority of FGDC was emphasised by 1990 Circular A-16 compelling all federal agencies involved in spatial data activities to be FGDC members and to coordinate their efforts under FGDC management (OMB, 2002).

FGDC members are part of GOS, and include the Agriculture, Commerce, Defense, Energy, Health and Human Services, Housing and Urban Development, the Interior, Justice, State, and Transportation Departments, and the Environmental Protection Agency (EPA), Federal Emergency Management Agency (FEMA), as well as the General Services Administration, Library of Congress, National Archives and Records Administration, National Aeronautics and Space Administration (NASA), and National Science Foundation (NSF).

The 2002 Circular A-16 (revised) explains FGDC tasks as:

1. "Prepare and maintain a strategic plan for the development and implementation of the NSDI.
2. Serve as the lead federal executive body charged with the leadership, development, implementation, and review of spatial data standards, the NSDI Clearinghouse network, and a plan for federal agencies responsible for the NSDI Framework and other data themes to collect and provide broad access to spatial data assets.
3. Communicate with and foster communication among federal agencies and others concerning spatial data technology development, transfer, and exchange.
4. Promote and guide cooperation and coordination among federal, state, tribal and local government agencies, academia and the private sector in the collection, production, sharing and use of spatial information, the implementation of the NSDI, and the identification of proven practices.
5. Coordinate with international organizations having an interest in the National or Global Spatial Data Infrastructures.
6. Provide and update at least annually:
    - An online status summary for each data theme authored by the lead agencies, the FGDC, or other subcommittees, working groups, and advisory committees.
    - An online collection of periodic technical publications, management articles and reports related to the NSDI.
    - An online FGDC membership directory, including current subcommittee and working group memberships.
    - Ensure consistency of the NSDI with national security, national defense, and emergency preparedness programme policies regarding data accessibility.
    - Support the development of electronic government with spatial data.
    - Support and promote the infrastructure of networks, systems, services, and standards that provide a digital representation of the Earth to users for many applications.
    - Through the Chair and Vice Chair, take actions where required to recommend appropriate additions, revisions, or deletions to this Circular" (OMB, 2002).

4.3.2.2 The US Geological Survey (USGS)

Formed in 1879, the US Geological Survey (USGS), as a body involved in the natural sciences, is a key spatial data and mapping services provider. The USGS has been instrumental in both proposing and implementing the database-backed, Web-based National Map concept offering an interactive topographic map of the USA with core spatial data, as found in its paper maps (GAO, 2004). The National Map initiative is the fruit of collaboration between partners at federal, state, and local level, which allows users to enjoy greater capability in accessing, applying, and integrating spatial data of various scales, to fit their needs (USGS, 2010). The National Map has a Web-based user interface for accessing data content, and is also connected to the GOS portal; both initiatives are similar in their goal of providing a national spatial data sharing system.

4.3.2.3 Implementation Team (I-Team)

The national spatial data sharing initiative in the USA benefits from a voluntary organization established in 2000, which aims to tackle those barriers facing the concept, whether financial or institutional, based on a series of strategic 3-5 year plans. This body represents a joint initiative of OMB, FGDC, and other parties, working to achieve "a planning and implementation process that focuses upon data as strategic, long-term capital assets. I-Teams (implementation teams) commit to the I-Team process. That commitment is what distinguishes an I-Team from ad hoc partnerships and other information consortia" (FGDC, 2010).

4.3.2.4 Cooperative Agreement Program (CAP)

In 1994, the Cooperative Agreement Program (CAP) was launched with the aim of facilitating partnerships, at levels other than the Federal government, that assist in NSDI development. CAP is the funding instrument by which non-federal partners, i.e. private sector bodies, and academia, as well as state and local government bodies, may forge cooperative agreements. CAP is a national initiative open to any organization, and encourages and facilitates the sharing of resources harnessing technology, and the efficient coordination and collaboration among bodies (FGDC, 2010). Therefore, CAP seed funding may be used to start collaborative projects and activities aimed at creating NSDI components. As such, CAP supports activities that include (FGDC, 2010):

- Involvement in the GOS portal and clearinghouse.
- Development and application of standards for spatial data and metadata.
- Application of OGC specifications.
- Involvement in the National Map initiative.

- Facilitating collaboration and cooperation among the various entities.

4.3.3 Datasets

The FGDC organised the spatial data by themes and usage. The most common is housed in what is called the Framework comprising seven core datasets arranged by individual theme. While FGDC may add other spatial data themes to the Framework, the existing ones are used in the majority of GIS applications. Themes are elevation, hydrography, governmental units, orthoimagery, transportation, cadastral, and geodetic control, where:

1. Elevation defines position on the vertical plane with reference to a surface datum.
2. Hydrography describes features of surface water, including coastline, oceans, rivers, lakes, and canals.
3. Governmental Units refers to official boundaries marking federal, state, local, and tribal government jurisdictions.
4. Orthoimagery brings together Earth surface images that are geo-referenced, and were acquired from a sensor device.
5. Transportation defines the national transportation system by geographic location, degree of interconnection, and attributes.
6. Cadastral describes property rights and interests in terms of geographic extents, both past, current, and future.
7. Geodetic Control defines a system based on a common reference used to set geographic data coordinates.

4.3.4 Standards

Among long-term programmes, continuing activities that relate to evolving data standards, have been part of FGDC work since its establishment. In Circular A-16, FGDC was given the authority, with jurisdiction over all federal bodies, to create the standards required for the US NSDI. As a result, in conjunction with the Geographic Information Systems Committee of the International Committee for Information Technology Standards (INCITS/L1), FGDC is introducing its Framework Data Standard as an American National Standard. The FGDC Framework Data Standard contains the commonest themes needed by users of spatial data, and has greatly influenced standards development efforts. Development of US spatial data standards have been largely influenced by the Spatial Data Transfer Standard (SDTS) project as well as the FGDC Content Standard for Digital Geospatial Metadata. The former initiative evolved mandatory federal standards, while the latter was concerned with a standard dataset search format. The 1994 FGDC Content Standard for Digital Geospatial Metadata defined both metadata content and structure in nearly 220 elements, and was updated in 1998 to accommodate profiles, as well as entities and elements that could be defined by users. FGDC efforts continued within the ISO TC211 Metadata project to contribute to development of ISO 19115.

4.3.5 Access

FGDC was the lead body in GOS, an interdisciplinary effort marking the collaboration of a wide variety of institutions, and technical and research bodies, public and private. This resulted in development of a Web portal through the efforts of the Environmental Systems Research Institute (ESRI) and others. Moreover, FGDC and OGC have also studied the issues surrounding discovery of, and access to, spatial data. As such, standards from ISO, FGDC, and OGC relating to GIS, as well as Web services, were explored. Finding solutions to technology-related issues, like data exchange standards, was a vital task assigned to GOS, and so the seven spatial data themes identified by FGDC above were used to develop a core standard for delivering services, namely (FGDC, 2010):

- The basic data needed for applications.
- A basis for adding or attaching geographic attributes and details by users.
- A source reference that correctly registers and compiles data sets belonging to participants.
- A reference map that shows locations and results generated by further spatial data analysis.

In this context, while many US spatial data clearinghouses allow search of available data irrespective of format or quality, only data available through GOS satisfies the criteria set by content standards (Peng and Tsou, 2003). Through the GOS portal, users can:

- Deal with networked and distributed resources and services from which to acquire spatial data, metadata, mapping products, etc.
- Perform searches of datasets using metadata and location.
- Acquire and view spatial metadata.
- Acquire and view spatial data maps by location and theme.
- Acquire data on features or coverage related to location and theme (OGC, 2010).

Within GOS, the discovery and acquisition of spatial data is based on searching by three categories of where, what, and when (Figure 4.2). However, spatial data categories for access by users extend to nineteen, including transportation, agriculture, cadastral, etc. It is worth mentioning that the datasets are not actually hosted on the GOS portal, which only links users to the providers of the resources of interest whether live maps or other websites. As such the GOS portal is built on principles of open standards and interoperability with nearly all GIS services and datasets.

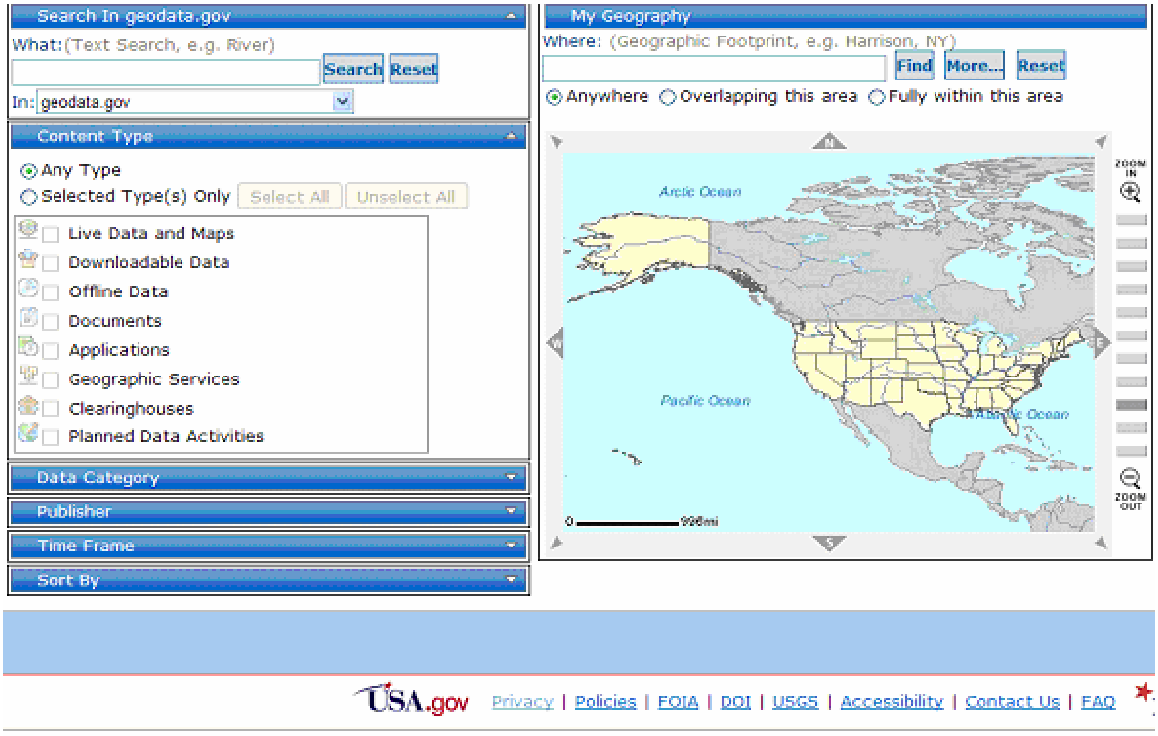


Figure 4.2: The GOS Portal (source: GOS, 2010)

4.4 Australian NSDI Collaboration Initiative

Australia is a large but sparsely populated country of 7.7 million square kilometers and 22.3 million people (U.S. Department of State, 2010a). The Australian Spatial Data Infrastructure (ASDI) is the national spatial data-sharing model, comprising all those technical and institutional elements needed for nationwide, as well as local spatial data sharing.

4.4.1 Initiative objectives and vision

ASDI was created as a national framework linking spatial data providers with users (ANZLIC, 2010), and its development took place in the nineties led by the Australia New Zealand Land Information Council (ANZLIC) (Nedovic-Budic et al., 2004a). As such, ASDI seeks to bring together people, technology and policy, in such a way as to facilitate spatial data creation and use by the public and private sectors (ANZLIC, 2010). In particular, through ASDI, access to all available spatial data, services and products must be achieved.

ASDI development is based on a model integrating the following core components, comprising institutional framework, technical standards, fundamental datasets, and clearinghouses (ANZLIC, 2010), where:

1. The institutional framework comprises the policy instruments and form of administration needed for the infrastructure to be implemented and then maintained.

2. The technical standards specify those characteristics required in fundamental datasets.
3. The fundamental datasets are created in the institutional framework and as such also satisfy the technical standards.
4. Clearinghouses are the means whereby users access the fundamental datasets following the policies of the institutional framework, and satisfying technical standards.

According to the ANZLIC Spatial Data Infrastructure Standing Committee (2003), ASDI aims to:

- support ASDI development by raising political awareness, and enhancing the institutional framework.
- create user tools to facilitate discovery of, and access to, available spatial data and services.
- raise the quality of present available spatial data;
- promote interoperability through relevant specifications and technologies.
- facilitate integratability of spatial data through a framework based on ISO series for standards development.

4.4.2 Initiative Coordination

The Australian system of government is federal and democratic, comprising a commonwealth of states (8), and local districts (727) (Clarke et al., 2003). With respect to spatial data, public sector bodies are responsible for it on every level, as is the private sector. However, there is an absence of legal instruments compelling spatial data stakeholders to adhere to any particular standard or policy (Clarke et al., 2003). In this situation, and since 1996, ANZLIC has been key in the evolution of ASDI (ANZLIC, 2010).

Among the core ASDI components identified in the conceptual model in 1996, the institutional framework is critical to the implementation of standards, and in creating, maintaining, and providing access to the datasets (ANZLIC, 2010). Moreover, it is the framework bringing together the spatial data industry and all levels of government.

The activities and functions performed by ANZLIC are funded by its ten jurisdictions (ANZLIC, 2010), while ASDI relies on decentralised funding, where the states, territories and commonwealth provide the funds for their own programmes (De Montalvo, 2004).

4.4.2.1 Australia and New Zealand Land Information Council (ANZLIC)

Australia and New Zealand Land Information Council (ANZLIC) originated from the Australian Land Information Council (ALIC), which was established in 1986, and then renamed when New Zealand became a full ALIC member in 1987 (Clarke et al., 2003). Therefore, ANZLIC is the body coordinating management of spatial data among the various jurisdictions, national, state and territory, in Australia and New Zealand. Given the diverse nature of spatial data providers, the main aim remains to ensure access to their data is both cost effective and easy. In fulfilling its role, ANZLIC has sponsored a number of initiatives, including ASDI, the Australian Spatial Data Directory (ASDD) referencing around 37,500 available spatial datasets, model agreements at national level for management of, and access to, spatial data, and best practices for spatial data management with creation of toolkits based on practitioners' needs (ANZLIC, 2010).

As a joint Australian and New Zealand government initiative, every Australian state and territory, the Australian Commonwealth Government, and the New Zealand Government, all have one representative each to ANZLIC (ANZLIC, 2010). Hence, in developing and implementing ASDI, ANZLIC has brought together government and private sector spatial data bodies, in order to agree the specifications of a national spatial data sharing initiative that ensures users acquire needed data (ANZLIC, 2010).

4.4.2.2 Public Sector Mapping Agencies (PSMA)

In 1993, a joint venture of all mapping agencies in the Australian Commonwealth, states, and territories was established in the Public Sector Mapping Agencies (PSMA). It was a response to the tender awarded by the Australian Bureau of Statistics in preparation for the 1996 Census of Population and Housing requiring mapping services and facilities. The scope of PSMA operations was defined by the following key objectives (PSMA, 2009):

1. To coordinate, collate, and provide spatial data products at national level from the datasets held at each jurisdiction;
2. To support ASDI and contribute to it;
3. To support and advance expertise, knowledge, and technical capability in the area of land information in Australia; and
4. To carry out future work that satisfies the criterion of economic viability, or brings about a "public good".

4.4.2.3 Cooperative Research Centre for Spatial Information (CRCSI)

Arising from the collaboration of Australian researchers working in academia, and government and private sector organisations, the Cooperative Research Centre for Spatial Information (CRCSI) has led spatial data research and development in the country (CRCSI, 2010). CRCSI objectives have been determined to be (Clarke et al., 2003):

- Create powerful collaboration between researchers working in academia, and government and private sector organisations
- Develop a national strategy for research in spatial data for the long-term
- Ensure that research training is of greater efficiency
- Promote commercialisation in the area of spatial data and allied technology

4.4.3 Datasets

In the context of ASDI, a fundamental dataset is presented as "*a dataset for which more than one government agency requires consistent national coverage in order to achieve their objectives*" (ANZLIC, 2010). Moreover, it is left to individual bodies or custodians to create the fundamental datasets, which are built on 10 themes based on usage patterns of many GIS users; these are place names, street addresses, administrative boundaries, cadastre, land use, elevation, roads, water, vegetation, and soils (Clarke et al., 2003).

A key role in the provision of fundamental datasets in ASDI is played by PSMA, which licenses a number of major datasets commercially, and seeks to develop more (PSMA, 2009). These national datasets include transport and topography, administrative boundaries, national cadastral, point of interest, and G-NAF, where:

- The national transport and topography dataset is built on road centreline data, and over 30 types of features from themes not only transport, but points of interest, parks, and hydrography.
- The administrative boundaries dataset arranges spatial data on administrative boundaries by theme.
- The national cadastral dataset holds spatial data for the 10.4 million parcels in Australia, along with five key attributes.
- The point of interest dataset holding data for locations of cultural value.
- The G-NAF database is the master reference holding data on street addresses and associated geocode attributes for Australia.

4.4.4 Standards

Among ASDI's core components, the technical standards specify the characteristics required of datasets ANZLIC (2010). As such, the accepted standard in the spatial data community is the Metadata Guideline introduced by ANZLIC in 1996. The standard defines elements in spatial datasets held by public and private bodies, and its vision is that through well-formed metadata:

> "*users of spatial data in Australia and New Zealand will have online access to information directories that are accurate and current and are in an internationally compatible format to better enable them to identify, to locate and, then, to access the information they require*" (ANZLIC, 2010).

The strategies to practically realise this vision for metadata are:

- Highlighting on the critical role of metadata in managing datasets
- Improving metadata collection as well as management
- Implementing the international standard on metadata
- Improving the development of the Australian Spatial Data Directory

The Australian Metadata Guideline follows the documentation developed by FGDC in the US. The standard classes metadata in 10 categories, i.e. dataset, description, custodian, contact information, dataset status, data currency, metadata date, data quality, access, and additional metadata. Furthermore, ANZLIC has contributed to the development of international standards, ISO 19100 series, and closely cooperating with the ISO/TC211 Committee by providing elements of the Australian standard.

4.4.5 Access

Addressing the issues of data discovery and access, led to creation of a spatial data directory, the Australian Spatial Data Directory (ASDD), as well as distribution network, the Australian Spatial Data Infrastructure Distribution Network (ASDIDN).

4.4.5.1 Australian Spatial Data Infrastructure Distribution Network (ASDIDN)

The Australian Spatial Data Infrastructure Distribution Network (ASDIDN) enables spatial data to be located, accessed, and viewed anywhere in the country. With the Internet as its main channel, ASDIDN consists of a network of spatial data repositories, maintained by academia, government bodies, private sector organisations, and others. It is based on a 3-component model, which aims to facilitate access to spatial data and services, and consists of:

1. All those issues relating to policy, intellectual property rights, data pricing, arrangements for access and licensing, and coordination make up the institutional component.
2. All those issues relating to the facilities for discovery, access and transfer of spatial data, including ASDD, make up the technical component.
3. All those matters relating to service providers, product integrators, value added resellers, and information brokers make up the products, services, and solutions component (ANZLIC, 2010).

4.4.5.2 Australian Spatial Data Directory (ASDD)

Introduced in 1998, the Australian Spatial Data Directory (ASDD) is the principal reference for Australian spatial data (ASDD, 2010). It functions as a gateway bringing together metadata information from the different jurisdictions and sources nationwide (Figure 4.3), represented in a distributed system of connections to public and private sector nodes across Australia. Through ASDD, 25 nodes can be interrogated enabling access to around 30,000 metadata records (ANZLIC, 2010). Responsibility for ASDD implementation was given to the ANZLIC Spatial Data Infrastructure Standing Committee (SDI-SC) in 1999, and the goals of ASDD were defined in the following terms:

> "*users of geospatial data in Australia and New Zealand will have online access to information directories that are accurate and current and are in an internationally compatible format to better enable them to identify the information they require*" (ANZLIC, 2010).

SDI-SC recommended that ASDD comprise a number of operational elements:

1. To provide a comprehensive reference enabling existing spatial datasets to be discovered.
2. To enable existing spatial data relevant to user needs to be found in an efficient and timely manner.
3. To enable access and use with ease.
4. To have a distributed operating environment to accommodate the diverse nature of bodies collecting and managing spatial data, and which also balances the rights of organizations with the needs of users in having effective access to metadata records nationally
5. To comply with best practice standards in its gateway, nodes and metadata records, which lead to optimised performance (ANZLIC, 2010).

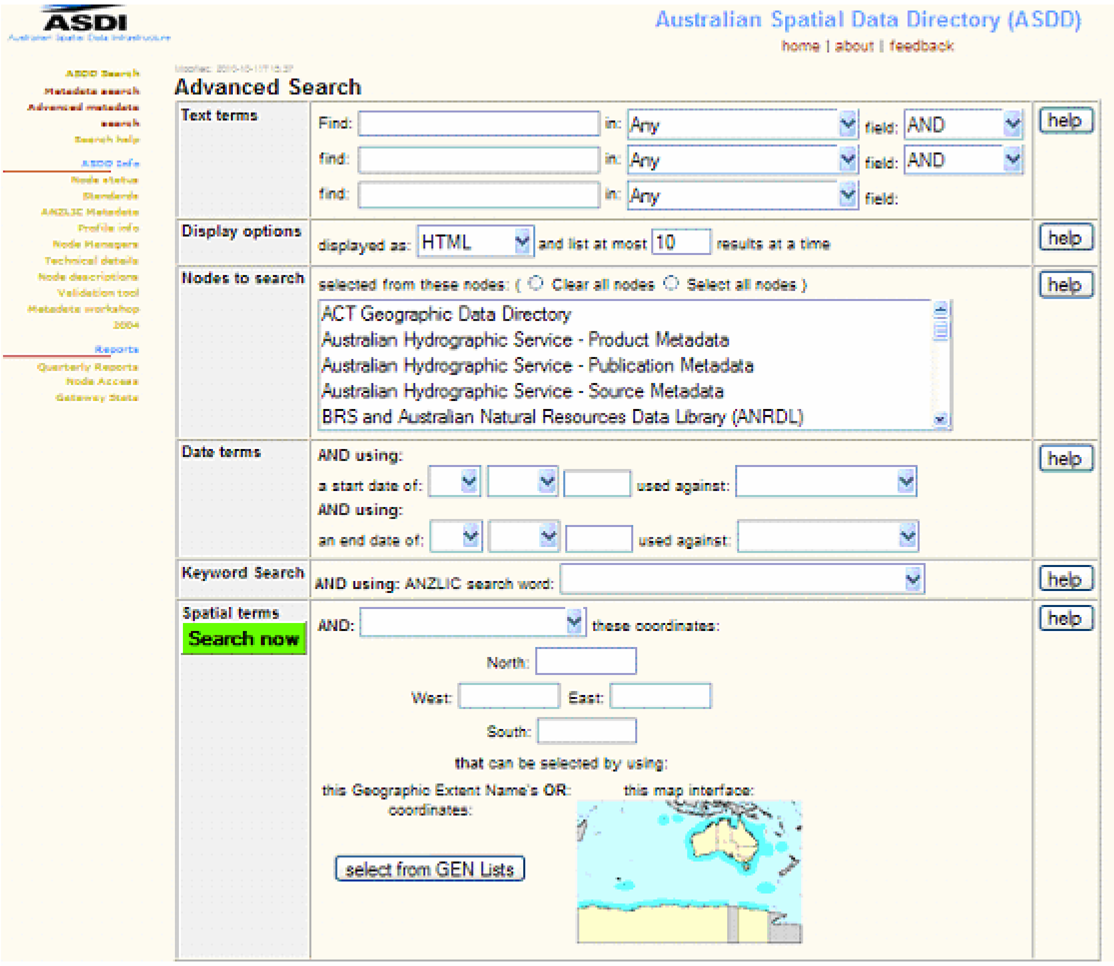


Figure 4.3: ASDD gateway (source: ASDD, 2010)

4.5 Canadan NSDI Collaboration Initiative

With a land area of 9.9 million square kilometers, Canada is the World's second biggest country, and is sparsely populated with a 2009 population of 33.7 million (U.S. Department of State, 2010b). The Canadian Geospatial Data Infrastructure (CGDI) is the country's national system for spatial data sharing, arising from the 1999 Canadian GeoConnections programme.

4.5.1 Initiative objectives and vision

The purpose of the spatial data infrastructure initiative in Canada is to enable spatial data services and products to be discoverable and accessible to the great variety of stakeholders in the country (GeoConnections, 2010). Therefore, CGDI builds on 5 key constituent components, namely policy, data, access, standards and technology, and so serves the associated aims identified for it by the Inter-Agency Committee on Geomatics (IACG). Accordingly, these aims are (Kucera and Keighan, 1999):

1. To facilitate access to spatial metadata, files, images, and allow querying of databases and extraction of data.

2. To acquire core spatial data for the framework, including data on elevation, topography, boundaries, and transportation.
3. To develop and implement standards so as to harmonise spatial data collection, distribution, description, and quality.
4. To enable collaboration and cooperation through spatial data sharing, as well as in collecting, and maintaining it.
5. To foster a policy environment that is supportive, and conducive to enhanced access, and lower cost, while enabling wider spatial data use by setting up joint activities.

CGDI seeks in its vision to provide a sustainable, widely available, and accessible infrastructure for all communities and users, which would positively enhance and protect well-being, and the social, economic, cultural, and natural heritage into the future (GeoConnections, 2010). Therefore, within the GeoConnections programme, CGDI is committed to facilitating prompt access to, and effective use of, spatial data to guide decision-, and policy-making, as well as economic activity by leveraging the collaboration between academic bodies, and the private and public sectors (GeoConnections, 2010). Thus, GeoConnections plays two key roles:

1. Enabling CGDI to be established, and through a powerful online search facility, to put spatial data in the hands of all users.
2. Coordinating federal, provincial, and territorial development efforts, and those of the private sector, in the context of policy and service provision that support the rapidly-expanding spatial datasets.

As a national collaborative effort between government, academia, and private sector, GeoConnections involves all stakeholders in developing CGDI, and so achieve online access to spatial data, services, and applications. As such, GeoConnections has five aims (GeoConnections, 2010):

1. to enhance spatial data accessibility and uses.
2. to evolve a standard-based, national framework for spatial data.
3. to create and apply common international standards for spatial data.
4. to enhance cooperation and collaboration between federal and provincial jurisdictions.
5. to develop policy for spatial data, which promotes the widest use.

4.5.2 Initiative Coordination

The system of governance in Canada is based on the federal model, whereby the country's three territories and ten provinces each elect their legislative and executive bodies, in the form of a legislative chamber and a premier respectively. With regard to spatial data resources, Canadian government bodies have made important investments (Labonte et al., 1999). Sharing of spatial data takes place within CGDI, which permits user access to government-held spatial data resources, in cases at no cost, while in others on payment of a fee designed to recover some of the costs associated with data collection and dissemination. Within CGDI, the private sector is encouraged to collaborate in developing, operating, and maintaining the system. With this in mind, CGDI policy is to seek funding from both the public and private sectors in the form of a joint partnership between these stakeholders (Labonte et al., 1999). The CGDI initiative has been successful in attracting the support of the academic community, and public and private sector bodies. Hence, development of CGDI has involved the Canadian Council on Geomatics (CCOG), the Geomatics Industry Association of Canada (GIAC), and the Inter-Agency Committee on Geomatics (IACG).

4.5.2.1 Inter-Agency Committee on Geomatics (IACG)

Academic groupings, the private sector spatial data industry association, and fourteen federal government bodies make up the membership of the Inter-Agency Committee on Geomatics (IACG), and so collaborate towards CGDI development (GeoConnections, 2010). The involvement of federal bodies has meant that IACG is the lead organisation involved developing CGDI.

4.5.2.2 Canadian Council on Geomatics (CCOG)

Since its establishment in 1972, the Canadian Council on Geomatics (CCOG) has been the main consultative body on spatial data management at the federal, provincial, and territorial levels. Spatial data producers at federal, provincial, and territorial levels form the membership of CCOG. In addition, CCOG aims:

- to facilitate consultation among representatives of government bodies through a forum, which enables information on various programmes to be exchanged, and current and prominent issues, achievements, organisational changes, proposed legislation, technology, new ideas, and procedures developed in the past year or for the future to be discussed.
- to create, champion, and propagate national and international standards;
- to provide the needed support for CGDI;
- to encourage spatial data exchange and collaboration, and allow all users effective access to, and use of, spatial data.
- to issue appropriate resolutions and recommendations (GeoBase, 2005).

4.5.2.3 Geomatics Industry Association of Canada (GIAC)

Established in 1961, the Canadian Association of Aerial Surveyors later evolved into the Geomatics Industry Association of Canada (GIAC), the national business association uniquely dedicated to representing the interests of the Canadian geomatics industry. As such, GIAC's diverse members include leading Canadian spatial data technology and services companies. The role of GIAC is to enable its members to network, and to provide information to them on available opportunities, areas where stakeholders may involve themselves, as well as any relevant policies and procedures (GIAC, 2010).

4.5.3 Datasets

There are three main types of framework data, or common fundamental datasets, configured as layers within CGDI (GeoConnections, 2010):

1. The alignment layers: these comprise geometric controls, e.g. the geodetic reference system, which locates spatial data, including:
   - The Canadian spatial reference system comprising active control systems and geodetic control points.
   - Data alignment layer, including highly visible feature points, such as road intersections.
2. The land feature layers: these represent physical features that are readily observable and well-defined, i.e. cannot be misinterpreted or speculated upon; e.g. power lines, railroads, roads, fixed structures, elevations, imagery, and hydrography.
3. The conceptual layers: these layers comprise that information created and used for the purpose of administering and describing the country; e.g. federal electoral districts, and municipal, provincial and territorial boundaries, as well as ecological zones.

4.5.4 Standards

It is widely accepted that CGDI must utilise international standards and specifications in its development. These are reviewed and selected by the GeoConnections Technology Advisory Panel. Currently, OGC web services standards, FGDC Content Standard for Digital Geospatial Metadata, and ISO 19115 geographic metadata standard core fields are supported by GeoConnections.

4.5.5 Access

Spatial data discovery in CGDI takes places through provincial, commercial, thematic, and national mechanisms:

1. Provincial: CGDI spatial data infrastructure at provincial level includes spatial data and services directories.
2. Commercial: CGDI is linked to commercial channels, which provide information and services for the benefit of users using a specific application or product.
3. Thematic: CGDI is connected to discovery mechanisms, coordinated by a number of public and private sector organisations, which are organised by themes of interest; e.g. geology, forestry, ecology, etc.
4. National: CGDI has the GeoConnections Portal as its national spatial data discovery mechanism.

National access to CGDI is through the interface of the GeoConnections Discovery Portal. This Internet portal is connected to, and references spatial data sharing systems across the country, and allows users to find out about available spatial data resources and products (Figure 4.4). The portal was designed with the following objectives in mind:

- To provide a search engine facility to spatial data users for discovering and evaluating spatial data products and services.
- To allow spatial data providers to distribute spatial data products and services, ranging from base data to high value services.

Figure 4.4: GeoConnections Discovery Portal (source: GeoConnections, 2010)

4.6 NSDI Collaboration Initiatives Comparison

An analysis of the different national spatial data sharing systems implemented by various countries is important to place any proposed system or set of recommendations into context, and contribute to improved decision-making within the complexities faced by the distinct communities. This analysis of the similarities and differences may be performed on the technical aspects of such national spatial data initiatives, and on the institutional aspects, which are critical areas in the creation and management of an NSDI (Williamson et al., 2003). Such a comparison is of value, where a systematic approach is adopted, and as such Masser's (1998a) 4-part common analytical framework compares:

1. Context, geographical and historical
2. Key providers,
3. Information distribution and legislative protection
4. Core data, and metadata, as well as coordination

Similarly, Steudler's (2003) proposed spatial data infrastructure comparison framework looks at a number of factors in the context of:

1. Policy encompassing the country's geographical, historical, and social context, and government spatial data sharing policy with respect to collection, distribution, and intellectual property controls.
2. Management and operation, with regard to core data, standard organisation, and policy on network access.
3. Influence with respect to human resources or people for spatial data providers and users.

In addition, this framework also proposes a performance evaluation based on indicators, such as objectives achieved, system reliability, and user satisfaction (Steudler, 2003).

It is accepted that spatial data can make a key contribution in realising national development targets, with impact on the social, economic, and environmental areas. As such, production of crucial, basic spatial data is exclusive responsibility of government. In the countries reviewed, i.e. the UK, USA, Australia, and Canada, it is the government that distributes spatial data, which is largely produced by government bodies representing the main, largest national providers. It is government through its various bodies that possesses both the legislative instruments and the necessary resources to collect and process national spatial data.

The national initiatives reviewed here, all highlighted three areas, which are key in NSDI development. These encompass:

1. framework data or fundamental datasets development;
2. standards and metadata development; and

3. enhancing spatial data sharing and access through connected online (Internet) distribution nodes.

In all cases, these areas were addressed through collaboration of academia, and the private and public sectors, at all levels and in every jurisdiction. Thus, collaboration was a critical factor in the success of all these initiatives.

A number of criteria are presented in this section, for the purpose of comparing the NSDI collaboration initiatives reviewed. These criteria involve the five themes by which each initiative was presented, i.e. objectives and vision, coordination, datasets, standards, and access.

4.6.1 Objectives and vision comparison

Success of a spatial data sharing initiative lies in having clear business objectives that are to be fulfilled (Williamson et al., 2003). Likewise, "*without a common goal, or objective, initiatives are likely to diffuse in any direction without taking advantage of each other. The vision provides the direction for SDI development*." Kok and van Loenen (2005, p.704). Therefore, good practice implies that vision, objectives, and associated tasks are clearly defined (Steudler, 2003).

The four national initiatives being discussed share a common conceptual approach in that a vision and aims have been defined and implemented. The common vision among the distinct initiatives was for creation of a tool for spatial data discovery, which also enables access to spatial data and services to serve the needs of diverse users nationwide. The common aim was to build a shared, collaborative spatial data resource and asset, governed and managed by specific policies and tools respectively. In each initiative, the aims were drawn as a series from the vision. All the initiatives recognized the need for direct involvement of the private sector and government at all levels. In practice, this is more prominent in both initiatives of the UK and Canada, and to a lesser extent Australia. While in the US GOS implementation there is absence of adequate representation of all government levels, and a lack of input from the private sector in terms of spatial data, even though its vision is more comprehensive and ideal. This real involvement of the private sector with its value-adding services in the UK, Canada, and Australian spatial data sharing initiatives brings significant benefits in terms of creating current and detailed datasets. In the US implementation, the ambiguity surrounding regulation of private sector spatial data has meant that GOS currently only offers data from federal bodies. This is in conflict with its vision of facilitating access to spatial data from a wide range of sources, not only government, but also academia and the private sector. This reflects an issue at the institutional level, where there is a need to look at private sector regulation, and also the means to encourage the sector to share spatial data, particularly where emergency response efforts or national security are at stake. Finally, while NSDI initiatives in the countries in question are relatively advanced, spatial data sharing, and access to it, nationally, is still not fully realized.

4.6.2 Coordination Comparison

Satisfactory relationships between organisations, and absence of duplication of effort is achieved through effective forms of coordination, realised through well defined policy or mandate. In effect, a lack of clarity or absence of a mandate to regulate coordination is one of the causes of difficulty in NSDI development (Williamson et al., 2003). Similarly, the lack of a mandate for data sharing severely limits collaboration, and that organizations require such a mandate to overcome their institutional inertia (Craig, 1995), and the bodies concerned must be forced to share their data (Azad and Wiggins, 1995). Therefore, an effective policy on coordination, based on a legal mandate or formal order, is key to the success of any spatial data sharing initiative, and evidence of good practice.

The absence of mandatory powers to compel sharing of spatial data, and push through development is apparent in the Australian ASDI initiative, for which ANZLIC is responsible. Moreover, added to this absence of mandatory authority for spatial data sharing and exchange, both UK NGDF and Canadian CGDI also lack a structure for coordination, rather they are built on purely voluntary arrangements between interested parties. The success of an NSDI hinges upon having a robust institutional national framework, with effective policy supporting it, and a clear mandate. In this respect, it can be seen that the US GOS initiative possesses a strong coordination component, in particular at the federal level, with other sectors, academia, private sector, and local government bodies, relegated to a secondary role. Yet a positive aspect of being a mainly federal initiative has meant that it possesses high-level political support, which would make it possible to gain policy mandating spatial data sharing. On the other hand, the weak participation of other levels of government, state and local, needs to be addressed for the initiative to be fully realized, which requires a mandate so far lacking.

Funding NSDI initiatives is also an area of variation between the countries studied, which fit the particular circumstances and needs of each. In this respect, "*there is no single funding approach that will meet the needs of all countries*." Giff and Coleman (2003, p. 212). Yet the sources of funding in a way influence the degree of data sharing (Kevany, 1995). In most cases, funding from central government has been the main contributor to the rapid development of spatial data sharing systems (De Montalvo, 2004), and so represents an excellent way of ensuring NSDI implementation.

The diverse approaches to NSDI development funding can be seen in that Australia chose the decentralized approach, with each jurisdiction providing for its own programme. On the other hand, in Canada, the costs of spatial data creation, maintenance, and distribution are met by a cost-recovery mechanism, where government bodies charge fees to provide spatial data. It is worthwhile mentioning the key role of the Canadian private sector through GIAC in developing CGDI, in contrast to the other countries. The UK has opted for a contractual arrangement, i.e. NIMSA, between the Deputy Prime Minister's Office and the OS, through which central government funding is made available. However, while public funding has been made available, a cost recovery mechanism, i.e. charging users for data, is also in place. The US NSDI initiative has benefited from central government funds given via FGDC among others since 1994; the aim is to help government bodies in development of the system. This central funding has contributed to accelerated NSDI development. Moreover, the US model does not adopt any cost recovery, rather open access is granted to data, especially at federal level, as the assumption is that spatial data activities lie within the publicly-funded role of such bodies. In contrast, at state and local government levels, some cost recovery measures may be applied with respect to their spatial data. Yet overall, and in a fundamental difference, the USA does not apply any copyright or intellectual property rights over spatial data in its custody, compared to the UK, Australia, and Canada, which do so.

4.6.3 Datasets Comparison

In any spatial data sharing system, fundamental or core datasets represent a key constituent (Williamson et al., 2003). For this purpose, common data themes that are widely accepted within the spatial data user community must be shared among stakeholder bodies (FGDC, 2010). Facilitating access to, and ensuring availability of spatial data remains the primary motivation for NSDI, and so data organized into datasets is its central cornerstone. In this respect, fundamental or core data from multiple sources must be seamlessly available and accessible at negligible cost (De Montalvo, 2004), which represents the ideal to be aimed for. This is reflected in NSDI good practice by an organised system of available fundamental datasets.

Within ASDI in Australia, GIS applications usage revealed ten common themes, but these are not yet completed (Clarke et al., 2003). Within the UK and Canadian NSDI initiatives, core themes still lack clear definition, while the USA has clearly specified seven fundamental datasets comprising the commonest spatial data themes used and accepted in its spatial data user community. A criticism leveled against GOS is that while 34 themes were identified by OMB as the proper foundation for the national spatial data sharing initiative, there are no plans to include the 27 remaining ones in GOS (Koontz, 2003).

4.6.4 Standards Comparison

Another factor identified as key to spatial data sharing initiative success relates to standards for spatial data and metadata (Williamson et al., 2003), which are the enabling basis for spatial data development, sharing, and use (Maitra and Andersen, 2004). In this regard, interoperability is achieved by implementing existing, recognised standards (Peedell, 2004), and success hinges on consistency in the standards and metadata. Good practice is reflected in plans or mechanisms to implement national and international spatial data standards.

The proper development of an NSDI involves collaboration between stakeholders based on the use of common standards. As such, the four national initiatives presented have included development and implementation of data and metadata standards to facilitate seamless exchange leveraging uniform methods of dataset metadata creation. This allowed metadata search to be provided in all the national initiatives discussed through a Web portal interface. In practical terms, metadata is created and uploaded to Internet servers using a specific, purpose-designed tool provided as a freeware application made available to spatial data producers.

It can be seen that the other countries' initiatives have made use of US standards and metadata to a certain extent. The US FGDC since 1994, in issuing the Content Standard for Digital Geospatial Metadata, and later versions, has actively contributed to international standards development by both OGC and ISO. This has meant that other countries have, in effect, de facto made use of US efforts, as they all adopted ISO standards and metadata.

4.6.5 Access Comparison

The reason for national spatial sharing systems is to ensure spatial data discovery and access. Therefore, metadata needs to be freely available to enable spatial data to be found (Peedell, 2004), since "*knowing which data exist, what their characteristics are, and under what conditions they are to be accessed will decrease duplication, improve efficiency and decision making, while reducing costs*" (Bernard et al., 2005, p.17). In this sense, good practice is the provision of metadata services with data access featuring short system response times (Steudler, 2003).

In the national spatial data sharing initiatives reviewed, clearinghouses or distribution nodes give access to spatial data, with the latter linking to data over the Web. All the initiatives discussed utilise the Internet to provide means to discover and access spatial data, involving: (1) a metadata search facility of related spatial data resources; (2) descriptive information for spatial databases allowing assessment of suitability to satisfy the needs of end-users.

Metadata services are part of all the initiatives, since this is key to locating spatial data preventing duplication and resulting in reduced costs. In contrast to the initiatives in the UK, Canada, and Australia, which only allow spatial data to be discovered, the US GOS portal includes the ability to access and download the spatial data from within the portal. This facilitates rapid and integrated access to spatial data. Thus, there is scope for further development of the other systems into portals that enable greater direct access to spatial products and services.

Spatial data sharing systems represent a powerful decision-making tool, since they function by seamlessly coordinating information across a variety of sources. "*Datasets that can be easily integrated to meet a variety of user requirements and business needs, have the benefit of increasing confidence in data use, consistency of presentation and consistency and comparability of results*" (Williamson et al., 2003, p.306). Deploying open standards that are internationally accepted in both spatial data and technology areas must be adapted for, and underpins proper NSDI development (De Montalvo, 2004).

Ensuring system architecture is interoperable is essential for spatial data to be accessed and shared using the Internet. As such, it represents a priority area in the implementation of all the national initiatives studied, which accept OGC open systems standards and specifications for this purpose. The aim of all initiatives is to raise levels of interoperability and so functionality in Web-based services; this has already been realized to a large extent in the US GOS initiative. The other initiatives, however, still need to do more achieve this. On the other hand, OGC web service standards still require further development to enable complex features to be supported and facilitate greater interoperability.

4.7 Summary

Initiatives to implement national systems for sharing spatial data must recognize that both institutional and technical factors are key elements in their success, which include organisational commitment, policies, and technological resources. The national initiatives reviewed here, for the UK, USA, Australia, and Canada, have been established for a number of years, and represent well advanced cases, but with some areas still requiring to be addressed (For comparison with KSA, refer to 'Barriers to Collaboration', Section 8.9.4, pp.194-199). The coordination among, and agreement, of all stakeholders may be achieved through accurate and reliable datasets, widely accepted metadata and standards, and interoperable technology.

The initiatives reveal the on-going nature of NSDI efforts, especially given the pace of change in technology-driven applications and tools. This guarantees that any successful initiative will enjoy a process of constant development. Currently, all initiatives require attention in the area of coordination between stakeholders, in particular by including all government jurisdictions and levels, as well as greater integration of the private sector. Also, interoperability of systems for accessing and integrating spatial data to meet user needs in public sector bodies, are areas for further effort.

This chapter has presented and compared the NSDI initiatives of UK, USA, Australia, and Canada within the frame of five main themes, namely initiative objectives and vision, coordination, datasets, standards, and access. The following chapter focuses on the research methodology, including the case study approach, and quantitative, qualitative, and mixed methods research. It introduces the survey questionnaire and semi-structured interview and reflects on those ethical aspects to be considered.

CHAPTER 5: RESEARCH METHODOLOGY

"*There are always many ways to tackle a problem – some good some bad, but probably several good ways. There is no single perfect design. A research method for a given problem is not like the solution to problem in algebra. It is more like a recipe of beef stroganoff; there is no one best recipe*…." (Simon, 1969, p.4).

5.1 Introduction

This chapter provides definitions of research methodology taken from the literature. It introduces the concepts of research designs, methods, and strategies, including case studies. The choice of inductive (theory building) and deductive (theory testing) approaches represented by qualitative and quantitative paradigms is explained. On a philosophical foundation of pragmatism, mixed methods research, which combines both quantitative and qualitative methods, and so gives the advantage of utilising both qualitative and quantitative methods within the same study, is presented. The strengths and weaknesses of the approach are highlighted.

The choice of mixed methods in this research project is justified by an analysis of the research questions, which comprised both quantitative and qualitative aspects. This mixed (quantitative and qualitative) research approach within the case study design allows research aims and objectives to be better achieved. Since the quantitative dimension is generally dominant, a mixed method approach where a quantitative inquiry is supported, explained, validated, and triangulated by a qualitative one, was considered to be best in fulfilling the aims and objectives of the work. The survey questionnaire as a quantitative research instrument, and semi-structured interviews as supporting qualitative instrument, are chosen for the purpose of collecting the necessary data.

5.2 Background

According to Bryman (2008, p.31), research design defines the overall "*framework for the collection and analysis of data*", while the research method is the technique used to gather the data. In the definition of Fellows & Liu (2003), research methodology is "*the principles and procedures of the logical thought process which are applied to a specific investigation*". The following sections briefly present an overview of the methodological background of this research, which is critical if valid and admissible answers are to be derived from the research effort. It also describes the research methods employed in satisfying the aims and objectives of the work.

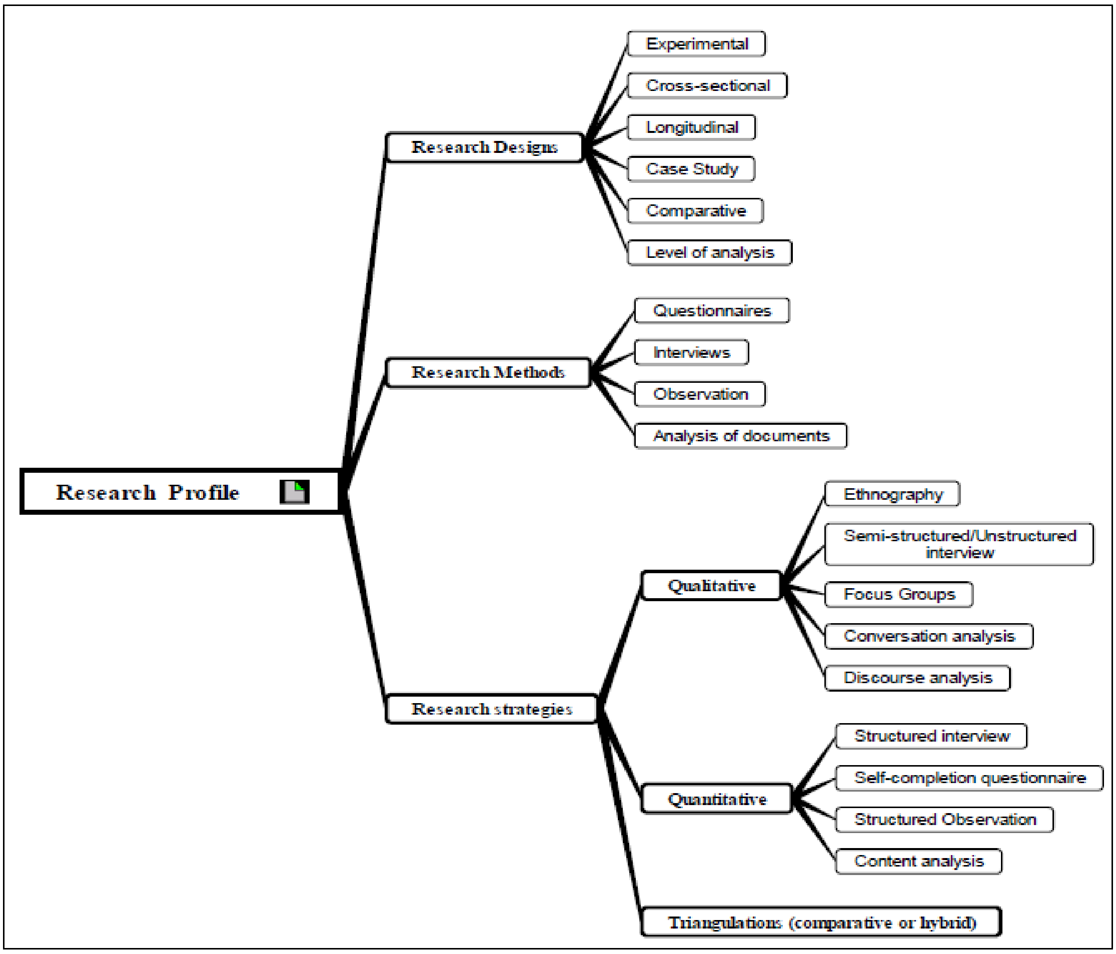


Figure 5.1: Research Designs, Methods and Strategies adapted from Bryman (2008)

5.3 Definitions of Research

Research is a systematic process of investigating problems to find solutions and explore and describe phenomena (Tan, 2004). Sekaran (2003) defined it "*as an organized, systematic, data based, critical, objective, scientific inquiry or investigation into a specific problem*". Research can be qualitative or quantitative, exploratory, descriptive, interpretive, and causal, and pure or applied, (Tan, 2004).

Pure research attempts to establish a "*theoretical explanation*" or "*understanding*", and is an area for academics. On the other hand, applied research focuses on finding solutions to problems, and is usually found in the industrial context (Fellows and Liu, 2003). In research, four aspects are of vital importance and relate to: bias, generalisation and particularisation, validity and rigour. The object of selecting a sound methodological approach is to ensure respect for these four factors. The different research designs, methods, and strategies are presented in figure 5.1.

5.4 Research Designs

The process of research design follows logically after determining the research questions, and by necessity must precede any data collection. This is because the purpose of the research design is a framework through which the research questions are answered by the collected data, both fully and clearly. According to Yin (2003), research design is "*a logical plan for getting from here to there, where here may be defined as the initial set of questions to be answered, and there is some set of conclusions (answer)*". Therefore, the research design is the framework binding the components of the research, i.e. the literature review, research questions, data collection and analysis, and the research findings (Tan, 2004).

A variety of research designs are available to researchers depending on the aims of the research and type of problem they wish to tackle. These include experimental designs, cross-sectional (survey) design, and case studies, among others. In experimental research designs, the independent variable is varied to determine its effect on dependent variables. Hence, it is rarely encountered in the social, business, or organisational research context. A cross-sectional research design requires data to be gathered on multiple cases "*at a single point*" in time to "*collect a body of quantitative or quantifiable data*" for multiple variables to find "*patterns of association*" (Bryman, 2008, p.44). A case study design involves the deep and detailed study of one or a number of cases. The approach used may be qualitative, quantitative, or a hybrid of both i.e. triangulation (Cresswell, 2002). Sometimes no real distinction can be drawn between cross-sectional and case study designs in the quantitative context (Bryman, 2008).

5.4.1 Case Studies

In the search for appropriate explanations for questions and issues, the case study approach allows human activities to be explored in their real world context, where the issue under investigation cannot be separated from its context. Case study research is characterised by reliance on multiple sources of evidence (Bryman, 2008). This research approach tends to be under-appreciated among others, yet can deliver comparable insights. Case studies in research are "*used extensively in social science research… (psychology, sociology, political science, anthropology, history, and economics) as well as practice-oriented fields such as urban planning, public administration, public policy, management science, social work, and education*" (Yin, 2003, pxiii). Indeed, Yin (2003) proposes case study research as going beyond observation and qualitative methods, but an approach in its own right. Generally, "*case studies are the preferred strategy when "how" or "why" questions are being posed, when the investigator has little or no control over events, and when the focus is on a contemporary phenomenon within some real-life context… Regardless of the type of case* *study, investigators must exercise great care in designing and doing case studies to overcome the traditional criticisms of the method.*" (Yin, 2003, p.1)

5.5 Research Methods

As illustrated in figure 5.1 previously, a number of research methods are available for use in research (Fellows and Liu, 2003). These represent techniques for data collection, and make use of specific instruments, such as questionnaire, interview, observation, or document analysis (Bryman, 2008).

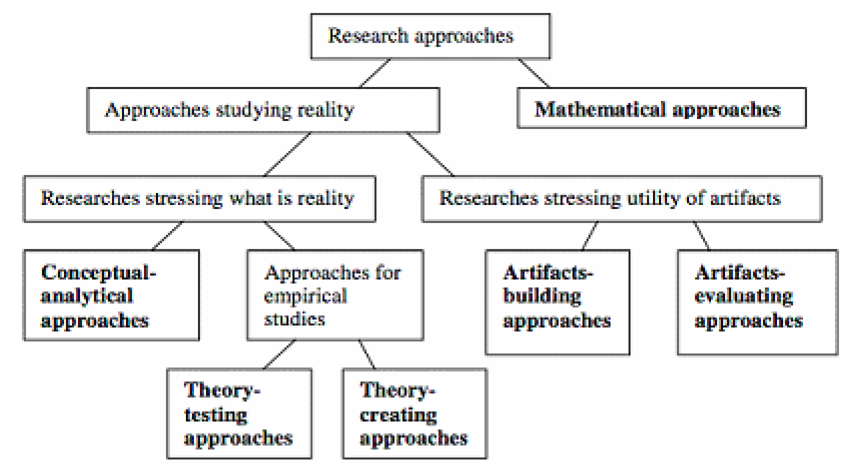


Figure 5.2: Research methods taxonomy. Source: Jarvinen (2000, p.125)

Table 5.1: Types of research design and methods

Author	**Bryman (2008)**	**Tan (2004)**
Research designs	Experimental and related designs (i.e. quasi-experiment). Cross-sectional design, a common form of social survey research. Longitudinal design and its various forms, such as the panel study and the cohort study. Case study design. Comparative design.	Case studies. Surveys. Experiments. Correlation research. Causal-comparative research. Historical research
Research methods	Questionnaires. Interviews. Observation. Analysis of documents.	Questionnaires. Interviews. Observation techniques. Analysis of past documents. Simulations

Jarvinen (2000) assembled a taxonomy of research methods (Figure 5.2), in which approaches studying reality were subdivided into those taking an empirical approach either creating theory or testing it. The theory-creating approaches included the normal case study, grounded theory, and others (Jarvinen, 2000).

5.6 Inductive and Deductive Approaches

There are two approaches to theory and research, the inductive and deductive. The deductive approach begins with a hypothesis that is either confirmed or not by the research findings arising from data collected, and is fundamental to quantitative research. On the other hand, the inductive approach seeks to extract inferences that can be generalised from findings acquired from the data and so constructing theory, and is fundamental to the qualitative approach. In a theoretical sense, this demarcates the difference between both approaches. However, in practice, there is an element of each approach that by necessity must be applied even in small measure. In a specific inductive approach, a researcher may reflect on data from the theoretical perspective, then seek to gather more data to find more general conditions in which the theory may hold true (Bryman, 2008).

5.7 Research Strategies

In the course of deciding the methodology suitable for the research work, the strategy for both collecting and analysing data must also be established (Fellows & Liu, 2003). This defines the way in which the research work is actually going to be conducted, regardless of whether a quantitative, qualitative, or mixed (triangulation) research was being undertaken (Bryman, 2008). It is clear that choosing the research strategy and attendant research methods has a significant influence on the outcomes. The differences between the quantitative and qualitative, as well as strategies are presented in tables 5.2 and 5.3.

Table 5.2: Differences between qualitative and quantitative (adapted from Bryman, 2008)

Quantitative	Qualitative
Numbers	Words
Point of view of researcher	Point of view of social actors
Researcher distant	Researcher close
Theory testing	Theory emergent
Static	Process
Structured	Unstructured
Generalisation	Contextual understanding
Hard, reliable data	Rich deep data
Macro	Micro
Behaviour	Meaning
Artificial settings	Natural settings

Table 5.3: Differences between qualitative and quantitative strategies (adapted from Bryman, 2008)

	Quantitative	**Qualitative**
Principal orientation to the role of theory in relation to research	Deductive; testing of theory	Inductive; generation of theory
Epistemological orientation	Natural science model, in particular positivism	Interpretivism
Ontological orientation	Objectivism	Constructivism

5.7.1 Quantitative Research

The quantitative research approach is oriented towards deductive, theory testing. It is commonly associated with experimental research of physical phenomena, and numbers, but is also encountered in organisational and social research (Bryman, 2008). According to Moore (2000), even qualitative issues may be treated quantitatively. Moreover, factual data can be collected, and the relationships between them investigated; this can then be compared against previously established results (Fellows and Liu, 2003).

Table 5.4: Quantitative Research: strengths and weaknesses (source: Johnson and Onwuegbuzie, 2004)

Strengths	**Weaknesses**
• Testing and validating already constructed theories about how (and to a lesser degree, why) phenomena occur. • Testing hypotheses that are constructed before the data are collected. Can generalize research findings when the data are based on random samples of sufficient size. • Can generalize a research finding when it has been replicated on many different populations and subpopulations. • Useful for obtaining data that allow quantitative predictions to be made. • The researcher may construct a situation that eliminates the confounding influence of many variables, allowing one to more credibly assess cause-and-effect relationships. • Data collection using some quantitative methods is relatively quick (e.g., telephone interviews). • Provides precise, quantitative, numerical data. • Data analysis is relatively less time consuming (using statistical software). • The research results are relatively independent of the researcher (e.g., effect size, statistical significance). • It may have higher credibility with many people in power (e.g., administrators, politicians, people who fund programs). • It is useful for studying large numbers of people.	• The researcher's categories that are used may not reflect local constituencies' understandings. • The researcher's theories that are used may not reflect local constituencies' understandings. • The researcher may miss out on phenomena occurring because of the focus on theory or hypothesis testing rather than on theory or hypothesis generation (called the confirmation bias). • Knowledge produced may be too abstract and general for direct application to specific local situations, contexts, and individuals.

5.7.2 Qualitative Research

Qualitative research is "*descriptive and inferential in character*", and is powerful in discovering potential explanations to issues under study (Graham, 2000, p.10). Qualitative research is used where it is not practical or perhaps ethical to undertake experiments. Such research looks at the "*reality*" existing in and between organisations, captured from the views of the people directly or indirectly involved (Graham, 2000). It involves collection of data using three means: open-ended interviews, first-hand observation, and written documents such as questionnaires. Analysis of documents, like questionnaires in an open survey, yields data in the form of quotations and extracts. This raw, descriptive information is then organised through content analysis into themes, and categories (Gillham, 2008).

Table 5.5: Qualitative Research: strengths and weaknesses (source: Johnson and Onwuegbuzie, 2004)

Strengths	Weaknesses
• The data are based on the participants' own categories of meaning. • It is useful for studying a limited number of cases in depth. • It is useful for describing complex phenomena. • Provides individual case information. • Can conduct cross-case comparisons and analysis. • Provides understanding and description of people's personal experiences of phenomena (i.e., the "emic" or insider's viewpoint). • Can describe, in rich detail, phenomena as they are situated and embedded in local contexts. • The researcher identifies contextual and setting factors as they relate to the phenomenon of interest. • The researcher can study dynamic processes (i.e., documenting sequential patterns and change). • The researcher can use the primarily qualitative method of "grounded theory" to generate inductively a tentative but explanatory theory about a phenomenon. • Can determine how participants interpret "constructs" (e.g., self-esteem, IQ). • Data are usually collected in naturalistic settings in qualitative research. • Qualitative approaches are responsive to local situations, conditions, and stakeholders' needs. • Qualitative researchers are responsive to changes that occur during the conduct of a study (especially during extended fieldwork) and may shift the focus of their studies as a result. • Qualitative data in the words and categories of participants lend themselves to exploring how and why phenomena occur. • One can use an important case to demonstrate vividly a phenomenon to the readers of a report. • Determine idiographic causation (i.e. determination of causes of a particular event).	• Knowledge produced may not generalize to other people or other settings (i.e., findings may be unique to the relatively few people included in the research study). • It is difficult to make quantitative predictions. • It is more difficult to test hypotheses and theories. • It may have lower credibility with some administrators and commissioners of programs. • It generally takes more time to collect the data when compared to quantitative research. • Data analysis is often time consuming. • The results are more easily influenced by the researcher's personal biases and idiosyncrasies.

5.7.3 Mixed Methods Research

The choice in research methodology between quantitative and qualitative has been the subject of heated debate for a significant period of time. Purists on both sides have argued the case for the superiority of one approach over the other, and argued the thesis of incompatibility, i.e. that both approaches cannot be mixed (Howe, 1998 cited in Johnson and Onwuegbuzie, 2004). Arguing a positivist philosophical position, quantitative purists maintain that social observations can be treated like physical phenomena, and reliance made on hard, and generalisable data. They separate the observer from the subject of his observation, advocating objective, time-, and context-free generalisation. On the other hand, the qualitative purists argue from a constructivist and interpretivist position. They reject the feasibility of objective inquiry, or even generalisation that is free from time or context. In the qualitative approach, the observer is indistinguishable from the observed context, as such values play a part, and indeed the deep and rich data gained from observation is considered superior (Guba, 1990 cited in Johnson and Onwuegbuzie, 2004).

Table 5.6: Mixed Research: strengths and weaknesses (source: Johnson and Onwuegbuzie, 2004)

Strengths	Weaknesses
• Words, pictures, and narrative can be used to add meaning to numbers. • Numbers can be used to add precision to words, pictures, and narrative. • Can provide quantitative and qualitative research strengths (i.e., see strengths listed in Tables 5.4 and 5.5). • Researcher can generate and test a grounded theory. • Can answer a broader and more complete range of research questions because the researcher is not confined to a single method or approach. • Specific mixed research designs have specific strengths and weaknesses that should be considered (e.g., in a two-stage sequential design, the Stage 1 results can be used to develop and inform the purpose and design of the Stage 2 component). • A researcher can use the strengths of an additional method to overcome the weaknesses in another method by using both in a research study. • Can provide stronger evidence for a conclusion through convergence and corroboration of findings. • Can add insights and understanding that might be missed when only a single method is used. • Can be used to increase the generalisability of the results. • Qualitative and quantitative research used together produce more complete knowledge necessary to inform theory and practice.	• Can be difficult for a single researcher to carry out both qualitative and quantitative research, especially if two or more approaches are expected to be used concurrently; it may require a research team. • Researcher has to learn about multiple methods and approaches and understand how to mix them appropriately. • Methodological purists contend that one should always work within either a qualitative or a quantitative paradigm. • More expensive. • More time consuming. • Some of the details of mixed research remain to be worked out fully by research methodologists (e.g., problems of paradigm mixing, how to qualitatively analyze quantitative data, how to interpret conflicting results).

Within a philosophical regime of pragmatism, a mixed approach applying both quantitative and qualitative models or methods has also been advocated by scholars for drawing on the strengths and reducing the weaknesses of each approach (Tashakkori and Teddlie, 2003; Creswell, 2003; Johnson and Onwuegbuzie, 2004). They contend that approaches may be mixed to provide the best way of answering the research questions (Johnson and Onwuegbuzie, 2004). As such, Johnson and Onwuegbuzie (2004, p.17) define mixed methods research "*as the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts, or language into a single study*". Importantly, they say that "*research methods should follow research questions in a way that offers the best chance to obtain useful answers*" (Johnson and Onwuegbuzie, 2004, p.17).

5.8 Relationship of Research Questions to Methodology

Specific research questions were identified from the research problem and statement. In KSA:

1. What are the spatial data and SDI concepts that are essential to developing NSDI?
2. In NSDI development, what relationships bind its components?
3. What is the experience worldwide of the best practice NSDI collaboration initiatives?
4. What is the current form of NSDI in KSA, and how far is it satisfactory to the needs of stakeholders?
5. What recommendations can describe a best practice Saudi NSDI collaboration initiative?

The choice of research approach must arise from a study of the research questions, and analysing their nature, according to Johnson and Onwuegbuzie (2004). In this research, the questions above are generally quantitative, but may also have qualitative dimensions. Questions 1, 2, and 3 are mainly quantitative in nature, and can mainly be answered from the literature review. Question 4 combines both quantitative and qualitative aspects, as it asks for a description of NSDI in KSA, which can be derived from the questionnaire, and also the interviews. However, how far NSDI in KSA satisfies stakeholders relies on qualitative data from interviews. As for question 5, it is best dealt with satisfactorily within a mixed method approach. Since the quantitative dimension is generally dominant, a mixed method approach where a quantitative inquiry is supported, explained, validated, and triangulated by a qualitative one, was considered to be best in fulfilling the aims and objectives of the work.

5.9 Research Instruments

The mixed (quantitative plus qualitative) method was chosen as the best way to address the research questions. Therefore, appropriate instruments need to be selected. In this case, quantitative data was collected mainly using a questionnaire, while supporting qualitative data was gained from semi-structured interviews.

5.9.1 Survey Questionnaire

A questionnaire is a widely used research instrument, which is distributed to a sample of participants to elicit responses to both closed-, and open-ended questions. Since it is self-administered, the questionnaire must be easy to follow and answer, as it is completed without available human guidance. Compared with interviews, it has a number of advantages, being cheaper, quicker to administer, with no interviewer influence or variability, and is convenient for those completing it. However, it also has a number of disadvantages, including no prompting, does not allow an issue to be probed, are restricted in length, questions have to be restricted to salient issues, and few open-ended (people do not want to write much), anonymous in that the person is not identifiable, risks missing data, and may suffer low response rates (Bryman, 2008).

The questionnaire was the primary instrument for the collection of quantitative data in this research. A total of 26 questionnaires were distributed to 26 key persons in the 26 key spatial data organisations in KSA. In the first stage, a pilot questionnaire was developed and circulated to 4 organisations. The comments and criticisms received were used to amend and improve it. The revised questionnaire was then distributed once more to 6 organisations, and comments showed that was clear, understandable, and straightforward. This final version of the questionnaire (see Appendix 1) was delivered to all the participants in the survey.

5.9.2 Semi-structured Interview

Semi-structured interviews were the means to obtain qualitative data to support, explain, validate, and triangulate the quantitative data gained from the questionnaire. The semi-structured interviews were important to bring depth and “rich” data to the research. In this work, 72 individuals in 26 stakeholder organisations were interviewed.

In the tradition of semi-structured interview of open-ended questioning, questioning and eliciting responses that guided further questions, discovery and exploration was possible, unlike a strict question format (Appendix 3). This would allow discovery in the qualitative context of this case study research. Questions were also tailored to the position and role of the person in his organisation, and reflected their experience. However, the questionnaire was used as a rough guide to the questioning, and so touched upon a description of the nature of the organisation, including employees, structure, and areas of business, the areas of spatial data it was involved in, exploring the nature of organisational relationships with regional and central government bodies, and coordinating agencies nationally, as well as spatial data used or provided by the organisation. In addition, participants were asked about any current or past collaboration venture involving their organisation.

In order to ensure the participation of key personnel, the interviews were scheduled and pre-agreed in each region for roughly a whole week. In each region, the leading SDI stakeholder organisation was asked to host the visit, and coordinate with the other stakeholders in the region to facilitate interviews and questionnaire distribution to relevant persons within each organisation. The persons concerned and their organisations were also sent briefing documents beforehand explaining the purpose of the research, the importance of their participation, ethical statement and consent form, as well as the questionnaire. In the interview, some interviewees supported their statements by providing documentation about the spatial data activities in their organisation. The data gathered during the visit to each organisation was aggregated, and represented each participant's view of SDI organisation, processes, and technical issues in their area.

5.9.2.1 Semi-structured Interview Schedule

The interviews broadly followed the research themes below, with the questionnaire acting as a rough guide to the questioning:

Theme 1: Organisational overview (structure, staffing, main business/role).
Example questions: Tell me about your organisation: in what areas of business does it work? How many people does it employ? How many staff are involved in spatial data activities? What role do you play in the organisation?

Theme 2: Spatial activities of the organisation.
Example questions: In what way is your organisation involved with spatial data, and in what areas. Is your organisation a consumer, or does it supply spatial data, or both?

Theme 3: Spatial data sharing
Example questions: Please describe the spatial data type your organisation uses or supplies to others? In as much detail, can you describe the nature, form including policy aspects, of any arrangements or agreements on spatial data sharing your organisation has? In these data sharing arrangements, would you comment on whether you prefer these as formal or informal? And why? Are spatial data sharing arrangements reflected in the organisation's policy? What standards do you use within the organisation for spatial data? Is there a case of different standards within organisation units or partners? In your view, can you outline the obstacles you face in data sharing? Can you describe any organisational, policy, non-

technology, technology, or other aspects that facilitated data sharing? What aspects have been obstacles?

Theme 4: Organisational relationships with regional and central government bodies, and coordinating agencies nationally.

Example questions: Can you describe the type of relationship that you have with other bodies and organisations, public and private sector. Do you have local partners only or do you collaborate nationally across the Kingdom? Is there a framework in which you collaborate with others in spatial data? Can you describe it? Does collaboration involve sharing resources, personnel skills, or technical infrastructure?

Theme 5: Specific SDI or collaborative initiative of the organisation.

Example questions: Can you describe any current or past SDI collaboration involving your organisation? What made you decide to collaborate? What would you say are the key obstacles to collaboration? What were the factors that facilitated collaboration? Has your organisation benefited from such collaboration? Would it be true to say that in the Kingdom, interpersonal rather than institutional relationships smooth the way for SDI collaboration? Was the collaboration implemented by formal agreement, e.g. service level agreement, memorandum of understanding etc.?

It is to be noted that there is a degree of overlap between questions across themes due to the dynamic nature of the semi-structured interview, where the responses of the interviewee guided the enquiry. One respondent may be asked a question under the heading of one theme, and so it is not repeated to them for another. The researcher also requested documentary evidence, policies, and documentation regarding the interview themes from the organisations, and a number of these organisations agreed and granted this request. This process secured a description of the nature of the organisation, including employees, structure, and areas of business, the areas of spatial data it was involved in, and allowed the nature of inter-organisational relationships with regional and central government bodies, and coordinating agencies nationally, as well as spatial data used or provided by the organisation, to be explored.

5.9.2.2 Saudi National Spatial Data Infrastructure E-Group

The researcher created an e-group under the name of “Saudi National Spatial Data Infrastructure”, which contained the contact emails of many of the experts from the different spatial data organisations in Saudi Arabia, especially those people who had participated in the semi-structured interview. The purpose of the e-group was to keep in touch with these experts, and so update the research data with any new information about spatial data activities in the KSA. The e-group was key to a continuing collection of data, which shed further light on issues that emerged even after the interviews and questionnaire survey had been concluded.

5.10 Ethical Considerations

Any research into a social or organisational context must consider the ethics of dealing with human subjects and participants in the work. Following the guidelines at the University of Nottingham, participants were explicitly informed of the aims of the research project. In the letter requesting assistance and appointments, participants were advised of what the researcher would require of them, and the time they would likely spend.

Participants were assured that their anonymity would be safeguarded, in that any information identifying their person or organisation would not be available to any other parties. No personally identifiable information would appear on any published material. Moreover, strict confidentiality would apply, in that the information they volunteered would be used only for the purposes of the research outlined.

The contribution of the participants in the research was acknowledged, and they were told that participation was completely voluntary, and they could withdraw at any time they saw fit. Participants were given the researcher's contact and university details, to allow them to get in touch regarding any aspect of their participation.

5.11 Summary

This chapter has provided definitions of research from the literature. It introduced the concepts of research designs, methods, and strategies, including case studies. The choice of inductive (theory building) and deductive (theory testing) approaches represented by qualitative and quantitative paradigms was explained. On a philosophical foundation of pragmatism, mixed methods research with the advantage of utilising both qualitative and quantitative methods within the same study were presented. The strengths and weaknesses of the approach were highlighted. The choice of mixed methods in this research project was justified by analysis of the research questions, from which a predominantly quantitative inquiry, supported, explained, validated and triangulated by a qualitative one was concluded to provide the best way of achieving the research aims and objectives. The survey questionnaire as a quantitative research instrument, and semi-structured interviews as supporting qualitative instrument were selected for the purpose of collecting the necessary data. Finally, ethical considerations in the conduct of the research were outlined.

The following chapter will cover the data collection tasks, and barriers encountered. In addition, it presents those organisations, representing all the stakeholders involved with spatial data in KSA, which were made a part of this study. It will briefly describe the conduct of the interviews and the return rate of the survey questionnaire.

CHAPTER 6: DATA COLLECTION IN KSA

6.1 Introduction

There are many different and isolated spatial data activities in the Kingdom of Saudi Arabia (KSA) within various ministries, government organisations and in the private sector. Each of them deals with spatial data and there is often poor sharing of this information with one other. The political and institutional relationships between the public and private sectors have, and will, continue to be challenging. This chapter presents the fieldwork undertaken for the purpose of gathering data in KSA.

6.2 Aim of the Fieldwork

Collecting data to satisfy the needs of this research took place over a period of time, which the researcher spent in KSA. During that time, a series of semi-structured interviews were carried out with lead persons in stakeholder organisations engaged in dealing with spatial data, principally key users and providers of spatial data in KSA. The data collection effort aimed at gathering the greatest amount of information to allow a full picture of spatial data sharing in KSA to be pieced together, including the challenges and obstacles that confronted the development of NSDI in KSA.

6.3 Description of Fieldwork

The field survey was conducted across a number of regions in KSA from May 2008 to September 2008. Then follow-up and updating of information continued with those persons, who had been interviewed, until the end of December 2010 by telephone, field visits, or through the Saudi National Spatial Data Infrastructure E-Group that was set up by the researcher. The aim was to update previously collected information, or add new data regarding spatial data in KSA, in areas which had not been previously addressed. This method was especially valuable in following up the current three SDI initiatives in KSA, namely the MOMRA, Ar Riyadh Development Commission, and Saudi National SDI initiatives. The data gathered in the field survey was key in building the conceptual framework and validating any assumptions made. The survey was preceded by a pilot questionnaire and refinement of the questionnaire, included semi-structured interviews of 72 individuals in 26 stakeholder organisations selected due to their involvement with SDI in KSA, whether users, providers of spatial data, or coordinating SDI efforts. The interviewees were selected for their position within the organisation in its different levels, and the researcher conducted the interview by prior appointment. The interviewees in the sample were given the necessary information explaining the importance and purpose of the research.

In addition, the code of ethical conduct in treatment of the information, and protecting the anonymity of the participants was also emphasised.

While conducting the interviews, themes based on the questionnaire were used to guide the discussion, and set questions were not used. Rather, open-ended questions were posed as prompted by the information given by the interviewee, taking into account the position, experience, and knowledge of the person concerned. The aim was to allow the interviewee to present their perspective of Saudi NSDI, in terms of culture and behaviour of organisations, intra- and inter-jurisdictional relationships, and collaboration.

A questionnaire was distributed to a select sample of 26 highly placed individuals (who were also interviewed), representing the higher level of management directing spatial data activity within the 26 stakeholder organisations. It was notable that of the 26 participants, 24 completed the questionnaire. Moreover, all but one agreed to join the e-group of key personnel working within Saudi NSDI. The research questionnaire explored the following themes:

- Background information on the organisation (structure, number of employees, primary areas of business);
- Activities in the area of spatial data;
- Relationships: intra- and inter-organisational with government, national coordination institutions and other organisations;
- Nature of the spatial data either used by the organisation or provided to others;
- Description of programmes for collaboration or in SDI initiated by the organisation.

The questionnaire design used multiple-choice questions extensively to allow rapid completion, and ensure a high response rate.

6.4 Fieldwork Tasks

The major tasks within this fieldwork can be summarised in the table (6.1) below.

Table 6.1 Fieldwork tasks scheduled from May 2008 to December 2010

Task
Start the fieldwork
Write official letters signed by General Director of King Fahd Security College to all target organisations.
Distribute the official letters, introduce myself and the survey questionnaire about spatial data in the KSA to all target organisations and record their comments / suggestions about the questionnaire.
Re-write the questionnaire according to the organisations' comments and suggestions.
Create a new e-group under the name of "Saudi National Spatial Data Infrastructure" which will contain the contact emails of many of the experts from different organisations in Saudi Arabia.
Distribute the final version of the questionnaire to 26 private and government

organisations (one copy per organisation).
Collect the completed questionnaires from all target organisations
Conduct a semi-structured interview with around 72 experts in Spatial Data from all target organisations

6.5 Target Organisations

Twenty-six paper/digital copies of the survey questionnaire (see Appendix 1) were distributed to government/private organisations in the three major regions (Ar Riyadh, Makkah and Eastern region) as shown in the following table (6.2):

Table 6.2 Participants in the study

Organisation Name	Location	Position of person received the questionnaire
General Commission for Survey (GCS)	Ar Riyadh	Director of GIS Centre
King Abdulaziz City for Science and Technology (KACST)	Ar Riyadh	Head of GIS Centre
Al Moammar Information Systems (AMIS)	Ar Riyadh	GIS Division Manager
High Commission for the Development of Ar Riyadh (HCDA)	Ar Riyadh	Manager, Spatial Information Management
King Saud University (KSU)	Ar Riyadh	GIS Department Manager
Saudi Consolidated Engineering Company – Khatib & Alami	Ar Riyadh	GIS Country Manager
Central Department of Statistics & Information	Ar Riyadh	Mapping Unit Manager
General Directorate of Civil Defence	Ar Riyadh	Manager of the Department of Developmental Projects
Software Vendor / Services Organisation	Ar Riyadh	Projects Director
Ministry of Agriculture	Ar Riyadh	Department of Information Technology
Saudi Aramco	Dammam	Supervisor of Surveying Services Division
Ministry of Municipal and Rural Affairs (MOMRA)	Ar Riyadh	Assistant Deputy Minister & General Director of Surveying and Mapping
Ministry of Water and Electricity	Ar Riyadh	Head of Ar Riyadh GIS
Presidency of Meteorology And Environment (PME)	Jeddah	GIS & RS Centre manager
Saudi Telecommunication Company	Ar Riyadh	Spatial Data Manager
Saudi Electricity Company	Ar Riyadh	GIS Project Manager
Saudi Post	Ar Riyadh	Assist manger of GIS centre
FarsiGeoTech	Jeddah	Project Manager & GIS Manager
GeoTech Group	Ar Riyadh	Director of IT
King Fahd University of Petroleum and Minerals	Dammam	GIS Unit Coordinator, Faculty Member at City and Regional Planning Department, and Chairman of Architectural Engineering Department
Ministry of Health	Ar Riyadh	Director Database and GIS unit in preventive department
Ministry of Transport	Ar Riyadh	E-Business Dep. GM
National Information Centre, Ministry of Interior	Ar Riyadh	GIS project- Analyst
Royal Commission for Jubail & Yanbu	Jubail	Section Manager, GIS
Saudi Geological Survey	Jeddah	GIS Manager
Saudi Commission for Tourism and Antiquities	Ar Riyadh	GIS Unit Manger

6.6 Fieldwork barriers

The researcher faced a number of barriers and impediments during the fieldwork. These barriers can be summarised as follows:

1) One copy of the questionnaire per organisation; it was very hard to find a qualified person in the organisation to complete the questionnaire.
2) If the researcher were to find the correct person for the semi-structured interview and questionnaire, then another difficulty was arranging a suitable time to meet this person.
3) At any time – possibly just before the appointment– the researcher would sometimes receive a call to cancel the meeting, because the target person had another important appointment or job for his organisation. This added to the time lost during the fieldwork.
4) The interviews may also highlight the potential problem of the effect of positionality of the interviewer in the eyes of the interviewee. The answers received might well be influenced by whether the interviewees saw the interviewer as scholar, representative of the government, or superior official. Generally, the replies tend towards the scholarly.

6.7 Survey Questionnaire

In this research, a total of twenty-six organisations, representing **all** the organisations working in spatial data in KSA, were included in the questionnaire survey. All except two completed the survey questionnaire, which were Saudi Aramco and the Saudi Telecommunications Company. Among the 24 copies, 92% were completed and returned (see Table 6.2). The number of the organisations that answered each question of the survey can be seen marked in the front of each section or question in Appendix 2.

6.7.1 Analysis of the Questionnaires

The analysis of the questionnaires from the survey was done following the procedure described by both Pallant (2007) and Kinnear and Gray (2009):

1. Coding each questionnaire, which involves assigning a unique identifying code to each questionnaire (Pallant, 2007).

2. Assigning specific codes to each question and its responses. In this case, “yes” and “no” responses were assigned numbers (1) and (2) respectively. In multiple choice type questions, each pre-determined response was given a number in ascending order, (1), (2), (3), etc. For ranking of statements, in this case ranking as “not very important”, “not important”, “neither”, “important”, and “very important” were assigned values of (1), (2), (3), (4), (5)

respectively. The same code values were used for responses of the same question types throughout the questionnaire.

3. In SPSS, a database for each questionnaire type was created. The data from the questionnaires was then input to the database.

4. The analysis of the data from the questionnaires was done using Microsoft SPSS.

In-depth statistical analysis of the data gathered in this study was not required, since most of the questions posed to respondents were closed-ended. It was judged sufficient to use descriptive statistics of percentages and frequencies to study whether the results were significant. According to Kinnear and Gray (2009), it is appropriate to present the responses of the participants in the survey in the form of percentages and frequencies.

6.8 Semi-structured Interview

The semi-structured interviews were important to bring depth and “rich” data to the research. In order to ensure the participation of key personnel, the interviews were scheduled and pre-agreed in each region for roughly a whole week. In each region, the leading SDI stakeholder organisation was asked to host the visit, and coordinate with the other stakeholders in the region to facilitate interviews and questionnaire distribution to relevant persons within each organisation. The persons concerned and their organisations were also sent briefing documents beforehand explaining the purpose of the research, the importance of their participation, ethical statement and consent form, as well as the questionnaire. The data gathered during the visit to each organisation was aggregated, and represented each participant’s view of SDI organisation, processes, and technical issues in their area.

In the tradition of a semi-structured interview employing open-ended questioning, eliciting responses that guided further questions, discovery and exploration was possible, unlike a strict question format as shown in Section 5.9.2.1. This would allow discovery in the qualitative context of this case study research. Questions were also tailored to the position and role of the person in his organisation, and reflected their experience. However, the questionnaire was used as a rough guide to the questioning, and so touched upon a description of the nature of the organisation, including employees, structure, and areas of business, the areas of spatial data it was involved in, exploring the nature of organisational relationships with regional and central government bodies, and coordinating agencies nationally, as well as spatial data used or provided by the organisation. In addition, participants were asked about any current or past collaboration venture involving their organisation.

Then follow-up and updating of information continued with those persons interviewed, until the end of December 2010 by telephone, field visits, or through the Saudi National Spatial Data Infrastructure E-Group. The aim was to update previously collected information, or add new facts regarding spatial data in KSA, in areas that had not been previously addressed.

6.8.1 Analysis of the Semi-structured Interviews

According to Merriam (1998) and Silverman (2009), it is worthwhile to begin analysis of qualitative data as soon as data collection starts, seeking to come to some conclusions and make generalisations that make sense. This analysis is made up of three stages, namely (1) reduction and (2) display of data, as well as (3) deriving conclusions and verifying them. The first stage of analysis, i.e. reduction, involved data simplification and abstraction using notes and interview transcripts. The second stage of data display involved organising this data and assembling it. In the third, conclusion and verification stage, ideas and themes begin to emerge from this data (Miles and Huberman, 1994).

In this research, the collection of qualitative data was conducted, mainly, using semi-structured interviews, supported by follow-up communication and field visits. The aim was to use these data to support, explain, and validate, (i.e. triangulate), questionnaire quantitativedata derived from the questionnaire data and to give, and give it more depth. The semi-structured interview format gave scope for open-ended questioning of interviewees allowing their responses to be developed by further questioning and so shed light on specific issues, taking into consideration the position and experience of the interviewee within an organisation. As such the interviews provided a depth of information, built on initial scoping questions related to organisation size, activities, and relationships with other organisations, including any collaboration, past or present. On many occasions, the interviews gave the researcher the opportunity to request and receive documentary evidence providing background material and facts describing the spatial data situation of organisations, and at national level. Moreover, the researcher was able to build rapport and trust with many interviewees, who remained in correspondence with the researcher through an e-group set up for that purpose, or in subsequent field visits, and telephone communication. This follow-up data collection was key in filling many gaps, and providing an up-to-date insight into the spatial data situation in KSA.

The data collected from the semi-structured interviews was processed in the following way:

1. Taking notes, during, and after each semi-structured interview.
2. Listening to the semi-structured interviews.
3. Transcripting the semi-structured interview.

4. Updating the semi-structured interview with any new information, which was gained through the Saudi National Spatial Data Infrastructure e-Group or by telephone or field visits.

5. Reading the semi-structured interviews and highlighting the ideas and themes.

6. Classifing the ideas and themes according to the questionnaire.

7. Omitting redundant and irrelevant information.

8. Coding the clear ideas and themes to make sure that any information identifying participants on the semi-structured interviews and their organisations would be safeguarded, as shown in the following Table 6.3:

Table 6.3 Semi-structured Interviews Coding

Code	Meaning
gou	government organisation user
gopu	government organisation provider and user
pou	private organisation user
popu	private organisation provider and user
ao	academic organisation

9. Translating these ideas and themes from Arabic to English.

10. Checking the translations with a professional Arabic and English language translator.

11. Using these ideas and themes to support, explain, validate, and triangulate the quantitative data gained from the questionnaire.

6.9 Summary

This chapter covered the data collection undertaken in KSA, and outlined the aims of the fieldwork as well as how it was done. The barriers encountered in the field were also presented. The chapter presented the target organisations, which consisted of all the stakeholders involved with spatial data in KSA. The interviews and the survey questionnaire returns were also treated.

The following chapter will look at the current spatial data situation in KSA. It will present the historical development of the SDI stakeholders in KSA. The chapter will also include the policy and legislation establishing and defining and regulating the roles of those bodies involved in using and creating spatial data in KSA, and will also explore the barriers to spatial data sharing.

CHAPTER 7: CURRENT SPATIAL DATA SITUATION IN KSA

7.1 Introduction

KSA saw huge growth in all areas, such as population, construction, industry, agriculture, education, etc. during an economic boom lasting from 1988 to date, along with rapid developments in IT. Yet, there was a lack throughout of comprehensive national strategies to leverage technological developments to help planners and decision-makers solve a majority of problems, related to the environment, urban context, and security, especially, with the availability of spatial data that could be put to use (Kubbara, 2007).

A lack of coordination resulted in duplicated efforts in the creation of base maps, and spatial databases, as well as varying specifications and standards. This lack of coordination could be attributed to absence of relevant legislation and policy. The price of such failure has had both a massive financial, as well as human cost, as documented in a single disaster event witnessed in KSA in late 2009, as mentioned previously in section 1.3.

This chapter explores the current situation of spatial data in KSA with respect to the key SDI stakeholders in KSA using information and documents obtained from the bodies concerned, and from interviews with key personnel involved in the area. The process of data gathering was also iterative, with updated information being received from many of the interviewees up to the end of December 2010 through communication by telephone, repeat visits, and the Saudi National Spatial Data Infrastructure e-Group, set up by the researcher. A further source of background information were the websites of these bodies (Table 7.1).

Table 7.1 Main SDI Stakeholders' Websites in KSA

Organisation Website	Organisation Name
http://www.gcs.gov.sa	General Commission for Survey (GCS)
http://www.momra.gov.sa	Ministry of Municipal and Rural Affairs (MOMRA)
http://www.sgs.org.sa	Saudi Geological Survey (SGS)
http://www.kacst.edu.sa	King Abdulaziz City for Science and Technology (KACST)

7.2 Main SDI Stakeholders in KSA

In KSA, four main stakeholder bodies are responsible for spatial data, as defined by Cabinet Decision No.70 dated 22/4/1410AH (21 November 1989) (KSA Council of Ministers, 1989). These are:

1. The General Commission for Survey (GCS)
2. The Ministry of Municipal and Rural Affairs (MOMRA)
3. The Saudi Geological Survey (SGS)
4. King Abdulaziz City for Science and Technology (KACST)

7.2.1 General Commission for Survey (GCS)

The General Commission for Survey (GCS) (previously known as the Military Survey) is attached to the Ministry of Defence and Aviation, which is under the direct authority of the Prime Minister's Office. The work of the GCS was defined in Cabinet Decision No.70 dated 22/4/1410AH (21 November 1989) (KSA Council of Ministers, 1989), and endorsed by Cabinet Decision No.8 dated 14/1/1427AH (12 February 2006) (KSA Council of Ministers, 2006a). The GCS was given responsibility for geodetic, topographic, and marine surveys, producing maps of scale (1:25,000), and less, and developing GIS systems related to its work and the needs of modernisation.

7.2.1.1 Brief history of the General Commission for Survey

The GCS was first established in 1926 as the "Survey Department". It was one of the departments in the Plans and Operations Directorate of the Military Operations Division in the Ministry of Defence and Aviation (at the time). The function of the Department was restricted to simply collating, classifying, and distributing old maps to the various branches of the armed forces. In 1393AH (1973), the Survey Department was renamed the Military Survey Department. In the first phase of establishing this department, it remained part of the Plans and Operations Directorate. In 14/6/1395AH (23 June 1975), the Military Survey Department was renamed the "Military Survey Directorate". Moreover, its function was modified to focus on collecting information, and producing maps and aerial photographs needed by all branches of the armed forces.

In 22/4/1410AH (21 November 1989), Cabinet Decision No.70 required that all agencies involved in survey work be unified in one body, called the Central Survey Directorate, linked to the Ministry of Defence and Aviation. The new body would undertake all work relating to geodetic, topographic, and marine survey, producing maps of scale (1:25,000) and less, and developing the GIS systems necessary for the Directorate's work and improvement.

Other survey work would fall within the jurisdiction of MOMRA, i.e. (1:25,000) scale maps and greater, while ground survey work related to oil and mineral related activity remained in the jurisdiction of the Geological Survey Commission of the Ministry of Petroleum and Mineral Resources (KSA Council of Ministers, 1989).

In 3/5/1422AH (23 July 2001), Cabinet Decision No. 133 changed the Central Survey Directorate in the Ministry of Defence and Aviation into the General Commission for Survey (GCS), an independent body with a separate budget, but linked to the Ministry of Defence and Aviation (KSA Council of Ministers, 2001). In 14/1/1427AH (12 February 2006), the Cabinet issued Decision No. 8 endorsing the formation of the GCS (KSA Council of Ministers, 2006a).

7.2.1.2 Functions of the General Commission for Survey (GCS).

1. Developing the technical specifications for geodetic, topographic, and marine surveys, as well as implementation and follow-up of said survey work.
2. Undertaking aerial photography related to its work, and coordinating, organising, and supervising the aerial surveys of other bodies.
3. Establishing and maintaining geodetic networks to serve the work of the Commission; measuring gravity according to need, as well as the necessary measurements for marine navigation maps.
4. Executing, in its own capacity or through designated agents, studies related to the areas of surveying within its jurisdiction, and providing consultancy services in these areas.
5. Marketing surveying services, and digital and paper products; publishing unclassified surveying, and geographical information.
6. Designing, implementing, and improving training programmes in its area of specialisation, and training Saudi personnel in KSA and abroad.

7.2.1.3 The GCS Board of Directors

The GCS is managed through a Board of Directors consisting of the Minister of Defence and Aviation and the Inspector-General (President), Deputy Minister of Defence and Aviation, (Vice President), and representatives from MOMRA, the Ministry of Transport, the Ministry of Economy and Planning, the Ministry of Finance, KACST, and SGS, as well as the Head of GCS, two specialist members, and two members from the private sector.

7.2.1.4 The most prominent achievements of the GCS

At national level, the GCS secured a number of prominent achievements, including:

1. Re-surveying the entire territory of KSA, and building the national geodetic network distributed throughout the Kingdom to the highest specification. This network was precisely tracked and calibrated using global positioning system (GPS) satellites. Hence, it is the reference used in all survey work, development and urban development projects, and studies related to movement of the Earth's crust, gravity, magnetic fields, etc.
2. Producing full coverage maps for KSA from modern digital and paper maps to scale (1:250,000).
3. Updating over 40% of mapping coverage of urban areas in the Kingdom in paper and digital maps of scale (1:50,000).
4. Building multi-level, multi-scale national geographical information databases, according to the latest technical specifications (formal specifications are not published).
5. Participating in surveying and drawing the land and marine borders of the Kingdom with neighbouring States.
6. Producing the official, authorised KSA map to scale (1:2,000,000) that shows and documents the international borders with neighbouring States.
7. Producing the road network map of the Kingdom for the Ministry of Transport to scale (1:3,000,000).
8. Producing the Atlas for the Holy Sites and major cities of the Kingdom.
9. Producing 3-D terrain model maps at different scales.
10. Surveying and measuring the positions (latitude and longitude) and heights above sea level of the Kingdom's airports, and connecting these to the local and international geodetic network.
11. Surveying the key positions in the Holy Sites in Makkah, in cooperation with the General Presidency for the Holy Sites Affairs.
12. Producing land/terrain form and feature models for the entire territory of KSA.
13. Preparing models for virtual aviation/ flight simulation.
14. Collating and updating national geographical feature names.
15. Implementing a number of projects and applications of GIS systems for a number of Ministries, and government agencies, including:
    a. Establishing a GIS centre for the Ministry of Education.
    b. Establishing a GIS centre for the Ministry of Health.
    c. Establishing a GIS centre for the Hajj Affairs Administration of the General Security Directorate.
16. Executing a number of aerial photography programmes within KSA, in addition to supervising aerial surveys by ministries, government bodies, and the private sector in KSA.
17. Surveying some of the Kingdom's marine regions, and collecting preliminary data necessary to prepare marine maps, almanacs, and navigation guides. In addition,

granting licences for marine research, and overseeing the implementation of directives regarding KSA marine territories.

7.2.1.5 The GIS centre at GCS

Geographical information systems are considered very important tools used to achieve the aims of GCS. The majority of modern uses and applications necessary for continuous development, the knowledge economy, and infrastructure, its maintenance and conservation require the use of capabilities provided by GIS, in combining spatial and non-spatial data in treatment, classification, analysis, and presentation.

7.2.1.5.1 *Functions of the GIS centre*

1. Collating survey and geographical data (spatial and descriptive) from the different sources.
2. Treating, organising, classifying, and coding geographical data according to the GIS Centre’s standards.
3. Establishing and managing multi-level, multi-scale comprehensive geographical information databases.
4. Studying, designing, and implementing different GIS projects and applications, and attending to their modernisation.
5. Producing and making available the geographical information and products requested by client bodies.
6. Providing training to centre staff in the field of GIS.
7. Coordinating with the relevant bodies in the field of GIS.
8. Providing technical advice in the area of GIS.
9. Working to establish standards, and regulations for geographical data exchange between producers and users according to unified standards. The aim being to make updated, comprehensive and integrated information available to serve public and private sector projects and programmes, and limit duplication and conflict leading to savings in money, effort, and time.

7.2.1.6 Achievements of the GIS centre

1. Establishing a topographic database of maps scale (1:250,000) for KSA.
2. Establishing a topographic database of base maps scale (1:50,000) of the main cities in KSA.
3. Establishing a database of the principal roads network in KSA.
4. Establishing a database for geographical features in KSA.

5. Executing many projects relating to applications of GIS for government agencies.
6. Providing a large number of government and private entities with maps, digital products, and geographical information.
7. Preparing the specifications and standards that meet the needs of GCS in the area of GIS.

7.2.2 Ministry of Municipal and Rural Affairs (MOMRA)

The Ministry of Municipal and Rural Affairs (MOMRA) falls under the direct supervision of the Prime Minister’s Office, and has 16 regional administrations distributed in the Kingdom’s regions. Each administrative region has a MOMRA regional administration that supervises a number of municipalities within its geographical jurisdiction, with the exception of Makkah and the Eastern Region, which have three regional administrations, Makkah, Jeddah, and Taif, and two regional administrations, namely Dammam and Ihsa, respectively. These MOMRA regional administrations supervise over 220 municipalities in the towns and villages of KSA.

By virtue of Royal Decree No. 266/A dated 8/10/1395AH (13 October 1975), MOMRA was granted responsibility for urban planning of KSA cities, in terms of roads, essential infrastructure, improvement and beautification of cities, development of rural and municipal areas, as well as managing the necessary services to maintain a clean and healthy environment in the Kingdom (KSA Royal Palace, 1975a). Cabinet Decision No.70 dated 22/4/1410AH (21 November 1989) further defined its remit regarding spatial data by allowing MOMRA to produce and update detailed mapping of all KSA cities and villages at different scales greater than (1:25,000), and preparing the necessary plans within these scale limits (KSA Council of Ministers, 1989).

7.2.2.1 Brief history of MOMRA

The first organisational framework for municipalities in the Kingdom was included within the basic directives issued by Royal Decree on 21/2/1345AH (30 of August 1926). Part 8 of these directives addressed municipal general councils, while Part 9 related to municipal management committees (KSA Royal Palace, 1926). In 1346AH (1927), the municipal constituency system was introduced, consisting of 62 articles, organising the administration of Makkah, Minna, and al-Shuhada municipalities. This was considered supplementary to Parts 8 and 9 of the Kingdom’s basic directives.

In 1357AH (1938), the capital city and municipalities administration system was introduced; this is considered the first independent system for municipalities, comprising 83 articles.

This new legislation cancelled the previous one regarding municipal general councils as included in the basic directives, as well as the municipal constituency system. Article 6 stated that the capital city administration was subject to the authority of the Prosecutor General's Office, while the remaining municipalities around the Kingdom were subject to the authority of administrative governors. When the Ministry of Interior was established, it became the authority overseeing all municipalities. The Ministry established an administrative unit looking after municipal affairs, called the "Municipalities Directorate".

In 25/9/1382AH (18 February 1963), Cabinet Decision No. 517 tackled the development, and improvement in the management of municipalities by setting up a Deputy Ministry for Municipal Affairs linked to the Ministry of Interior (KSA Council of Ministers, 1963). This new body was tasked with overseeing all municipal affairs, water resources development, and taking responsibility for studies and plans to improve municipal services in the Kingdom. In 13/8/1384AH (6 December 1965), Royal Decree No. 17 appointed the first Deputy Minister to head the Deputy Ministry for Municipal Affairs (KSA Royal Palace, 1965). In 4/7/1395AH (12 July 1975), Royal Decree No. 141/1 promoted the administrative grade of the agency to level of Deputy Minister of the Interior for Municipal Affairs – level Excellent (KSA Royal Palace, 1975b).

In 8/10/1395AH (13 October 1975), MOMRA was established by Royal Decree No. 266/A, and given responsibility for the urban planning of KSA cities, in terms of roads, essential infrastructure, city and environment improvement, rural and municipal development, and managing services for a clean and healthy environment (KSA Royal Palace, 1975a). In 21/2/1397AH (10 February 1977), Royal Decree No. 5/M defined the functions and tasks of municipalities, and MOMRA regional administrations (KSA Royal Palace, 1977a). In 22/4/1410AH (21 November 1989), Cabinet decision No. 70 defined the work of MOMRA regarding spatial data in producing, and updating detailed maps for all cities and villages of the Kingdom at scales greater than (1:25,000), and preparing development plans at these scales (KSA Council of Ministers, 1989).

7.2.2.2 The main functions of MOMRA

1. Urban planning of the Kingdom's cities.
2. Production and updating of detailed plans for all cities and villages of the Kingdom at scales greater than (1:25,000).
3. Providing roads and essential infrastructure.
4. City improvement, and rural and municipal development.
5. Adopting measures to maintain a clean and healthy environment in the Kingdom

7.2.2.3 MOMRA administrative units dealing with spatial data

MOMRA consists of 7 deputy ministries, and a group of different administrations, as well as 16 regional administrations covering 220 municipalities. The majority of these bodies deal with spatial data, which makes MOMRA a huge warehouse of large quantities of spatial data.

Discussion will focus here on the two most important agencies in MOMRA, both dealing with spatial data most; these are the Deputy Ministry for Land and Survey, and the Deputy Ministry for Urban Planning.

7.2.2.4 Deputy Ministry for Land and Survey

With the intent of improving performance in government work, and to facilitate citizens' transactions, a ministerial decision in 1379AH (1959) established a new body in the form of the General Administration for Land and Land Issues within the Deputy Ministry for Municipal Affairs at the Ministry of the Interior. Then in 1388AH (1968), a Royal Decree established the GCS in the Ministry of Interior. In 1395AH (1975), a Royal Decree established MOMRA into which both the Land and Survey Agency and the General Administration for Land and Land Issues were absorbed. A ministerial decision on 1412AH (1992) established the Grants Unit in the MOMRA Deputy Ministry for Urban Planning. In 1415AH (1995), the supporting agency for Land and Survey was established within the Deputy Ministry for Urban Planning. Then on 4/11/1424AH (27 December 2003), the Minister for Municipal and Rural Affairs issued directive No. 63713 establishing the Deputy Ministry for Land and Survey. In 19/3/1427AH (17 April 2006), Cabinet decision No. 61 established the supporting agency for Survey and Lands with its work limited to land and property registry (KSA Council of Ministers, 2006b).

7.2.2.4.1 *Aims of the Deputy Ministry for Land and Survey*

1. The management of land, and resolving any related issues.
2. Undertaking survey and mapping work to ensure spatial data, aerial photographs, and KSA village and city maps are available.
3. Organising and documenting title deeds and ownership through a land register.
4. Organising and documenting grant records.
5. Organising and documenting municipal properties and possessions.
6. Developing and improving spatial data systems.

7.2.2.5 The General Directorate for Survey and Maps

The General Directorate for Survey and Maps is linked to the Deputy Ministry for Land and Survey, and is considered its main arm in terms of spatial data. The General Directorate for Survey and Maps consists of a number of departments, namely Projects, Aerial Survey, Ground Survey, Map Production, Property Survey, Land Information, and Technical Training.

Cabinet Decision No. 70 dated 22/4/1410AH (21 November 1989) defined the work of MOMRA regarding spatial data in producing, and updating detailed maps for all cities and villages of the Kingdom at scales greater than (1:25,000) (KSA Council of Ministers, 1989). This responsibility was devolved by the Ministry to the General Directorate for Survey and Maps.

7.2.2.5.1 *Functions of the General Directorate for Survey and Maps*

1. Proposing plans and general policies related to survey work and its organisation.
2. Making available, detailed and topographic maps for the Kingdom's cities and villages, and updating them.
3. Establishing and tracking fixed ground references, and linking them to the national network in the Kingdom.
4. Undertaking production of maps for cities and villages in the Kingdom.
5. Establishing the conditions and technical specifications for aerial survey projects, in a form appropriate to the needs of development projects.
6. Preparing information systems specifically for survey and map activities, and making available a key surveying database for the Kingdom's cities and villages. This should be set up on computer, and maintained up to date, in coordination with the relevant authorities.
7. Establishing a comprehensive geographical information system.
8. Organising and archiving surveying records and documents, as well as maps, and aerial photographs, using a proper system of classification according to current standards.
9. Carrying out inventory, and determining property units, and linked documents, and recording any updates.
10. Providing technical support for the different Ministry organs in the area of surveying and maps.
11. Organising and archiving data and information related to the Directorate's activity.

12. Carrying out any other tasks it is given within its sphere of specialisation.

7.2.2.5.2 *Achievements of the General Directorate of Survey and Maps*

The land reference programme is one of the executive programmes of the General Directorate of Survey and Maps, within which it was able to establish around 25,000 reference points in the past period. The Directorate was able to establish a new geodetic support reference in the framework of the international ITRF system using 13 live transmission stations, and support network on this reference, from more than 600 new points. The aerial survey programme covered all cities, villages, and areas of the Kingdom with photographs of scale (1:5000), and (1:45,000) from which image, topographic, and property maps are produced to detailed scale from (1:1000) up to (1:25,000). In addition, a database was built of spatial data considered the largest in all government sectors. Furthermore, programmes were implemented for publishing and distributing survey information, and providing technical support and advice, as well as developing digital information databases containing records of ground position, aerial photographs, digital base maps, measurement specifications for maps, space photographs, property maps, land and property registry, land deeds, and area codes. The Directorate also undertakes training and qualification of surveying office personnel.

7.2.2.6 Land Information Directorate

This Directorate is linked to the General Directorate for Surveys and Maps. It aims to make available a database and system of land information.

7.2.2.6.1 *Functions of the Land Information Directorate*

1. Providing information, and the essential constituents of geographical information systems, represented in a ground reference network, databases of base and property maps, and preparing application programmes according to the needs of the work.
2. Extracting and deriving geographical information from aerial photographs and satellite pictures using remote sensing technology, and developing its uses.
3. Ordering and classifying geographical information, according to the different applications of remote sensing science.
4. Organising records, and documents, as well as maps and aerial photographs at different scales. Moreover, ordering, classifying, and coding according to the prevailing standards, while following up storage and use, and guaranteeing security and secrecy of content.

5. Establishing comprehensive spatial data databases.
6. Continuously updating geographical databases, and remote sensing applications.
7. Setting and disseminating guidance protocols for geographical information systems, which must be followed in practical application of such systems, in coordination with other specialist bodies.

7.2.2.7 Deputy Ministry for Urban Planning.

This Deputy Ministry was formed following the Royal Decree that established MOMRA in 1395AH (1975). At first, it was responsible for setting planning standards, and providing the necessary technical assistance to prepare and execute urban development plans locally, and at the level of regions and municipalities. As a result of progress in work and tasks, as well as variety in specialisations, administrations with specific specialisations were formed to direct development, and regulate it in the general context. These administrations were the General Directorate for: Local Planning, Studies and Research, Urban Planning, Transport and Traffic Engineering, and Project Coordination.

7.2.2.7.1 *Functions of the Deputy Ministry for Urban Planning.*

1. Setting general policies related to comprehensive urban development.
2. Establishing and supporting planning rules at all levels.
3. Preparing regional and urban plans for all KSA regions.
4. Setting the foundations, and modernising planning information systems.
5. Preparing detailed urban plans, and following up their updating.
6. Setting the foundations for following up the effect of development plans on the environment.
7. Producing detailed digital planning maps for all the Kingdom's cities.
8. Safeguarding, developing, and disposing of government land in the frame of achieving the public and private interest.

7.2.2.7.2 *Achievements of the Deputy Ministry for Urban Planning*

1. The National Urban Strategy, ratified by Cabinet Decision No. 127 dated 28/5/1421AH (28 August 2000), aimed at achieving balanced urban development in the Kingdom's regions (KSA Council of Ministers, 2000b).
2. The Regions Development Strategy as one of the outcomes of the National Urban Strategy.
3. The National Urban Observatory.

4. Preparation of infrastructure plans for cities, and continuously updating them. The updating process included base maps, road networks, land use, and digital city database.
5. Studies of development priorities are considered the first coordination project bringing together all sectors of development in the Kingdom at all levels. This study presented a practical process to order, and programme the priorities of supply in facilities and public services to residential neighbourhoods in cities and villages according to actual needs.
6. Study of the development and improvement strategy for facilities aimed at drawing up a strategy to provide all inhabited areas, with facilities and public services. According to actual need, and in the framework of reasonable economic cost.
7. Establishing the digital information database for cities and villages, which comprises base maps, approved plans, road networks, improved land use, detailed information on public services and facilities, in addition to many layers specific to town information.
8. Naming roads, and numbering properties.
9. The Deputy Ministry for City planning, through the General Directorate for Urban Planning established a national database of geographical information. In this case, the Urban Planning Administration, part of the General Directorate for Urban Planning built a national database of geographical information aimed at use in current planning processes in the Deputy Ministry of City Planning. This digital database contains:
    a. Aerial photographs at different scales and precision, which are continuously updated by the Deputy Ministry for Land and Survey.
    b. Corrected satellite pictures at the level of the Kingdom at a precision of 15 m for entire large cities, and 1 m and 0.6 m for city neighbourhoods, small towns, and villages that are continuously updated by KACST.
    c. National road networks.
    d. Residential plans (land boundary plans), whereby 5422 residential plans have been verified and numbered, covering a total area of 9332 square kilometres. Approved residential plans are updated daily, and verified and corrected against base maps.
    e. Land use, for all cities and villages in the Kingdom.
    f. Priorities of urban development.
    g. Studies of infrastructure plans.
    h. National urbanisation strategy.
    i. Studies of urban extents of cities and villages.
    j. Information on land plots (plot number, plan number... etc).
    k. Planning applications specific to urban planning and studies.
10. Currently, the information in the digital city database is being linked to the information in the National Urban Observatory established by the Deputy Ministry.

11. The General Directorate for Urban Planning in the Deputy Ministry for City Planning provides all government sectors with information, and digital maps, contributing in the achievements of projects in the right way.
12. The Deputy Ministry for City Planning is currently connecting the administrations and municipalities in the Kingdom by a geographical data exchange network to enable automatic update of information systems, and, assist administrations and municipalities in the area of digital information systems. Six administrations and municipalities have been connected in the first pilot phase, after which all administrations and municipalities will be connected to the Deputy Ministry for City Planning.

7.2.3 Saudi Geological Survey (SGS)

The SGS is linked administratively to the Ministry of Petroleum and Mineral Resources, which is linked directly to the Prime Minister's Office. The work of SGS has been defined by Cabinet Decision No. 70 dated 22/4/1410AH (21 November 1989) (KSA Council of Ministers, 1989), and subsequently emphasised by Cabinet Decision No. 115 dated 1420AH (1999) (KSA Council of Ministers, 1999). The SGS carries out all survey and exploration work for minerals, while improving its performance. Moreover, making available sufficient information on mineral deposits, and undertaking relevant studies and researches related to Earth sciences.

SGS strategy included the following detailed aims:
1. Providing society with information, and geological base maps.
2. Securing continuing strategic reserves of mineral resources.
3. Monitoring, surveying, and studying geological dangers, and contributing to mitigating their effects.
4. Studying environmental problems related to geological hazards, in addition to other hazards arising from urban expansion.
5. Supporting construction and urban projects through geological engineering studies.
6. Building and improving national Earth science databases.
7. Supporting and providing relevant advice related to Earth sciences to public and private sector bodies.

7.2.3.1 Brief history of the SGS

In 1366AH (1947), the first steps in establishing the Kingdom's geological infrastructure were taken; the Mining and Companies Directorate was established in the Ministry of Finance, and carried out the first aerial survey of the Kingdom, which was completed in 1368AH (1949). In 1373AH (1954), the Directorate was restructured, and renamed the

Directorate General for Oil and Minerals, which in turn continue to work under the umbrella of the Minister of Finance. From 1373AH to 1387AH (1954-1959), the organisation implemented the project for production of geological plans for the Kingdom in the scale (1:500,000) and (1:2000,000), in cooperation with both Aramco and the US Geological Survey. Moreover, it documented all mineral exploration and extraction activity, old mines, and carried out different studies on water sources.

In 1380AH (1961), the Ministry of Petroleum and Mineral Resources was established, and then in 1382AH (1963), the Directorate General for Mineral Resources (DGMR) was established and attached to the Ministry. Its work focused on geological survey, minerals exploration and extraction, and producing geological maps. In parallel with establishment of the DGMR, all maps produced in previous projects had been printed. The government began to sign contracts, and treaties, with many bodies and international companies in the field of Earth sciences.

In 1415AH (1995), the DGMR was renamed Deputy Ministry for Mineral Resources (DMMR) under the Ministry of Petroleum and Mineral Resources. In 1420AH (1999), Cabinet Decision No. 115 established the Saudi Geological Survey (SGS) with the task of carrying out surveying and exploration for minerals, and replacing both American and French geological survey missions. The SGS would act as the official advisory body for the State in the area of Earth sciences (KSA Council of Ministers, 1999).

7.2.3.2 Functions of the SGS

- Undertaking geological, geochemical, geophysical, and hydrological surveys, and mineral prospecting.
- Utilising the best methods for exploring and prospecting for mineral resources.
- Undertaking pre-feasibility studies on promising ores useful in the minerals industry.
- Classifying and verifying geological information related to mineral sources; preparing reports, and various geological plans, etc., related to its activities; printing, publishing, and storing such data on computers.
- Undertaking, either in its own capacity or instructing others, studies, researches, and providing investment services related to its work and activities to public and private sector bodies. SGS is allowed to solicit such services, as well as working in partnership with companies, bodies, universities, research centres, and others undertaking similar activities.

- Undertaking surveying and prospecting work to determine water sources, and aquifers, quantifying type and quantities to be extracted, and identifying the extent to which it is suitable for different uses, in consultation with the Ministry of Agriculture and Water (currently Ministry of Water and Electricity).
- Studying the geological aspects of environmental issues, including identifying the best means for disposing of harmful by-products of mineral extraction, and environmental waste resulting from geological and mineral extraction activities.
- Carrying out the necessary studies and research to track potential earthquake and volcano activity in the Kingdom, monitoring flooding and earth subsidence resulting from rainfall, and producing maps showing danger levels related to the different types of natural disasters, and maintaining a historical record.

7.2.3.3 SGS Board of Directors

SGS is directed by a board consisting of the Minister of Petroleum and Mineral Resources (President), and representatives from the Ministries of Defence and Aviation, Finance, Petroleum and Mineral Resources, Higher Education, Water and Electricity, and Economy and Planning, as well as KACST, the Head of SGS, and three specialist members.

7.2.3.4 Administrative units working with spatial data

7.2.3.4.1 *National Earth science databases in the SGS*

The national earth science databases are interconnected information databases, forming the national information database framework used to provide society with verified geological information to serve development projects, prepare scientific research and different studies. The earth science databases in the SGS consist of:

1. Geological maps;
2. Atlas of industrial minerals in the Kingdom;
3. Water resources;
4. Geophysical surveys;
5. Chemical analysis;
6. Digs and wells;
7. Climate;
8. Environmental geology;
9. Engineering geology;
10. Minerals exploration and extraction;
11. Remote sensing;
12. Aerial photograph;

13. Technical reports;
14. Geological hazards; and
15. Earthquake activity monitoring in the Kingdom information database.

7.2.3.4.2 *Geographical Information Systems (GIS) unit*

The GIS unit seeks to achieve the objectives of the SGS in building, updating and developing the national database in the areas of Earth sciences, mineral prospecting, earthquakes, and geological hazards, while providing services, support, and assistance to all projects, departments, and units in SGS in the area of GIS.

Functions of the GIS unit.

1. Working to update and develop geographical information databases, and mineral-related websites.
2. Collecting technical information from all technical directorates, and departments in the SGS, in coordination with programme and project directors.
3. Obtaining the necessary technical information from other bodies using authorised official channels.
4. Transferring paper maps into digital format using light scanning of paper geological maps, and building up a digital map database.
5. Data treatment and analysis, as well as producing statistics.

7.2.3.5 Achievements of the SGS in the area of spatial data

- Executing the geological map for KSA at scale (1:3000,000).
- Executing geological maps for Arab Shield at scale (1:250,000).
- Executing land, and valent and non-valent minerals maps.
- Executing mapping of the Red Sea coastal areas.
- Executing maps of earthquake and volcano zones in the Kingdom.
- Transferring all geographical features from maps of scale (1:50,000) into digital point form.
- Executing maps of Haql sector and Eastern Region for the Border Guards Service.
- Executing maps of administrative regions in the Kingdom at different scales.
- Executing the engineering geological map of Makkah.
- Transferring all technical information in the mineral resources handbook for the Kingdom into digital form, with all mineral prospecting sites identified by geographical position.

- Mapping projects for studies related to development, services to society, and water studies.
- Executing the Atlas of Islands of the Kingdom of Saudi Arabia.
- Specifying supervisory jurisdictions between regions and centres in the Makkah region, in cooperation with the Emirate of Makkah.
- Training many university students, and personnel from other government bodies in using GIS.

7.2.4 King Abdulaziz City for Science and Technology (KACST)

King Abdulaziz City for Science and Technology (KACST) is administratively directly attached to the Prime Minister's Office, and is considered a government, academic, not-for-profit institution with independent status. KACST aims to support and encourage applied academic research, coordinating the activities of academic research centres and organisations in keeping with the development needs of the Kingdom. Moreover, cooperating with the relevant authorities to set national policy and priorities in the area of science and technology, and achieving a strong technical and scientific foundation in the agricultural, industrial, mineral resource, and other sectors. KACST works to develop national scientific capability, and attract highly qualified persons able to work in the City, and contribute to its development, and put modern technology in the service of development in the Kingdom.

7.2.4.1 Brief history of KACST

The establishment of KACST can be traced back to 18/12/1397AH (29 November 1977) when Royal Decree No. 60/M decreed the establishment of the National Science and Technology Centre (KSA Royal Palace, 1977b). It continued to accomplish its functions, until renamed by Royal Decree No. 61/M dated 20/12/1405AH (5 September 1985) as the National Centre for Science and Technology (KSA Royal Palace, 1985a). In 19/4/1406AH (31 December 1985), Royal Decree No. 8/M changed it into a technology city named King Abdulaziz City for Science and Technology; the decree also defined the organisation for KACST (KSA Royal Palace, 1985c). Finally, in 9/1/1409 (21 August 1988), Royal Decree No. 23/7/M was issued endorsing the resolution of the Higher Committee for Administrative Reform No. 182 dated 15/5/1408 AH (4 January 1988), including organising KACST (KSA Royal Palace, 1988), most prominently having two Vice-Presidents, one supporting research, and the other overseeing KACST research centres (Higher Committee for Administrative Reform, 1988).

7.2.4.2 Functions of KACST

1. Proposing a national policy for developing science and technology with allied strategy and implementation plan.
2. Implementing applied research programmes to serve development in the Kingdom.
3. Assisting the private sector in improving agricultural and industrial products through research executed by KACST.
4. Supporting joint research programmes between the Kingdom and international research bodies to keep abreast of scientific developments on the international front, through a programme of grants, or joint work.
5. Awarding study and training scholarships to develop the necessary skills for preparing and implementing academic research programmes, and providing grants to individuals and organisations to do applied academic research.
6. Coordinating with government organs, and academic institutions and research centres in the Kingdom in the area of research, exchange of information and experience, and preventing duplication of effort. Coordination committees of experts from government agencies and organisations related to the work of KACST were formed to achieve these aims.

7.2.4.3 KACST Higher Council

The KACST has a Higher Council formed of the following: the Prime Minister (President), the Deputy Prime Minister (Vice-President), Minister of Defence and Aviation, Minister of Higher Education, Minister of Agriculture and Water, Minister of Industry and Electricity, Minister of Petroleum and Mineral Resources, Minister of Planning, Minister of Finance and National Economy, Head of General Intelligence, Head of KACST, and three members selected by the Prime Minister.

7.2.4.4 KACST units dealing with spatial data

Information is the key foundation for research, studies, and analysis; moreover, it is essential in improvement projects, and decision making in different vital areas. New technologies, represented by digital databases for archiving, classifying, and retrieving huge amounts of information, have greatly facilitated this.

Spatial data systems had brought an added dimension to digital information databases in terms of linking information to location. The availability of new technologies, represented by high capability remote sensing via satellite, have allowed regular monitoring and follow-up of changes on the earth's surface, and have become one of the key sources for building geographical information systems. Therefore, many public and private sector bodies have taken advantage of such technologies in acquiring, and analysing information, and planning projects that depend vitally on precision information, and rapid implementation.

In harmony with the aims of KACST represented by implementation of applied research programmes to serve development in the Kingdom, while coordinating with government bodies, and academic and research institutions in the Kingdom, and exchange of information and experience, preventing duplication of efforts, spatial data are presented through the centres for Remote Sensing, and Geographical Information Systems (GIS) attached to the Space Research Institute, which administratively is linked to the vice president of KACST responsible for research centres.

The following is a brief overview of the Space Research Institute, and the Remote Sensing and GIS centres.

7.2.4.4.1 *Space Research Institute*

The Institute's vision can be summarised as: "In the next five years, the Space Research Institute with the help of relevant authorities, will become a regional pioneer in space and aviation activities; its functions will not be limited to research and development, but also providing assistance and support to the needs of national security, and continuous development within the Kingdom of Saudi Arabia in these areas".

The Space Research Institute aims to transfer and localise space technology, execute academic and applied research, and coordinate with universities, and specialised scientific centres. The Institute works on building up qualified Saudi capacity, and benefiting from that in harmony with the plans and directions of national development and its key principles, which include adopting major directions in academic research, and technical development to satisfy the requirements of national security, and continuous development in the Kingdom of Saudi Arabia.

7.2.4.4.2 *Functions of the Space Research Institute*

1. Identifying the problems related to space research sciences.
2. Developing and implementing plans and programmes for applied research in this area, reviewing the results, and disseminating them to the relevant bodies.
3. Executing high-technology projects in the areas related to space science and aviation serving technology transfer and localisation in the Kingdom.

4. Organising and activating cooperation between the Institute and public and private sector bodies through joint projects aimed at developing applications in the areas of remote sensing, GIS, and IT programmes.
5. Cooperation with specialist international organisations in joint programmes, and exchange of experience in the area of space science and aviation.
6. Providing consultancy, and technical and academic support in this area to the public and private sector.
7. Building the National scientific information database in the area of space sciences, in coordination with the General Directorate for Information.
8. Providing the appropriate research environment in the fields covered by the Institute.
9. Proposing a programme for developing human resources, and work methods in the Institute in coordination with the Directorate of Administrative Development.
10. Proposing organised scientific activities falling within the area of speciality of the Institute.
11. Presenting regular reports on Institute activities.
12. Presenting a proposed budget for the Institute annually.

7.2.4.4.3 *The Saudi Centre for Remote Sensing*

The Saudi Centre for Remote Sensing was established by Royal Decree No. 8/1322 dated 24/7/1403AH (6 May 1983). The decree instructed that a satellite receiver station, and the Saudi Centre for Remote Sensing be established (KSA Royal Palace, 1983). The centre is one of the most distinguished in the world, since it has an integrated system for receiving, treating, analysing, and producing space photographs; in addition to the multiple satellites from which it receives information. The centre is considered the focal point for disseminating and integrating remote sensing technologies, as well as providing the infrastructure for many applications and uses of space photographs. It was influential in promoting and disseminating this technology at the level of government bodies and research centres in KSA.

The satellite receiver station at the centre covers an area of around 23 million square kilometres, which includes the majority of Arab countries and the Middle East region. The station tracks satellites within its area of coverage, and receives information from the satellites, and records that on various media. The centre has exerted efforts in ensuring multiple sources of information with differing technologies and applications, in order to provide appropriate information to the relevant authorities, scholars and researchers. A number of agreements have been concluded with international space agencies to receive, or purchase satellite data, which currently includes Landsat, Spot, Ikonos, QuickBird, Geo-A, NOAA, and others.

The area covered by these photographs varies from (11×11 km) to (3000-6000 sq.km) per photograph, and a resolution that varies from 0.5 m to 1100 m; it also varies according to the types of sensors, and variety of extents, angles, and periods of coverage. Since 1407AH (1987), more than 500,000 space photographs had been received from these satellites; these pictures cover all areas of the Kingdom and neighbouring countries.

The centre carries out primary data treatment of photographs received by the station, and producing them on standard models, and multiple levels in the form of tapes, CDs, or printed photographs of different sizes. In addition, the centre produces analytical photographs with added value for studies and research, which researchers and relevant authorities can benefit from. The centre also undertakes research, and implements projects related to remote sensing applications, in addition to organising conferences and specialist training courses.

7.2.4.4.4 *Functions of the Saudi Centre for Remote Sensing*

1. Receiving information from satellites.
2. Treatment, analysis, and production of satellite photographs.
3. Promoting academic awareness of remote sensing.
4. Developing academic research in the area of remote sensing technology.
5. Providing technical support and consultancy in the area of remote sensing.
6. Executing joint projects with beneficiaries.
7. Proposing appropriate programmes for human resource development at the centre.
8. Preparing regular reports on centre activities.
9. Preparing the proposed annual budget for the centre.

7.2.4.4.5 *GIS centre*

Establishment of the GIS centre was in harmony with the key functions of KACST represented by coordination with government bodies, academic institutions, and research centres in the Kingdom, in the area of research, exchange of experience, and providing technical and consultancy services to those wishing to benefit from these.

The GIS centre was established in 1420AH (1999), at the same time as the Space Research Institute, in order to use advanced technology to serve development purposes by way of coordination between related bodies to make available verified information to relevant authorities taking into account unifying efforts, and rationalising costs, while taking advantage of the available resources in the Institute, in terms of available space photographs for the Kingdom, as well as the high performance computing facility to build GIS databases, and connect these to beneficiary bodies through an information network.

7.2.4.4.6 *Functions of the GIS centre*

1. Participation in the work of committees related to national GIS.
2. Striving to unify national standards for GIS.
3. Participating in establishing systems and rules for exchange and update of information.
4. Developing models for the different applications of GIS.
5. Implementing joint projects with beneficiary bodies to serve development in the Kingdom.
6. Developing personnel through study and training abroad, as well as local training programmes.
7. Providing technical support and consultancy to beneficiary bodies.
8. Building an information database serving the aims of the centre.

7.2.4.5 Achievements of KACST in the area of spatial data

1. Implementing a number of projects for the Saudi telecommunications company; producing digital maps derived from corrected space photographs, and integrating these with a network of digital maps for communications.
2. Implementing the project for a base map of the city of Makkah for the benefit of the city's administration.
3. Executing an exploratory study on GIS in the Kingdom for the benefit of the Development Commission for Makkah, Madinah, and the Holy Sites.
4. Supervising implementation of the project for developing a GIS infrastructure in the Development Commission for Makkah, Madinah, and the Holy Sites.
5. Implementing a cooperation agreement with al-Daleel company for Information Systems to publish the Explorer series, introducing CDs containing digital maps for the main cities in the Kingdom supported by descriptive information on the positions of features, and different services.
6. Implementing the project identifying water stations and wells in some areas of the Kingdom using space photographs, and GIS, supported by Madinah administration.
7. Producing precision digital maps for the Kingdom's cities suitable for vehicle tracking systems, containing major and minor roads, neighbourhoods, government and service bodies, schools, hospitals, mosques, and other features.

8. Participating in producing the space atlas for all KSA in cooperation with King Saud University, and funded by Emir Sultan bin Abdulaziz Charitable Foundation.
9. Beginning implementation of the project for updating geographical data for the benefit of the Higher Commission for Tourism.
10. Taking the lead in forming a higher committee, with the participation of a number of bodies influential in GIS to coordinate with government bodies in unifying efforts, and preventing duplication in accumulating information, and setting national standards, as well as systems and rules relating to information exchange, and establishing a national network for this purpose.
11. Coordinating with a number of ministries, and government agencies to implement pilot projects serving their needs, and providing technical support.
12. Organising a number of conferences, seminars, and meetings in the area of the GIS.
13. Obtaining membership of the international GIS standards committee (ISO/TC211), and participating in several projects aimed at setting international standards for GIS, and in turn benefiting from this in setting national standards.
14. Applied training on GIS and remote sensing for university students and personnel from other bodies.
15. Organising a number of basic and advanced courses in the area of GIS for female teaching staff of universities and faculties.

7.3 Other SDI Stakeholders, in brief

7.3.1 High Commission for the Development of Ar Riyadh

In half a century, Ar Riyadh was transformed from a small town surrounded by walls into a modern city with boundaries extending 1000 sq. km comprising 15 municipalities with 160 neighbourhoods. This reflects the huge developments, and rising population, which grew from around 300 thousand in 1968 to nearly 4.6 million in 2008, and is predicted to rise to 7.2 million in 2024 according to Khabar newspaper (Al-Dawsari, 2009, 26 April).

Given the readiness of the city to become one of the largest cities in the Arab region and the world, it was natural that the government take rapid and studied steps to keep up with the pace of development, and provide this capital city with the means to absorb these civilisational, economic, and social changes. These steps included a clear and comprehensive vision of all the needs of the city, in terms of infrastructure, and urban expansion, in addition to the potential for such strategies to be achieved in reality. The response was immediate to these needs, in setting appropriate rules for planning the city, in a way commensurate with the urban progress, economic, social and cultural prosperity; Cabinet Decision No. 717 dated 28/5/1394AH (18 June 1974) established the High

Commission for the Development of Ar Riyadh presided over by the Emir of Ar Riyadh (KSA Council of Ministers, 1974). The commission was tasked with planning for the development and improvement of the city at all levels, urban, economic, cultural, and environmental, through developing policies, and instituting measures aimed at raising the level of services, improving facilities related to society's needs, and bringing variety in opportunities for a prosperous life.

7.3.1.1 Membership of the High Commission for the Development of Ar Riyadh

The commission is formed of members as follows:

- The Emir of Ar Riyadh (President)
- The Deputy Emir of Ar Riyadh (Vice-President)
- Commissioner for Ar Riyadh
- Deputy Minister of Economy and Planning
- Head of the Commission’s Projects and Planning Centre
- Deputy Finance Minister for Budget Affairs and Organisation
- Deputy Minister for Municipal and Rural Affairs, and Urban Planning
- Deputy Transport Minister for Road Affairs
- Executive Director of the Saudi Electricity Company
- Adviser to the Minister of Communications and Information Technology
- General Director for Water in Ar Riyadh area
- Deputy Commissioner for Ar Riyadh Urbanisation and Projects
- Deputy Commissioner for Ar Riyadh Services
- President of the board of directors for Ar Riyadh Chamber of Industry and Commerce
- One expert
- Two businessmen

7.3.1.2 Functions of the High Commission for the Development of Ar Riyadh

The High Commission for the Development of Ar Riyadh was delegated the responsibility for carrying out a number of planning and development tasks, which may be summarised as follows:

First: planning in the comprehensive sense, including:

1. Preparing comprehensive plans for development of the city.
2. Modifying such comprehensive plans according to need, including studying, and endorsing changes in land use, and undertaking amendments to building and planning systems.

3. Preparing studies, including studies of urban extents, and following up implementation.
4. Undertaking preparation of land plans for private and public use.

Second: functions of the municipal council, and powers given to the Commission by Cabinet Decision No. 439 dated 8/6/1398AH (15 May 1978) (KSA Council of Ministers, 1978).

Third: coordinating projects for key preparations, and setting programmes and implementation, based on Cabinet decision No. 37 dated 11/2/1402AH (8 December 1981), which included revising and ratifying annual and five-year plans for relevant bodies (KSA Council of Ministers, 1981).

Fourth: supervising any improvement project needed by Ar Riyadh city, based on Cabinet Decision No. 221 dated 2/9/1403AH (12 June 1983) (KSA Council of Ministers, 1983).

7.3.1.3 Administrative unit working with spatial data

The Directorate for Urban Information Systems Services within the Projects and Planning Centre in the Higher Commission for the Development of Ar Riyadh is the body responsible for collecting, entering, and recording spatial data for Ar Riyadh city. The aim is to build base maps for land use, and urban aspects of the city. The Directorate for Urban Information Systems Services since establishment has passed through the following phases:
In 1405AH (1985), work began in developing and establishing an urban information system in the Commission. This arose out of a comprehensive study of user needs within the Commission to identify those units that would benefit from application of urban information system technology. This was followed by a further study to evaluate the different urban information system technology offerings from around the world, and select the most appropriate one for the needs of Ar Riyadh city, and its urban growth issues.

The study revealed the huge potential for applying urban information systems in the Commission, as well as making three key recommendations: implementation of a digital database for Ar Riyadh city; implementation of urban information systems in integrated form throughout the Commission; and establishment of a specialist administration named the Directorate for Urban Information Systems Services. This new administrative unit would be responsible for setting the specifications for building, developing, maintaining and operating the urban information system in the Commission. It would ensure that the system would be implemented in an organised manner serving the requirements of the different administrations within the Commission in a balanced and independent form.

One of the key functions of the Directorate for Urban Information Systems Services in the Commission was to develop and maintain a database of high precision topographic data (base map), which currently forms the fundamental framework for many uses of urban information within the Commission.

This was followed by identifying the appropriate equipment and software applications that would be installed and operated at the end of 1406AH (1986). The system was built on two interconnected and integrated databases, namely the spatial data and descriptive information databases.

1407AH (1987): the executive body in the Commission initiated a number of studies and field surveys in the different areas of the city. These studies and surveys included land-use information, population, economy, transport, environment, land prices, as well as information on services and facilities, water sources, and hydrological and geological features of the city. The information acquired was added to the descriptive information database linked to the digital base map of Ar Riyadh city, which was built based on the precision UTM coordinates standard. This map contains 255 other maps at scale (1:2500), which cover the majority of the city's modern neighbourhoods, and 407 maps at scale (1:500) for the city centre, and old quarter of the city.

1408AH (1988): the system was made operational, and began to receive different requests for specific and detailed maps, reports, and statistics from specialists within the Commission, including 750,000 items of information on land-use, and thousands on family data and demographics, and tens of digital maps extracted from the first digital base map for Ar Riyadh city at this level of detail and variety of information.

The information database grew, with the repeat of surveys to update the main database on land-use, property, family and demographic information, as well as the digital base map linked to it. Surveys were carried out in 1411AH (1991), 1417AH (1997), and 1425AH (2005). In this way the amount of information held rose to around 3 million items of information on land-use with records organised historically since 1407AH (1987) to 1425AH (2005). This provides an opportunity to monitor urban growth of the city. This was in addition to the updates on hundreds of interlinked maps, which constitute in totality the city's base map, including land and administrative, urban development, and development protection boundaries based on high precision satellite photographs, added to the aerial survey of 1416AH (1996), and the approved plans by Ar Riyadh City Commission.

1419AH (1999): the Higher Commission for the Development of Ar Riyadh was given responsibility for operating, maintaining, and updating the unified digital base map for Ar Riyadh city, and its distribution to public and private sector organisations as the sole digital base map for the city.

1423AH (2003): the first edition of the unified digital base map for Ar Riyadh city was produced. This map was distributed to all government departments in the city, as well as relevant private sector organisations, such as the Saudi Electricity Company, and Saudi Telecommunications Company, to prevent duplication and rationalise costs in building similar maps for the city. The Commission continues to encourage stakeholders to use this map, and benefit from it, while providing support and advice to them in developing their work, and facilitate information exchange between stakeholders to achieve the desired outcome.

1426AH (2006): the second edition of the unified digital base map for Ar Riyadh city was produced, following completion of the 1425AH (2005) survey of land-use. This was distributed to more than 100 stakeholders in the city, while maintaining coordination among them.

1426AH (2006): the Higher Commission for the Development of Ar Riyadh launched the Ar Riyadh Spatial Data Infrastructure initiative aimed at simplifying information exchange, and sharing processes among the different stakeholders in Ar Riyadh city, to unify efforts, prevent duplication, and rationalise costs, while works to continues on making the initiative effective to this date. This initiative will be discussed more fully in section 9.2.2.

7.3.2 Saudi Post

Following the unification of the Kingdom of Saudi Arabia, and discovery of oil, development in the postal system was rapid and took the following form:

- The Postal Work Authority was established in 1354AH (1935).
- The Telegraphs, Post, and Telephone authority prior to 1373AH (1954) managed postal activity, which was then transferred to the Ministry of Communications and renamed Deputy Ministry of Communications for Cable, Wireless, and Postal Affairs.
- In 1392AH (1972), the Public Authority for Post was established, and the first independent budget for the postal service was approved.
- The Ministry of Telegraphs, Post, and Telephones was established by Royal Decree No. 236/A dated 8/10/1395AH (13 October 1975) (KSA Royal Palace, 1975d).

- The Public Authority for Post introduced the special mail service in 8/10/1404AH (6 July 1984).
- In 29/3/1423AH (10 June 2002), the Public Authority for Post was transformed into a private sector organisation.
- In 1426AH (2006), a large-scale restructuring of the Saudi Post took place, with new administrative units, new services, and the announcement of a new project for postal addressing and coding, as well as modern methods of delivery to homes and properties.

7.3.2.1 Saudi Postal Codes

The Saudi Post faced the problem that the postal code was not unified for all Saudi cities, and in many areas, non-standard addressing was used for letters and parcels. The solution was in the hands of city administrations and municipalities, which still faced the problem of naming streets and neighbourhoods, while using numbers and codes that were not understandable. This forced the Saudi Post, in 1430AH (2009), in conjunction with the Saudi Arab Commission for Specifications and Standards to complete the setting of procedures and foundations to build postcodes covering the entire geographical extents of the Kingdom, in the form of a unified national coding system for postal addressing. The number of spaces for the postcode was set at five, as can be seen in figure 7.1.

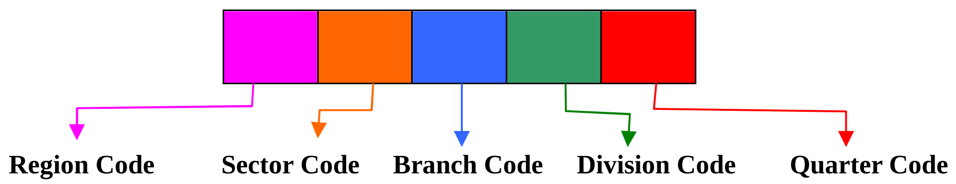


Figure 7.1 Five Digits of the Saudi Postal Code

1. Region:

The territory of the Kingdom of Saudi Arabia was divided into eight postal regions. The postal region may include more than one administrative region, by including regions. Each postal region was assigned a unique number (see Table 7.2), which occupied the first place in the new postcode.

2. Sector:

The second digit of the new postcode was dedicated to sectors, in a system whereby the number 2 designated the regional capital, and odd-numbered digits used to designate the postal sectors lying to the north of this regional capital, and even-numbered digits used for south lying sectors. The aim was to provide a simple method, in which the farther north, or south a sector lay with respect to the regional capital, then the third digit would be a higher, odd and even number respectively.

3. Branch:

In the new system, the third digit was used to identify the postal branch, as each sector was subdivided into a number of branches. For landlocked sectors, an axis point located centrally was chosen as a datum, such that even numbers were given to areas lying to its east, and odd numbers to those areas lying to the West of this axis point. In this numbering system, the starting point is from the North, such that lower numbers are assigned to north-easterly and north-westerly branches with reference to the datum, and higher numbers to south-easterly and south-westerly branches.

For those sectors running along the Kingdom coastline, the southernmost point in that sector on the coastline is chosen as an axis point. From this axis point, even numbers are assigned to branches close to the coast, while those farther inland given odd numbers. The odd and even numbers increase the farther north the branches are from the axis point.

Table 7.2 Postal Regions Code

Postal Regions	Postal Region Code
Ar Riyadh region	**1**
Makkah region	**2**
Eastern region	**3**
Al Madinah region + Tabuk region	**4**
Al Qasim region + Ha'il region	**5**
Assir region + Najran region + Al Bahah region	**6**
Northern Border region + Al Jawf region	**7**
Jizan region	**8**

4. Division:

In the postal code system, each branch is subdivided into a number of divisions, which are represented by the fourth digit. Divisions within each branch formed equal sized areas based on factors such as:

- Geography,
- Density of population.

Moreover, main and connecting roads are the basis for division boundaries, and numbering relies on distance from the axis point; the lowest numbers are assigned to divisions closest to the axis point.

5. Quarter:

Quarters represent subunits within the division in the new postal coding system, and are designated by the fifth digit in the code. Nine quarters represent the maximum number of subunits within a division. The rules used to decide quarter boundaries were:

- In size, each quarter would occupy less than 4×4 km.
- A smaller, 2×2 km, would be used in densely populated zones.
- An even smaller, 1×1 km, would be used in very densely populated zones.

The local coordinate grid system for building the unified postcodes was based on the international coordinate system. These international coordinates were acquired based on the geographical information system built on the international coordinate reference, UTM WGS 1984, for each individual city space.

In each postal division, numbers ranging from 2000 to 5999 were assigned to the Eastern axis (X), while numbers ranging from 6000 to 9999 were assigned to the Northern axis (Y), in a 1m grid. Furthermore, distinction was made between streets in a northerly direction, and those in an easterly direction; northerly streets have an angle of direction in the range 45° and 135°, while easterly streets lie at other angles. In terms of numbering, easterly streets were designated using the XY digits from the grid system, while northerly streets were designated using YX digits. In easterly streets, properties to the north were assigned even numbers, while those to the south were assigned odd numbers, with respect to that street. Similarly, in northerly streets, even numbers were assigned to properties on the west side, and odd numbers to those on the east, with respect to that street.

Among the key achievements of the Saudi Post, following introduction of the new postal code system, was a postal search tool. This comprised a system of digital geographical maps providing the capability of fixing position using the new postal code system. The service aims at easing the process of finding postcodes, as well as defining the main features of the city, such as public buildings, organisations, company locations, markets, banks, amenities, hospitals etc. Distinctive features of this postcode search service are:

- Clarity and simplicity of use, as the aim was to facilitate acquisition of information on postcodes/ addresses quickly and easily.
- Availability of several options in searching for a postal address, either using a map with a zoom function, or by building number, and neighbourhood name.

- The search tool is available on the Internet by following the appropriate link (http://saudilocator.sp.com.sa/weblocator); the webpages are also configured for accessibility by hand-held PDA or mobile phone by following the link (http://saudilocator.sp.com.sa/pdalocator).
- The ability to show or hide features on the map.
- The ability to move the map, and navigate quickly.
- The postcode search tool helps users identify position easily and precisely, and as such the service is an add-on to digital maps.
- The tool consists of a number of information layers, such as land plot numbers, postcodes, street names, different services (hotels, banks, hospitals, restaurants, public services, government offices, etc).
- The postcodes search tool is available to all users, and allows guidance and navigation to any point in cities with relative ease. This allows organisations, shops, transport companies, and courier services to deliver to their clients.

Among the achievements of Saudi Post, is the use of general packet radio services (GPRS) and GPS devices to track vehicles and personnel, allowing letters and parcels to be guided and tracked electronically. This is open to all users, who may track their letters or parcels from collection to delivery via the Saudi Post website (www.sp.com.sa).

7.3.3 Central Department of Statistics & Information

The KSA Ministry of Economy and Planning was established in 1390AH (1970), and the most important body attached to it was the Central Department of Statistics and Information. The main aim of the Central Department of Statistics and Information is to collate, analyse, and publish statistical data and information in the different areas, social, economic, and population. Moreover, to undertake different statistical studies according to need. Since the Central Department of Statistics and Information is the sole statistical reference authority in the Kingdom, therefore it is tasked with preparing and supervising the general census of population and properties in the Kingdom, collecting, organising, and analysing statistical data from other government bodies, and publishing this in different statistical periodicals. Statistical activities began officially in KSA with the introduction of a statistical system for imports and exports for the Kingdom's customs authority by Royal Decree No. 326 dated 3/2/1349AH (29 June 1930). This task was given over to the customs authority, until it was transferred to the Ministry of Finance and National Economy.

The Department was established within the general statistical system of government by Royal Decree No. 23 dated 7/12/1379AH (1 June 1960), and attached to the Ministry of

Finance and National Economy by replacing the statistics section in the Directorate-General for Financial Affairs considered the precursor for the Central Department of Statistics (KSA Royal Palace, 1960). Ministerial decision No. 7/2870 dated 22/9/1392AH (29 October 1972) attached the Department to the Assistant Deputy Minister for Budget Affairs and Organisation until later the department was promoted and linked directly to the Minister of Finance and National Economy by virtue of ministerial decision No. 17/3961 dated 23/8/1400AH (6 July 1980). The general statistics system of the government defined the area of authority of the Central Department of Statistics, and designated it as the sole focal point for statistical information in the Kingdom. It was given responsibility to undertake the different types of statistical operations needed in all development areas. The Department is considered the authority responsible for supplying public and private sector bodies, and individuals with information, and official statistics.

By virtue of Cabinet Decision No. 55 dated 19/ 3/1416AH (15 August 1995), the Central Department of Statistics was transferred from the jurisdiction of the Ministry of Finance and National Economy to the Ministry of Planning (KSA Council of Ministers, 1995).

Many decisions and Royal directives were issued emphasising the importance of the Department's role in providing data and statistics, and providing government and private sector bodies, as well as researchers, regional and international organisations with such information. The Cabinet crowned these achievements by issuing decision No. 284 dated 24/11/1426AH (25 December 2005) endorsing the recommendations of the ministerial committee for administrative organisation presented in its 32nd meeting minutes dated 26/5/1426AH (3 July 2005), in which a number of recommendations were made, including adding significant technical functions, and important administrative procedures. Most prominently, making available all necessary resources to build databases in all areas, connected by a network and aiming to establish a national databank. Moreover, rapidly developing plans and technical programmes necessary to achieve the task of collecting information. The Central Department of Statistics was renamed the Central Department of Statistics and Information.

The most prominent statistical operations undertaken by the Department during its history were the population censuses for the Kingdom, which were organised by virtue of Royal Decree No. 13/M dated 23/4/1391AH (17 June 1971) (KSA Royal Palace, 1971); three official censuses were undertaken in 1394AH (1974), 1413AH (1992), and 1425AH (2004), while the current census for 1431AH (2010) will be the fourth. The Department also executed a census of organisations in 1387AH (1967), 1391AH (1971), 1396AH (1976), 1401AH (1991), 1414AH (1994), and 1424AH (2003). In addition, the Department exerts significant efforts in carrying out different studies and statistical surveys in the population, social, and economic areas, as well as preparing continuous and regular statistical studies (monthly, quarterly, biannually, annually).

The maps unit attached to the Central Administration for Population and Social Statistics within the Department is responsible for providing statistical maps for all areas of the kingdom, and helping administrations in identifying locations where field surveys are being carried out. The unit's work is limited to collating maps and preparing them for a statistical use. The need for use of GIS within the maps unit arose in 1422AH (2001) to replace traditional paper maps with digital maps, in addition to the benefits of GIS technology, in terms of organising and analysing geographical information, as well as linking spatial and descriptive data related to demographic or economic studies undertaken by the Central Department of Statistics and Information. This would not be possible using traditional means based on paper maps.

Among the prominent and recent achievements of the maps unit are:

- Publishing initial results for the general census of population and property for 1425AH (2004).
- Designing a website presenting statistical distribution on maps of the Kingdom in Arabic and English (http://www.cdsi.gov.sa/asp/index.asp). Through the site, data can be searched (population data, education, social status; educational, health, agricultural, social, administrative, and public services; property data, and undertaking comparisons and various statistical analyses).

7.3.4 Saudi Commission for Tourism and Antiquities

The Saudi Commission for Tourism and Antiquities is a government body with independent status linked directly to the Prime Minister’s Office.

Cabinet Decision No.9 dated 12/1/1421AH (16 April 2000), established the High Commission for Tourism, emphasising tourism as a productive sector thus ensuring the Saudi tourist industry thrives in the country, and opening up further investment opportunities, developing national manpower, and providing new work opportunities for Saudi citizens (KSA Council of Ministers, 2000a). Given the importance of antiquities and museums, Royal Decree No. 2/A dated 28/2/1424AH (30 April 2003) merged the Antiquities Agency with the High Commission for Tourism, such that the Commission became responsible for implementing initiatives regarding antiquities, in addition to work in tourism (KSA Royal Palace, 2003a). Then Cabinet Decision No.78 dated 16/3/1429AH (23 March

2008) renamed the Commission as the High Commission for Tourism and Antiquities (KSA Council of Ministers, 2008).

In the frame of building a tourism information database, and carrying out studies related to tourism in the Kingdom, the Commission in 1423AH (2002) established the National Centre for Tourism Information and Studies. The centre has carried out many studies and tourism surveys, and made the information available in the form of an interactive digital map of the Kingdom comprised of digital maps and tourism information, like historical and museum sites, public gardens, theme parks, traditional markets, shopping centres, festival and exhibition sites, public libraries, universities, educational and cultural centres, hotels, furnished apartments, hospitals, bus stations, and car rental agencies, for all regions and cities in KSA. This was placed in reach of tourists on the Internet (http://www.sauditourism.com.sa/en/MasSearch/).

The Commission also printed paper maps at (1:25,000) scale for all cities in the Kingdom, designed to be comprehensive, highlighting tourist points of interest, and pocket size, as well as being in Arabic and English. These maps are freely available from tourist Information points at hotels, theme parks, airports, museums, exhibitions, and fairs that the Commission organises or attends in the Kingdom, and abroad.

The Commission built many databases, the most prominent being one for the tourist sites distributed in the kingdom's regions, using GIS technology; over 12,000 tourist sites were identified, each accompanied by 180 facts and images. In addition to this, a database on the most important cultural and heritage sites in the Kingdom was developed using GIS; the number of sites recorded was around 8000. Furthermore, a database for tourist services in the Kingdom, and one for agents abroad representing local trip organisers under a programme named “Discover the Kingdom”. In addition, a database for Umrah, and travel and tourism agencies, was developed for organisations providing tourist services and products. Finally, a database for employment and training in the tourism sector in the Kingdom has been produced.

7.3.5 Ministry of Agriculture

The Ministry of Agriculture is one of the main ministries in the Kingdom, and the aim behind its establishment was the development of productivity and diversity in agricultural, animal, and fishery resources. Moreover, the Ministry is responsible for development studies of the animal, fish, and agricultural resources, providing treatment and preventative measures for animal and plant wealth, evaluating, classifying, improving and utilising land for agriculture.

The Ministry of Agriculture passed through a number of phases before arriving at its present form:

- In 1367AH (1940), the Directorate-General for Agriculture was established in and linked to the Ministry of Finance, with the task of developing agricultural land, improving irrigation, distributing water pumps, building dams and canals, digging and repairing springs and artesian wells, providing loans to farmers, and co-operating with agricultural technical expertise in providing training, and guidance to farmers on modern agricultural methods.
- In 18/4/1373AH (24 December 1953), the Directorate-General for Agriculture was transformed into the Ministry of Agriculture and Water by Royal Decree No. 5/21/1/4951 (KSA Royal Palace, 1953).
- In 1381AH (1961), the Agricultural Affairs Agency, and the Water Affairs Agency were established.
- In 21/6/1385AH (16 October 1965) the High Commission for Administrative Reform issued resolution No. 8, which divided the Ministry of Agriculture into two main sections: agriculture headed by the Deputy Minister for Agricultural Affairs, and administrative and financial affairs by the director of the General Directorate (High Commission for Administrative Reform, 1965).
- In 1390AH (1970), the Desalination Affairs Agency was established; later, in 1394AH (1974), it was changed to the General Corporation for Salt Water Desalination.
- In 1397AH (1977), a new agency, called the Agricultural Development and Research Affairs agency was formed.
- The General Corporation for Granaries and Mills was transferred to the jurisdiction of the Ministry of Agricultural and Water by virtue of Cabinet Decision No. 34 dated 7/2/1406AH (20 October 1985), and endorsed by Decree No. 3/M on 12/3/1406AH (24 November 1985) (KSA Royal Palace, 1985b).
- In 1408AH (1988), the fish resource sector was established headed by the Deputy Minister for Fish Resource Affairs.
- In 1420AH (1999), the agency for land affairs was established.
- In 1425AH (2004), the agency for animal resource affairs was established.
- 9/7/1423AH (5 September 2003), Royal Decree No. 27482 separated the water sector from the Ministry of Agriculture, and established a separate ministry called the Ministry of Water, linked to the Prime Minister (KSA Royal Palace, 2003b).

The Ministry of Agriculture remained abreast of technical developments in the area of documenting information, and established its computer centre in 1400AH (1980) as a tool supporting collecting, and organising information. The centre was merged with the library and documents section in 1408AH (1988) into the Documents and Information Centre to prevent duplication of effort. In 1425AH (2004), the centre was restructured and renamed the Information Technology Directorate, with the addition of the GIS and Remote Sensing Section, in a step aimed at unifying efforts in these areas.

GIS databases were introduced in the Ministry in mid-1427AH (2006), which included establishing a digital map of the Kingdom at (1:250,000) scale, and more than 20 key information layers overlaid over modern satellite images at a resolution of 5-30m, and less for some applications. Currently, the first two applications of GIS have become operational. These are:

1. The early warning system: This identifies hazards, and their area of spread, and emergency preparations to prevent epidemics entering the Kingdom, advertising the plan appropriate for each disease, and preventative measures to be implemented, to control and contain it.
2. The field surveillance system for work teams using vehicle tracking technology, which is based on GPS, and the GIS digital map.

Recently, a project linking the descriptive information database to the geographical information database was implemented. This aimed to open up opportunities for specialists in the branches of the Ministry (agriculture, research, animal resources, fisheries, and land) to take advantage of the software applications, GIS, and remote sensing in their applications for studying, and analysing phenomena, for planning, for identifying locations on the digital map, printing routes and explanatory maps, and many other GIS applications. Each specialist was granted access using username and password controls, via an Internet portal (http://gis.moa.gov.sa/MoAServer/MOAHome.aspx).

7.3.6 Farsi-GeoTech

This is a private sector company working in the area of maps and GIS in KSA, and is widely recognized among citizens as the only company in KSA that provides tourist and navigation maps for the majority of the Kingdom's large cities. Success of the company can be traced back to 1982, when it produced the first guide maps for Makkah, which was considered a key achievement at that time. In the years following, the company expanded its product line to include maps, guidebooks, folding maps, and reference atlases that included many of the Kingdom's cities. These products were developed based on a database including important geographical information that is improved and updated continuously.

Today, the company is considered one of the important sources of maps, and geographical information systems throughout the Kingdom. The company established a highly precise geographical information database, including valuable information related to GIS. Currently, this database is used in developing GIS applications, and GIS website service technologies, which are considered a key source for GIS studies and research within the Kingdom.

The company established the GIS department with the aim of supporting the company's functions, and established a highly motivated team of analysts and developers of Geographical Information Systems, which is responsible for working closely with clients to conduct deep needs analysis studies, that in turn defined the features, procedures, and conditions for data, and a profile of the user, and the required conditions for dissemination, before developing their solution.

Among the company’s products:

- Farsi MAPS which is an interactive application consisting of CDs containing electronic maps that provide detailed digital maps of the Kingdom of Saudi Arabia and its cities.
- A tracking device, Farsi TRACK, which specifies the position of vehicles within KSA using GPS, and is easily available through the Internet, WAP, or SMS.
- Farsi NAV, which is a navigation system, which specifies location precisely using GPS, and provides detailed information to connect between two specified points.
- Farsi PRO, which is a search and analysis tool that helps in specifying positions, and areas of investment. This was specially developed for consultancy service companies and research centres.
- Farsi Locator, which is an interactive web-based application that helps in defining a person's location through their address, street name, neighbourhood, postal code.

7.3.7 Saudi Electricity Company

In the period from 1396AH (1976) to 1401AH (1981), successive Saudi electricity utilities were established in four of the regions in KSA; namely, Eastern, Central, Southern, and Western regions. Since that time, electricity networks have been consolidated, and electricity services provided. The State at this stage, and through its development plans was able to bring electricity to cities, villages, and remote areas in KSA. The national electricity network extends for thousands of kilometres to cover the majority of the Kingdom.

On 11/8/1419AH (30 November 1998), Cabinet decision No. 169 directed the merger of electricity companies into a single utility company named the Saudi Electricity Company (KSA Council of Ministers, 1998).

The Saudi Electricity Company used GIS in developing its work, over a number of phases, as follows:

- In 1414AH (1993), a contract was signed for the IBM GFIS product, which ran on a mainframe computer and used the IBM DB2 database application.
- In 1422AH (2001), the company had difficulties and technical problems in implementing IBM GFIS, which dictated a move to the ESRI ArcGIS system for use in all its applications.

The Saudi Electricity Company uses GIS in a number of applications, among them:

- Single line drawing (SLD) of medium voltage (MV) network.
- Single line drawing (SLD) of low voltage (LV) network.
- Work orders for medium and low voltage supply.
- Sending electricity network location data to GPS devices.
- Planning programmes, and new requests.
- Printing load models and statements.
- Numbering new subscriptions.
- Reaching the subscription locations without requiring presence of the subscriber.
- Searching and printing routes for meter reading personnel.
- Identifying faults positions in the network, and choosing the optimal route to the location.

7.3.8 King Saud University

King Saud University was established by Royal Decree No. 17 dated 21/4/1377AH (14 November 1957) (KSA Royal Palace, 1957). It is considered one of the pioneering universities in the Kingdom in introducing GIS in its study plans represented by three faculties:

- Faculty of Engineering: civil engineering and surveying engineering departments. The specialisation was introduced in 1408AH (1988) as a result of the resolution and recommendation of the defence ministers of the Gulf Cooperation Council Countries (GCCC). The University provides an integrated programme in spatial data culminating in a Bachelors degree following five years of study in which the engineering graduate will have learnt all types and sources of spatial data (ground survey, GPS systems, remote sensing, cartography, geodesy, GIS, map referencing and datums). This specialisation is considered one of the oldest in the area of spatial data in the Kingdom.
- Faculty of Arts: geography department. The Department established the first modern, specialist laboratory for GIS in 1417AH (1997).
- Faculty of Architecture and Planning: introduced GIS in the area of planning.

King Saud University established an applied GIS department in the University projects section, which is considered one of the most powerful systems related to infrastructure and facilities management at the University. This extends over the entire university campus of around 9 million square metres. Access to the system is through the University website (www.gis.ksu.edu.sa). The system comprises the cutting edge technologies of spatial data systems, based on the following key information resources:

- Digital Earth information, scale 1:500, and horizontal and vertical resolution of around 10 cm.
- Advanced information collected using GPS, where seven geodetic ground control points with permanent markers were established, with an accuracy of millimetres.

The database contains a large amount of information, such as information on services and infrastructure: drinking water supply networks, energy and electricity networks, irrigation water networks, sewage networks, communications networks, air conditioning and mechanical services networks, and computer networks; housing information: teaching staff accommodation, student residences, parking, and schools; amenities information: parks, sports grounds, swimming pools; academic building information, road information, and King Saud teaching hospital information, survey information and ground control points.

The system also allows University security staff to watch and follow vehicle movements, as well as important installations within the University through surveillance cameras linked to the system.

7.4 Discussion

It is quite clear from the information presented regarding spatial data stakeholders in KSA that there is a significant amount of duplication in projects, and absence of cooperation between the different stakeholders in spatial data projects. The lack of unified efforts leads to a lack of savings in financial and time resources regarding the many duplicate spatial data projects throughout the Kingdom. It is quite disheartening that some organisations are managed by a High Commission with membership from the different administrative arms working with spatial data, yet the presence of these members in Higher Commissions of organisations has not helped unify efforts in spatial data projects. The reason is that these members are not highly qualified in the area of spatial data, and have no knowledge of the advantages of unifying efforts and cooperating in implementing joint spatial data projects in partnership with the different stakeholders to which they belong on the one hand, and the organisation in which they are higher management members.

An example of this duplication and conflict in implementing spatial data projects is that the GCS is the sole organisation with authority and responsibility for geodetic networks in the Kingdom, and as such no other body has the right to work in the area. However, MOMRA has done work in this area, unilaterally and without coordination, or even sharing data with GCS. MOMRA established a new geodetic reference in the frame of ITRF using 13 live transmission stations, and support network on this reference for more than 600 new points. In addition, some city commissions, such as in Jeddah, have established their own geodetic network within their administrative jurisdiction without coordination with MOMRA, or GCS.

Another example of duplication and conflict is that the Saudi Post since early 1430AH (2009) in conjunction with the Arab Saudi Specifications and Standards Commission completed the procedures and foundations for a postal code for the entire territory of the Kingdom, in a unified national system of postal addressing, which all stakeholders can take advantage of. However, a number of regional commissions continue to sign project contracts for naming and numbering, each within its administrative jurisdiction. One of these projects was reported in Ar Riyadh newspaper (issue 15160) dated 9/1/1431AH (Al-Bushra, 2009, 26 December) regarding the signature by the Commissioner for Assir Area of a contract for naming and numbering the city of Abha, worth SRS 3 million (around £0.5 million). The newspaper reported that the aim of this project was that visitors or any other party would be able to find addresses quickly and easily.

In addition to the above, exploring the situation with regard to spatial data in KSA has revealed further documentary examples of duplicated, uncoordinated effort (see table 1.1 and figure 1.1 in section 1.3). A large number of organisations are engaged in implementing the same projects but with varying specifications and scales, completely oblivious to the others. The chaotic situation has had severe consequences as an aggravating factor in a disaster situation, as was the case in the floods that hit Jeddah in late 2009 (see section 1.3).

7.5 Summary

This chapter has explored the situation in KSA with respect to the main SDI stakeholders by providing background on their historical development, and the legislation and policies that both established these bodies, and regulated their roles. Moreover, the barriers to sharing spatial data were presented. (A wider view of barriers to collaboration in KSA is provided from the perspective of stakeholders in Section 8.9.4, pp.192-197).

The following chapter will present the questionnaire survey results and an analysis. It will explain the organisational, technical and institutional aspects relating to the current situation of spatial data organisations in KSA. The semi-structured interview data will be used to support, explain, and validate, i.e. triangulate, questionnaire quantitative data, and give it more depth.

CHAPTER 8: RESULTS & ANALYSIS

8.1 Introduction

This chapter presents the results of the field survey conducted by distributing a questionnaire, and carrying out semi-structured interviews of personnel in 24 organisations representing nearly all the bodies working in spatial data in KSA. Both the questionnaire and interviews covered a range of themes, including types of spatial organisation and sphere of operations, data types and themes, standards and technical issues, and inter-organisational relationships and collaboration, among others. Furthermore, an analysis of the results gathered by questionnaire has been supported by presenting the perspectives of interviewees in the chapter.

8.2 Spatial Data Organisations

8.2.1 Types of Spatial Data Organisations

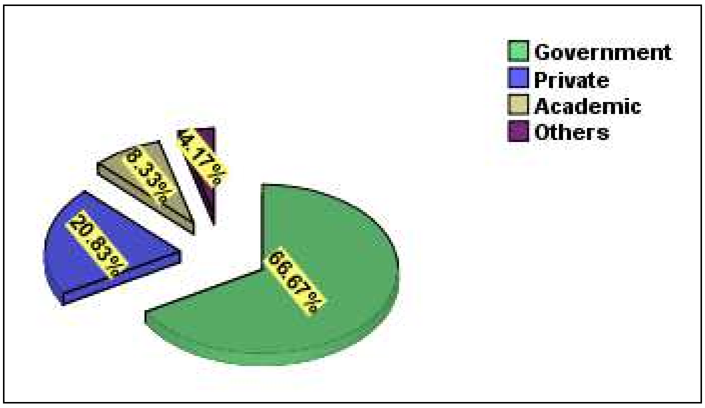


Figure 8.1 Types of Spatial Data Organisation

The survey indicated that there are four types of organisation in KSA dealing with spatial data: public sector or government, private sector, academic, and also a category classed as ‘other’, which do not fit any of the other three types. According to the survey responses, the majority, approximately 67% of the spatial data organisations surveyed were considered public sector or government organisations, while private sector spatial data organisations comprised only 21%. By far the fewest were academic bodies involved in spatial data, and organisations classified under “other” or utilities by respondents, at around 8% and 4% of spatial data organisations respectively.

The issues surrounding organisation types, and extent of responsibility for current spatial data situation in KSA were addressed in the semi-structured interviews by all 72 participants from the different government, private sector, and academic bodies. The majority, 59 individuals (82%), were of the opinion that government bodies were responsible for the current problems, in terms of duplication seen in spatial data projects. This was clearly explained by one interviewee:

> "*Sadly, it is the government bodies which are the main cause of the current situation of duplication in spatial data projects in KSA. This is because they are in control of the situation, and represent the majority of organisations working in the area of spatial data*" (gopu-07). (See Table 6.3 for definition of interviewee type)

While a large number of respondents agreed that the government bodies were responsible for the current problem situation in spatial data in KSA, eight interviewees (11%) held the opinion that private sector bodies also carried part of the responsibility for this duplication in spatial data projects. This was emphasised by one interviewee:

> "*private sector bodies are much fewer than government bodies, but they employ more experts in spatial data, and are always seeking to attract any prominent expert in the area taking them away from the different government and academic bodies by offering high salaries. These experts do know about the prevailing problem, yet because the aim of these companies is to make profit, they hope that the current situation would continue so that they are able to secure more profits, with the many duplicate spatial data projects commissioned by government bodies, in particular*" (gopu-25).

The remaining interviewees, five individuals (7%), also blamed academic bodies for the problems faced in spatial data projects for several reasons, as mentioned by one interviewee:

> "*We cannot ignore the role of academic bodies in the current situation regarding wasting of time and public funds in the duplicated projects in spatial data. These bodies must take the responsibility for educating all the bodies working in the area. If you look at the syllabuses in the area of spatial data, you will not find in any of them an attempt to bring out this problem, or to present the international experience in solving it. Therefore, I blame the universities and academic institutes, which hold courses, or issue certificates in the area of spatial data, for the situation that we suffer now in terms of duplicate spatial data projects, even if these bodies are few in number*" (popu-13).

8.2.2 Organisation Sphere of Operations

Issues relating to the organisation sphere of operations were explored through question 1.2 of the questionnaire. From the 24 organisations, only four are involved in spatial data internationally. However, the majority comprising 17 organisations limited their spatial data operations to the national level, within KSA only. Three organisations operated only at the local (region or city) level. These responses, in terms of the spatial data work of the majority of organisations reflect the importance of an NSDI framework in the context of KSA. They probably reflect the answers that might be provided by other countries in the region—but unfortunately no such studies exist.

This question was addressed by the 72 interviewees from the different bodies working in spatial data. Sixty-five percent emphasised that all the bodies working in spatial data focus on the national level in KSA. The reason for this is quite clear, in the response:

> "*if all the bodies, whether governmental or otherwise,were to deal only with spatial data at the national level, they would have saved effort and money, and prevented duplication, through coordination between them in all spatial data projects*" (gopu-18).

On the other hand, a number of interviewees (13), representing 18% of those interviewed, considered that it was vital that all the bodies working in spatial data should be open to the international level. This was justified:

> "*it is difficult for a person to understand why some organisations shut themselves off and restrict themselves in working on spatial data projects to the national level only, or their region or city, and fail to take advantage of the international expertise in spatial data available through attending conferences, seminars, and scientific workshops to find out what is happening outside national borders*" (ao-04).

The remaining interviewees (12) considered that all bodies concerned with spatial data must focus on the local level, whether region or city; the reason provided was:

> "*if we look at the area of the Kingdom of Saudi Arabia, approximately 2 million square kilometres, then it is quite difficult to coordinate at national level between the bodies dealing with spatial data; however, if coordination took place at the level of the city or region that would be better than wasting effort at the national level*" (gou-09).

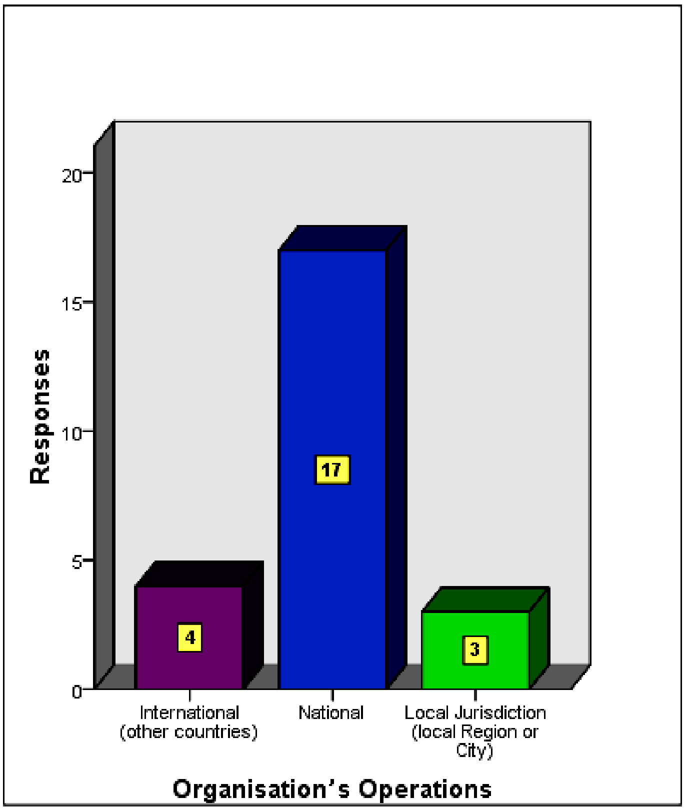


Figure 8.2 Organisation Sphere of Operations

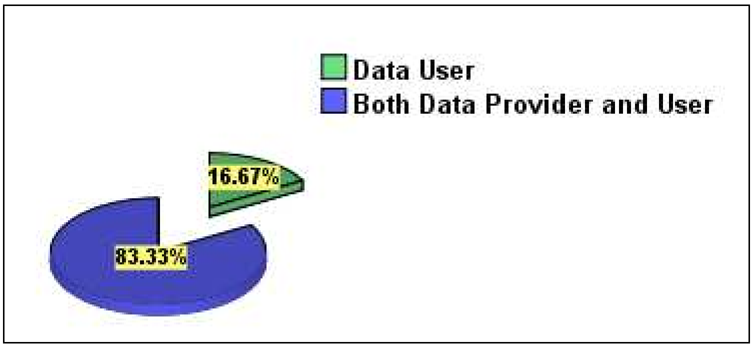


Figure 8.3 Provider-User Relationships

8.2.3 Provider-User Relationships

It was clear from the questionnaire data and semi-structured interviews that an organisation is one of three types: (1) a user of spatial data, (2) a provider, or (3) both a user and provider. Figure 8.3 shows a minority, 17% of the organisations surveyed, used spatial data sourced from other provider organisations, and were users only. The vast majority, over 83%, were both providers and users, and no organisation was exclusively a provider of spatial data. However, the responses do not reveal whether the spatial data used by such organisations was exclusively generated in-house, or sourced from other providers.

On the issue of provider-user relationships, responses were elicited from all 72 interviewees. Eighty-eight percent considered that the majority of bodies dealt with spatial data as producers and users. This point of view was justified in different ways. One interviewee stated:

> "*our organisation has a very large budget, which allows us to depend on our own efforts in implementing all spatial data projects, according to our specifications,without needing to bother or beg from other spatial data producers*" (gopu-22).

Another interviewee explained why, in that:

> "*there is no system for spatial data that unifies specifications and standards for the data at the national level; [moreover,] there is no supervisory or audit body to prevent duplication in projects. Therefore, why should we oblige ourselves to adhere to something other organisations do not abide by, and that the legislator has not addressed*" (gopu-16).

A number of interviewees (9) considered that the bodies in which they worked were only spatial data users. One of them justified this by saying:

> "*it is our ambition in the future to produce our spatial data according to our specifications, as we suffer from not being able to obtain this information from providers according to our special needs. Also, we suffer delay in receiving orders, and the need to follow up these orders constantly. Despite this, we do not get what we want, rather less, or according to the specifications of the producer organisation*" (gou-10).

Another interviewee from these nine explained:

> "*we, as a private sector organisation, seek profitability. Therefore, it is best for us to receive spatial data from producers, rather than producing it ourselves*" (pou-03).

8.2.4 Organisation Size

The survey included organisations of various sizes, ranging from very small (less than 150 employees) to very large (more than 15000 employees) (Figure 8.4). The majority of organisations were public sector (14), and ranged from medium size (751 to 4000 employees) to very large. Private sector spatial data organisations fell in the very small and small (151 to 750 employees) categories of organisation. While a utility company, and an academic institution were in the category of large organisations. In the sample, one third of the organisations were medium sized, while large organisations made up nearly 21%. Both very large, and small organisations made up 17% of the sample respectively, and very small organisations only 12.5%.

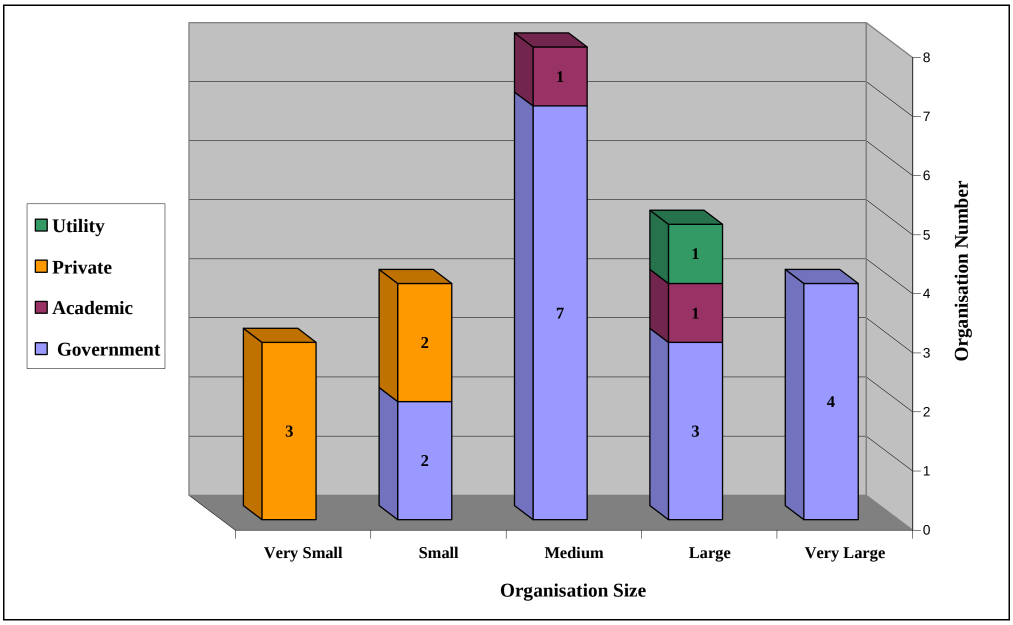


Figure 8.4 Organisation Size including Type

All the interviewees, whether from public or private sector, and academic bodies, responded to this question. They all agreed that organisation size had a significant role in relation to spatial data. One interviewee explained this by saying:

> "*our organisation is very large, to the extent that there is a lot of duplication in spatial data, and lack of harmony in specifications and standards between such projects*" (gopu-13).

Another stated:

> "*in large organisations, it is difficult to control duplication in spatial data projects, while in small organisations it is very easy to make decisions collectively, and according to the interests of the organisation*" (ao-06).

8.2.5 Length of Involvement with Spatial Data

Figure 8.5 illustrates the depth of experience of the organisation, measured in terms of the length of their involvement in spatial data operations. It can be seen clearly that a significant number, 10, have over 15 years of involvement in spatial data. Over 50% of the organisations have been involved in spatial data work for more than a decade.

This question was addressed by most of the participants in the interviews (69), representing government, private sector, and academic institutions working in the field of spatial data. They all focused on the fact that the length of involvement by the organisation in spatial data plays a vital role. This was clearly emphasised by one interviewee:

> "*advanced countries take advantage of long experience in renewal and development. However, we have problems that have accumulated from the past, because some of our organisations have been dealing with spatial data for a long time, and with an outdated mentality; they consider that what they say is what is correct, while disregarding other views, and destroying any person showing creativity in the area of spatial data, so that these organisations can only move in a direction that they have drawn a long time ago, and so that no one may appear to understand things better than them in front of their bosses*" (popu-02).

Another said:

> "*through observation, modern organisations are always more open to other bodies, and easy to deal with, while the opposite is true of old organisations*" (ao-11).

Another interviewee mentioned:

> "*many of the younger generation, are ambitious; they wish to change the status quo in spatial data. However, you come up against old systems, which had been developed by those who are now high officials in the organisation, and so we must accept what we have, until the young generation is able to reach the decision-making levels, and then be able to change matters*" (gopu-19).

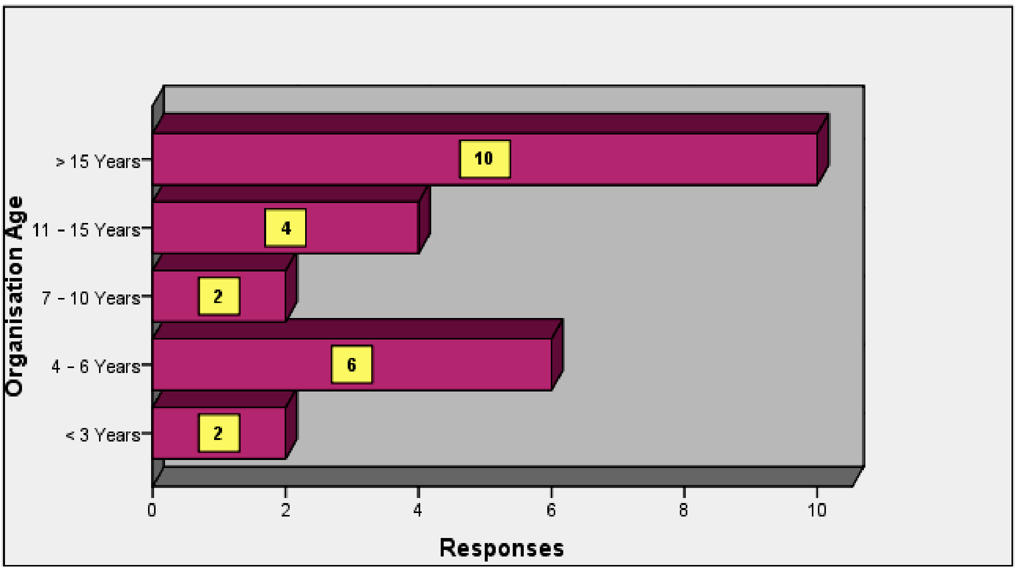


Figure 8.5 Organisations' Length of Involvement with Spatial Data

8.2.6 Size of Spatial Data Department

The size of the spatial data operations of the organisations surveyed is generally reflected by the levels of staffing in each. Figure 8.6 shows the number of employees working in the spatial data operation of each organisation. Only three organisations have staffing levels that exceed 200 working with spatial data and only six with more than 100 people. In contrast 15 employed fewer than 50 spatial data staff, of which 11 had departments with fewer than 20 individuals. Only three organisations maintained departments of between 51 to 100 employees working with spatial data. A wide range of organisations in terms of size was included in the survey; although small spatial data operations dominate.

This question was addressed by all the interviewees (72), representing the various bodies working in spatial data. Fifty-four interviewees (75%) considered that recruitment of large numbers of personnel to government spatial data departments and sections was random and chaotic, and did not depend on specialisation in spatial data. Moreover, after appointment there was insufficient training of personnel in these units in the different areas of spatial data. This was made clear in the words of one interviewee:

> "*workers in the spatial data sections and departments are many in number, but the majority are not specialised in spatial data. Rather, through their connections, they are employed in these sections and departments due to the special financial rewards, without regard to the public interest*" (gou-07).

Another interviewee stated that:

> "*an organisation of the size of our organisation has many sections and departments dealing with spatial data at the level of the Kingdom of Saudi Arabia. However, you are shocked to discover that in some of them there is not a single specialist with a bachelors degree in a spatial data specialisation, and that the majority of workers are perhaps not skilled in spatial data work. The best worker may have only received a course for several weeks in an area of spatial data*" (gopu-06).

Another said:

> "*the problem in some government bodies, is the presence of large numbers of employees in spatial data sections who do not have an academic qualification in spatial data. The other problem, is that there are no policies in these bodies to train and qualify them even if at the sharp end of spatial data, so that these employees can become useful in performing the tasks allocated to their sections*" (ao-03).

The remaining 18 interviewees, i.e. 25% of the participants, considered that private sector bodies work towards maintaining a low number of personnel in spatial data sections, but who are highly qualified in the area. This is clear in the response of one interview:

> "*our policy in the private sector is to create the post that we find quite necessary in our area of work, regardless; in particular, those posts related to spatial data. After which, there is a competition between the applicants, so that the job is taken only by the person who carries the best qualifications, according to fair competition between all applicants. This gives our organisation leading advantage in attracting the best specialists, who satisfy the ambitions of the organisation in being distinguished in all its work related to spatial data. In order to maintain our level of distinction, we must continue to train employees to the state of the art*" (popu-14).

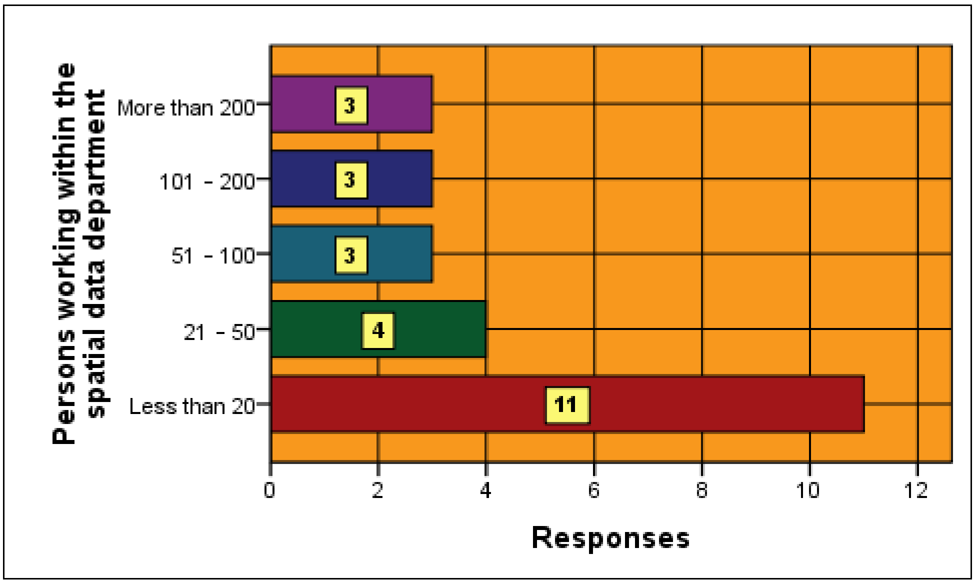


Figure 8.6 Size of Spatial Data Department by Number of Employees

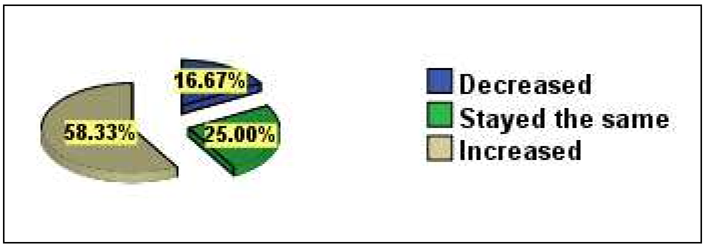


Figure 8.7 Spatial Data Department Growth 2003-2008

8.2.7 Spatial Data Department Growth 2003-2008

In response to the survey question on the changes in staffing levels within spatial data departments in the previous five years, the general conclusion is one of expansion. In this respect, 58% of organisations in figure 8.7 exhibited increasing spatial data employee numbers. In contrast, 17% of the organisations reduced staffing levels in the last five years. Only a quarter had not changed in size. For most organisations, spatial data represented an expanding area of business.

All the interviewees addressed this question, and all of them agreed that the number of employees in spatial data sections and departments vary, i.e. increase, decrease, or stay the same, according to the amount of work in spatial data given to these sections and departments. This is articulated clearly in the following two viewpoints:

> "*the increase in number of employees in spatial data administrations always depends on the number of new posts allocated to these administrative units*

> *annually in the State budget. Normally, this arises from the view of the principal decisionmaker in the organisation, such as the Minister or the general director, that there is a need for such an increase. Similarly, the reduction in personnel numbers,and increasing the practical load on them, or the need to contract work out to external private sector bodies, at high expense, to carry out some spatial data activities, even though there is the possibility to replace these contracts by employing persons on the payroll of these departments to carry out these activities*" (gopu-02).

> "*as a private sector organisation depending on profitability in all its actions, we constantly seek to harmonise the ratio of employees to the ratio of spatial data projects that we may be awarded. Therefore, if we have many projects, we seek to increase the number of employees whether by annual contracts, or contracts for the duration of the project, after which we review the position of the employee; if we considered that his presence would be in the best interests of the organisation, then we would keep him, and if not then we would respect our part of the contract, and inform him that we would not be renewing it*" (popu-12).

8.2.8 The Spatial Data Department in the Organisation

The location of the spatial data work within the internal structure of the organisations surveyed is shown in figure 8.8. This essentially reflects the intra-organisational relationships regarding spatial data, as well as the prominence or otherwise of spatial data within the operations of the organisation. As such, nine had a dedicated spatial data unit with an independent position within the organisation hierarchy. However, seven organisations considered spatial data to lie within the sphere of their IT operation, and as such allocated the responsibility for spatial data to the IT department. Two had no spatial data unit, and instead relied on the services of outside consultancies to satisfy their spatial data needs. In the case of three of the organisations surveyed, the respondents were not able to place the spatial data unit within predefined divisions in the organisation hierarchy, and so responded with "Other" defined in their responses as "Maintenance Department, Tourism Information, and GIS Unit for Teaching, Training and Research". In the case of two organisations spatial data handling was found within the planning department, and within engineering/works department in one organisation.

This question was answered by all the participants in the interviews, representing the different spatial data bodies in KSA. Forty two interviewees, i.e. 59%, considered that spatial data administrations must be completely independent, and linked directly to the principal decision maker in all the bodies. One of the interviewees explained the reason:

> "*in my view, spatial data administrations must be completely independent, and all personnel in them should be those holding high qualifications in spatial data, because the nature of the work in the administration cannot be supervised except by those qualified in all the areas of spatial data; for example, geodetic network projects, satellite imaging projects, GIS projects,*

or other spatial data projects, need specialists, and independent management, through which to deal with the project phases, and the complex computer programs used in such projects, as well as enabling them to make their voice heard at the top of the organisational pyramid" (popu-07).

On the other hand, 16 interviewees (22%) expressed the view that spatial data would best be placed under IT. This is explained by one interviewee, saying:

"*spatial data is considered one of the key types of data that requires high bandwidth servers, as well as a high-level secrecy to protect it from penetration, by providing special protective programmes, which can only be provided through IT management, given their expertise*" (gou-13).

Eight interviewees (11%) expressed the view that it is best to link spatial data activities to the engineering affairs department. This is explained by one interviewee:

"*all our spatial data activities are supervised by the engineering affairs department, because by nature, these activities are linked to all engineering projects*" (pou-08).

Three interviewees (4%) considered that the planning department should supervise spatial data activity; one of them mentioned:

"*the planning department in our organisation supervises all our spatial data, because it is the only body that uses [such data]in the area of establishing future plans*" (pou-01).

The remaining interviewees (3) did not feel there is a need for an independent spatial data department. One of them explained:

"*we do not have a department that independently performs spatial data activities, because in the majority, all spatial data activity is supervised by private sector companies that relieve us of the need to find specialists in spatial data, and the effort of searching for spatial data according to our specifications from the different spatial data producers. We are released from all this, and dictate very strict terms in contracts with these private sector companies,in that all spatial data must be precise and up-to-date, and relevant to the work of organisation*" (gou-05).

Figure 8.8 Spatial Data Department Location in Organisations

8.3 Spatial Data

8.3.1 Spatial Data Types in Use

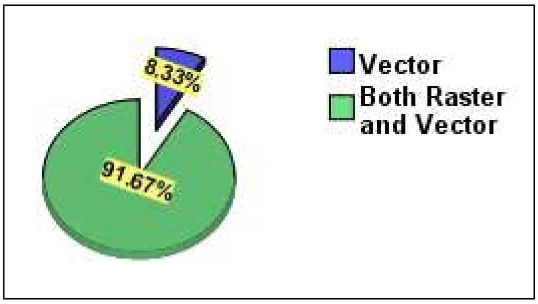


Figure 8.9 Spatial Data Types in Use

The format in which spatial data is handled is also important, and might also reflect a distinction between spatial data providers and users; this is shown in Figure 8.9. A large majority of the organisations, 92%, had the capability of handling spatial data in both raster and vector formats. On the other hand, a very small minority, 8%, admitted to handling spatial data only in vector format. It is highly likely that this reflects in the small number of spatial data users, as opposed to providers within the survey sample of organisations. At the same time, no organisation handled raster data exclusively.

This issue was addressed by all the interviewees from the various participant bodies from government, private sector, and academia working in the area of spatial data in KSA. A majority of interviewees (69), i.e. 96%, indicated that spatial data is available in raster and vector form. One interviewee explained the reasons:

> "*From my experience, all the bodies make sure that spatial data is available to them in raster and vector form. The availability of abundant funds plays a part in the availability of extensive amounts of spatial data that these bodies perhaps do not need*" (gopu-23).

With this high proportion of spatial data in raster and vector forms in the majority of bodies working in the spatial data area, there was also a number of interviewees (3), who considered that there were bodies that prefer spatial data in vector form. One interviewee explained:

> "*We always make sure that we receive spatial data in vector form, which is simple for us to deal with in the different applications that we need, and because raster data needs time and expertise to be converted into vector form*" (pou-06).

8.3.2 Spatial Data Themes

Figure 8.10 illustrates the different spatial data themes reflected in the spatial datasets and data handled by the organisations surveyed. The bars reflect the level of detail to which spatial data is maintained and required by the organisations concerned. As such, of the 24 organisations, 19 handle aerial and satellite imagery, and 14 work with geodetic information. Information on road networks and topography is handled by 21 and 20 organisations respectively. Only two organisations deal with "Other" types of spatial data.

The 72 interviewees, all, responded to questions around this issue. A number of interviewees (56) considered that it was better to give each body the freedom to specify the spatial data themes it needed. One interviewee explained:

> "*look, the country is doing well, from a financial perspective, and the State supports all the bodies working in spatial data with everything that they need. This is because the State knows, absolutely, that each body has its own specifications and standards through which to specify spatial data themes as needed by each one*" (gopu-04).

The remaining interviewees (16) from the different spatial data bodies, representing 22% of the group, considered that the State should put an end to the duplication occurring between the different bodies working with spatial data. This was clearly stated by one interviewee:

“the State is the one to carry the responsibility for this duplication in the freedom of dealing with all the levels of spatial data given to all the different bodies; to date, there is no legislation by the State to regulate the situation regarding spatial data in the Kingdom of Saudi Arabia, and there is no supervising authority to coordinate between the different bodies to prevent what is happening now in terms of misuse of public funds in this context” (ao-12).

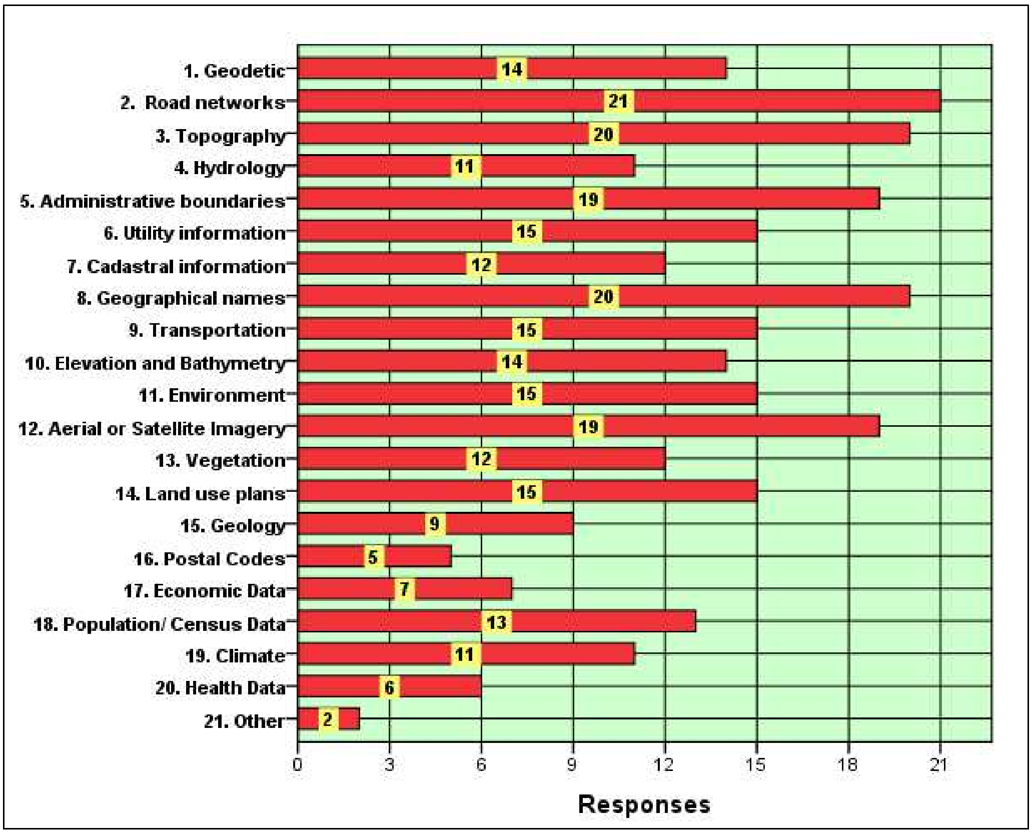


Figure 8.10 Spatial Data Themes

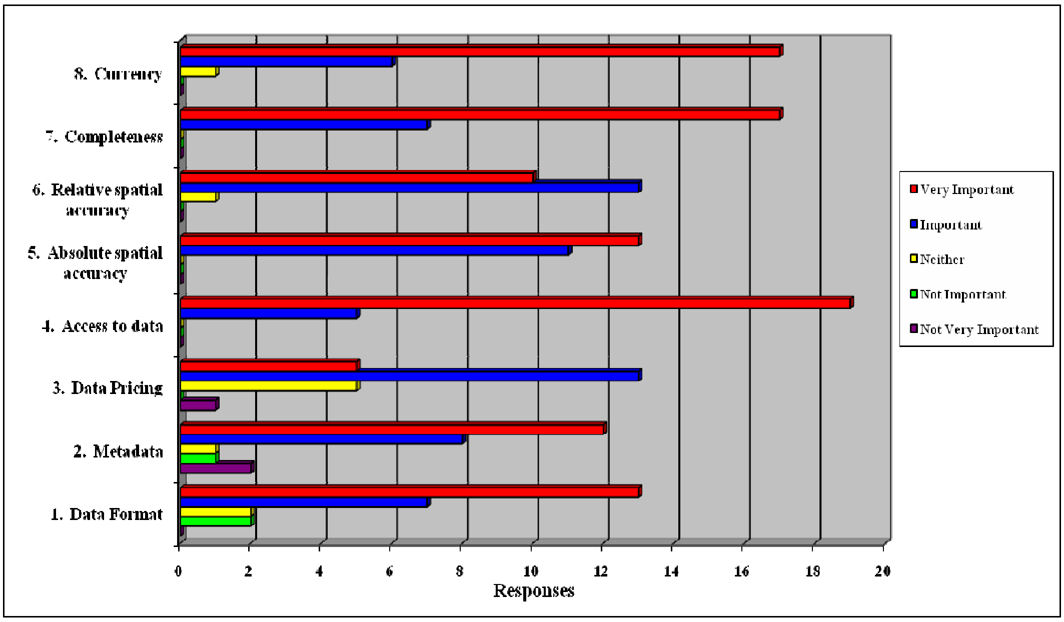


Figure 8.11 Ranking of Spatial Data Aspects

8.4 Spatial Data Aspects

8.4.1 Ranking of Spatial Data Aspects

The views of respondents in the survey regarding the importance of a number of aspects of spatial data are presented in figure 8.11. Thirteen respondents judged spatial data format to be very important, while only seven considered this to be merely important. The rest were largely unconcerned about format issues. Similar results were obtained for the importance of metadata. Pricing of spatial data was an important issue but less so than for most other aspects.

All respondents judged the issue of access to data to be of importance; 19 considered this to be very important.

The issues of absolute and relative spatial accuracy were considered at least important by all respondents; only one respondent remained neutral. Spatial data completeness was another issue judged by all respondents to be important. Indeed, seventeen organisations considered this very important, and only seven organisations as important. Similarly, data currency was considered very important by an overwhelming 17 organisations.

The table indicates that the organisations value and rate highly access to spatial data that is both complete and current; in fact price, format, or demanding maximum spatial accuracy are secondary.

This issue was addressed by all the interviewees working in the 72 spatial data bodies from both public and private sector, as well as academia. Of the interviewees, 67% (48) considered that the majority of bodies using spatial data are not capable of specifying the spatial data features they require. This appears in the statement by one interviewee:

> "*the problem in the majority of bodies using spatial data is that they do not know the importance of the spatial data features needed by their organisations. Therefore, we find that some of them ask for high accuracy in spatial data, and pay large sums of money to acquire such data, while, in fact, their organisations do not require such a high degree of accuracy. I would hope that they distinguish between the requirements for accuracy in spatial data from one region to the other. For example, spatial data for the area surrounding the holy site in Makkah, should be requested at the highest possible accuracy, because the value of 1 square metre there exceeds 100,000 SD Riyals, and property owners will never accept any mistake in defining their property even at the level of five centimetres. In contrast, you will find that in some desert areas, the value of a square metre does not exceed a single SD Riyal, and spatial data for that area should be requested at a level of accuracy that is appropriate to the value and importance of the area. However, you are surprised in such areas that some spatial data users*

ask for highly accurate spatial data for no convincing reasons. As a spatial data producer, we cannot force our views on anyone, however, if we were asked for advice, we would give it" (gopu-20).

A number of interviews (24), representing 32% of the group interviewed, offered the opinion that many spatial data producers have no concern for the features of the spatial data they produce. This is clearly mentioned by one of the interviewees:

"*Spatial data producer bodies do not stick to the standards of spatial data that are asked of them. Sometimes, or the majority of times, you cannot find the documentation for the spatial data that we receive from them, and sometimes the spatial data is incomplete, or is not to the level of accuracy required. The problem is that their prices are very high, and most of the time, you cannot come to an understanding with them regarding price*" (pou-02).

One of the academics specialising in spatial data proposed a solution for this issue. He said:

"*I agree with you that there is a problem between spatial data producer and user bodies regarding spatial data features. I think it is better to hold workshops or conferences with the participation of a number of experts in spatial data to explain the best procedure for specifying spatial data as needed by each body. Also, if academic bodies or experts at producer organisations, some of whom hold PhDs, would design a small booklet or brochure, to be distributed to spatial data user organisations that would explain the concept of spatial data features to them, and the best method to specify the needed spatial data*" (ao-07).

8.5 Data Providers

8.5.1 Percentage of Spatial Data Creation in the Organisation

The extent to which spatial data providers in the sample are engaged in creating data is given by figure 8.12. It is worth noting that 25% of the spatial data providers in the study sample have created more than 90% of the data required in their operations, while 15% of the sample responded by stating that they created between 80 and 90% of the spatial data for their operations. While, 10% created between 70 and 80% of the spatial data needed in their operations. Moreover, 10% were able to create 60 and 70% of the spatial data for their operations, and 5% (one organisation) created 50 and 60%. The remaining spatial data providers comprising 15%, 5%, 5%, and 10% were able to create between 40 to 50%, 30 to 40%, 20 to 40%, and 5 to 10% of their spatial data respectively. Half the spatial data providers in the sample were able to create more than 60% of the spatial data required in their operations.

Fifty-one interviewees, from the various spatial data producer bodies, responded to the questions posed on this issue. Sixty-five percent, i.e. 33 individuals, considered that the size of budget for government organisations played an important role in the ability of these organisations to produce spatial data for the area in which they work. This was clearly articulated by one interviewee:

> "*the [limited] funds earmarked in the budget for our organisation are a huge obstacle to us producing spatial data for the whole area within our jurisdiction, and therefore, in some of our spatial data projects we are forced to divide the projects into several stages spaced over several years*" (gopu-24).

Another interviewee stated:

> "*due to the permanent support provided to our organisation by the government, represented by a generous organisation budget, we are able to produce spatial data, effectively, which allows us to cover more than 90% of the areas in which we work*" (gopu-03).

On the other hand, 35% of interviewees, i.e. 18 individuals, considered that matters were different for private sector bodies. These bodies took great care in producing spatial data, which would assure profitability for their organisations. This is quite apparent in the statement of one interviewee:

> "*government bodies depend on the State for funding, and therefore you see them seeking to cover many areas of the Kingdom of Saudi Arabia, by producing spatial data for these areas. Perhaps, they do not consider the importance of costs of production of this spatial data, while we, in the private sector, are concerned about profitability. Therefore, our production of spatial data always depends on determining the extent of profitability of any spatial data project. Therefore, you find that the majority of private sector organisations cover only a small percentage of the area of the Kingdom's regions*" (popu-10).

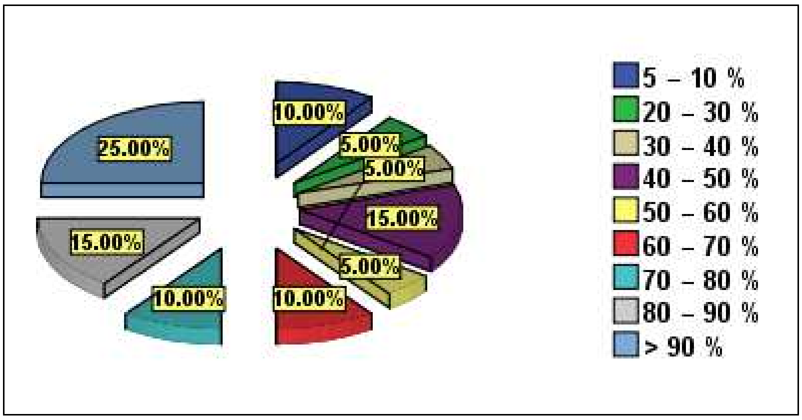


Figure 8.12 Percentage of Spatial Data Creation in the Organisations

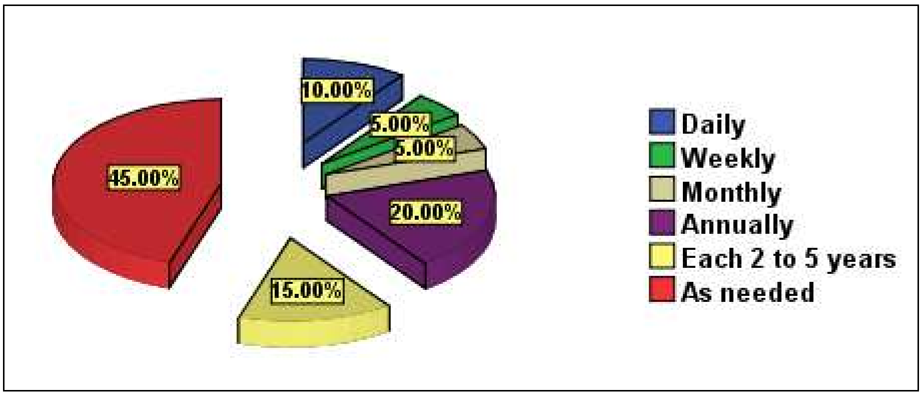


Figure 8.13 Provider Organisation Spatial Data Frequency of Update

8.5.2 Provider Organisation Spatial Data Update Frequency

Figure 8.13 clarifies the mechanism for keeping spatial data up-to-date within the provider organisations by presenting the frequency in which they update it. Forty-five percent (nine) of the spatial data providers surveyed updated their spatial data on an *ad hoc* basis. In contrast, 10% of the spatial data providers (two organisations) updated their data every day. Only 5% (one) updated their data on a weekly basis, and a monthly basis respectively. 20% of these organisations only updated their data annually, while 15% did so every two to five years.

It is worthwhile noting here that updating of spatial data is must be linked to its nature, were some data does not change frequently with time, if at all; for example, altitude data. On the other hand, some areas, like Makkah, are subject to change more so than other regions due to the pace of urban re-development, especially around the Haram area. As such, the policy for updating different types of data should be linked to the spatial data themes they belong to. For each spatial data theme, an appropriate rather than a fixed update period should be instituted in the organisations' policies in this respect.

Regarding this issue, 51 interviewees from the different spatial data producer organisations responded to questions. The majority, 78%, focused on the fact that the bulk of government bodies have the financial capability to update spatial data on a daily, weekly, monthly or annual basis. This was made quite clear by one of the interviewees:

> *"in the same way that government organisations have the financial ability to produce spatial data for any area in the regions of the Kingdom of Saudi Arabia, they also have the capability to determine the time period for updating spatial data. This is because there is no specialist body in the*

> *Ministry of Finance that has full knowledge of the importance of producing or updating spatial data. Therefore, you find that government bodies have a free hand in producing or updating spatial data, depending on the whims of those responsible in the organisations*" (gopu-05).

Eleven interviewees, representing 22% of all interviewees, considered that private sector bodies, carefully study whether to update their spatial data, in order to achieve the highest profitability. This is clearly stated by one interview:

> "*we, in private sector bodies seek to benefit from updating our spatial data to achieve profitability of our organisation, because some areas of the Kingdom of Saudi Arabia are more important, in terms of up-to-date spatial data, compared to other areas. For example, the capital, Riyadh, sees changes every year in its buildings and roads. Therefore, you will find that we make sure we update the spatial data for it, while there are cities or villagers, where there is no great change, and therefore updating our spatial data depends on the need for such a data*" (popu-01).

8.5.3 Network Infrastructure

The network infrastructure within these spatial data provider organisations was explored. Figure 8.14 shows the network arrangement used to access spatial data. As can be seen, 15 organisations depended on a LAN network arrangement, while nine had their own organisation intranet, and nine used the Internet for connectivity. At the same time, only one organisation did not have any type of network arrangement, while another made use of an external drive.

On being questioned on this issue, 51 interviewees responded. Of these interviewees, 28 emphasised that their organisations prefer to transfer spatial data through their private local area network. One interviewee justified this by saying:

> "*the spatial data held by our organisation is considered to be top secret, especially since it deals with large-scale maps, and includes sensitive and secret areas in the country. Therefore, our organisation has a private network connecting all the administrations and departments, and we transfer spatial data only using this private network, to maintain data secrecy and prevent unauthorised access*" (gopu-08).

A number of interviewees, 23 individuals, considered that their organisations preferred using the intranet and Internet to transfer their spatial data. One of the interviewees mentioned this:

> "*protection software is now of high-quality in assuring the secrecy of information that is transferred through the intranet, and similarly with regard to the Internet; these are now more safe for the transfer of information. Therefore, our organisation prefers using our intranet, as well*

as the Internet, to transfer spatial data, because this makes it easy to use your authorisation to access spatial data from anywhere in the world, and because the protective software that we have is very safe, and makes it difficult to compromise our spatial data" (popu-03).

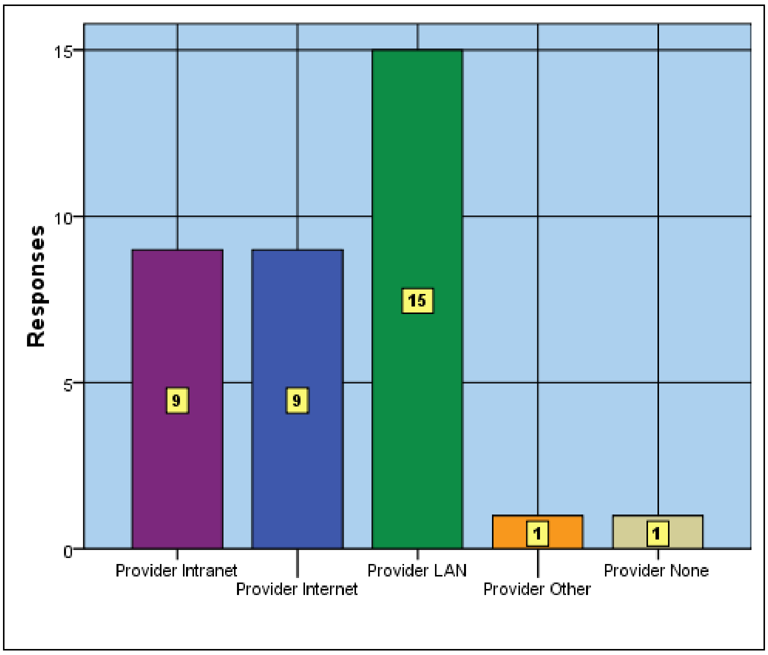


Figure 8.14 Network Infrastructure within Organisations

8.5.4 External Access to Organisation Spatial Data

The sample of data providers in KSA were asked about whether they granted external bodies access to their spatial data (Figure 8.15). Thirty-five percent, i.e. seven, responded that they already provide external organisations with access to their spatial data. At the same time, 40% aim to allow this in future. In contrast, 25% of these organisations do not allow access, and have no plan to do so in future.

Questions around this issue were posed to 51 interviewees, i.e those employed by spatial data producer bodies. The majority, i.e. 82%, emphasised that their organisations wished that there were robust policies for the protection for the intellectual property of each body, with respect to the spatial data it produces. This would allow them to authorise those bodies interested in their spatial data to access it. One interviewee explained this saying:

"*up to now there are no policies from legislators in the country to protect intellectual property rights residing in spatial data. Moreover, there is no body responsible for implementation of such legislation or policies, which would also coordinate between the different bodies working in the area of spatial data. This is because the existence of such a body would enable us to* *authorise others to access our spatial data, according to a specific procedure*" (gopu-12).

As for the remaining interviewees, nine individuals, they considered that their organisations would not allow access to the spatial data they hold, even if there were policies to protect intellectual property residing in such data. This was clearly explained by one interviewee:

"*I swear... that if the State were to implement all the policies in the world for protecting intellectual property and spatial data, we would have no intention to allow anybody to have a look at our spatial data, because organisations are used to stealing the efforts of others, if they are able to, and then claim it as their own; there is plenty of evidence for this, if you want to confirm it*" (popu-06).

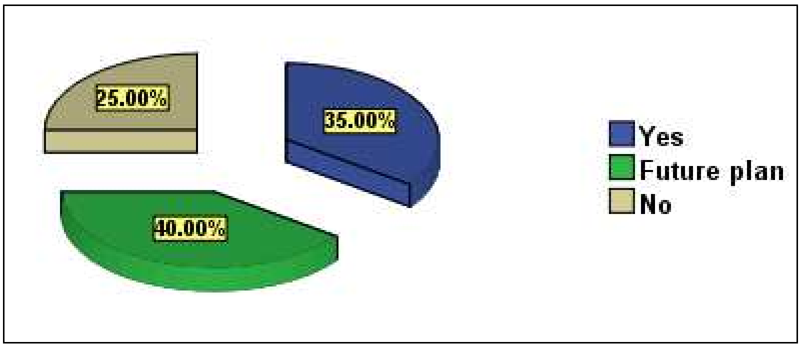


Figure 8.15 External Access to Organisation Data

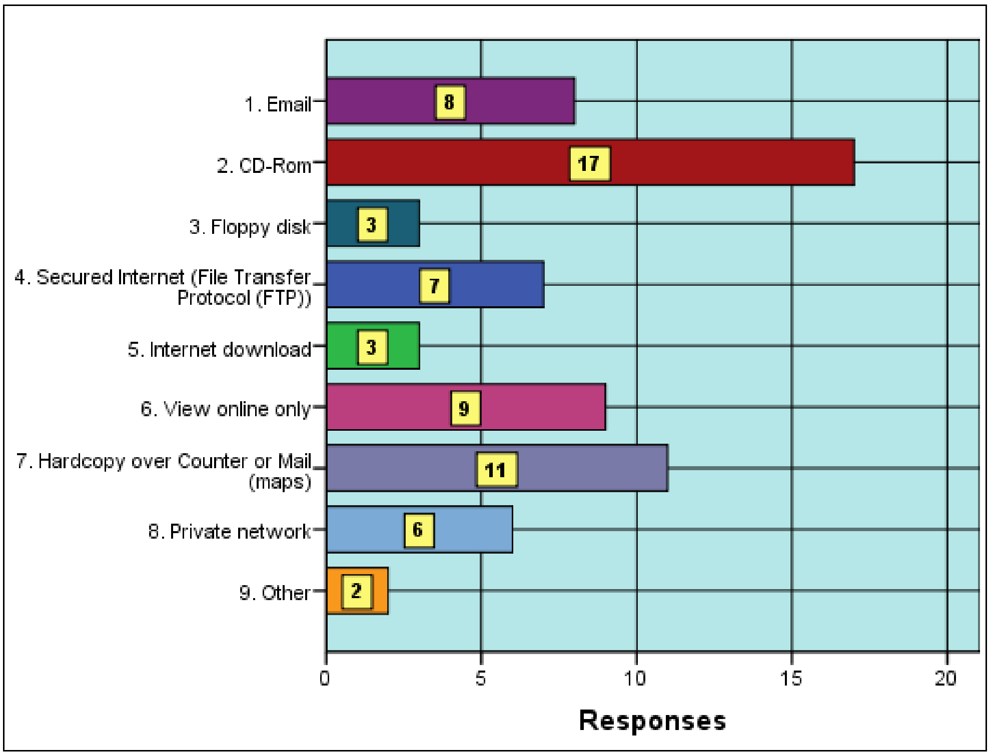


Figure 8.16 Format used for Spatial Data Transfer

8.5.5 Format used for Spatial Data Transfer

The means by which the spatial data providers, in the sample, send data to users are presented in figure 8.16. By far the commonest mode is by CD-Rom, practiced by 17 of the 20 organisations. However, hardcopy (maps) are still provided by 11 of these organisations. Nine providers allow users to view the spatial data online, yet for downloading the data online, three allow normal Internet download, while seven provide the facility for secure transfer of data using secured file transfer protocol (FTP). Six providers make use of a private network allowing users to receive the data. Email is used by eight organisations to send data, while only three provide data on Floppy disk. Of the spatial data organisations surveyed, two sent spatial data to users on DVD, and on a project basis only.

Among the interviewees, 51 worked in bodies that produced spatial data, and they all agreed that they used all the available state-of-the-art methods in transferring spatial data to user organisations. However, the means used depended on the level of secrecy, and the size of the required spatial data. This was explained by one interviewee, in saying:

> "*the secrecy of spatial data and file size oblige us to choose the appropriate means of delivering spatial data to those bodies that request it. In some cases, spatial data is not highly secret, and small in size, and so can be sent by e-mail or by sending a link to the requesting body through which to download the spatial data. In the case of the data being large in size, or highly secret, then it is sent appropriately on a DVD or CD-ROM*" (popu-05).

8.5.6 Spatial Data Provision, Sharing, and Redistribution

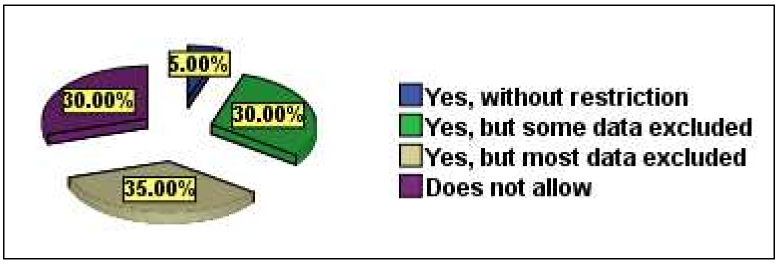


Figure 8.17 Spatial Data Provision, Sharing, and Redistribution Arrangements

Twenty organisations provide spatial data and the rest intend to do so in the future. Seventeen of the 24 organisations responded that they were actively data sharing at the present time, but very few were doing so without some restrictions on data supplied by them or to them. Thirty percent did not allow any redistribution at all [see Figure 8.17]. A clear picture emerges where 50% have defined policies regarding the distribution of their spatial data and a further 40% show encouraging signs of developing such policies in the future. Surprisingly, two organisations do not seem to have plans to introduce such policies.

The content of this question was addressed by all the interviewees from spatial data producer bodies, i.e. 51 individuals. The majority, 36 individuals, agreed that spatial data producer bodies should satisfy the needs of those bodies asking for spatial data, provided that a written and signed undertaking is given by the beneficiary body, that the spatial data will only be used by the organisation. One of the interviewees explained this clearly:

> "*it is difficult for our organisation to isolate itself with respect to spatial data, which obliges us to provide spatial data to those who request it, when they sign a form that protects our rights to that spatial data, and prohibit these bodies from redistributing our spatial data to any other body, regardless of the reasons, without written permission by our organisation*" (popu-11).

The remaining interviewees, 15 individuals, held the view that their organisations cannot provide anybody with spatial data held by them. This was clarified by one interviewee:

> "*in light of current circumstances, and the absence of a watchdog body that prevents bodies requesting our spatial data from selling or providing other bodies with this spatial data, we cannot risk losing our efforts in producing such data to other bodies that cannot be trusted, because of lack of respect for intellectual property rights; I do not say this for no reason, but once we provided one private body with some of our spatial data, and we were surprised after a time that a government body bought the same spatial data from this private body for 6 million Saudi Riyals [one million pounds Sterling]. This private body had claimed the spatial data as its intellectual property, because in this country, there is no system to compel them to respect the rights of others*" (gopu-01).

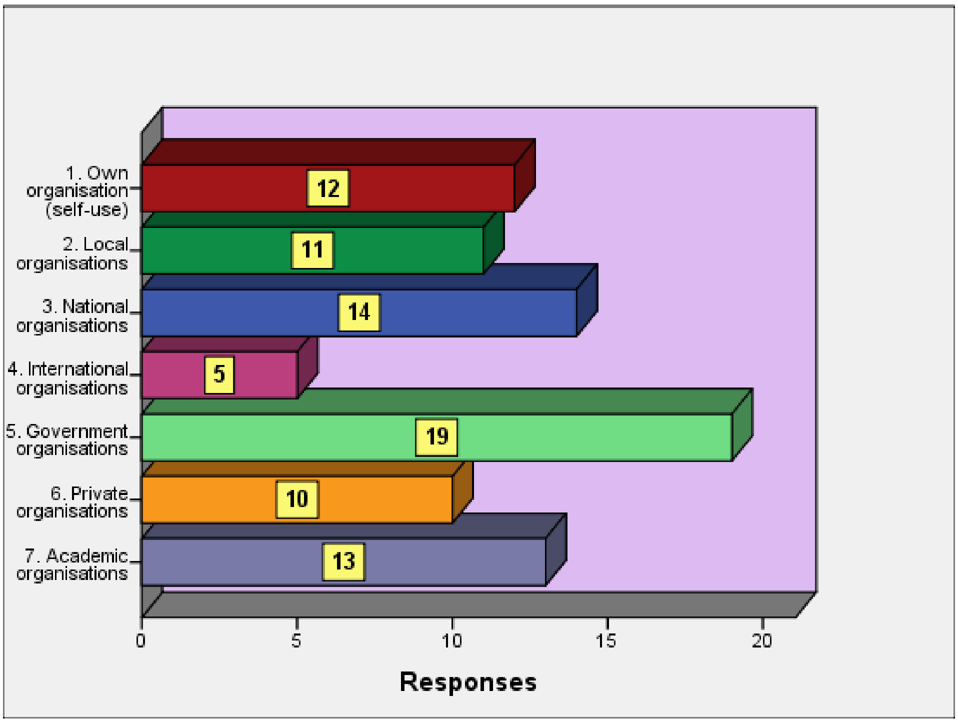


Figure 8.18 Spatial Data Use in Provider Organisations

8.5.7 Spatial Data Use in Provider Organisations

An insight into the nature of the partnerships regarding spatial data use and sharing between providers and other organisations in the sample is given by figure 8.18. The figure reveals that 12 providers make use of the spatial data within their organisation, while 11 supply local organisations. Among the organisations surveyed, 14 spatial data providers made their data available to national organisations, while five made it available to international ones. Moreover, 19 organisations provided spatial data to government bodies, and 10 gave private sector organisations access to their data. Thirteen of the respondent organisations dealt with academic organisations.

Those interviewees working in spatial data producing organisations, 51 individuals, responded to questions on this issue. The majority, 34 individuals, emphasised that the bulk of government bodies working in the area of spatial data depended in their co-operative relationship with other bodies on the quality of personal relationships between those in charge of the respective organisations. This was explained by one interviewee:

> "*quite clearly the relationship of our government organisation with other organisations working in the area of spatial data is due to the relationship of higher management in our organisation, as well as that of those responsible for spatial data in the organisation with counterparts in other organisations. Each represents a relationship of mutual interests, where there is no oversight over these managers that would hold them to account for their*

actions. Therefore, if the relationship was good then other organisations will be provided with everything they need in terms of spatial data, quickly and easily. However, if the relationship was bad, then it would be very difficult for other organisations to get spatial data except under fairly complex conditions, which are very difficult to fulfil" (gopu-11).

Eleven interviewees considered that private sector bodies depended in their dealings with other bodies on agreements and contracts that regulated their role in implementing spatial data projects on behalf of these organisations. This is quite clearly stated in the words of one interviewee:

> "*in private sector bodies we work at improving our relationships whether at national or local level in the Kingdom of Saudi Arabia, and even internationally. This is because we believe that a good reputation improves the level of dealing, and opens the door to opportunities for us to work in successful spatial data projects at the different levels according to contracts and agreements that specify our responsibilities and duties in relation to implementing these projects. As for our dealings with academic bodies, we seek to benefit from them in the area of consultancy, and especially where we win large spatial data projects*" (popu-04).

The remaining interviewees, six individuals, considered that academic bodies cooperate with other bodies through satisfying the need in the area of consultancy in the implementation of spatial data projects, or in the area of training for employees in the form of courses related to spatial data. This is clear in the words of one of the six interviewees:

> "*it is difficult for us as an academic body to force ourselves on others, but through participation in conferences, and seminars, we are invited to cooperate in consultancy for spatial data projects, whether by government or private sector bodies, or we may be asked to hold training courses in spatial data for their employees*" (ao-02).

8.6 Issues relating to Spatial Data User Organisations

8.6.1 Main sources of Spatial Data for User Organisations

An overview of the sources of spatial data from the perspective of users is given in figure 8.19. Twenty-one organisations, i.e. the majority of the sample, received their data from government organisations. Private sector spatial data providers were used by seven organisations, while five user organisations received their spatial data from "Other" sources.

In the semi structured interviews, all the 72 participants responded to questions around the issue of spatial data sources in user organisations. Forty-six individuals informed that their organisations received spatial data from government bodies, which was justified in the words of one interviewee:

> "*we can get the majority of spatial data for free from some government bodies, if our relationship with those in charge of these government bodies was good. Even if they wanted to receive money in exchange for the spatial data, these would only be symbolic sums compared to other sources of spatial data*"(gou-08).

In addition, 17 interviewees indicated that their organisations receive spatial data from private sector bodies. One interviewee explained:

> "*thanks to Allah (God) that we have the funds that give us independence in our decisions, and allow us to receive spatial data from the private sector, according to our own specifications and standards, without being subjected to the humiliation that is standard on the part of some managers in government bodies*" (gopu-15).

The remaining interviewees, nine individuals, held the view that their organisations receive some spatial data from international bodies. One of these interviewees mentioned:

> "*sometimes we need highly accurate spatial data with special specifications, that cannot be found within the kingdom of Saudi Arabia, and therefore we turn to international companies that are pioneering in the field, to directly get what we want*" (popu-09).

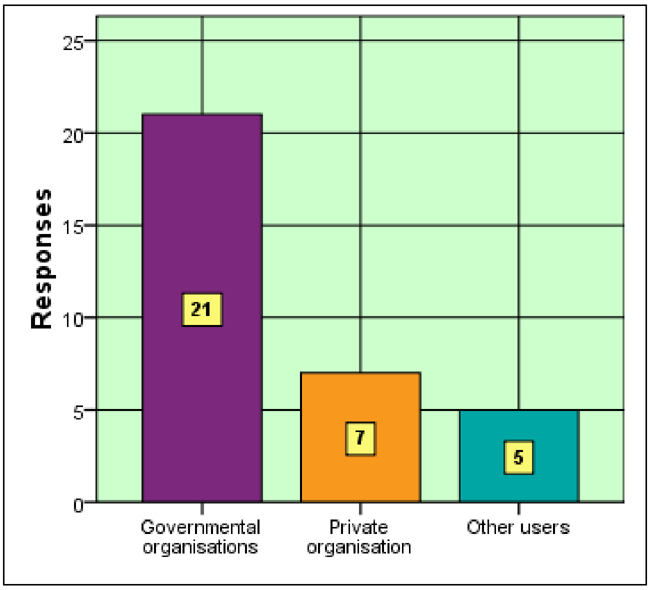


Figure 8.19 Main Sources of Spatial Data for User Organisations

8.6.2 Methods for requesting Spatial Data from Others

The means by which spatial data needs are communicated by users to providers is presented in Figure 8.20. As can be seen, the organisations surveyed in KSA, relied in the majority, 21, on official letters to request spatial data. The second most common means was through agreements on spatial data sharing; Fourteen organisations had these in place. Eight organisations requested spatial data through the means of filling forms for that purpose. The relatively rapid means of email and telephone to ask for spatial data were used in only five and four organisations respectively. Meetings and visits between users and providers was reported as other means of securing spatial data by two organisations.

In the semi-structured interviews, all the 72 participants were questioned regarding their methods for requesting spatial data. In this respect, 29 interviewees held the view that their organisations requested spatial data from producer bodies by way of official letters. As stated by one of the interviewees:

> "*regarding our organisation, we always contact spatial data producer bodies using official letter to ask for spatial data, because producer bodies would want to document such requests by archiving this correspondence, and referring to it in the future, if need be*" (gou-12).

A number of interviewees (18), or 25% of interview participants, considered that their organisations have agreements in place with some spatial data producer bodies, with the objective of ensuring they are supplied with what they need in terms of spatial data, with specified conditions and negotiated prices. This was clearly expressed by one of those interviewed:

> "*we are seeking to reduce the volume of official request letters, and save effort in this respect by signing agreements with some spatial data producer bodies, for them to supply us with spatial data according to conditions and prices agreeable to both parties. These agreements are usually renewed annually, or depending on the agreed duration of such agreements*" (pou-07).

A group of interviewees (10) held the view that their organisations should complete and sign special templates for requesting spatial data from some spatial data producer bodies to get such data. This was clearly stated by one interviewee:

> "*some spatial data producer bodies are concerned about their intellectual property rights with respect to spatial data. Therefore, they ask that our organisation complete and sign special request forms, which contain conditions set by these organisations, strictly prohibiting re-distributing their spatial data to other organisations, and that use of such data be*

restricted to our organisation. Also, to credit their organisation as the producer organisation in any applications using that data" (popu-08).

With respect to the remaining interviewees (15), their organisations obtain some spatial data through e-mail, telephone contact, or by visiting some of the producer bodies. One of the interviewees explained this saying:

"*sometimes, the relationship with those responsible in the producer bodies plays a large role in facilitating the process of our organisation receiving what it needs in terms of spatial data quickly and easily. For example, we may send an e-mail, or we may call them up, or visit them at their offices, especially when the spatial data is not highly secret*" (gou-01).

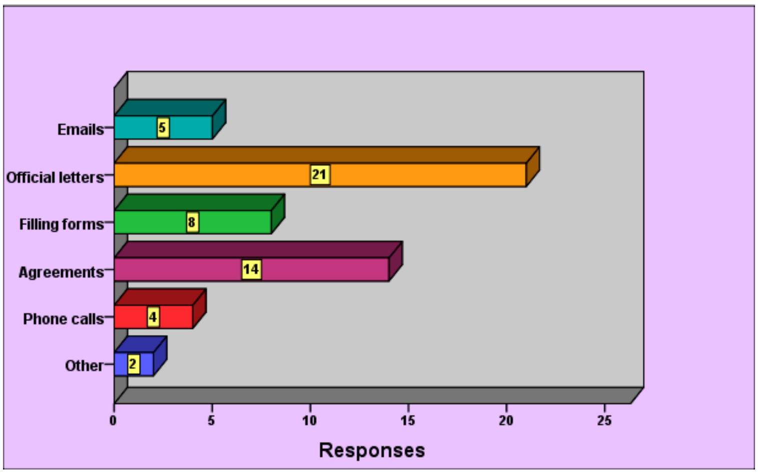


Figure 8.20 Methods for requesting Spatial Data from Others

8.6.3 Methods of defining Requested Spatial Data

The means by which spatial data is identified in requests to providers is summarised in figure 8.21. Twenty organisations constituting the majority of those surveyed used coverage area as an identifier in requests for spatial data. A high number, i.e. 17 organisations, defined their spatial data needs in the form of coordinates. Content was used by 11 organisations, and main features by nine, to define their requests. Only three organisations used cost or price to define their spatial data needs, and the same number, three, reported other means to do so.

With respect to this issue, all the interviewees (72) from the different organisations using spatial data responded. Twenty-three individuals considered that their organisation defines its request for spatial data on the basis of the area of coverage for which they wish to obtain spatial data. One of them mentioned:

> "*our organisation has branches in all regions of the Kingdom of Saudi Arabia. Therefore, we request spatial data only on the basis of the region that we wish to be covered by this spatial data*" (gou-04).

A number of interviewees (19) considered that their organisations request spatial data based on specifying the coordinates of the area that they need. This is clearly stated by one interviewee:

> "*it is easy for us to specify the coordinates of the area that we need spatial data for. It is then quite easy for our colleagues in the spatial data producer bodies to provide us with such spatial data according to our specification using coordinates, because this will prevent errors in defining location*" (popu-14).

Several other interviewees (12), considered that their organisations defined their request for spatial data based on key features. One interviewee mentioned:

> "*from our perspective in our organisation, when we request spatial data, we define such data based on the features of the main area, such as roads; therefore, for example, we may request spatial data lying between two roads, A and B, and roads C and D, in order to make it easy for us and also for the spatial data producer bodies*" (gou-11).

Another set of interviewees (13) considered that there organisations defined requests for spatial data based on the content. This is explained by one interviewee:

> "*in our organisation we take care, by virtue of our specialist knowledge of the locations of tourist and archaeological sites, to define our requests for spatial data by asking the spatial data producer bodies to provide us with detailed spatial data for tourist and archaeological areas, as well as roads leading to them and service facilities, as well as other things necessary for the tourist*" (gou-06).

The remaining interviewees, five individuals, considered that their organisations specify their requests for spatial data based on the price set for such data, as well as other criteria. One of the interviewees mentioned:

> "*we, as a private sector body, are not allowed to request very expensive spatial data, because our organisation will not be able to pay. Therefore our requests depend on specifying price and accuracy for the spatial data, and other matters that we must take into consideration before submitting our request*" (pou-05).

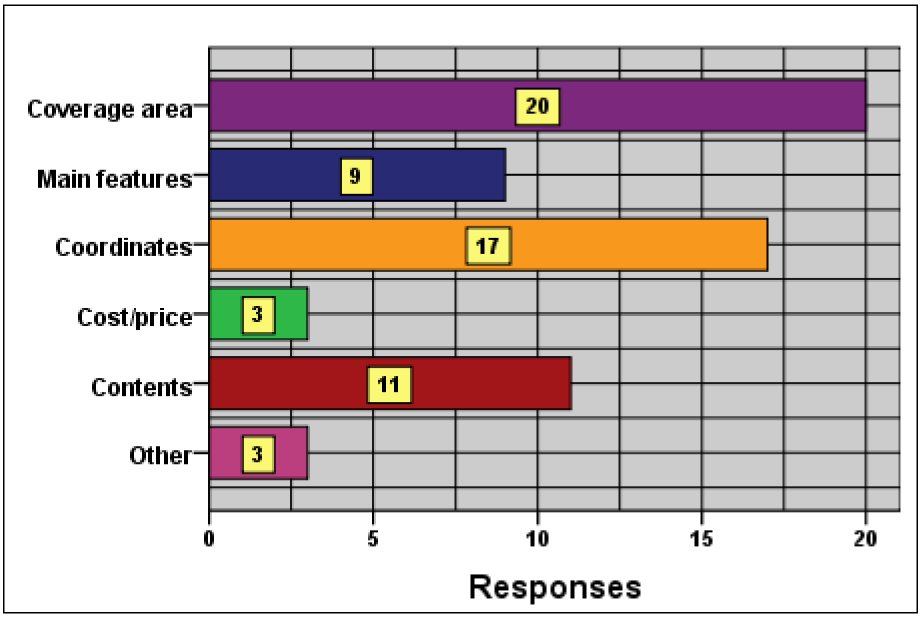


Figure 8.21 Methods of defining requested Data

8.6.4 Pooling Funds for Purchase or Collection of Spatial Data by User Organisations

User organisations were asked how they funded their spatial data needs. The responses revealed that only one organisation pooled purchase resources with others to obtain spatial data, while a large majority, 21 did not do so. However, four organisations planned to do so in future.

All the interviewees (72) from spatial data user bodies responded to questions around this issue. The majority (61), representing 84%, indicated that there organisations had no wish to pool funds with other organisations to pay for spatial data. One of those interviewed explained this by saying:

> "*we have sufficient funds in our organisation to cover the costs of the spatial data that we need; we do not intend to pool resources with other organisations in order to cover the costs of obtaining spatial data, which we always request according to our own specifications and standards. In sharing costs with other organisations, then these organisations will seek to enforce their own standards and specifications, which may not be according to what we want*" (gopu-1).

Seven interviewees held the view that their organisations hoped in future to explore opportunities to share costs with other organisations in purchasing spatial data. This was clearly stated by one interviewee:

"*if there was a system that would allow us as a private sector body to share costs with other organisations with respect to spatial data, which would achieve benefits for all partners, then we would hope that that would be the case, and we encourage this, providing of course that it protects the rights of each party*" (popu-12).

The remaining interviewees, four individuals, considered that their organisations pooled resources and shared the costs of purchasing spatial data with others. One interviewee mentioned:

"*our organisation shares with another private sector organisation the costs of some spatial data, in order to reduce the financial burden on the two organisations to obtain this spatial data*" (pou-03).

8.6.5 Annual Spend on Spatial Data

The extent of spatial data needs of the organisations participating in the KSA survey, expressed in the annual spending on spatial data purchases is shown in figure 8.22. Divided into predefined brackets, six organisations (25%) spend over 10 million Saudi Riyals (1.67 million pounds), and two (8%) spend between 5 and 10 million Saudi Riyals (830 thousand and 1.67 million pounds) a year to acquire spatial data. Ten organisations (42%) spend between one and five million Saudi Riyals (170 and 830 thousand pounds), while six (25%) spend less than one million Saudi Riyals (170 thousand pounds) on spatial data annually.

With regard to this issue, all the participants from the different bodies using spatial data, 72 individuals, responded to questions. They all agreed that there is no system in the Kingdom of Saudi Arabia that unifies efforts in the area of spatial data. Moreover, there is no body that has responsibility for coordinating efforts in this regard, which would reduce the financial costs of spatial data. This was clarified in the words of one of the interviewees:

"*in the Kingdom of Saudi Arabia, we do not have a legislated system that unifies efforts in the sphere of spatial data, and which would safeguard the rights of all the organisations. Also, we do not have a body that plays the role of the coordinator between the different bodies working in the area of spatial data, in order to save huge sums that are paid to purchase spatial data*" (ao-10).

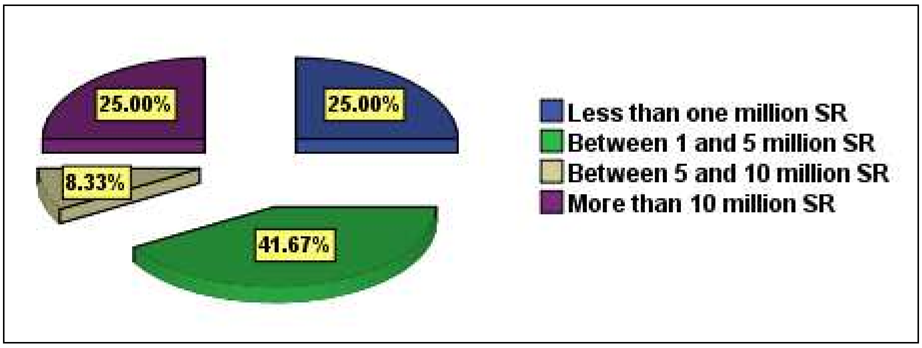


Figure 8.22 Annual Spend on Spatial Data

8.6.6 Difficulties in finding External Sources of Spatial Data

The degree of difficulty in searching and compatibility of spatial data among organisations is presented in figure 8.23. Twenty-five percent (six organisations) consider that spatial data is found easily and is compatible, while 33.33% (eight) find it difficult to find the spatial data they are looking for, yet when it is found, it is compatible. Ten organisations (41.67%) reported that although spatial data was found easily, it was not compatible.

Questions on this issue were addressed to all participants (72) in the interviews, who worked in user organisations. Of the interviewees, in searching for spatial data, 35 suffered difficulty in obtaining it from those bodies producing spatial data. Moreover, even when they obtained such spatial data, it would usually be incomplete. This was explained by one interviewee saying:

> "*part of the problem that we face in our organisation when we are looking for spatial data, is the difficulty in obtaining it from some spatial data producer bodies, due to the complexities of the system which they use, and the routine involved to get to such spatial data. Nearly always, we find to our surprise that after all these complications, the spatial data that we requested is incomplete, and does not satisfy the required standards and specifications*" (pou-08).

Of those interviewees, 25 representing 35% of participants considered that their organisations in searching for spatial data faced great difficulty in finding this data held by producer bodies. However, this situation is made more bearable, since they find the spatial data in complete form. This is explained by one interviewee:

> "*sometimes bodies producing spatial data ask our organisation for an official letter that provides the details of the spatial data that we would like to have. This letter is then taken away and a a relatively long time elapses, as it is passed around among a number of those responsible, to secure their*

agreement. Perhaps one of them may refuse, which would require us to follow up on our request on an almost daily basis. After meeting different conditions, and signing different paperwork, with regard to this spatial data, we are provided with it, but only after a lot of trouble. However this is made bearable by the fact that they give us complete and full spatial data in accordance with our specifications" (gou-02).

The remaining interviewees, numbering 12, and representing 17% of all those interviewed considered that their organisations source the spatial data that they look for quite easily from the producer bodies. This is articulated by one of them saying:

"*since our organisation is one of those bodies that produce spatial data, therefore when we need spatial data from another body that produces that data, we receive it quickly and easily, and typically the spatial data is complete and in accordance with the specifications that we set in our request. They do this because they wish that we would deal with them in the same way when they require spatial data from us*" (gopu-21).

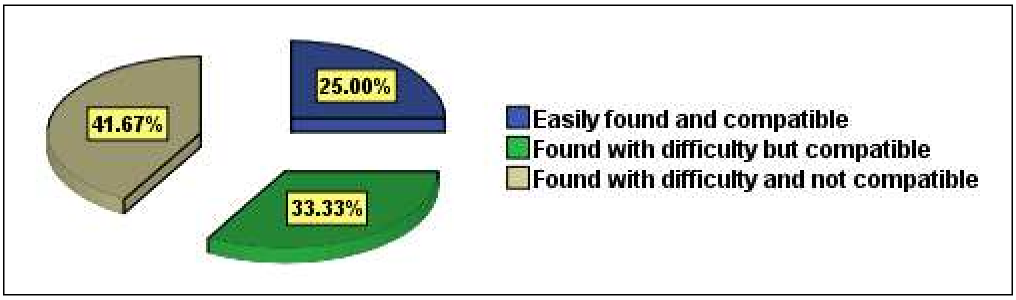


Figure 8.23 Difficulties in finding External Sources of Spatial Data

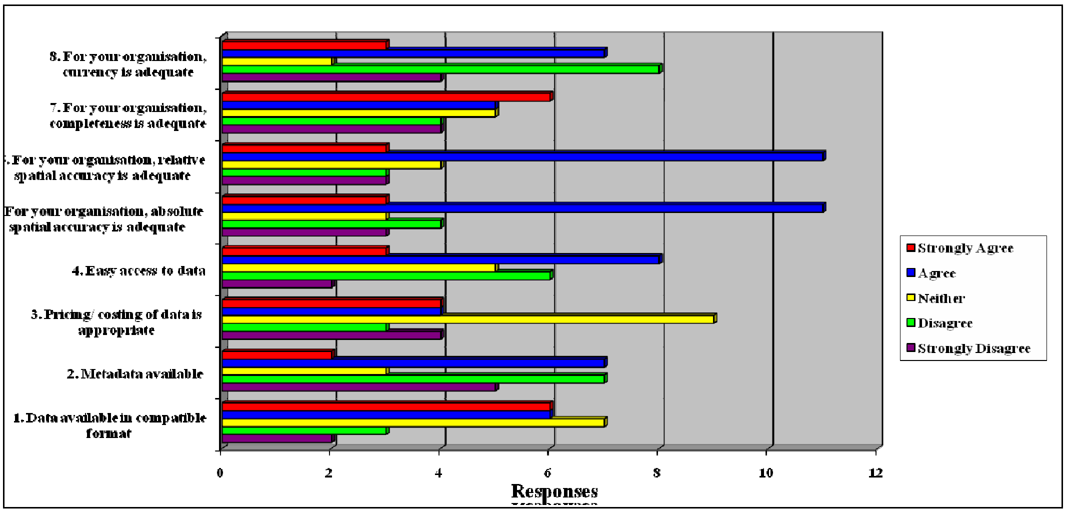


Figure 8.24 Spatial Data Status

8.6.7 Spatial Data Status

The opinions of respondents, i.e. the spatial data organisations, regarding a number of issues concerning spatial data are presented in figure 8.24. When questioned on whether spatial data was available in compatible format, six respondents agreed strongly, while another six agreed. Seven respondents chose to remain neutral, and neither agreed nor disagreed. However, five respondents considered that data was not available in a compatible format, with two strongly agreeing to this, and three agreeing.

In terms of metadata availability, two respondents strongly agreed this was the case, and seven others also agreed to this. Three respondents neither agreed nor disagreed on this issue of metadata availability, while seven disagreed, and five strongly disagreed.

On the issue of data pricing and cost, four respondents strongly agreed this was appropriate, and four more only agreed. While nine respondents answered neutrally, in neither agreeing nor disagreeing that cost and pricing of data were appropriate. However, three respondents disagreed and four strongly disagreed to cost and price being appropriate.

In gauging access to data, three respondents strongly agreed that this was easy, and nine agreed. With four respondents choosing to neither agree nor disagree, two strongly disagreed and six disagreed that they had easy access to data.

On the issue of absolute data accuracy, three respondents and 11 others considered that this was adequate by respectively strongly agreeing and also agreeing to such a statement, while three respondents neither agreed nor disagreed. In contrast, three respondents judged that absolute data accuracy was not adequate to their needs, by strongly disagreeing, and were joined by four others who disagreed with the adequacy of absolute spatial accuracy.

When questioned on relative spatial data accuracy, three respondents strongly agreed that this was adequate to their needs, and 11 agreed to this. Four respondents were neither in agreement or disagreement with the idea, but three strongly felt this to be inadequate, and three others concurred by disagreeing to relative spatial accuracy being adequate.

In judging completeness, six respondents reported that they strongly agreed that this was adequate, and another six agreed. Of the other respondents, four were neither in agreement or disagreement. However, four respondents did not find completeness to be adequate and strongly disagreed to the statement it was so. Moreover, four more respondents held the view that completeness was not adequate for their organisation, and disagreed to the statement “For your organisation, completeness is adequate”.

Addressing currency, the statement “For your organisation, currency is adequate” was met by respondents, in that three strongly agreed, eight agreed, three were neutral towards it. Of the other respondents, six disagreed with that statement, and four strongly disagreed.

On this issue, all the participants (72) in the interviews responded. Sixty-one interviewees considered that spatial data is always formulated according to the specifications and standards of those bodies producing it, and that user bodies can only request what is available from these producer bodies. This is mentioned by one interviewee:

> "*spatial data producer bodies create spatial data according to their needs, and based on their own specifications, standards, and scales, as for spatial data user bodies, they can only ask for what is available at producer bodies*" (gou-03).

Several interviewees (11) considered that user bodies could obtain spatial data according to their specifications and standards from spatial data producer bodies. One of these interviewees explained this:

> "*some spatial data producer bodies work on private projects to produce spatial data for those user bodies that request spatial data according to their own standards and specifications. However, the cost of such projects is generally very high*" (ao-09).

8.6.8 Practical Difficulties in obtaining Spatial Data from Owner

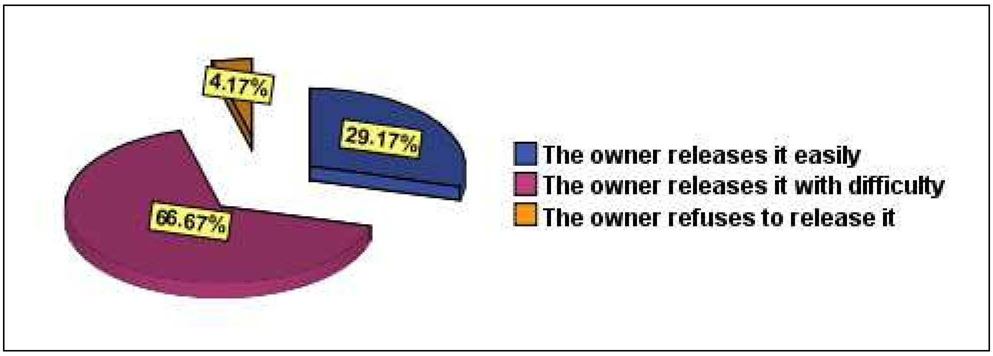


Figure 8.25 Practical Difficulties in obtaining Spatial Data from Owner

The levels of difficulty encountered in making another body with ownership of spatial data release it to organisations wishing to make use of it, is illustrated in figure 8.25. Among the organisations surveyed in KSA, 66.67% (16) found that with difficulty they could persuade a spatial data custodian to release it to them, compared to 29.17% (seven) who noted that it was easy to achieve this. However, for 4.17% (one), they discovered that the other organisation would completely refuse their request for that data.

In the interviews of all 72 participants from spatial data user bodies, questions on the practical difficulties encountered in obtaining spatial data from owners were posed. The majority, represented by 42 interviewees, considered that their organisations suffer from the severely strict measures imposed by spatial data producers in releasing their spatial data. One interviewee explained that:

> "*The spatial data producer bodies are very strict in releasing their spatial data, and always want to find out the reason for such requests for spatial data by user bodies. For example, our organisation, once requested some spatial data from a particular body. We spent a long time following up our request from one manager to another, as though we were beggars, to the point at which they were saying to us: you do not need this spatial data. After suffering a lot, they made us sign a number of undertakings and conditions to protect the spatial data that they would hand over to us. In the end, the spatial data they provided was not to the grade that we had expected*" (gou-13).

On the other hand, a number of interviewees (22), representing 31% of the sample, held the view that spatial data producer bodies released their data with great ease. This was clearly expressed by one interviewee:

> "*We consider our organisation to be both a producer and user of spatial data. Therefore, our relationship with spatial data producer bodies is one of mutual interest, where we provide them with the spatial data they need with great ease, and they provide us with the spatial data we need with great ease*" (gopu-19).

The remaining eight interviewees (11% of the sample), considered that some spatial data producer bodies refused to release their spatial data. One interviewee stated:

> "*Some spatial data producer bodies, especially the military ones, shock us by refusing to release spatial data to us. The reason is that they believe that their spatial data is top secret, and that they cannot provide it to private bodies, or commercial companies in particular*" (pou-06).

8.6.9 Kinds of Spatial Data Applications

The areas to which organisations surveyed in KSA apply spatial data are presented in Figure 8.26. As reasonably expected, 21 organisations apply data to mapping. seven organisations use spatial data for public safety, and 10 for the purposes of serving transportation. Spatial data is used in the area of natural resources by eight organisations, and 11 organisations apply it in environmental issues. Six organisations reported that spatial data was used in agriculture, while 13 organisations used spatial data in the area of utility services. Land development purposes were served by 13 organisations using spatial data, and in the area of national security, nine organisations applied spatial data. Five organisations applied spatial data to a variety of other purposes: planning, research and development, and census.

The classification of spatial data applications was the subject of a number of questions posed to all 72 interviewees from spatial data user bodies. They all agreed that their organisations developed spatial data applications according to their own perspective, without cooperating with other bodies to produce common applications. This was clearly explained by one interviewee:

> "*In the Kingdom of Saudi Arabia, we suffer in that you find each organisation working in the area of spatial data performing a number of applications of spatial data according to their own particular perspective, while other bodies also implement their applications using a different perspective; to the point to which the number of base maps for some cities in the Kingdom numbered around ten, each produced by a different body, and each body claiming that the map that they had produced was the correct one, while the other maps were wrong. The reason for this situation is the absence of awareness among all those working in the different bodies, of the importance of cooperation in carrying out joint applications that would benefit everyone, and would greatly improve the accuracy in the specifications of the final product; the other reason is that to date the State has not produced legislation that limits this phenomenon*" (ao-04).

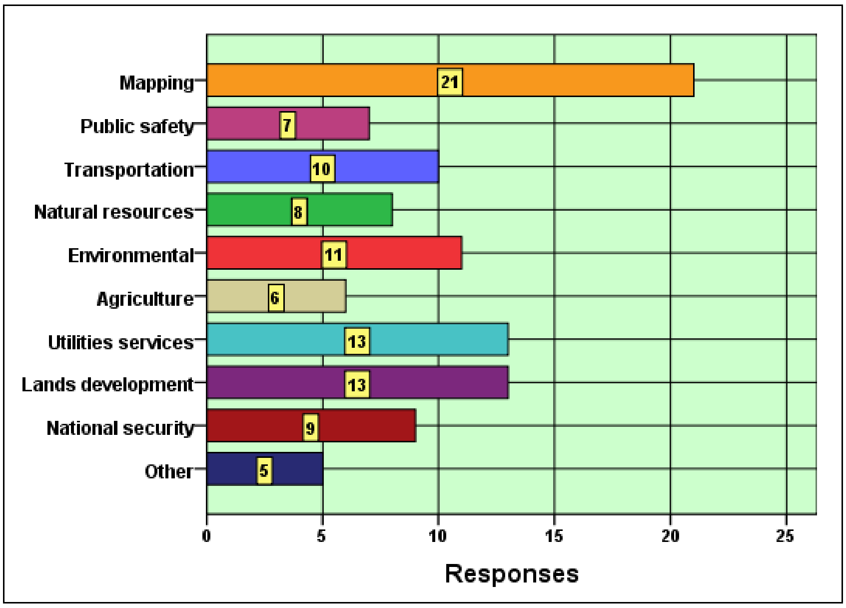


Figure 8.26 Kinds of Spatial Data Applications

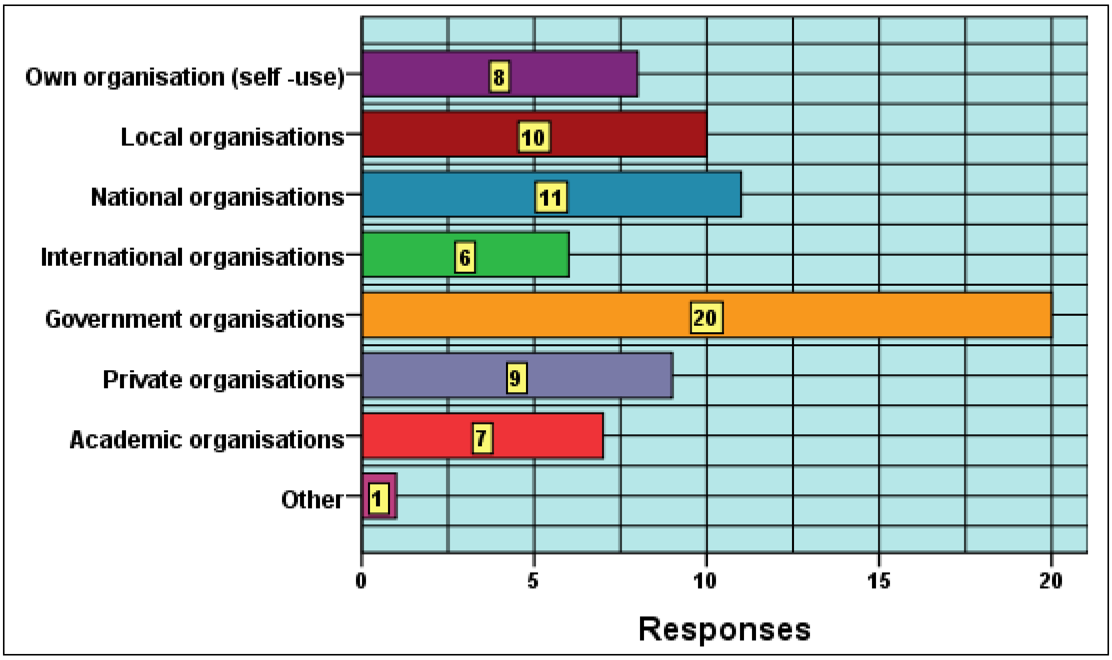


Figure 8.27 Organisations supplying Spatial Data

8.6.10 Organisations supplying Spatial Data

Spatial data users reported on whom they dealt with in acquiring spatial data (Figure 8.27). eight organisations reported that this occurred within the organisation. Ten stated that they dealt with local spatial data providers, and 11 dealt with national ones compared to six who dealt with international spatial data providers. By far the majority of respondents, 20, found that they acquired spatial data from the public sector, government spatial data organisations. Those dealing with private sector and academic organisations for their spatial data needs were nine and seven respectively; whereas only one organisation approached others, i.e. utility companies, to access spatial data.

On this issue, all the participants in the interviews from the different spatial data user bodies were questioned. The majority, 54 persons, considered that spatial data user organisations were keen to cooperate with all the bodies working in the area of spatial data production at national or local level in the Kingdom of Saudi Arabia, or at international level. This was explained by one interviewee, quite clearly:

> "*Our organisation is considered to be a user of spatial data, and we do not have the capabilities to produce spatial data. Therefore, we are very keen to cement our relationships with all spatial data producer bodies, governmental or private, at local or national level within the Kingdom of Saudi Arabia, or at international level abroad. The purpose is to diversify the sources of spatial data that are needed by our organisation*" (pou-04).

The remaining interviewees, 18 persons, considered that spatial data producer bodies, as well as user organisations dealt with spatial data providers on a like-for-like basis. This appears quite clearly in the words of one interviewee:

> "*Those bodies, producing and using spatial data, deal on a like-for-like basis with spatial data provider bodies, in that the spatial data provider bodies take advantage of the demand for the data they create, and delay their requests to buy time, until they are able to secure their own needs of spatial data from the requesting bodies. In those cases, where such organisations are unable to get what they want, in terms of spatial data from providers, then they would in most cases, apologise and refuse requests on the basis of equal treatment, as well as a punitive measure, because until now there is no system in the country that obliges any organisation working in the production of spatial data to provide other bodies with spatial data that it creates*" (ao-02).

8.7 Spatial Data Standards

8.7.1 Spatial Data Standards in Use

The types of standards in use in the organisations surveyed are presented in figure 8.28. It can be seen that 18 organisations, a large number, rely on the International Standards Organisation ISO, Technical Committee for Geographic Information / Geomatics – TC211 standard to create, update, integrate, or distribute spatial data. The Open GIS Consortium OGC standard is used by eight organisations, while four use the World Wide Web Consortium W3C, and five have their own data standard.

On the issue of standards used by spatial data bodies, all the 72 interviewees from the different government, private sector, and academic bodies working in spatial data responded. Of these interviewees, 33 individuals, representing 46% of the sample, considered that their organisations did not have knowledge of international standards and specifications relating to spatial data. This was explained by one interviewee:

> "*In our organisation we do not have qualified persons with the knowledge of international spatial data standards and specifications; therefore, we are under no obligation to abide [by such standards and specifications], and work towards having spatial data complying with our own unique standards and specifications, which meet the needs of our organisation. However, we are told by bodies that provide us with spatial data that this conforms to ISO standards*" (gou-05).

On the other hand, 39 interviewees, held the opinion that some organisations working in the area of spatial data claim that their spatial data complies with international standards and specifications. However, on inspection of such spatial data, they found that this is not correct, and that the majority of such data conforms to the standards and specifications unique to these organisations. This is quite clearly stated by one interviewee:

> “*I hope that we do not lie to one another, when we claim that our organisation holds spatial data conforming to international standards and specifications, because this is absolutely not true, and you may perhaps find some attempts in some areas to follow international standards and specifications. However, the majority of our spatial data is in accordance with in-house standards and specifications; however, some of our colleagues in the organisation may wish to deny this fact. In my view, the reason for this situation, is the lack of a law to compel our organisation and others working in the spatial data area to follow international standards and specifications*” (gopu-17).

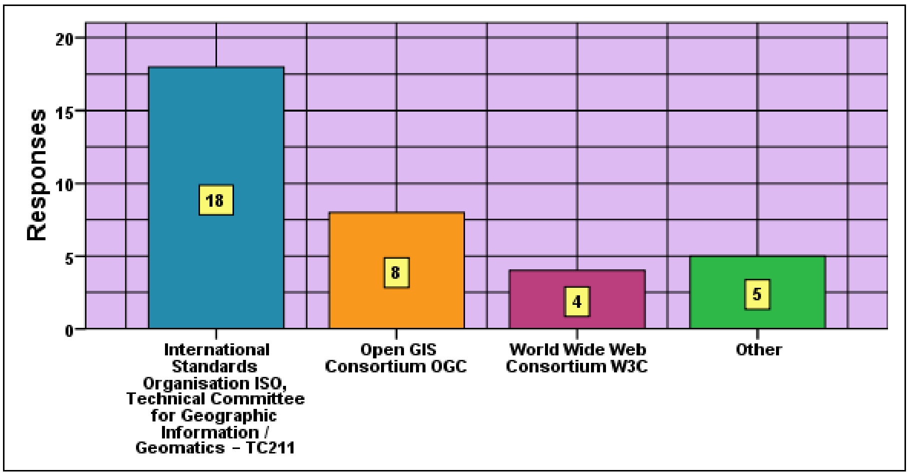


Figure 8.28 Spatial Data Standards in Use

8.7.2 Spatial Metadata Creation and Maintenance

The issue of metadata creation and maintaining in the view of the organisations participating in the survey is illustrated in figure 8.29, where 42% (10 organisations) create and maintain metadata, while the same number again (10 organisations), representing 42% of respondents plan to do so in future. Only 16% (four organisations) do not do so at present, and do not have plans for that.

All 72 interviewees from the different bodies working in the spatial data area responded to questions regarding creating and maintaining metadata. The opinion of 25 interviewees, representing 35% of the sample, was that their organisations were currently working to document their spatial data. This was clearly stated by one interviewee:

> "*I always define metadata as the identity of information. Indeed, data lacks an identity, if there is no metadata to describe it. In reality, what we have done in our current project, we have focused 70% of technical effort on the metadata for the spatial information. Unless search and maintenance of the*

data is done through the metadata, then we will not have achieved anything. Therefore, we are carrying out intensive testing in this respect" (gopu-14).

On the other hand, 32 interviewees considered that their organisations were seeking to attempt to document their spatial data in the future. This was indicated by one interviewee:

"*In the future, we will seek to document our spatial data, in our own way, so as to facilitate referring back to it, and using it, because we found difficulty in dealing with our old spatial data, because it was not documented by identifying those persons who produced it, and the date it was created, which was missing, as well as other necessary information needed to document spatial data*" (popu-02).

The remaining interviewees, 15 individuals, considered that their organisations did not document spatial data. This was indicated by one interviewee:

"*there is no documentation of spatial data by our organisation, because there is no sufficient knowledge of the importance of this by those in charge*" (gou-10).

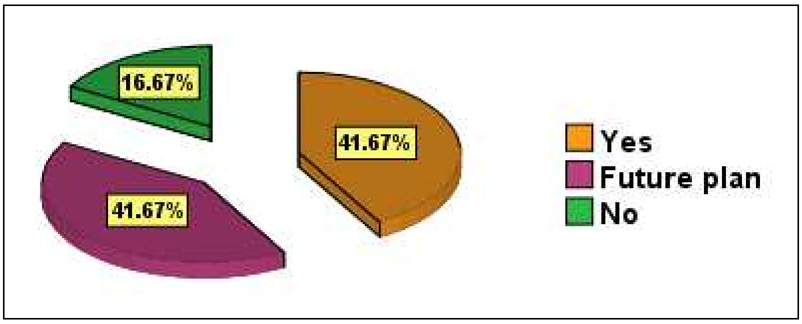


Figure 8.29 Spatial Metadata Creation and Maintenance

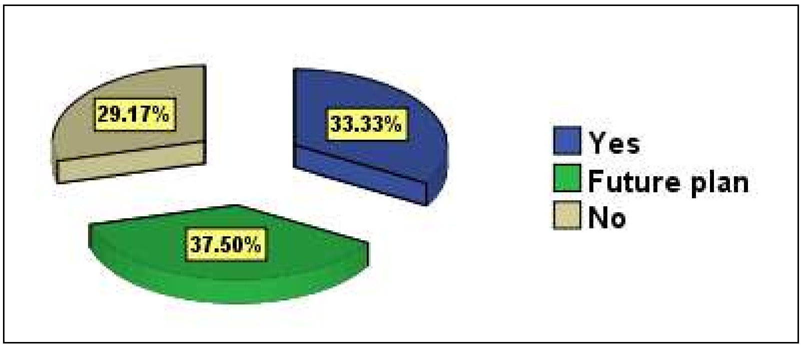


Figure 8.30 Standards in Metadata Creation

8.7.3 Standards in Metadata Creation

Figure 8.30 shows how organisations consider standards in creating metadata, in that 33.5% (eight organisations) presently use standards to create metadata, while 37.5% (nine organisations) plan to use standards in future. However, 29% (seven organisations) report that they do not use standards to create metadata.

Questions regarding creation of metadata were posed to all 72 interviewees, representing the different spatial data bodies. A total of 28 interviewees considered that their organisations used their in-house standards to document spatial data. This was mentioned by one interviewee:

> "*We use our own standards and specifications to document spatial data, in a way that achieves our objectives and meets our needs. By studying the nature of our spatial data, and the essential things that would facilitate identifying and dealing with it, when needed second time around*" (gopu-18).

The remaining 44 interviewees considered that their organisations, up to that moment, did not have in-house standards to document their spatial data. This was clearly stated by one interviewee:

> "*In our organisation you have not reached that level yet, where we would adopt in-house standards to document our spatial data. Perhaps, this will happen in future, when we have specialists who would be able to carry out this process of documentation; but before then, they would need to convince those in charge, of the importance of documenting our organisation's spatial data*" (gou-07).

8.7.4 Use of Metadata Creation Standards Similar to Other Organistions

Figure 8.31 illustrates whether common standards are used by the organisations concerned in creating spatial metadata, where 37.50% (nine organisations) report that they use standards. However, an equal number, i.e. 37.50% do not. Yet 25% (six organisations) plan to employ standards in spatial metadata creation.

With respect to metadata standards, and how far they were similar among the bodies engaged in the spatial data field, all 72 interviewees responded to questions on the issue. The opinions of 19 interviewees agreed in that their organisations sometimes benefited from the experience of other organisations working in the spatial data area, in terms of standards adopted to document spatial data. This was explained by one interviewee quite clearly:

> "*Some organisations in the Kingdom of Saudi Arabia, have been ahead of us in starting to think about establishing standards specific to documenting*

spatial data; therefore, our organisation seeks to benefit from their experience in this, in establishing standards for documenting our spatial data" (gopu-25).

However, the remaining 53 interviewees held the view that their organisations did not care for the outcomes reached by other organisations in terms of standards for documenting spatial data. This was justified by one interviewee:

> "*The last thing that those in charge of our organisation think about is the process of documenting spatial data, or benefiting from other bodies that have beaten us, in starting work in this area. This is due to the lack of knowledge regarding the importance of documenting spatial data, and the absence of a national system that would compel them to adhere to a specific procedure to document spatial data. Above all, those in charge are keen to maintain the independence of our organisation from other organisations in everything related to spatial data*" (gou-02).

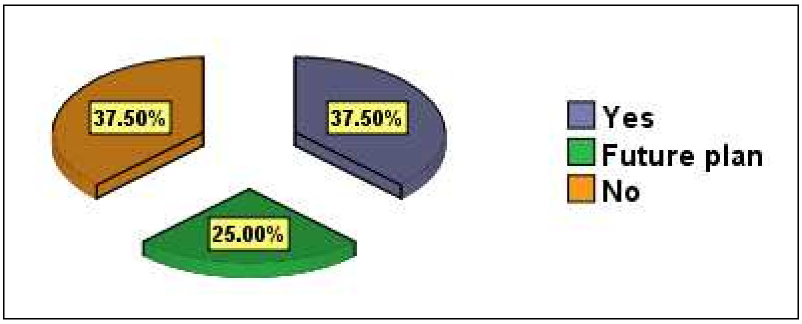


Figure 8.31 Use of Common Metadata Creation Standards among Organisations

8.8 Technical Aspects

8.8.1 Software used by the Organisations

The software tools available to the organisations for handling spatial data are presented in Figure 8.32. The majority of organisations, 21, use ESRI - ARC/INFO, while 18 use ESRI – ArcView, and 13 use ERDAS – IMAGINE. nine organisations use AutoDesk AutoCAD in their operations, and eight use Bentley Systems Microstation, while seven use ESRI-ArcCAD, and five use ESRI –Atlas. Of the software tools available, four organisations use Mapinfo, two use Intergraph MGE, and one uses CARIS. six organisations use other tools: Intergraph GeoMedia, Intergraph G/Technology, ESRI – ARC/Editor, and ER Mapper.

The participants in the interviews, 72 individuals, representing the different bodies working in spatial data in Saudi Arabia, were asked about the technical aspects, in terms of software applications in use at their organisations. The interviewees all agreed that each body working with spatial data in the country had full authority to choose the software applications they needed to deal with spatial data. This was explained by one interviewee:

> "*In the Kingdom of Saudi Arabia there is no single body, at this time, that has responsibility for coordinating between the different bodies working with spatial data. At the same time, there is no official legislation by the State that regulates the process of cooperation between these different bodies, which makes each organisation have the full authority to choose the appropriate software applications for its spatial data work*" (popu-13).

Moreover, all the interviewees agreed that the most widespread software applications, among the bodies working with spatial data in the Kingdom of Saudi Arabia, is the ESRI software suite. This was explained by one of the interviewees:

> "*The most widely used software in the area of spatial data in the Kingdom of Saudi Arabia is the ESRI software family. This is because of a number of things, most prominently is the international reputation, and effective solutions provided in the area of spatial data, in addition to the widespread use in all countries, through support and patronage of conferences, workshops, and specialist activities in the area of spatial data*" (ao-05).

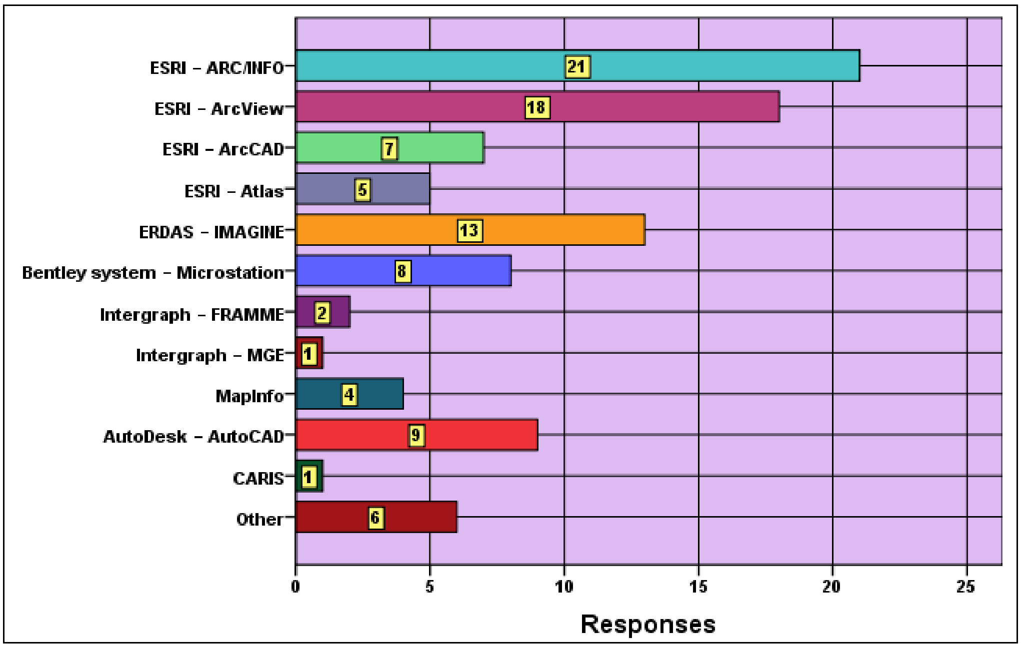


Figure 8.32 Software used by Organisations

8.8.2 Scales used by the Organisations

The positional accuracy ranges of spatial data used or created by the organisations in the survey is shown in figure 8.33. Nine organisations work with spatial data of greater accuracy than 1:500 scale. 11 organisations work in the range of scales between 1:500 and 1:1000, and 13 in the range 1:1000 and 1:5,000. Furthermore, 13 organisations work in the range of scales between 1:5,000 and 1:10,000, 14 in the range 1:10,000 and 1:25,000, and 13 in the range 1:25,000 and 1:50,000. Another 13 organisations create or use spatial data in the range of scales 1:50,000 and 1:100,000, 13 in the range 1:100,000 and 1:250,000, and 11 in the range 1:250,000 and 1:500,000. At other positional accuracy scale ranges, namely, 1:500,000 and 1:1,000,000, 1:1,000,000 and 1:2,000,000, 1:2,000,000 and 1:4,000,000, and less than 1:4,000,000, we find eight, seven, seven, and four organisations working respectively.

Questions were posed to all 72 interviewees working in the different spatial data bodies, regarding scales. The interviewees all agreed that each body working with spatial data in the Kingdom of Saudi Arabia had the ability to create any spatial data according to any map scale it needed. Moreover, the person authorised to make such a decision was the head of each body. The reason for this was explained by one of the interviewees:

> "*The decision was issued by the Council of Ministers in 1427H (2006) prohibiting duplication between the largest two organisations working in the area of spatial data in the Kingdom of Saudi Arabia. The essence of this decision was that the General Commission for Survey belonging to the Ministry of Defence and Aviation was responsible for producing spatial data on the scale equal to, and less than 1:25,000. While, MOMRA would be responsible for producing spatial data at scale equal to, or greater than 1:25,000. However the surprise after that, is that each body flouted the decision, and each one of them produced spatial data as it wished, and at the scales it wanted, which made all the bodies working in the area of spatial data in the Kingdom follow suit, and produce the spatial data they wanted, at different scales*" (ao-08).

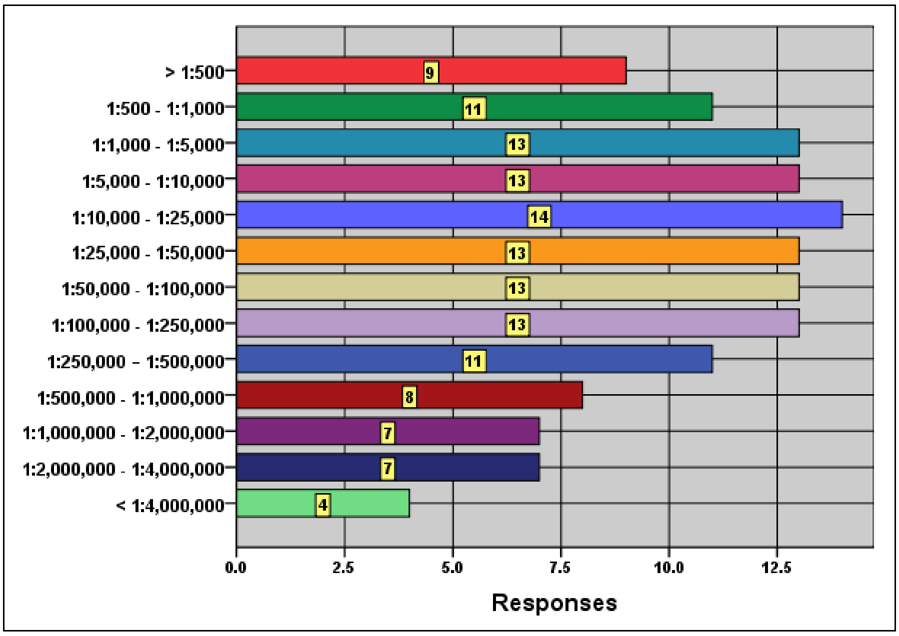


Figure 8.33 Positional Accuracy Scales in Use

8.8.3 Elevation Data Vertical Accuracy

Figure 8.34 illustrates the approximate vertical accuracy ranges to which the spatial data organisations work in handling elevation data. From the figure, it can be seen that 41.67% (10) of the organisations create or use elevation data to a vertical accuracy between 1 to 5 metres. 25% (six organisations) work to a higher accuracy of less than 1 metre, while 12.50% (three) and 25% (five) work to vertical accuracies of 5 to 10 metres, and more than 10 metres respectively.

All 72 interviewees from the different organisations working with spatial data in the Kingdom responded to questions on issues related to vertical accuracy of elevation data. All the interviewees considered that each body working with spatial data had the authority to specify the vertical accuracy of their spatial data in the way they saw fit. This became clear in the statement of one interviewee:

> "*We specify the vertical accuracy for spatial data according to what we think achieves the aims of our organisation, where we seek to achieve a vertical accuracy for our spatial data within cities up to 5m, while outside of cities, at times it may be as much as 25 m. For the record, all the organisations specify vertical accuracy according to what achieves the objectives of each, and we are not alone in this in the Kingdom of Saudi Arabia, because there are no specific obligatory standards by the State imposed on these organisations*" (gopu-02).

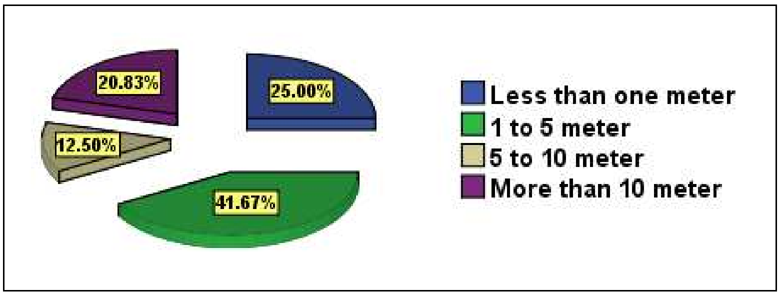


Figure 8.34 Elevation Data Vertical Accuracy Scales

8.8.4 Survey Standards

In the questionnaire, survey standards were covered. Regarding geodetic reference systems in use by the organisations, nearly all but one, of the 24 surveyed, use the WGS84 system while the remaining organisation uses WGS72. No organisation reported using the International Spheroid geodetic reference system.

In terms of horizontal datums used by the organisations, the majority, 95.83% (23), use Ain Al abd, while 4.17% (one organisation) uses the MTRF2000 datum. For vertical datums, the large majority, 91.67% (22), use Jeddah (1972), while 8.33% (two organisations) use another datum, namely, Jeddah (1969).

In terms of map projection, 95.83% of those surveyed (23) reported that they used UTM in map projection. Only 4.17% (one) among the organisations reported using another system, but did not specify which. None of the organisations reported using Cassini, or Lambert conformal.

While for coordinate systems, 21 organisations reported using geographic coordinates. nine organisations reported used the Cartesian coordinate system, while two organisations used another system; namely, the Military GRID.

On the matter of survey standards, all 72 interviewees working in different spatial data bodies, considered that each organisation had the freedom to do what it wanted, according to what it wished to achieve. As a result, duplicate spatial data projects came to exist in the different bodies, and according to different preferences. This in turn resulted in spatial data different in its details; indeed, the final outcome of some of these spatial data projects was incorrect. This is mentioned quite clearly by one interviewee:

> "*When you come and find the same map produced five times, in five different places, each time under a different budget, and therefore the information is different, the control points are different, the extent is different, the datum is different, the perspective is different! I would accept only one map from one body, with its errors regardless, and from there we can work at correcting it*" (gopu-14).

He concluded his statements by giving the following illustrative example:

> "*I will finish the point, 'Ain al-'Abd for example, at some point I was using MapInfo, which has a specific projection from its vendor. Therefore, they always had something called ED50, which refers to the European reference 50. 'Ain al-'Abd, which is ours, does not exist in the package. Unless you are able to program the software and place 'Ain al-'Abd, then you are going to use the European reference. We found that in so many cases this was the case. The point is that our specialists have not thought of actually adding this projection to the list offered internationally. Therefore, we found many maps that have been produced using this reference, which means that this information is not useful, regardless*" (popu-14).

8.9 Partnerships and Collaboration

8.9.1 Collaboration Contexts

The context or basis of collaboration among the organisations is illustrated in the results presented in Figure 8.35. By far the largest number of organisations (19) collaborate on the basis of sharing data. This is followed by 13, which collaborate through a transfer of knowledge and know-how. Ten organisations exchange technology, nine work together in the area of technical skills, and another nine collaborate in commercial, product development. Shared human resources as a basis for collaboration is practiced by seven organisations, and five collaborate for the purpose of achieving economies, and improvements in terms of efficiency or reduced costs.

With regard to collaboration, all 72 interviewees from the different public and private sector, as well as academic bodies involved with spatial data, responded to interview questions. The majority of interviewees, 51 individuals, held the view that their organisations were not keen to cooperate with those organisations working in spatial data in the area of human resources. Rather, cooperation was restricted to the exchange of spatial data and technology, after which each organisation was free to benefit from the spatial data it obtains, and to use it according to what achieves its interests and objectives. One of the interviewees explained this:

> "*I mentioned this to you before, that here in the Kingdom of Saudi Arabia, we do not have legislation that regulates cooperation between the different bodies with respect to spatial data. Therefore, in our organisation, we seek to benefit from the spatial data and related technology available in the hands of other bodies. We then shape it in ways that achieve our objectives. In terms of cooperating in the area of human resources, we do not have this type of cooperation, because we always want to employ specialists working under the umbrella of our organisation to help us in achieve our objectives the area of spatial data; cooperation in this area is quite sensitive from the perspective of those in charge of organisation; it is not allowed for any person from another body to have sight of the details specific to our spatial data*" (gopu-20).

Among the interviewees, 13 individuals, representing 18% of the participants considered that their organisations preferred to cooperate with other bodies in the area of human resources. One interviewee explained this saying:

> "*We derived great benefit from the existing cooperation between our organisation and other bodies in the area of human resources. Our organisation, sometimes, when purchasing spatial data or new technologies for spatial data from other bodies would request specialists from those bodies to supervise work at our sites for six months or a year depending on the type of project. We have noticed significant benefits from the presence of the specialists, who perform training for our employees on the new technology that we have purchased from them, and they also train our employees on the best procedures for dealing with spatial data, which has raised the level of knowledge of our employees, and achieved benefits that we had not expected*" (gou-12).

On the other hand, the remaining interviewees, eight individuals, considered that their organisations had initiatives to cooperate in the area of spatial data, on which they were currently working, with the aim of reducing costs in future. One interviewee explained this clearly saying:

> "*Our organisation is one of five others, currently engaged in cooperating at the level of Riyadh city, in the area of spatial data. The aim being reducing costs and time that is lost in duplication of projects, and hence reduce the financial costs of implementing projects in spatial data by these five organisations*" (gopu-05).

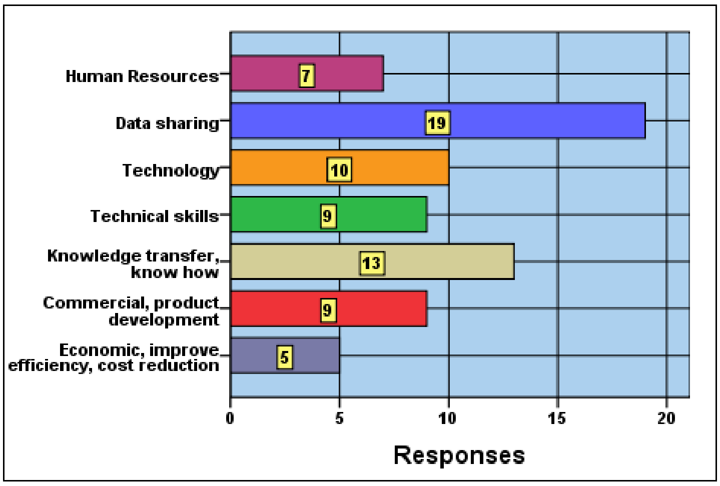


Figure 8.35 Collaboration Contexts between Organisations

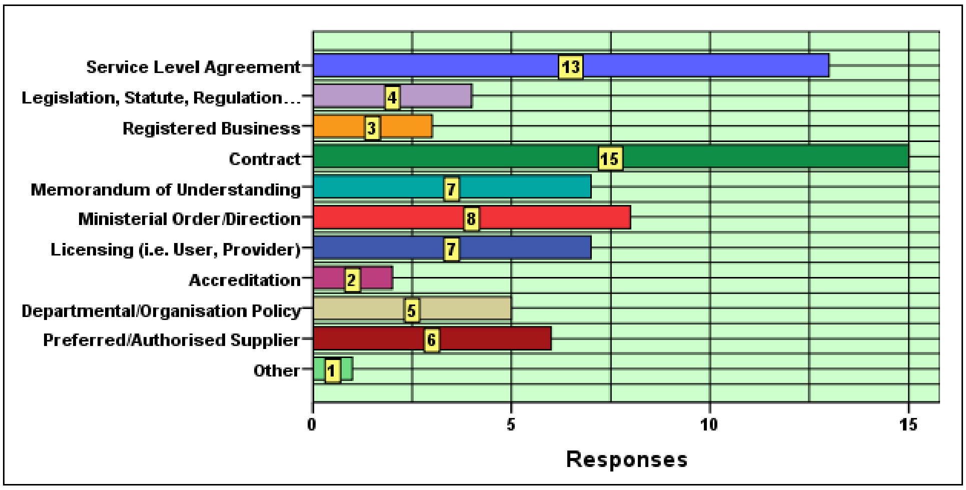


Figure 8.36 Basis for Formal Collaboration between Spatial Data Organisations

8.9.2 Basis of Formal Collaboration

The basis for formal collaboration between the spatial data organisations is presented in figure 8.36. 15 organisations have a contractual arrangement between them, 13 work together on the basis of a service level agreement, and eight operate under a ministerial order/directive. Moreover, a memorandum of understanding binds the work of seven organisations, a licensing arrangement between seven, as does a preferred or authorised supplier arrangement in the case of six. A departmental or organisation policy forming collaboration is the basis for five organisations, while four are compelled by legislation in the form of statutory or regulatory mechanism to collaborate. Three organisations collaborate on the basis that they are registered businesses, two rely on accreditation, and one is bound by a training and research agreement.

The issue of formal collaboration was considered in the interviews of the 72 individuals representing the different bodies working in spatial data in the Kingdom of Saudi Arabia. The majority of them, 57 individuals, held the view that the majority of official collaboration between the different bodies in spatial data would take place through formal contracts, or agreements between those bodies wishing to cooperate. One interviewee explained this clearly:

> "*The majority of bodies working in the area of spatial data depends on contracts or agreements formalising collaboration with other bodies in the area of spatial data, in order to protect the rights of all parties*" (ao-06).

The remaining 15 interviewees considered that the organisational structure allowed collaboration with other bodies through providing some old spatial data, or that which was not to high accuracy. This appeared quite clearly in the words of one interviewee:

> "*the system in our organisation allows us, given the huge volume of spatial data we own, to open the way for collaboration with others by providing some of our old spatial data or that spatial data that is not of high accuracy, for free*" (gopu-12).

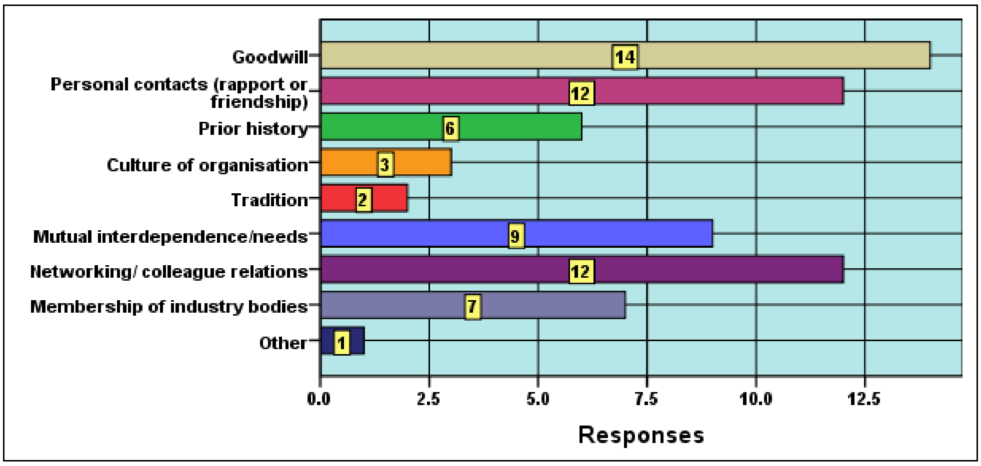


Figure 8.37 Basis for Informal Collaboration between Spatial Data Organisations

8.9.3 Basis of Informal Collaboration

Figure 8.37 reveals the elements on which informal collaboration takes place in the spatial data organisations surveyed in KSA. Fourteen respondents identified goodwill as being a basis for informal collaboration, and 12 cited personal contacts (rapport or friendship) as another. Networking and relations between colleagues were identified by 12 respondents, while mutual interdependence and needs were highlighted by nine, as a basis for informal collaboration. Seven respondents indicated that membership of industry bodies was grounds for informally collaborating, while three assigned this to organisational culture. Tradition was mentioned as a basis for collaboration by two respondents, while one respondent cited not applicable.

With regard to informal collaboration, the 72 interviewees, representing workers in the different spatial data bodies, responded to the interview questions. Of these interviewees, 49 considered that informal collaboration with some bodies working in spatial data allowed them to receive more than their need of spatial data belonging to these other bodies. This was clearly stated by one interviewee:

> "*I would be lying to you if I said that we do not benefit from the presence of acquaintances, whether relatives or friends, working in other bodies, who facilitate obtaining spatial data from these bodies; in some cases, they provide us with more spatial data than what we need, and if we were to request such spatial data officially, believe me would never receive it*" (popu-07).

The remaining 23 interviewees expressed their view that they do not believe in informal collaboration between bodies working in the area of spatial data. This was clearly indicated by one interviewee saying:

> "...*why should I humiliate myself, and grovel to people in other bodies in order to receive their spatial data; I expect that if there was a robust system, it would never have allowed such behaviour. What is appropriate is that one should request spatial data needed by his organisation through official channels, and should not stoop to inappropriate behaviour*" (gopu-23).

8.9.4 Barriers to Collaboration

The views of the organisations regarding barriers to collaboration, which were rated by importance are illustrated in figure 8.38. Responding to the statement "Data sets exchanged are not of same quality or value", eight respondents thought this to be very important as an obstacle, and another 10 judged it important. Four respondents did not feel it was important nor that it was unimportant, yet two judged it to be unimportant.

Regarding spatial data standards, 16 considered that these were very important as an obstacle to collaboration, and seven viewed them as important. However, one respondent thought they were not important.

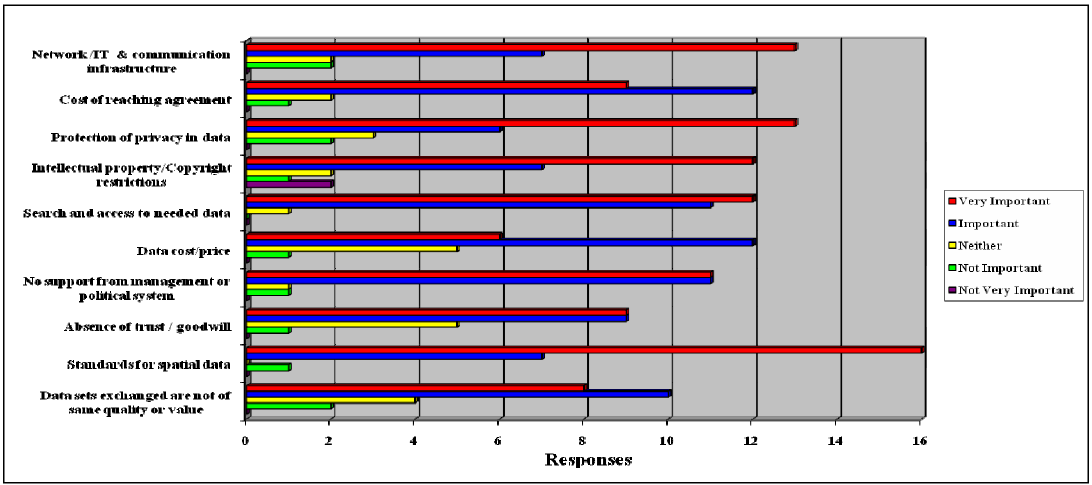


Figure 8.38 Barriers to Collaboration between the Spatial Data Organisations

The absence of trust or goodwill was viewed as a very important obstacle by nine respondents, and another nine thought this was an important obstacle to collaboration. While one respondent did not think that absent trust or good will was important, yet five rated it to be neither important nor not important.

The absence of management or political support as an obstacle to collaboration was viewed as a very important by 11 respondents and important by another 11 respondents. While one respondent was neutral in response (neither), and another one thought it was not important.

Six respondents judged data cost and price to be a very important obstacle to data exchange and sharing, while 12 thought it was only an important obstacle. five respondents did not think this was either important or otherwise, yet one respondent felt it was not important as an obstacle to collaboration.

Regarding searching and accessing data, 12 respondents were of the opinion that this was a very important obstacle to collaboration. Moreover, 11 others considered that it was an important obstacle. At the same time, one respondent felt it was neither important nor unimportant.

The restrictions, imposed by intellectual property rights and copyright, were also seen as very important obstacles to collaboration based on sharing and exchanging data by 12 respondents. In addition, seven respondents regarded these as an important obstacle. However, three respondents differed, in that two respondents did not consider these restrictions as very important, as did one respondent who judged they were not important in this context. Two respondents held that these were neither important nor unimportant.

Thirteen respondents expressed their view that protection of privacy in data was a very important obstacle to collaboration; also six respondents felt this was important. Three respondents expressed a neutral “neither”, while two considered these were “not important” as a barrier to collaboration in data sharing and exchange.

The cost of reaching agreement was seen by nine respondents to be “very important”, and 12 felt this was “important” as an obstacle to data sharing and exchange. one respondent thought it was “not important”, and two others felt it was “neither” important nor unimportant to collaboration efforts between spatial data organisations.

Infrastructure comprising networks, IT, and communication was seen as a “very important” barrier by 13 respondents, while seven respondents only felt it was “important”. On the other hand, two respondents felt it was “not important” and another two judged it “neither” important nor unimportant to inter-organisational collaboration in spatial data.

The barriers to collaboration were discussed in the interviews with the 72 individuals representing the different government, private sector, and academic spatial data organisations. All the interviewees agreed that the reason for the lack of collaboration in the exchange of spatial data between the different bodies in the Kingdom of Saudi Arabia can be assigned to the following factors:

The lack of knowledge and awareness among decision-makers with regard to the benefits and need for collaboration in spatial data exchange between the various bodies was one of the obstacles highlighted by the interviewees:

> "*The reason in my view for the absence of collaboration between bodies with respect to the exchange of spatial data is the lack of awareness, and knowledge of the advantages and benefits of such collaboration among decision-makers, and in the majority of bodies dealing with spatial data in the Kingdom of Saudi Arabia*" (gopu-16).

Conflicting policies and legislation was another factor that was raised. It was noted by the interviewees that on several occasions, different bodies were employing legislation and executive decisions that had been superseded by others to exercise powers that led to duplication. This situation was explained by an interviewee:

> "*During the phases of development of the bodies working in the area of spatial data, many official decisions were issued giving them wide powers in the area of spatial data. Other more recent official decisions did not indicate that the old decisions had been rescinded, which made those heading the organisations depend on the old decisions to widen their powers in dealing with spatial data, resulting in duplication in spatial data projects with other bodies working in the same area*" (gopu-04).

The absence of a coordinating body with authority across Saudi spatial data organisations was part of the problem facing development of effective spatial data collaboration, which would remedy the situation present in KSA. It was recognised that such a body would require its mandate and authority to be provided by the government. This obstacle was outlined by one of the interviewees:

> "*There is no official body overseeing coordination of efforts among the bodies, in terms of collaborating in spatial data, or one that would adopt a collaborative initiative in the exchange of spatial data, and work towards making such an initiative effective at national, region, and city level within the Kingdom. For the record, all the currently existing initiatives from some bodies may be considered to be spontaneous, and none have been officially recognised to date*" (gou-09).

Fear of losing power and control related to competition in this respect among bodies was a further obstacle that was identified through the interviews. The concept of information as power led to a fear of data sharing that would in some way lead to loss of power or control. The situation was summed up in the words of one interviewee:

> "*Among the majority of bodies, there is a policy of keeping information, out of fear that exchanging spatial data would result in these bodies losing some of their authorities and powers in terms of control over spatial data*" (popu-10).

The lack of sufficient numbers of qualified professionals in the area was one of the obstacles that contributed to creating an unsatisfactory situation, in terms of spatial data work in KSA. As such, a significant number of persons were employed in spatial data work, with little or no qualifications in the area; in the words of one interviewee:

> "*...believe me, the reason is the weak local expertise, and the few specialists, especially Saudi nationals in the area of spatial data. I, personally, have inspected many of those sections dedicated to spatial data in some organisations, and was surprised to find no specialists in spatial data; rather, there were persons who were not University qualified, and if they were University graduates then the specialisations of some of them were sometimes in humanities. While some of them had attempted to improve themselves by attending courses in spatial data*" (ao-12).

The absence of clear procedures to facilitate collaboration and spatial data exchange constitute an obstacle to achieving progress in this sensitive area. The process of spatial data exchange is governed by specific rules that serve to regulate and organise it, at both technical and institutional levels. As such one of the interviewees shed light on this:

> "*...up to now we do not have clear policies and instructions for exchanging spatial data that would compel all bodies to collaborate in the exchange of spatial data*" (popu-03).

The weak technical infrastructure and its inadequacies in KSA were highlighted as one of the obstacles to spatial data collaboration. An interviewee stated that:

> "*...the technological infrastructure that we have here in the Kingdom of Saudi Arabia for transferring and exchanging spatial data is weak*" (gopu-24).

The lack of adequate protection and controls for data, typically the absence of secure Web portals that would safeguard the data held by the organisations caused them to be reluctant to disseminate their data. Hence, the issue of securing the process of spatial data transfer was also mentioned among the obstacles to realising the goal of exchange and collaboration. One interviewee indicated:

> "*The organisations are worried that their holdings of spatial data would be compromised by security breaches through the Internet, due to the absence*

> *of an electronic portal with software protection for such vital and highly important information and data*" (ao-08).

The lack of intellectual property protection was another factor that contributed to the absence of an inclination to share spatial data, and led to a real danger of abuse and misuse. The situation was described by an interviewee:

> "*The fear that we have in our organisation is the misuse of our spatial data that is exchanged with other bodies, or that these data are transferred to other bodies, because in Saudi [Arabia] we not have the systems and laws regarding [protection of] intellectual property rights in spatial data, and the necessary legislation*" (gopu-11).

The lack of conformity in the area of standards and specifications, where interviewees complained of the absence of State efforts to introduce uniformity in this respect. The existence of agreed common standards and specifications is the foundation on which collaboration and data sharing is established. In the view of one interviewee:

> "*If the State did not step in to resolve the lack of conformity to standards and specifications, as well as the difference in digital referencing in the databases of spatial data among the different bodies working in the area of spatial data, then this will be a key reason, in future, for the inability to collaborate with each other in exchanging spatial data*" (ao-03).

The existence of erroneous data produced at significant public expense, as a result of the absence of qualified professionals working in the spatial data area, in some bodies. Therefore, this data cannot be placed beyond the domain of the body that commissioned or produced it. So, these organisations refuse any requests to share such data with others, but without exposing themselves. As one interviewee observed:

> "*...some bodies hold spatial data that is not accurate, which has cost them huge amounts of money. The reason for this was the absence of specialists in spatial data working in these bodies while such projects were underway. Once those responsible find out the reality of the shortcomings in their spatial data, they work very hard to prevent its exchange*" (popu-05).

The rapid promotion of, and turnover in specialists before they can effect change, and promote and sustain efforts to introduce collaboration and spatial data exchange was argued as being a factor contributing to the current situation. One interviewee stated:

> "*Some specialists in the area of spatial data when they are promoted to the position in which they are able to influence those in charge to adopt the idea of collaboration in exchanging spatial data with other bodies, are then promoted or move to another body, and the idea of collaboration goes with them*" (gopu-07).

The absence of a strategic vision, and ineffective management, was a contributing factor to the spatial data situation in KSA. According to one of the interviewees:

> "*It is quite sad that one of the factors that prevent collaboration in the exchange of spatial data between the different bodies is the absence of a comprehensive view to the development of solutions, and the weak expertise in managing work in relation to implementation and responsibilities*" (ao-10).

The absence of the concept of collaboration within teaching and training curricula in academic and training bodies working in the spatial data area. In this regard, one of the interviewees pointed out that:

> "*It is quite strange the despite the existence of learning materials, and several courses in different universities, institutes, and centres specialising in spatial data, they do not include the topic or idea of encouraging collaboration between bodies in exchanging spatial data*" (pou-01).

Inefficient working practices and lack of expertise in project implementation in spatial data bodies was another factor. This was highlighted by the interviewees; one opined:

> "*In my view, the lack of efficiency of many of the companies that undertake implementation of spatial data projects in the Kingdom of Saudi Arabia, is considered a key reason for the sad situation that we face in the absence of collaboration between bodies working in the area of spatial data*" (gopu-21).

8.9.5 Benefits of Inter-organisational Collaboration

The benefits of inter-organisational collaboration in spatial data are summarised in figure 8.39. As can be seen, 15 respondents considered that matching and checking resulting in better quality data was a “very important” benefit of spatial data exchange. Nine respondents thought this was an “important” benefit.

As a benefit of collaboration, reduced duplication of effort and resources was seen by 19 respondents as a very important benefit of collaboration. Another five respondents agreed, but only that it was an “important” benefit.

Savings and cost reductions were highlighted by 15 respondents as very important benefits of collaboration. Eight respondents felt these were important, while one respondent thought it was neither.

Eleven respondents thought it was very important, and eight judged it was important, when asked their opinion of whether a single source of verified data was a benefit for their organisation resulting from collaboration. On the other hand, four respondents indicated it was neither important nor otherwise, while one felt it was not important.

Eight respondents felt that the benefit of less demands for data from others was a very important benefit of collaboration. 10 other respondents judged this was important as a benefit of spatial data exchange in a collaboration. However, six respondents chose “neither” important nor the opposite.

Better service to rate payers as a benefit of collaboration in spatial data was rated as very important by 10 respondents, important by another 10, and neither by four.
Improved decision making was rated as very important by 17 respondents, important by six, and neither by one, as a beneficial outcome of spatial data exchange between organisations in collaborative relationships.

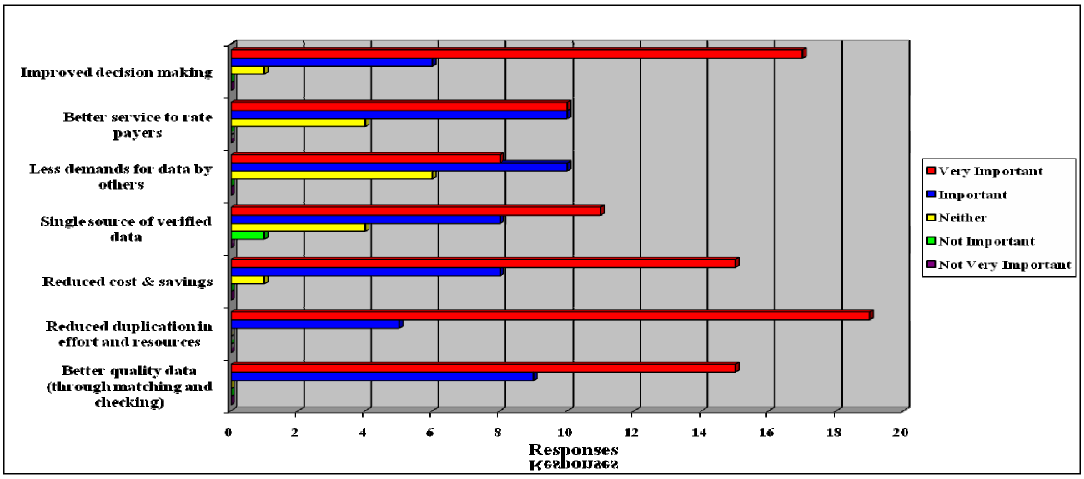


Figure 8.39 Benefits of Inter-organisational Collaboration between the Spatial Data Organisations

With respect to questions on inter-organisational collaboration, all 72 interviewees representing different government, private sector, and academic institutions working in the area of spatial data responded. All the interviewees agreed that all the bodies working in the area of spatial data would benefit, if collaboration would occur between them. However, there was the belief among interviewees that the government had to play a proactive role in making this happen. This was clearly explained by one interviewee:

> "*If it were to happen that all the bodies in the Kingdom of Saudi Arabia working in the area of spatial data would collaborate amongst themselves at national, or local level, they would save effort and money, and prevent duplication through coordinating amongst themselves in all spatial data projects; they would, as a result, gain higher accuracy in their spatial data, which would help decision-makers formulate more accurate decisions. If it were to happen that some of these bodies think that they would not benefit in*

the short-term from this collaboration, I am sure that if they were to reflect, they would find that they would benefit a lot in the medium to long-term. However, all this must come from the conviction at the level of the higher legislative echelons in the Kingdom, because if they were to be convinced of it, they would establish the required regulatory mechanism for this, and would form a committee that would follow up the process of implementing such a system" (ao-11).

8.10 Discussion

It became clear from the data collected using the questionnaire and semi-structured interview, that the quantitative and qualitative data supported each other, and had achieved the objectives in revealing the situation, accurately and in detail, with respect to spatial data in KSA. This facilitated determining those areas in which there are shortcomings, in terms of the collaboration between the different spatial data bodies.

The data highlighted that the majority of spatial data bodies in KSA are government bodies; these are considered by many as responsible for the current situation, given their ability to influence the State’s decision-makers, and to enable legislation establishing a system to prevent duplication between the different bodies working in the area of spatial data. The research also revealed that private sector bodies seek to attract specialists in the area of spatial data working in government bodies by offering attractive pay and benefits packages, and denying the public sector from their expertise. The private sector has a vested interest in maintaining the staus quo in government bodies by ensuring that they are at a disadvantage in terms of their skills pool. The resulting widespread duplication in spatial data projects is financially rewarding to private sector bodies involved in implementing such projects.

Academic bodies are also responsible in that they act to spread awareness and educate those taking their courses or degree programmes in spatial data, on the importance of collaboration in spatial data in all projects, and in clarifying the best means to prevent duplication.

The study also noted that the majority of spatial data bodies work at national level, which increases project duplication, due to the large area of the country, leading to scattered efforts and difficulty in controlling many spatial data projects distributed across the different regions of the Kingdom.

It was also found that the majority of bodies are both producers and users of spatial data, and that each organisation is keen to produce different spatial data, almost on a competition basis. Government bodies especially, are able quite easily to secure the required funding from the government to implement projects duplicating the effort of others, owing to the lack of awareness and understanding by State decision-makers of the problem, which they could resolve by issuing legislation and policy to regulate work in the spatial data area, and prevent duplication occurring in these projects. Moreover, designating a coordinating body to oversee these projects at national level would protect public funds. The existence of generous funding, especially in government bodies, have led to holdings of spatial data in these bodies in both raster and vector formats, as revealed by the data. This also led to duplication among these bodies, in that each body has complete freedom in dealing with the different spatial data themes according to their in-house standards and specifications, which would achieve their own interests.

In this work, data showed that large organisations suffer duplication between different departments working with spatial data, due to the lack of a system to unify efforts, and the wish of each department to keep its spatial data to itself, considering it to be among its achievements, and not wanting other departments to share in this achievement.

It is worthwhile to point out that some organisations with long experience in the spatial data domain have mature leaders, who may not believe in collaborating with other bodies in the area of spatial data, relying instead on past executive decisions to provide their organisations with powers to undertake spatial data projects that duplicate the work of the other bodies.

This research also highlighted the lack of sufficient spatial data specialists in the majority of government bodies. Moreover, the majority of those working with spatial data come from other specialisations that do not serve the spatial data area; even though the number of employees in recent years has increased, the situation is perpetuated by the lack of proper selection of qualified personnel to work in spatial data. In addition, some organisations do not seek to improve the knowledge and competence of employees in the area of spatial data, for instance, by providing them with opportunities to attend specialist courses, or participate in spatial data conferences and seminars, whether in the Kingdom, or abroad.

The survey also highlightd that departments or units working in the spatial data area preferred to remain independent, or to be linked directly to the principal authority in the organisation, so that the person in charge is aware of the importance of their work, and may resolve any obstacles in their path.

The data also revealed that the majority of spatial data producer bodies have created spatial data for the majority of regions that are within their jurisdiction, according to their own, in-house, standards and specifications, and that these are updated as needed.

The weak infrastructure relating to spatial data transfer networks in the Kingdom of Saudi Arabia, and the absence of robust protection programs that prevent data being compromised, in the view of many spatial data producers, have led each body to develop and use its own intranet to transfer spatial data between the different departments of that body; the aim being to maintain the secrecy and security of the spatial data they hold.

The lack of policies protecting intellectual property rights residing in spatial data of producer bodies, have led to reluctance and fear among many of these bodies to authorise access for other organisations to their spatial data. If others wished to receive spatial data, then this would be done through official request letters presented by the applicant body, which would be studied by the producer bodies, and if approval is secured, then the applicant body would have to sign undertakings to not use the spatial data for any other purpose than the one requested, and that the data would not be handed over to any other body, regardless of the circumstances, in order to protect intellectual property rights. In this work, it was found that questions of secrecy of spatial data and file size dictated the method of delivery to those bodies that request it, either by e-mail, download link, CD-ROM, DVD, or otherwise.

The lack of a system regulating the relationship between bodies producing spatial data among themselves, and with user organisations led to the appearance of a role for personal relations with high officials in the government bodies, especially, in influencing the process of obtaining spatial data from such government bodies. In contrast, the relationship of private sector bodies producing spatial data with others was dictated by material profit, and payment for the value of spatial data requested.

Spatial data user bodies preferred receiving spatial data from government bodies, due to the lower cost compared to private sector bodies. However, spatial data provided by private sector bodies, by contracts and commercial agreements, were delivered in accordance with the specifications and standards dictated by them. However, spatial data requested from government bodies was in accordance with the standards and specifications of these bodies. Moreover, they could only obtain such data after a long process, beginning with the sending of official request letters, then convincing the officials in those government bodies of their need for that spatial data, and then after approval, they would have to sign specific forms related to protecting the rights of these government bodies, in that use would be restricted to the purpose for which it was requested, and that it would not be transferred to any other body.

The data showed that spatial data user bodies, especially government bodies, preferred not to cooperate with others and share in the costs of spatial data. This was justified by saying that each body had its own in-house standards and specifications, and that the State provided the funds, while there was no system obliging them and others to collaborate. This led to annual spending of millions of Saudi Riyals by each organisation in spatial data projects without coordination with others.

Each of these bodies was also found to implement its own applications of spatial data according to their own perspective, without cooperating with other bodies in producing common applications. As a result, there are more than ten base maps for some cities in the Kingdom. These were produced by different bodies, which claimed that their map was correct, while the others were not.

This research also showed that all spatial data user organisations worked to consolidate their relationships with all the spatial data producer bodies, whether public or private, at local, national, or international level, in order to diversify sources of spatial data.

It also appeared that the majority of bodies working in the area of spatial data were using their own in-house standards and specifications. Therefore, the claim by some bodies that their spatial data met international standards and specifications was incorrect, as was expressed by interviewees; on inspection, in-house standards and specifications were discovered.

A further finding is that some bodies were not concerned about documenting their spatial data using metadata, using their own in-house rather than international standards and specifications. It was also shown that there is no cooperation between these organisations to unify standards and specifications for metadata in documenting spatial data.

The absence of legislation by the State to regulate collaboration between the different bodies working in the area of spatial data, and the lack of a coordinating authority to supervise such collaboration, has led each organisation to have a free hand in choosing those software systems needed for handling spatial data to produce spatial data according to any map scale, and following whatever technical standards they saw fit. The authorised person deciding on such matters is the head of each organisation.

Collaboration among the majority of bodies working in the area of spatial data in the Kingdom of Saudi Arabia is restricted to the exchange of spatial data and technology, as shown by the survey data; otherwise, each body is free to make use of the spatial data and treat it in a way that achieves its interests and plans. In the majority of cases, official collaboration between bodies working in the area of spatial data depended on contracts and agreements between such bodies, in order to protect the rights of all parties. It was noted that unofficial collaboration, for example through friends or relatives in a spatial data producer bodies facilitates those linked to them to acquire spatial data for their organisation from these bodies quickly and easily; in some cases, perhaps receiving more than what their organisation needs. The reason is that there is no system in the country to prevent such behaviour, especially in the government sector.

This research also revealed that there are key obstacles that lead to the absence of collaboration between organisations working in the area of spatial data in the Kingdom, summarised as follows:

1. Absence of awareness and culture regarding the advantages and benefits of exchanging spatial data among decision-makers, and the majority of stakeholders working with spatial data.
2. In the historical development of government organizations working in the area of spatial data, a number of official decisions were issued (as is described previously in the historical development of each organization), and when new decisions were issued, these did not cancel the effect of the prior decisions; this provided the excuse to refer to these in the duplication witnessed in spatial data work.
3. Lack of an official body that supervises coordination of efforts among all stakeholders, towards cooperation in spatial data and sharing, which would adopt an initiative regarding cooperation and spatial data sharing, and giving impetus to this initiative at national level, or a level of regions and cities within the Kingdom. Currently, there are initiatives from some bodies, but none have been officially recognized to date.
4. Among the majority of stakeholders there are policies of maintaining strict control over information, for fear that exchange of spatial data will lead to loss of power and influence through losing control over their spatial data.
5. Weakness in local expertise, and lack of sufficient experienced manpower, especially among Saudi nationals, in the area of spatial data.
6. Absence of clear policies and directives for spatial data exchange that compel all stakeholders to cooperate in the area of spatial data and spatial data sharing.
7. Weak technological infrastructure for transferring and exchanging spatial data.
8. Fear of security breaches via the Internet, due to the absence of an organised and secure electronic portal for such sensitive information and data.
9. Fear of misuse of spatial data, or leaks to other undesirable parties due to the lack of systems and laws related to intellectual property, and necessary legislation.

10. Discrepancies among stakeholder systems, in terms of specifications, standards, and digital formats of the spatial data.
11. Some stakeholders hold spatial data that is not sufficiently precise, despite costing large amounts of money, due to the lack of expertise in spatial data within these organisations at the time spatial data projects were implemented. Once the faulty data was identified within these organisations, the management put obstacles on its sharing and exchange.
12. Lack of job stability in the personnel specialising in the area.
13. Absence of a comprehensive view to develop solutions, and weak expertise in managing the work in terms of implementation and responsibilities.
14. Training material and courses exist at the different universities, institutes, and centres specialising in spatial data; but, these do not include the idea of cooperation regarding exchange of spatial data.
15. A lack of expertise in the majority of companies that implement spatial data projects in the Kingdom.

All those interviewed, and those who responded to the questionnaires, in this research had been positively affected (by their own admission) by this work. They had become convinced of the benefits of collaboration between all the spatial data bodies in KSA. They all agreed that this collaboration could be achieved if the higher authorities in the State issued legislation and policy regulating this collaboration between the different bodies working with spatial data. In addition, establishment of a higher authority would allow coordination between these different bodies to unify collaborative efforts, and prevent duplication in spatial data projects at national, region, or city level in the Kingdom.

8.11 Summary

This chapter has presented the results of both a widely distributed questionnaire survey to 24 organisations representing all the bodies working in spatial data in KSA, and subsequent semi-structured interviews of 72 key persons and experts. The data collected covered a range of themes, including types of spatial organisation and sphere of operations, data types and themes, standards and technical issues, and inter-organisational relationships and collaboration. The results of analysis of the quantitative questionnaire were supported by qualitative data derived from the interviews. These results revealed the extent of the problem in the spatial data domain in KSA representing an obstacle to establishing an NSDI, including lack of collaboration due to negative organisational cultures, technical obstacles relating to need for unified spatial data and metadata standards and specifications, and absence of legislation correcting the aforementioned points, as well as protecting intellectual property and providing a system defining collaboration among these bodies.

The next chapter will describe the current state of SDI initiatives in KSA through detailed data from secondary and primary sources, such as reports, documentation, and legislation, as well as the questionnaires and in-depth semi-structured interviews, obtained in repeated field visits and communication by telephone, and email encouraging active participation of interviewees.

CHAPTER 9: CURRENT SDI INITIATIVES IN KSA

9.1 Introduction

The current state of SDI initiatives is presented in this chapter, based on the information from both secondary and primary sources of data. These included relevant reports, documentation, and legislation obtained from the stakeholder bodies' personnel directly and from their websites, as well as the questionnaire survey and semi-structured interviews of key persons and experts engaged with spatial data in KSA. Primary data was collected from interviewees during repeated field visits, and updated through continuing communication by telephone, and the Saudi National Spatial Data Infrastructure E-Group created by the researcher with approval and participation of interviewees. Through these means, data collection continued until the end of December 2010. Therefore, the chapter will deal with the state of current SDI initiatives in KSA. It is worth mentioning that barriers to collaboration in KSA, as seen by stakeholders, were presented in Section 8.9.4 (pp.194-199).

9.2 Current SDI Initiatives

There are three current SDI initiatives in the KSA:

1. MOMRA SDI initiative.
2. Ar Riyadh SDI initiative.
3. Saudi National SDI initiative.

9.2.1 MOMRA SDI initiative

MOMRA supervises 16 MOMRA regional administrations distributed around the regions of the Kingdom, and 220 municipalities distributed among the different cities of the kingdom, which are spread over the whole area of KSA.

Cabinet Decision No. 70 dated 22/4/1410AH (21 November 1989) defined the sphere of its work with respect to spatial data, in undertaking production and update of the detailed maps for cities and villages in the Kingdom at all scales greater than 1:25,000, and preparing the necessary plans within the scope of these scales (KSA Council of Ministers, 1989).

Within the Ministry, there are many departments that deal with spatial data, such as the Deputy Ministry for Land and Survey, and the Deputy Ministry for Urban Planning. Each Deputy Ministry has implemented many spatial data projects, which exclusively served its purposes, without coordinating with other bodies both within the Ministry or even the regional administrations and municipalities in the different regions of the Kingdom.

Furthermore, the MOMRA regional administrations have powers to implement spatial data projects, in their own right, in the absence of a specific department at the Ministry to supervise these projects, and coordinate efforts of the regional administrations as well as the different bodies within the ministry. This resulted in duplication in the implementation of spatial data products, as well as differences in specifications, terms, and scales for these projects.

Studies were conducted by the Deputy Ministry for Urban Planning and the Deputy Ministry for Land and Survey to investigate the situation within the Ministry, and how it maps out future directions, as well as looking at international experiences. It was concluded that it was important to unify efforts, and coordinate projects, to prevent duplication, and help municipalities and MOMRA regional administrations unify specifications and terms, while maintaining strict coordination in the management of spatial data. This would be achieved by creating a highly transparent framework through which information exchange would take place according to specific controls and powers. It also became apparent that it was important for coordination to take place between the ministry and related bodies, such as other ministries, institutions, and sectors with interest in spatial data. For this purpose, and after conducting studies and meetings with international and local experts, the ministry reached the conclusion that it was necessary to create a unified environment in the management of spatial data, to coordinate activities, organise data exchange, manage user access, and assure data protection. Moreover, there was a need to establish specifications for systems, data, and terms, and coordinate spatial data projects and their priorities, including building, and managing effective relationships both within the Ministry and externally, in the areas of GIS. As a result, MOMRA decided to develop a GIS centre, which would be given responsibility for the previously mentioned tasks. Hence, each body, department, regional administration, or municipality would continue on its tasks, while the centre would carry the burden for the specialist tasks related to management, coordination, protection, training, supporting and organising the priorities, as well as establishing specifications and developing human resources.

9.2.1.1 MOMRA SDI initiative Goals

The goals of the MOMRA SDI initiative can be summarised in the following:

- Providing a central data repository for both spatial and non-spatial data housed at the Deputy Ministry for Urban Planning.
- Providing a central metadata repository for the spatial data of the Ministry, which can be accessed through the web-based GIS portal via intranet/Internet.
- Providing a browser (GeoWeb Explorer) on the Internet.

- Providing a GIS portal that catalogues all the spatial and non-spatial data available from the Ministry (figure 9.1).
- Preparing centralised procedures for collection, treatment, and storage of spatial and non-spatial data, and facilitating access.
- Developing standards and protocols for data sharing and exchange between the different bodies within the Ministry.
- Providing an effective mechanism for search with appropriate spatial and cataloguing capabilities.
- Removing repetition and duplication in data storage, in such a way as to achieve improvement and effectiveness in the use of the database.
- Providing advanced server-based technology that would improve the effectiveness of the system, and its performance.
- Providing a safe protection and appropriate mechanism for backup storage of the data held at the ministry.
- Preparing the key instructions and wrappers for the different data and content that may be used by the Ministry in future.
- Providing essential and continuous training to enable personnel at the Ministry to maintain the spatial data infrastructure over the long term.

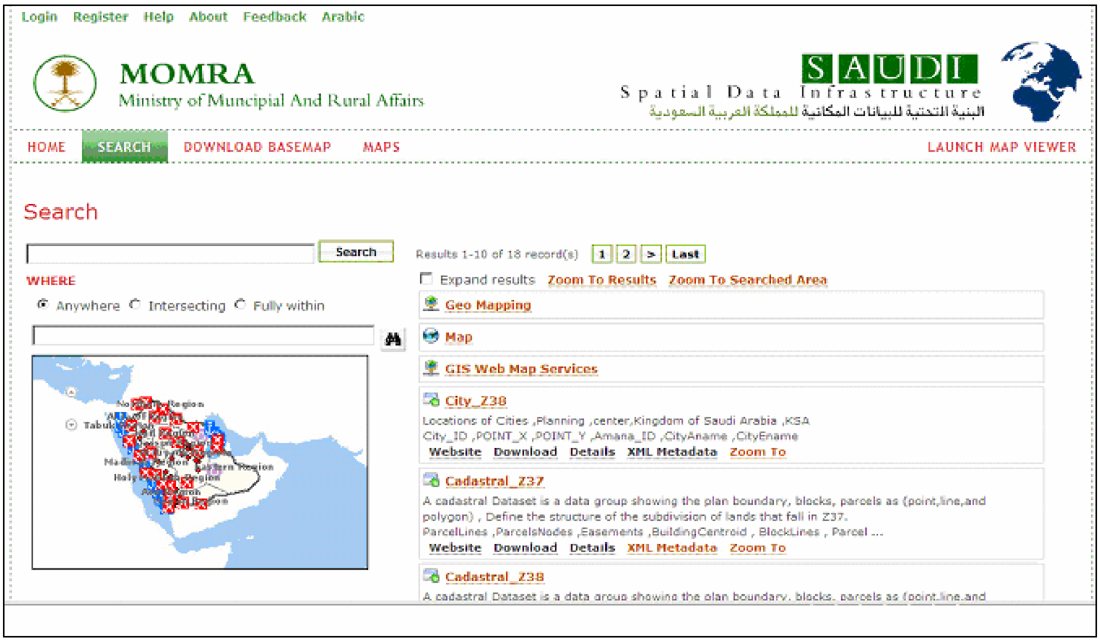


Figure 9.1 MOMRA SDI Portal

9.2.1.2 MOMRA SDI initiative Stages

1. The idea for this initiative came from the Deputy Ministry for Urban Planning, after which the Deputy Ministry for Land and Survey gave its backing for the idea following a series of meetings held throughout 2008. In these meetings, the Deputy Ministry for Urban Planning explained that the aim of the initiative was not to take control of the data held by other bodies in the Ministry, rather it aimed to prevent duplication that was occurring in spatial data projects among the different agencies and administrations within MOMRA.
2. By the end of 2008, the idea had been further developed, and all the agencies and administrations in the Ministry were invited to a presentation of the proposal. Initially, many of these agencies and administrations disapproved, but following several meetings, and convincing the responsible persons in the Ministry of the importance of this initiative, the idea was approved by the Minister, who issued a decision (the researcher was unable to obtain a copy of this ministerial decision or its reference number), where the initiative would be implemented only within the agencies and administrations of the Ministry.
3. The implementation of this project began in 2009 with:
    a. Design of a comprehensive spatial database at the Deputy Ministry for Urban Planning, which allows the different administrations and bodies within the Ministry to access it, through a dedicated browser over the intranet/Internet. This was flexible to allow the Ministry to later expand its scope to include the other regional administrations and municipalities in the different regions and cities of the Kingdom.
    b. Designing and developing a Metadata Repository, connected to a GIS portal, which would display both spatial and non-spatial data available at the Ministry, as well as links to others.
4. The project was almost complete by the end of 2010, having linked the spatial and non-spatial data held in the majority of administrations and bodies at MOMRA, and with the design of the GIS portal (figure 9.1) connected to a comprehensive spatial database housed at the Ministry, with the following functionalities:
    a. Search of spatial data sources.
    b. Displaying detailed spatial data, with the possibility of use by those authorised to do so.
    c. Direct browsing and display of available live mapping.
    d. Creating and uploading descriptive metadata pointing to spatial data produced by the different bodies.
    e. Managing and updating user access authorisations.
    f. Managing and storing maps and search operations for later re-use.

It is predicted by a number of those responsible for the initiative at MOMRA that by 2011, the project will be expanded to include Ar-Riyadh regional administration, and all the municipalities within its jurisdiction.

9.2.2 Ar Riyadh SDI initiative

This SDI initiative is distinct in that it is specific in dealing with spatial data at the level of Riyadh city; the concept had come from the High Commission for the Development of Ar Riyadh in 2006. The Commission presented is initiative to many of the bodies working in the area of spatial data in Riyadh City, and invited them to participate in a pilot project to implement the initiative, without any financial burden on them; moreover, each body would maintain control over its spatial data. However, only five bodies agreed to participate:

1. The High Commission for the Development of Ar Riyadh
2. Riyadh City Municipality
3. Saudi Post
4. The Public Directorate for Water in Riyadh
5. Saudi Telecommunications Company

All the partners agreed that the pilot project for the Riyadh SDI initiative would be applied to the Rawdah district (figure 9.2). Contingent on the success of this pilot, the project would be widened to all districts of the city, after obtaining approval from the authority, i.e. the Emir of Riyadh region. Moreover, this expansion would include the remaining spatial data bodies working in Riyadh.

9.2.2.1 Ar Riyadh SDI initiative Goal

The initiative aimed at exchanging spatial data at the level of Riyadh city, such as road and district names, house numbers, postal codes, cadastral data and applications, the routing of electricity, communications, and water lines, which would achieve the following objectives:

1. Establish a partnership based on mutual benefit between the different bodies working in the area of spatial data at the level of Riyadh city.
2. The direct exchange of information between bodies that depend on spatial data in executing their work at the level of Riyadh city.
3. Updating spatial data from key sources continuously and precisely.
4. Maintaining the integrity and security of the spatial databases held at the participating bodies.
5. Preventing duplication, rationalising costs, and working within a system that specifies the responsibility of each body.

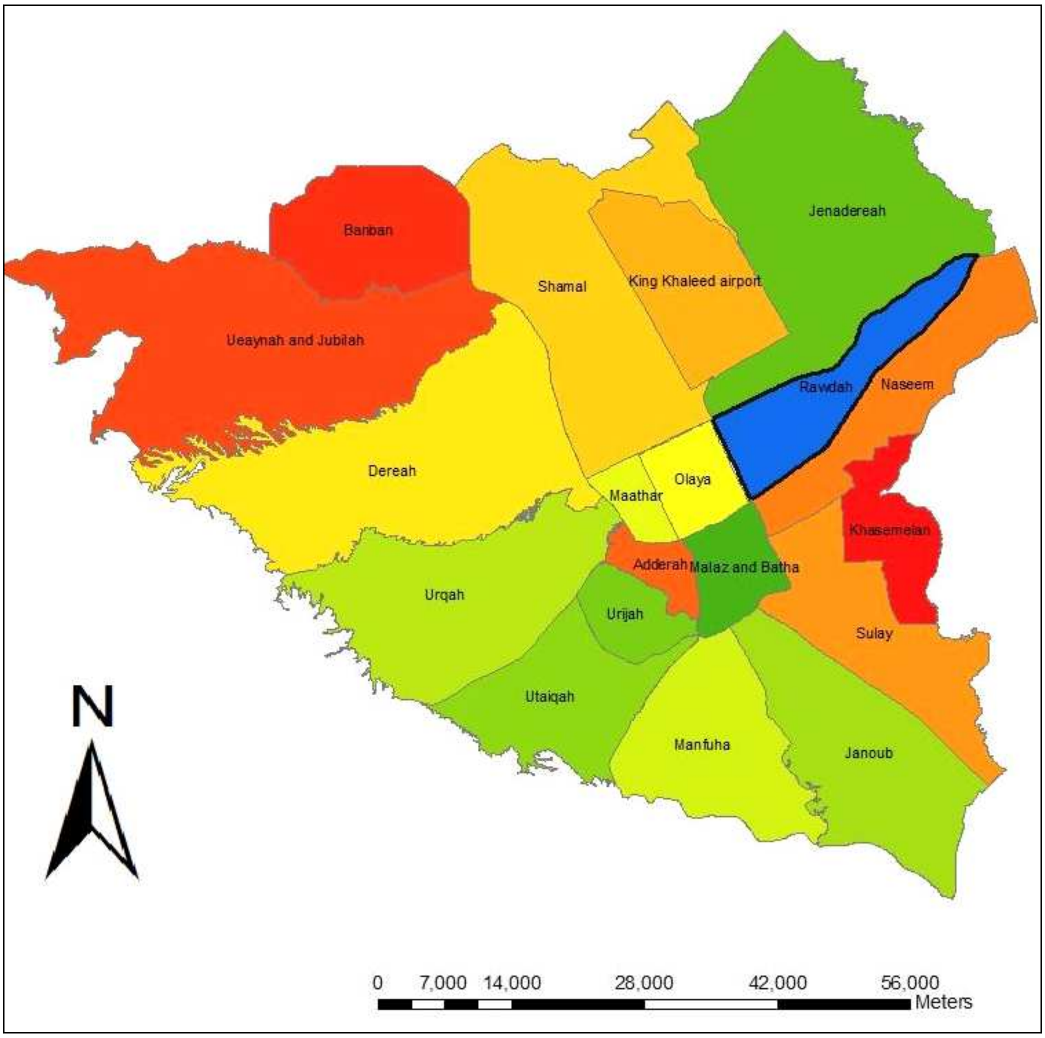


Figure 9.2 Ar Riyadh Districts

9.2.2.2 Ar Riyadh SDI initiative Stages

The idea originated at the High Commission for the Development of Ar Riyadh in 2006. The Commission had noticed the prevalence of duplication in spatial data projects among the different bodies at the level of Riyadh city, which had led to the existence of more than 10 base maps for the city in the hands of different bodies; each body considering its base map to be correct, and that all the others were not so. In early 2007, the High Commission for the Development of Ar Riyadh launched an SDI initiative for Riyadh city, and implemented a pilot project for this initiative; the Commission assumed the whole financial burden, and guaranteed that each participating organisation would maintain control over its spatial data. On this basis, it presented the idea to many bodies working in the spatial data domain at the level of Riyadh city, in particular those bodies that possessed base maps of Riyadh city and spatial databases. Agreement for participation in this pilot project came from four bodies, in addition to the High Commission for the Development of Ar Riyadh. The phases of the pilot project began in mid-2007, with the participation of:

1. The High Commission for the Development of Ar Riyadh
2. Riyadh City Municipality
3. Saudi Post
4. The Public Directorate for Water in Riyadh
5. Saudi Telecommunications Company

In the final quarter of 2007, the High Commission for the Development of Ar Riyadh signed an agreement with Galdes, the Canadian company, to implement the pilot project for Riyadh SDI, where it was agreed that work would be divided into two phases, and the first phase of the project comprised:

1. Advising the five bodies participating in the pilot project of its objectives.
2. Field visits to collect data from the five bodies.
3. Determining the requirements.
4. Establishing the final document of requirements, signing off and approval by the implementing body (Galdes) and the contracting body (the High Commission for the Development of Ar Riyadh).
5. Galdes would develop a website for the pilot project on the Internet through which the participating bodies would be connected to the pilot project in the future.
6. Establishing the final design.
7. Implementing and developing the system by programming the pilot project applications at Galdes in Canada.

The second phase of the project comprised:

1. Supplying the necessary equipment and software.
2. Installing and commissioning the system at the High Commission for the Development of Ar Riyadh.
3. Installing and commissioning the system at the other bodies participating in the pilot project.
4. Providing training on the system.
5. Operating and inspecting the system.
6. Providing support and maintenance.

At the end of 2007, Galdes began implementing phase 1 of the pilot project, by presenting all five participating bodies with the objectives of the project. It also visited all the bodies, and collected all the needed data. It then developed a website for the project on the Internet (figure 9.3), and gave a representative from each body with the authority to access and follow the different phases of the work on the project, and to facilitate the exchange of information between these five bodies in future. In 2008, Galdes finished the final design of the system, and proceeded to implement and build the system with programming for the pilot project in the company offices in Canada. Before the end of 2008, Galdes completed the first phase of the pilot project. Work then stopped before the second phase, due to financial and administrative issues at the High Commission for the Development of Ar Riyadh. At the end of 2009, these administrative and financial issues were resolved at the Commission, and Galdes was asked to proceed in implementing the second phase of the pilot project.

In 2010, Galdes supplied the equipment and software necessary for the pilot project, and installed a server at each of the five bodies participating in the pilot project. The system was then tested through the website on the Internet (figure 9.3). The persons responsible for the system in the five bodies were then trained for three weeks on the system. Galdes proceeded to supervise operation of the system, and provided support and maintenance for six months according to the conditions of the contract until the end of 2010, where the final handover of the project took place.

The High Commission for the Development of Ar Riyadh is currently at work presenting what was achieved to the Emir of Riyadh region, to make him aware of the results of the pilot project, and secure guidance on the possibility of continuing to cover the remaining districts of the city; in addition, connecting all those bodies working in the spatial data area at the level of Riyadh city to the system. The High Commission for the Development of Ar Riyadh aims to develop policies and legislation to regulate collaboration between the different bodies working in the spatial data domain at the level of Riyadh city, and will seek to gain approval from the Emir of the region, such that these regulatory policies and legislation are obligatory on all bodies in Riyadh city.

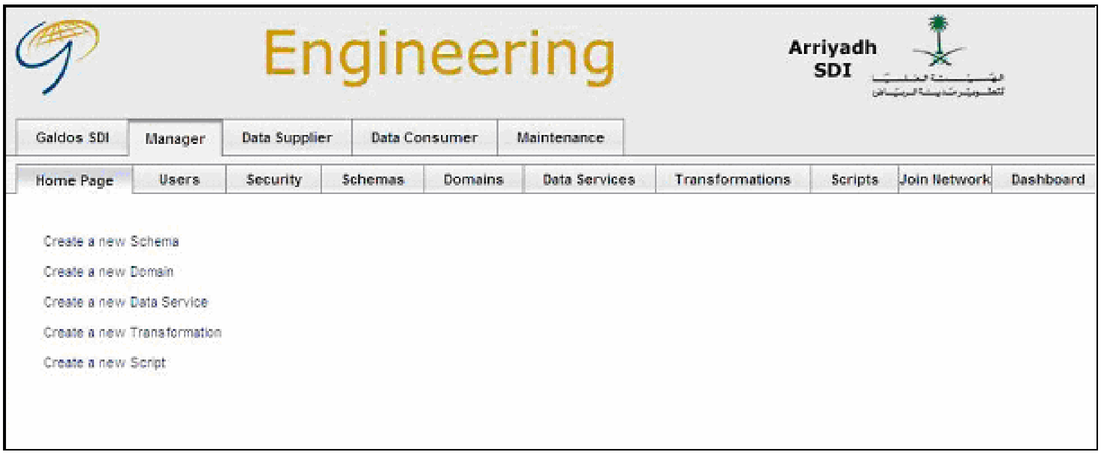


Figure 9.3 Main page for Ar Riyadh SDI

9.2.2.3 Advantages of Ar Riyadh SDI System

The claimed advantages to the system are:

1. Establishing the system on open standards:
   - The ability to link GML data to the different spatial databases.
   - The ability and ease of adding other bodies to the system.
2. There is no need to change the GIS systems existing in the participating bodies:
   - Enabling participants to view any operation to update or change spatial data by the producer of the spatial data.
   - The participating bodies have the capability and authority to rectify and amend their own spatial data.
3. Facilitating exchange of spatial data between the participating bodies:
   - Augmenting and publishing spatial data automatically.
   - The ease of adding spatial data or comments by any one of the participating bodies producing spatial data.
4. Establishing a continuous procedure for updating spatial data:
   - Sending comments to the participating bodies, and responding to them rapidly.
   - The system displays the time available for the spatial data producer to respond to comments.

9.2.3 Saudi National SDI initiative

This initiative is distinguished from the previous two by being comprehensive and concerned with spatial data in the custody of all stakeholders in KSA.

The idea for this initiative came from KACST in 1421AH (2000), which informed the royal palace that it had established a centre for GIS at the Space Research Institute, with the aim of cooperating and coordinating with the different stakeholders in building and establishing a comprehensive national database for GIS in the Kingdom.

9.2.3.1 Historical background to the initiative

In 1421AH (2000), KACST established a GIS centre at the Space Research Institute. In 26/8/1421AH (23 November 2000), Royal Decree No. 7/B/1725 approved the KACST initiative, and directed that a committee be formed under its supervision, with membership of the influential stakeholders in GIS represented by the Ministry of Defence and Aviation/GCS (formerly the Military Survey), Ministry of Petroleum and Mineral Resources, MOMRA, Ministry of Communications, Ministry of Finance and National Economy, Higher Commission for Development of Ar Riyadh, and Ministry of

Planning/Central Department for Statistics, tasked with studying establishment of national database and setting general strategies (KSA Royal Palace, 2000).

The Ministry of Defence and Aviation, in 19/10/1421AH (14 January 2001), presented a letter No. 1/1/1/3229 to the royal palace, which mentioned that the idea of establishing a centre for production of geographical information at KACST would lead to duplication of effort, and burdened the state with unjustifiable costs, as there was already a body tasked with this work, the GCS (General Directorate for Military Survey, at the time). Moreover, KACST did not possess a database or geographical information necessary for building the centre, while such information was available to GCS as a result of many years of survey work, which had been organised in programmes and systems suitable for all organisational uses. In addition, the custom in the majority of countries was that geographical data belonging to the state would be placed in the custody of a security/military body. Moreover, Cabinet Decision No. 70 dated 22/4/1410AH (21 November 1989) had ruled that military survey and geographical information lay within the jurisdiction of Central Directorate for Survey (now GCS).

On 12/12/1421AH (7 March 2001), Royal Decree No. 7/B /16925 approved the proposal by the Minister of Defence and Aviation regarding formation of a committee comprising three state ministers, and members of the Council of ministers, headed by the eldest, and with membership of the head of KACST, Deputy Minister of Finance and National Economy, Deputy Minister of Petroleum and Mineral Resources, General Director of General Directorate of Survey (now GCS), a specialist officer from the Ministry of Interior, and another from the National Guard, to study the issue from all perspectives, and present a set of recommendations (KSA Royal Palace, 2001a).

The designated committee met on 21/2/1422AH (14 May 2001) and discussed the proposal by KACST in the letter No. 94258/M/10 dated 29/1/1422AH (22 April 2001), in which it was explained that the request by KACST was regarding formation of a temporary committee of relevant bodies with the aim of unifying specifications and standards required in establishing a national geographical information system database, saving financial and human resources, and unifying terminology. Moreover, KACST did not aim to establish a national centre for GIS. The committee resolved to form a preparatory committee comprising the Ministry of Defence and Aviation, Directorate of Military Survey (GCS), Ministry of Interior, KACST, and the Ministry of Petroleum and Mineral Resources (Commission of Geological Survey) to clarify and define that the aim of KACST was not to establish a new centre, rather that all stakeholders should meet and unify the fundamentals of their work. Moreover, that the request by KACST aimed at cooperation and coordination between the relevant bodies, and emphasised that the proposal by KACST did not aim at duplicating any effort, and would not replace the existence of work by the General Directorate of Military survey (GCS) and other bodies. The preparatory committee ended its work as minuted on 6/3/1422AH (28 May 2001), and presented its report to the parent committee.

On 26/3/1422 (17 June 2001), the committee presented its report to the Royal Palace. The findings of the committee included that a committee be formed at KACST, in addition to approving the KACST proposal, and that the committee should be headed by the Ministry of Defence and Aviation (General Directorate of Military Survey, currently GCS). The objectives of the committee, its functions, and the participating stakeholders were also identified by the report.

Royal Decree No. 7/B/9838 dated 24/5/1422AH (13 August 2001) directed that a temporary committee for unifying specifications and general standards in the requirements for a national GIS database would be formed at KACST, and presided over by the Ministry of Defence and Aviation represented by the General Directorate of Military Survey (now GCS), and membership of influential stakeholders (KSA Royal Palace, 2001b).

9.2.3.2 Temporary Committee for Unifying Specifications and General Standards in the Requirements for a National GIS Database (also "Temporary Committee")

In order to achieve coordination between the different stakeholders, and find out the needs and requirements in the area of GIS data, the aims of the committee were to draw up strategies and plans, and unifying efforts in building a GIS network according to the specifications and rules specified, to serve all sectors, while providing the required technical support.

9.2.3.2.1 *Functions of the Temporary Committee*

- Ensuring that efforts are not duplicated, and distributing tasks to stakeholders to build their databases.
- Defining the participating stakeholders in the network, and beneficiaries as well.
- Identifying these sections and information that could be disseminated.
- Forming the specialist technical committees.
- Establishing and unifying national standards for GIS.
- Setting rules and systems for exchange and updating of information.

- Coordination with all stakeholders to survey available data and resources, and identifying requirements.
- Establishing appropriate designs for databases in coordination with relevant bodies.
- Taking advantage of modern technologies in building the network.
- Studying formation of an appropriate network for information exchange.
- Developing systems and protocols for data protection and exchange.
- Setting the requirements for allowing organisations to access the network.
- Making available technical assistance and consultancy to beneficiary organisations.
- Setting a time schedule to implement tasks.
- Studying the possibility of marketing information to the private sector.
- Exploring the possibility of using national expertise and the private sector in executing technical work.

9.2.3.2.2 *Stakeholders participating in the Temporary Committee*

The committee was formed from representatives of:

- The Ministry of Defence and Inspectorate General (GCS) (President);
- KACST (Secretariat);
- The Ministry of Interior;
- The Ministry of Petroleum and Mineral Resources (SGS);
- MOMRA;
- The Ministry of Economy and Planning (Central Department of Statistics);
- The Ministry of Transport;
- The Ministry of Finance;
- The Ministry of Higher Education;
- The High Commission for Development of Ar Riyadh; and
- The Saudi Arab Commission for Specifications and Standards.

Since the committee had authority to invite anyone it considered was needed from other government bodies, the following were invited to join: representatives from the Ministry of Justice, and Saudi Telecommunications Company.

- The Temporary Committee resolved to meet every three months, in order to receive regular reports from the subcommittees, and to study the recommendations presented by all subcommittees, and take the appropriate decisions. However, the committee could meet extraordinarily at any time as deemed necessary.

9.2.3.2.3 *Decisions of the Temporary Committee*

The committee made a number of decisions:

- Formation of technical committees as follows: information, networks, rules and systems, specifications and standards, and financial.
- Formation of a pilot project team.
- Approval for adoption of the International Technical Committee for Geographical Information Specifications (ISO/TC211), as appropriate for the nature and needs of KSA.

Technical committees

Technical committees were formed at the second meeting of the Temporary Committee on 25/2/1424AH (27 April 2003). Each committee was formed from a number of experts with relevant experience and knowledge in their committee's area of work. The president of each committee had the right to request the help of any expert in any area serving the purpose of the technical committee. Each committee held a number of meetings to study the relevant topics, which contribute to achieving the tasks of the committee. The committees presented their recommendations according to summarised minutes agreed by members, and then presented to the Temporary Committee to act in the way it saw fit. The technical committees held several intensive meetings, in some cases an average of six meetings every three months, i.e. twice a month; in some committees, meetings could be more, while in others less depending on the nature and quantity of the tasks given to each committee.

Functions of the information technical committee

The tasks of the information technical committee may be summarised as follows:

- Collating and analysing geographical and descriptive information available in the Kingdom.
- Organising information, and identifying sources, so as to achieve the required precision and quality of information.
- Verifying geographical and descriptive information available in the Kingdom.
- Setting rules for collecting, creating, organising, and producing geographical and descriptive information.
- Working to unify the reference authority for the geodetic network in the Kingdom.

Functions of the networks technical committee

The tasks of the networks technical committee may be summarised as follows:

- Developing a primary concept of the network for transferring and exchanging national geographic data, and describing how relevant organisations would be connected.

- Developing systems and protocols to secure information and its exchange.
- Exploring the latest developments in the area of networks and network technologies.
- Coordination and cooperation with other committees to unify and complement efforts in achieving the common goal of all committees.
- Developing the basic requirements for building a national GIS network.

Functions of the rules and systems technical committee

The tasks of the rules and systems technical committee may be summarised as follows:

- Exploring the legal basis and rules regulating the collection, publication, and exchange of information.
- Finding an organisational mechanism for updating information.
- Developing a mechanism to identify available information, and determine authorities and jurisdictions.
- Studying intellectual property rights relating to geographical information in the Kingdom.

Functions of the specifications and standards technical committee

The tasks of the specifications and standards technical committee may be summarised as follows:

- Developing a concept of how to prepare specifications and standards specific to GIS.
- Coordination and cooperation with other committees to unify and complement efforts to achieve the common goal of all committees.
- Adopting the best internationally approved specifications and standards for GIS, and modifying these to suit national information requirements.
- Unifying specifications, standards, codes, terminology, and technical definitions used in the area of maps and geographical information in KSA.
- Contributing to efforts of translating specifications and standards, and terms and definitions, in the GIS area, to the Arabic language.

Functions of the financial committee

The tasks of the financial committee may be summarised as follows:

- Setting provisional budgets.
- Proposing a mechanism to save in financial resources.

Pilot project

The Temporary Committee formed a working party to prepare a specifications handbook, and reference conditions to implement a pilot project in Ar Riyadh and Madinah areas. This comprised developing an experimental geographical information database through which geographical information would be transferred and exchanged between the different sectors using unified specifications, in line with international specifications, through an experimental electronic portal.

The working party concluded with the proposal to utilise five servers housed at: the GCS, KACST, MOMRA, High Commission for Development of Ar Riyadh, and Madinah Commission. A server would carry specific models and subsets of maps and geographical information available in each body. Data would be checked in the frame of the standards system (ISO-TC211). At the same time, metadata would be generated for the project information according to the standard (ISO-19119/19139). The working party also suggested that the core hub be installed at KACST.

9.2.3.2.4 *Achievements of the Temporary Committee*

The committee was successful on a number of fronts:

1. Collecting comprehensive information available at the different ministries and government bodies in the Kingdom, comprising digital and paper maps of all types and scales, geographical information systems, descriptive information, aerial photographs, satellite pictures. The information was organised and classified by type, scale, year of production, source, geodetic reference, coverage area, etc. These were housed in an accessible database available for reference.
2. Identifying participating bodies and users, who would benefit from the system.
3. Agreement on unifying some standards and procedures at stakeholders producing maps and geographical information of the Kingdom.
4. Studying and evaluating the data transfer and exchange network at the level of the Kingdom.
5. Exchanging information, expertise, and experience in the area of GIS among a number of government bodies in the Kingdom.
6. Coordinating with the saudi e-government programme to ensure harmony in specifications, plans, and strategies, as well as benefiting from resources, and infrastructure of the programme.
7. Promoting the importance of unified specifications and general foundations for the requirements of a national database for GIS in the Kingdom, through workshops, seminars, and conferences held in the Kingdom.
8. Studying the translation of many terms in the area of spatial data to the Arabic language.
9. Preparing the specifications and reference conditions handbook for implementing the pilot project covering the areas of Ar Riyadh and Madinah.

10. Exploring the procedures, and preparing systems governing intellectual property rights for geographical information, as well as the requirements for implementing a programme for national GIS infrastructure.
11. Approval by the Arab Saudi Commission for Specifications and Standards of those standards derived from the international technical committee for the preparation of specifications for digital geographical information (ISO-TC211), based on the recommendation of the Saudi delegation participating in the committee.
12. Studying the geodetic references, vertical and horizontal, used in the Kingdom, and recommending unification.
13. Participating in organising the 23rd international meeting of the international technical committee for preparation of digital geographical information specifications (ISO-TC211), hosted by the Kingdom by invitation of the Arab Saudi Commission for Specifications and Standards in the period 20-24 Shawwal 1427AH (11-15 November 2006) in Ar Riyadh with accompanying exhibition and workshop.

9.2.3.2.5 *Conclusion and recommendations of the Temporary Committee*

On 23/12/1428 (31 January 2008), the Temporary Committee concluded its work following several years of efforts involving meetings, communications, and coordination with relevant bodies both within the Kingdom and abroad. It studied the status quo in some advanced countries, and made some notable achievements. The committee presented its final report including the recommendation that the Temporary Committee be transformed into a permanent committee named the “National Committee for GIS” based in the Ministry of Defence and Aviation (GCS), with responsibilities including:

1. Establishing a programme called “the national GIS infrastructure programme”, through which a national database for GIS is established according to the latest national and international standards and specifications, and coordinating between the different sectors to provide services to users from the public and private sectors.
2. Preparing the vision, mission statement, aims, detailed tasks, organisational plan, human and financial resources, for the national database for GIS, infrastructure programme, and establishing the systems and policies for transfer in exchange of geographical information and data
3. Unifying technical standards and specifications for geographical information in the Kingdom, with approval through the Arab Saudi Commission for Specifications and Standards, while encouraging all relevant sectors dealing in digital geographical information to apply the international technical committee specifications (ISO-TC211), in which the Kingdom enjoys permanent membership.
4. Proposing the implementation of a pilot project, as prepared by the Temporary Committee, and for which specifications, technical standards and reference conditions

were produced, with coverage of Ar Riyadh and Madinah areas. This would act as the first phase towards building the national database for GIS, and the second phase would cover the remaining areas of the Kingdom, and connect all government bodies. The first phase would allow operational problems to be addressed, and system performance to be evaluated, while the third phase would involve further development, and marketing geographical information to the private sector.

5. Emphasising that all stakeholders in the area of geographical information, and descriptive information databases, as well as users implement the following national bases for surveying and GIS:
    a. The international geodetic reference (WGS84), and developments derived from it, such as (ITRF2000), and others.
    b. The vertical reference for the Saudi geodetic network is the average sea level for Jeddah 1969 (SAVD71), or any developments made to this reference due to further measurements and monitoring.
    c. The international Mercator reference (UTM) system.

    Adopting these reference elements is a matter of urgent priority in building the general foundations necessary for establishing the national database for GIS.
6. Full coordination with the saudi e-government programme to ensure notification, and guarantee harmony in specifications, plans, and joint strategies, as well as benefiting from the saudi e-government programme's infrastructure.
7. Building the human resource capacity through a training strategy.
8. Organising a national conference for GIS in the Kingdom, held every three years. In addition, holding meetings, organising workshops, publishing regular specialist periodicals to serve development and localisation of technology.

9.2.3.2.6 *Obstacles faced by the Temporary Committee*

The Temporary Committee faced a number of obstacles, most prominently:

1. Committee members were involved in other activities, which affected performance, delayed its work, and prevented some of its aims from being achieved.
2. The lack of sufficient funding prevented some studies, necessary consultancy, and pilot projects from being done; technical committee members were also not rewarded for their efforts.
3. The level of representation at the Temporary Committee was not as it should be, as some stakeholders were represented by one person, while others were represented by many. Furthermore, some members were unaware of the requirements of establishing a national database for GIS.

4. The lack of necessary documentation and references in Arabic, especially in the area of specifications, systems, laws, and intellectual property regarding geographical information.

In the phase following conclusion of work by the Temporary Committee, and following its final report presented to the Royal Palace on 23/12/1428AH (31 January 2008), a number of actions were taken:

1. On 3/6/1429 (7 June 2008), Royal Decree No. 4340/MB directed that the High Commission for Administrative Reform study the proposal of transforming the Temporary Committee into a permanent committee named the "National Committee for GIS" based at the GCS (KSA Royal Palace, 2008). The High Commission for Administrative Reform formed a full-time working party under its supervision with the following membership: two members each from the High Commission for Administrative Reform, and the Ministry of Defence and Aviation (GCS), while MOMRA, KACST, the Ministry of Petroleum and Mineral Resources (SGS), and the Ministry of Finance were each represented by one member. The aim behind forming this working party was to analyse some of the decisions and systems relating to the work of government bodies in the area of GIS, and finding out the status quo in these bodies.
2. The working party began its work on 18/10/1429AH (08 in October 2008), and continued for six months in which it carried out a review of other experiences, with visits to Britain, Malaysia, and Canada to study the experience in other countries. Moreover, the working party undertook study and analysis of the systems, and decisions relating to GIS in the Kingdom, as well as studying the status of GIS in relevant bodies. The working party members met with the key responsible persons at these bodies, as well as experts at universities to gather their opinion regarding establishment of the permanent National Committee for GIS at the GCS.
3. The working party completed its work, and concluded as to the importance of forming the National Committee for GIS bringing together relevant bodies that would undertake establishment of the Saudi NSDI. This was reported confidentially to the Ministerial Committee for Administrative Organisation, which in turn also reported this confidentially to the Council of Ministers.

9.2.3.3 National Committee for GIS

On 30/12/1431AH (6 December 2010), the Council of Ministers approved the transformation of the Temporary Committee to a permanent committee, named the National Committee for GIS based at the GCS (Sabq, 2010).

9.2.3.3.1 *Functions of the National Committee for GIS*

The National Committee for GIS is tasked with several specific matters (Sabq, 2010):

1. Developing national policy and strategy, and setting priorities in the area of GIS.
2. Developing a programme called the National GIS Infrastructure programme, through which the national spatial database would be established.
3. Building up the human resource capabilities through a training and professional development strategy.
4. Organising a national conference for GIS to be held every three years.

9.3 Discussion

It was quite clear that the three initiatives, i.e. MOMRA, Riyadh, and Saudi National SDI, were developed independently of each other. The Temporary Committee did not attempt to integrate the initiatives by MOMRA and Ar Riyadh Development Commission and bring them under its umbrella; even though among its members were representatives of both MOMRA and the High Commission for Development of Ar Riyadh. It is noticeable that the Riyadh initiative, as well as that of MOMRA, focused on technical aspects, and ignored the legislative aspect of organising exchange of spatial data, until the end of the pilot projects. The aim was to develop policies and legislation to coordinate collaboration in spatial data exchange following approval by the person in authority, based on the success of these pilot projects.

The time cycle is quite significant, extending over several years to implement the necessary government procedures for the three initiatives. It appeared that the Ar Riyadh and MOMRA SDI initiatives did not undertake coordination with the Saudi e-government programme, ensure absence of duplication, and harmony in common specifications, plans, and strategies, and benefiting from the infrastructure of that programme.

The Riyadh initiative aimed at coordinating collaboration between the different spatial data bodies at the level of Riyadh city. In contrast, the MOMRA initiative aims at coordinating collaboration between the different agencies and departments within the Ministry in Riyadh, and at all levels and regions of the Kingdom. As for the Saudi National SDI initiative, it is much wider than the other two, in that it aims to coordinate the collaboration between the different bodies working in the spatial data domain at national level in the Kingdom.

9.4 Summary

This chapter has explored the current state of SDI initiatives, in particular the key initiatives of MOMRA, Riyadh, and Saudi National SDI, which were developed independently of each other, tracing their historical development. Data on these initiatives was collected from both secondary and primary sources, including relevant reports, documentation, and legislation obtained directly from the stakeholder bodies and their websites, as well as through the questionnaires and semi-structured interviews. The chapter highlighted the distinct nature of each initiative, MOMRA, Riyadh, and Saudi National SDI, in dealing with collaboration at city, ministry and region, and national levels respectively. In contrast, the challenges to collaboration that exist are presented in Section 8.9.4 (pp.194-199). The following chapter presents the summary, recommendations for future work, and conclusions.

CHAPTER 10: SUMMARY, RECOMMENDATIONS AND CONCLUSIONS

10.1 Introduction

In KSA, up to the date this research was completed, there was no single body responsible for overseeing and coordinating spatial data activity in the Kingdom[1]. All the initiatives mentioned in this thesis are either under study, or are pilot projects. To date, no law has been passed to regulate spatial data to compel all bodies to collaborate and coordinate in all areas of spatial data work in the Kingdom. This results in competing interests, absence of strategic planning, and lack of professional management, coordination, and complementarity; each body is an isolated island with respect to spatial data projects.

In light of this research problem within KSA, the research questions were identified:

1. What are the spatial data and SDI concepts that are essential to developing NSDI?
2. In NSDI development, what relationships bind its components?
3. What is the experience worldwide in the best practice NSDI collaboration initiatives?
4. What is the current form of NSDI in KSA, and how far is it satisfactory to the needs of stakeholders?
5. What recommendations can describe a best practice Saudi NSDI collaboration initiative?

For the purpose of responding to the research questions, a mixed (triangulated) quantitative and qualitative case study research design was adopted. A quantitative questionnaire was distributed to personnel working in the nearly all the spatial data bodies in KSA, 26 organisations in total. Semi-structured qualitative interviews were then conducted with 72 key persons in these organisations. The data was analysed giving a view of the current status of spatial data in KSA, including the current challenges and obstacles.

A literature review was conducted in the relevant areas of SDI and SDI collaboration, exploring definitions and main components, and the hierarchical nature of SDI, It included definitions for collaboration, motivational factors, and potential risks and costs. The review revealed that a conventional NSDI is top down, while new technologies connected to social developments are potentially disruptive of this; a rapid, parallel development of commercial-

[1] On 6 December 2010, the Temporary Committee for Unifying Specifications and General Standards for a National GIS Database became a permanent committee, named the National Committee for GIS based at the GCS.

and consumer-led SDI, or dynamic ‘GeoWeb’, represents the next generation, or ‘Web 2.0’ NSDI (Jackson et al., 2009). However, key elements in the success of current NSDI collaboration initiatives are institutional and technical factors, including organisational commitment, policies, and technological resources. The UK, USA, Australia, and Canada NSDI initiatives were reviewed and compared along five key themes: objectives and vision, coordination, datasets, standards, and access. This highlighted the evolving nature of NSDI, given the rapid pace of developments in technology-driven applications and tools, and that coordination and agreement among all stakeholders requires accurate and reliable datasets, widely accepted metadata and standards, and interoperable technology, and must include all government levels and jurisdictions, with greater private sector integration.

The current situation in KSA was surveyed regarding the main SDI stakeholders, and their historical development, including legislation and policies and the barriers to sharing spatial data existing, facilitates background to understanding the issues involved in development of a Saudi NSDI. The historical development and current status of key, independent SDI initiatives in KSA, MOMRA, Riyadh, and Saudi National SDI, representing city, ministry, and national level SDI collaboration initiatives, were explored with secondary and primary data. Primary data was collected through the questionnaire survey, and semi-structured interviews. The data collected included spatial organisation types and sphere of operations, data types and themes, standards and technical issues, and inter-organisational relationships and collaboration.

10.2 The Research Questions and Findings

Question One: What are the spatial data and SDI concepts that are essential to developing NSDI?

From the literature, the key SDI components are data, people, institutional policy and framework, standards, and technology.

Data: fundamental datasets are primary spatial data themes considered in supporting the key functions of a country or jurisdiction, providing the common spatial reference and context which underpins many other forms of business information. Common fundamental themes include geodetic control, cadastre, administrative boundaries, geographic names and localities, street address, transportation, elevation, hydrology and orthophoto imagery.

People: users, providers, administrators, custodians of spatial data and value-added re-sellers. Users can be corporate, small or large business or individuals, public or private. Users and administrators of spatial data have very different qualifications and professional backgrounds.

Institutional framework: The administration, coordination, policy and legislation components of an SDI. This relies on successful partnerships and communication between agencies within and between jurisdictions.

Standards: Consistent standards and policy required to enable the sharing, integration and distribution of spatial data; standards for data models, metadata, transfer and interoperability of storage and analysis software. Consistent policy for pricing and access to spatial data, within and between jurisdictions.

Technology: Access and distribution networks, clearinghouse and other means for getting the spatial data or datasets to the users; also involves acquisition, storage, integration, maintenance, and enhancement of spatial data.

Question Two: In NSDI development, what relationships bind its components?

The institutional and technical underpinnings of an NSDI are there to fulfil the prime goal of facilitating sharing and accessing available spatial data. From the experience of leading countries in NSDI development, these involve five key themes: objectives and vision, coordination, datasets, standards, and access.

Three areas are essential in NSDI development:

1. framework data or fundamental datasets development;
2. standards and metadata development; and
3. enhancing spatial data sharing and access through connected online (Internet) distribution nodes.

In practice, these areas are addressed through collaboration of academia and the private and public sectors, at all levels and across jurisdictions. This collaboration is a critical factor in the success of any of these NSDI development initiatives.

Question Three: What is the experience worldwide in the best practice NSDI collaboration initiatives?

The best practices in NSDI collaboration initiatives as presented in the experiences of four leading countries in spatial data, the UK, USA, Australia, and Canada.

Spatial data can make a key contribution in realising national development targets, with impact on the social, economic and environmental areas, and so, it is the responsibility of government to ensure the availability of basic spatial data. In the UK, USA, Australia, and

Canada, it is the government that distributes spatial data, largely produced by government bodies representing the main, largest national providers. Government through its various bodies possesses both the legislative instruments and necessary resources to collect and process national spatial data.

A number of criteria are presented for the purpose of comparing the NSDI collaboration initiatives. These criteria involve the five themes, i.e. objectives and vision, coordination, datasets, standards, and access.

The four national initiatives share a common conceptual approach in that a vision and aims have been defined and implemented. The common vision among the distinct initiatives was the creation of a tool for spatial data discovery, which also enables access to spatial data and services to serve the needs of diverse users nationwide. Moreover, the common aim was to build a shared, collaborative spatial data resource and asset governed and managed by specific policies and tools respectively. The initiatives recognized the need for direct involvement of the private sector, with its value-adding services, and government at all levels. In practice, this is clearly achieved in the UK and Canada initiatives, and to lesser extent Australia. In the US, there is absence of adequate representation of all government levels, and a lack of input from the private sector. In the US, the GOS currently only offers data from federal bodies, in conflict with its vision of facilitating access to spatial data from a wide range of sources. The NSDI initiatives in these countries are relatively advanced, yet spatial data sharing, and access to it, nationally, is still not fully realised.

The absence of mandatory powers to compel sharing of spatial data, and to push through development is apparent in the Australian ASDI initiative, for which ANZLIC is responsible. In addition, both UK NGDF and Canadian CGDI also lack a structure for coordination, and are built purely on voluntary arrangements. The US GOS initiative possesses a strong coordination component, in particular at the federal level, with other sectors, academia, private sector, and local government bodies, relegated to a secondary role. A positive aspect of being a federal initiative has meant that it possesses high-level political support. On the other hand, there is weak participation of other levels of government, state and local. Funding NSDI initiatives is also an area of variation between the countries studied, which fit the particular circumstances and needs of each. For NSDI development funding, Australia chose the decentralized approach, with each jurisdiction providing for its own programme. On the other hand, in Canada, the costs of spatial data creation, maintenance, and distribution are met by a cost-recovery mechanism through fees to provide spatial data. The UK has a contractual arrangement, i.e. NIMSA, through which central government funding is available to supply data to all government users, but a cost recovery mechanism is also in place for other users. The US NSDI initiative has benefited from central government funds given via FGDC among others since 1994. The US model does not adopt any cost recovery, rather open access is granted to data, especially at federal level. In contrast, at state and local government levels, some cost recovery measures may be applied with respect to their spatial data. Fundamentally, the USA Federal Government does not apply any copyright or intellectual property rights over spatial data in its custody, compared with the UK, Australia, and Canada.

Within ASDI in Australia, GIS applications usage revealed ten common themes, but these are not yet completed (Clarke et al., 2003). Within the UK and Canadian NSDI initiatives, core themes still lack clear definition, while the USA has clearly specified seven fundamental datasets comprising the commonest spatial data themes used and accepted in its spatial data user community.

The proper development of an NSDI involves collaboration between stakeholders based on the use of common standards. As such, the four national initiatives presented have included development and implementation of data and metadata standards to facilitate seamless exchange leveraging uniform methods of dataset metadata creation. This allowed metadata search to be provided in all the national initiatives discussed through a Web portal interface.
It can be seen that the other countries' initiatives have made use of US standards and metadata to a certain extent. The US FGDC since 1994 in issuing the Content Standard for Digital Geospatial Metadata and later versions, has actively contributed to international standards development by both OGC and ISO. This has meant that other countries have, in effect, de facto made use of US efforts, as they all adopted ISO standards and metadata.

In the national spatial data sharing initiatives reviewed, clearinghouses or distribution nodes give access to spatial data, with the latter linking to data over the Web. All the initiatives discussed utilise the Internet to provide means to discover and access spatial data, involving: (1) a metadata search facility of related spatial data resources; (2) descriptive information for spatial databases allowing assessment of suitability to satisfy the needs of end-users.

Metadata services are part of all the initiatives, since this is key to locating spatial data, preventing duplication, and results in reduced costs. In contrast to the initiatives in the UK, Canada, and Australia, which only allow spatial data to be discovered, the US GOS portal includes the ability to access and download the spatial data from within the portal. This facilitates rapid and integrated access to spatial data. Thus, there is scope for further development of the other systems into portals that enable greater direct access to spatial products and services.

Ensuring system architecture is interoperable is essential for spatial data to be accessed and shared using the Internet. As such, it represents a priority area in the implementation of all the national initiatives studied, which accept OGC open systems standards and specifications for this purpose. The aim of all initiatives is to raise levels of interoperability and so functionality in Web-based services; this has already been realized to a large extent in the US GOS initiative. The other initiatives, however, still need to do more achieve this. On the other hand, OGC web service standards still require further development to enable complex features to be supported and facilitate greater interoperability.

Question Four: What is the current form of NSDI in KSA, and how far is it satisfactory to the needs of stakeholders?

In KSA, four main stakeholder bodies are responsible for spatial data, namely the General Commission for Survey (GCS), Ministry of Municipal and Rural Affairs (MOMRA), Saudi Geological Survey (SGS), and King Abdulaziz City for Science and Technology (KACST). The survey conducted, using a questionnaire and semi-structured interviews, revealed shortcomings in the collaboration between the different spatial data bodies. The majority are government bodies, and are seen as responsible for the situation, since they can influence decision-makers, and so bring the legislation considered necessary to institutionalise collaboration, and prevent duplication. The data indicated that the private sector may also contribute to the lack of experts in government bodies. A situation that is financially rewarding, as it maintains the dependence of government bodies on these private sector organisations. The third type of spatial data body is represented by academic institutions, which are also expected to promote collaboration through their academic and training courses.

The research found that the majority of bodies work at national level in this large country, which greatly increases the chances for duplication in projects, and difficulty in controlling the spatial data situation in KSA. Furthermore, spatial data bodies are mainly producers and users, with competitive and non-collaborative attitudes, resulting in a culture of duplication. This is aggravated by easy access to funds for government bodies. The decision-makers' lack of awareness and understanding of the problem resulted in absence of a regulatory and organisational framework, including designating a coordinating body to oversee spatial data projects at national level.

The survey revealed absence of coordination between departments within large organizations, and each department unwilling to share spatial data with others. In some cases, the problem of lack of collaboration was attributed to managers with long experience within their organizations, who do not subscribe to the idea of collaboration. Instead, they entrench their authority from past executive decisions that have been overlooked when more recent legislation was issued.

Emphasising the competitive and adversarial relationships within spatial data bodies and between individual units, the data showed that departments or units preferred to remain independent, or be linked directly to the highest authority in the organization. This favoured status would grant them wide power and flexibility to operate as they wished without seeking to collaborate or coordinate.

Within the public sector, the survey data revealed a significant lack in qualified spatial data personnel, and the majority of workers held qualifications from outside the spatial data area. The expansion in numbers of spatial data workers in recent years has not resolved the problem due to the lack of proper personnel selection. Training of personnel was another related area, which the data highlighted as one where organisations only exerted token effort, if at all.

The availability of significant funds for government bodies allowed them to boost their individual holdings of both raster and vector spatial data, for the majority of regions within their jurisdiction, with much duplication. This data was only updated as needed. The data showed that quite large annual budgets, in the millions of Saudi Riyals, were available to government organisations for spatial data projects meant they had no incentive to cooordinate, cooperate or share costs with others. Furthermore, the funding gave them complete freedom to define spatial data themes using in-house standards and specifications. Therefore, the claim by some bodies that their spatial data conformed to international standards and specifications was not true, as stated in interviews.

The survey revealed concerns regarding the secrecy and security of the spatial data, given the poor spatial data transfer network infrastructure in KSA, and lack of robust protection software systems. Therefore, many spatial data producers have each developed their own intranet linking different departments of that body. In addition, the file size and level of secrecy determine the means by which spatial data is delivered to requesting bodies, either by e-mail, download link, CD-ROM, DVD, etc.

Collaboration and spatial data exchange has also been prevented by the absence of intellectual property protection. Spatial data producer bodies are reluctant to allow other organisations access to their spatial data. However, some bodies require formal requests for data to be submitted, and written undertaking to prevent abuse of intellectual property rights.

The relationship between spatial data producers and users remains unregulated, as highlighted by this research. Therefore, personal relations have come to play a significant role in influencing the process of obtaining spatial data from government bodies, in particular. Relationships with the private sector are driven primarily by profit, and charging for spatial data.

For spatial data user bodies, the survey revealed that they preferred obtaining spatial data from government bodies, at lower cost than the private sector, yet it was usually in accordance with the standards and specifications of these bodies. On the other hand, spatial data from the private sector was guaranteed by contract and commercial agreement to meet specifications and standards as stipulated. Furthermore, requests for spatial data from the public sector followed a long and complex process, driven by the whim of officials, which had been criticized by participants in the survey. However, all the spatial data user bodies worked to consolidate their relationships with producers, in both the public and private sectors, and at local, national, or international level. The aim is to diversify spatial data sources.

The data collected showed that bodies developed their own spatial data applications, and did not cooperate with others to create common applications. This is evidenced by the existence of over ten base maps for some cities in the Kingdom produced by different bodies, each claiming their map to be exclusively correct.

The survey revealed a lack of concern for using metadata to document spatial data in some bodies. Others that did so, failed to apply international standards and specifications, preferring to use in-house ones. In addition, there was lack of cooperation and agreement between organisations on implementing common metadata standards and specifications.

On the technical level, the data showed that organisations were free to choose the spatial data software systems with a lack of regulatory mechanisms for collaboration, including a coordinating body. Therefore, they proceeded to create spatial data to any map scale, and to any technical standards. The decision lay with the head of each organisation. In these circumstances, collaboration among the majority of spatial data bodies in KSA is restricted to exchanging spatial data and technology. Each body is free to handle and use spatial data according to its narrow interests and plans.

The survey highlighted that, in the majority, current forms of official collaboration between bodies were based on contracts and agreements, to protect the rights of all parties. But, unofficial collaboration, for example through friends or relatives working in spatial data producers offered a quicker and smoother route to obtaining spatial data. Currently, there is no system in place to prevent this, especially in the pubic sector.

The research also found key obstacles to collaboration between spatial data organisations in KSA, in summary:

1. Lack of awareness, among decision-makers, and the majority of stakeholders, of the advantages and benefits of spatial data exchange.
2. Old official decisions were not rescinded, when new decisions were issued. This provided official cover for duplication in spatial data projects.
3. Lack of an official coordinating body, which would oversee cooperation and spatial data sharing, at national, region, and city level. Current initiatives, by some bodies, have no official recognition.
4. The majority of stakeholders maintain a strict hold over their data due to issues of power and control.
5. Limited pool of human resources and poor skills and qualifications in the spatial data area.
6. Lack of policies defining spatial data exchange, and also compelling stakeholders to collaborate.
7. Poor infrastructure for spatial data exchange and delivery.
8. Lack of secure Web portals to prevent data from being compromised using the Internet.
9. Lack of intellectual property legislation.
10. Different spatial data specifications, standards, and digital formats between stakeholder systems.
11. Existence of inaccurate spatial data due to the lack of expertise within organisations at implementation of projects. The faulty data is not made available, yet without exposing the lapses.
12. High rates of promotion and turnover among spatial data specialists prevent consistent collaboration frameworks from being created.
13. Lack of a comprehensive vision and poor management to develop solutions, manage implementation, and devolve responsibilities.
14. Absence of the concept of collaboration and data exchange as a learning element in training materials and courses given by academic bodies.
15. Poor expertise in the majority of private sector bodies implementing spatial data projects.

During this research, the participants indicated they had become convinced of the need for collaboration among all the spatial data bodies in KSA. The government was expected to facilitate this through legislation and policy frameworks, and appointing a single body to coordination spatial data work at all levels.

The findings of this research, in terms of the obstacles presented above, may be compared with past experiences of GIS implementation. In particular, Openshaw et al. (1990) identified a number of reasons contributing to fundamental GIS problems. The findings from this work on KSA and those of Openshaw et al. (1990) reveal common problems, in relation to absence of experts and qualified persons in GIS/SDI implementation, lack of long-term planning/strategic vision, and resistance to change in organisations, represented in conflict over data control and access. Therefore, it is clear that in the context of this research in KSA, the majority of problems related to GIS, SDI, and NSDI seem generic. In addition, this demonstrates that the obstacles to NSDI in KSA identified by this work conform with the results of other researchers.

Question Five: What recommendations can describe a best practice Saudi NSDI collaboration initiative?

Recommendations for the Saudi NSDI Collaboration initiative

The literature review revealed that collaboration in NSDI must consider its components, namely technology, policies, standards, and human resources (Clinton, 1990). Moreover, the various stakeholders in NSDI present a challenge to achieving proper integration and coordination. There are multitiple approaches to NSDI management though the one adopted is typically heavily influenced by the nature of the political system in place (Warnest, 2005). Moreover, collaboration both within and between the stakeholders, government, industry, and academia, in NSDI is critical for its success (Williamson et al., 2003). Such collaboration harmonises policies, approaches, and management issues relating to access, pricing, etc.

This research has made a number of findings, which allowed a best practice initiative for Saudi NSDI collaboration to be described through a number of recommendations. Primarily, the nature of the Saudi system of government implied the adoption of the top down approach to NSDI implementation and management. These recommendations have been based on the opinions and information provided by many well informed people and organisations including the main implementers and users of NSDI in the KSA.

Therefore, for the Saudi NSDI collaboration initiative to, it is recommended to take the following actions:

1. Issue a Royal decree endorsing the system for Saudi NSDI, including a specific vision and objectives, and the procedure for spatial data exchange at national, regional, and city

levels. This system would specifically prohibit duplication among government organizations.

2. This Royal decree and the accompanying system must cancel/repeal all prior decrees and powers regarding spatial data that had vested responsibility in organizations, with this system taking their place.
3. The system must strictly define the powers given to each organization, and its area of work in spatial data to prevent duplication.
4. The Royal decree and system must include formation of a committee for NSDI, which is linked to the committee of experts at the Council of Ministers, and under it sub-committees in each region that are linked administratively to the Regional Governor (Emir) in each region, in order to derive authority from that of the Regional Governor (Emir) directly. As for the national NSDI committee, its authority is derived from its semi-direct link to the Prime Minister's Office. These committees may be considered to be responsible for implementing the system, and issuing the executive policies concerning the system, and distributing it to all concerned bodies.
5. Appoint committee members from public and private sector bodies, as well as academia, to participate in the NSDI committees at national and regional levels.
6. Define the layers on which work is to be carried out at national, regional and city levels; for example the transportation layer, geodetic network, etc.
7. Distribute layers to government bodies and private sector, so that each group would collaborate on a spatial data layer, with appropriate justification, and prior experience of work on this layer, and also based on the wishes of users.
8. Develop a unified Saudi code for spatial data systems with management and technical policies, specifications and standards, which are disseminated to all bodies concerned with spatial data to facilitate efficient exchange and transfer of spatial data to users, regardless of differing systems and applications. The code should define framework data and metadata using ISO standards, particularly ISO 19103, 19107, 19109-12, 19123, 19136 for framework data, and ISO 19115 and 19119 for metadata.
9. Create a single, accessible, Web portal, based on interoperable standards (OGC) providing facilities for spatial data discovery, search, and download.
10. Establish a link with international committees working on standards, that clearly developed with ISO, such as TC211, to ensure continuing development and updating of technical specifications and standards.
11. Create a central spatial databank connected to the networks of regional and international databanks for the purpose of information exchange. This centre provides the scientific content to the spatial data centres in the different government sectors, and academics and researchers interested in this field by easy, safe and secure means to ensure arrival of information to the widest range of beneficiaries. The centre is also registered with

scientific databases and provides a service to researchers and workers to remain abreast of the latest developments in this field.

12. Take full advantage of current experiences of MOMRA with respect to its SDI initiative, as well as the pilot project of the High Commission for Development of Ar Riyadh, and their SDI initiative. Also find out the results of the Temporary Committee for Unifying Specifications' requirements for establishing Saudi NSDI, follow this up, and endorse the conclusions of said committee.
13. Issue the directives to all the active sectors in the area of spatial data to activate use of the national reference, and to task those bodies that previously used more than one reference to unify efforts in establishing a national reference for spatial data, which is the World geodetic reference, WGS84 and its derivatives, such as ITRF2000, and developments to date. The vertical reference being the average sea level at Jeddah 1969 or any updates to that reference, while the projection would be the international Mercator UTM.
14. Create human resource capability by working on a training strategy, organizing meetings, and workshops for personnel in spatial data, publishing specialist periodicals, which would contribute to development and transfer of spatial data technology.
15. Create a virtual working environment on the assumption of empowering workers in the different spatial data areas, regardless of their position. This would create an environment for collaboration and sharing, irrespective of time or location. Therefore, several sectors may partner on a single project without the need for a single specific workplace; the design team for example could be distributed across different sites, and would work together on the design, background research, and development using ICT components, applications and the Internet.
16. Provide technical and expert support with the capability of remote service provision, i.e. supporting government organisations, the private sector, and individuals through a number of experts in the area of spatial data technologies using telephony and Internet networks, which would prevent duplication in employment of experts in each sector leading to reduced effort and costs.
17. Create a centre for GIS research paving the way for development of qualified personnel, and encouraging innovative scientific research, and providing the materials and resources for such research, in an appropriate scientific atmosphere, while providing the scientific and technical support to these researchers. At the same time, organise the process of communication with local, regional and international research centres, and cooperate with these centres to benefit from the latest developments. Provide technical and scientific consultancy to both public and private sectors in the field of spatial data and software standards and specifications etc.

18. Create a digital library comprising information systems characterised by ease, precision, and effectiveness in terms of organising, and storing data and information, so that it is easily retrievable. The digital library also provides users with the capability to access data and information without any time or location barriers. Also derives from access by a large number of users simultaneously.
19. Provide virtual training and learning through tested and approved Internet technologies to transfer and exchange lessons and research topics between trainers and trainees with respect to spatial data. Through virtual training the trainer can stream the lecture to trainees in audio and video, and also using the electronic whiteboard. The programme allows the trainer to track trainee attendance, and monitor study activities, while trainees can comment or ask questions by microphone. The lectures may also be recorded for reviewing later on. This allows an implementation to be done between trainee and trainer, or the trainees as a group.
20. Support government bodies working in the area of spatial data with personnel carrying specific qualifications in spatial data, and allow them to manage spatial data in these bodies, and tasking them with unifying standards and specifications.
21. Cooperate with the e-government initiative in electronic transactions to ensure no duplication occurs, and that strategies and plans are in harmony, while taking advantage of the infrastructure of the e-government programme in KSA.
22. Direct all government bodies, especially the large organizations, such as ministries, to prohibit duplication within the bodies, and creating a specific committee for spatial data within each of these bodies that coordinates with the high committee for NSDI with regular monthly reports of achievements in spatial data.
23. Request regular reports from all bodies on their achievements in spatial data projects, and their collaboration and relationships with other bodies.
24. Ensure spatial data bodies use vendor-neutral OGC specification software. Award spatial data project contracts only to those bodies that have qualified personnel, and capability.

10.3 Contribution to Knowledge

There have been studies on National Spatial Data Infrastructure (NSDI) in the Kingdom of Saudi Arabia (KSA). For example, the study by Dr Abdullah M.R. Al-Shahrani (2002) "*Towards the Development of a Strategy for a National Spatial Data Infrastructure*", a PhD thesis submitted at the University of Nottingham. This research by Al-Shahrani (2002) addressed NSDI technical infrastructure strategy. In contrast, this study focused on the institutional/organisational issues in collaboration for development of NSDI in KSA.

The problem investigated in this research is how national spatial data collaboration models in KSA consider the technical, institutional, political, cultural and economic factors there, and whether as a result of their potential to contribute to NSDI development is limited. This research proposed a collaboration initiative of best practice for Saudi NSDI, based on research and evaluation, to contribute to help advance the goals and implementation of SDI in the KSA.

10.4 Future Work

At the conclusion of this research study, it is apparent that there are wider areas to be explored. Further work is suggested in relation to development of the Saudi NSDI, and the impact of new technology, represented by the potential for crowd source mapping (Jackson et al., 2009; Jackson et al., 2011), with its challenges of data quality assurance (Hirth et al., 2010; Exel et al., 2010), that has already been harnessed effectively in disaster management scenarios (Neis et al., 2010; Zook et al., 2010).

1. Evaluate and quantify the development benefits of Saudi NSDI on decision-making and the economy.
2. Identify and evaluate new technological developments, which may impact on SDI developments and (i) define the nature of their impact on, or disruption of, current approaches to SDI and (ii) consider how these new technologies might be incorporated to contribute positively to NSDI.
3. Explore the possibility of Saudi NSDI initiative being expanded to form a Gulf Cooperation Council (GCC) regional SDI.

The world has changed, with spatial data taken from highly centralised government control to public participation in sharing in spatial data development harnessing Web 2.0 technologies. In addition, spatial data domain ontologies pave the way for Web 3.0 technologies to integrate data from both formal and crowd sources, and allow data mining and analysis. Also, global metadata descriptors are vital for successful spatial data infrastructure communication, domestically, regionally, and globally. KSA is a key country in the region. Due to its large development, social and economic needs, KSA requires an effective NSDI. This should form part a regional SDI that covers the Gulf area, and wider Middle East. As such, KSA needs to implement its own NSDI initiative successfully, with regard to the recommendations given in this work (pp.236-239). After which, using its experience, resources, and political power, KSA needs to lead the way in establishing a Gulf-wide regional initiative.

Looking to the future, new technology provides an area of further work relating to the influence of new technologies on the KSA NSDI, and the associated decisions. Crowd sourcing is a concept that has emerged allied to the Internet and a large base of workers contributing to building knowledge (Hirth et al., 2010; Guittard and Schenk, 2011). The impact of technology potentially involves a degree of interaction between a number of elements, such as public access, use, provision and accuracy, where data is crowd-sourced. In addition, how this external data will be integrated with the secure and accurate data held within the NSDI must also be determined.

It is suggested that these elements are subject to study:

1. Public access: In the KSA NSDI, to what extent should the general public be allowed to access it, would mapping be available as free download or subject to fees, and which networks would be used.
2. Public use: The flexibility of creating maps very rapidly is a positive aspect of crowd sourcing compared to formal production concepts. This is particularly true, where high accuracy is not required; as seen in mapping for disaster management (Neis et al., 2010; Zook et al., 2010). The impact of public use of the NSDI is a potential area of research.
3. Crowd-sourced data accuracy: A concern relating to crowd-sourced spatial data is that of quality (Exel et al., 2010) and ensuring intentionally erroneous data is detected (Hirth et al., 2010), which raises a number of questions. As such, what methods can be used to evaluate this data? What tags may be used to represent the levels of accuracy, and the source?
4. Integration: This represents a major challenge in enabling access to the NSDI for data that is crowd sourced. Relevant questions are how to deal with duplication, i.e. deciding what to keep. This mirrors the situation in KSA regarding the various geoid systems implemented by different spatial data providers, where the data is accurate, but incompatible.
5. New technology: Crowd source mapping has been made possible by the spread of powerful gps-enabled mobile (handheld) devices with cameras, etc. (Exel et al., 2010). Research in this aspect, relates to the ability of the KSA NSDI to receive and provide spatial data in a timely way to innovative mobile (handheld) devices.
6. Security: Within the NSDI, there are different layers of information, and users have differentiated access. Moreover, some data will be expected to remain secret. In this situation, use of the Internet as the common means of access to the NSDI provides a significant security challenge, and so requires careful evaluation.

10.5 Conclusion

This research has explored the nature of NSDI collaboration among stakeholders in KSA. It has successfully used a questionnaire survey, and interviews, as well as review of official documents to determine the current state of NSDI implementation in KSA, and the obstacles to collaboration between the different stakeholders.

As follow-up steps to this research work, first, it would be useful to study the extent to which implementation of all or part of the recommendations (see pp.236-239) has an effect in eliminating the obstacles to collaboration (see p.235) facing Saudi NSDI identified in this work.

Second, this work would be extended logically, through the design of a general model describing an implementation of Saudi NSDI based on the collected data, obstacles identified, and recommendations made in this work.

Third, it would be worthwhile to evaluate the satisfaction of stakeholders with the implemented NSDI as recommended in this work, using the research instruments of questionnaire and interviews.

Fourth, since KSA has a monarchical system, it is also worthwhile to study how such an absolute centralised and formal system may handle the trends in SDI collaboration, like crowd sourcing.

Fifth, given the close relationships between KSA and other Gulf and Arab countries, it would be useful to study the common elements and differences in the nature of NSDI implementation across the Gulf and Arab countries. This may be part of a pan-Gulf study that would pave the way for a regional NSDI initiative.

On the other hand, this work has reviewed major NSDI initiatives in the UK, US, Canada, and Australia/New Zealand. Each of these important initiatives is influenced by the political organisation and economic state of each country. In this context, the major features of the difference in NSDI implementation in KSA compared with other regions are the ready availability of money and the absolute monarchical system. This research has established that with some variation in funding availability between NSDI stakeholder organisations, generally, there are large amounts of money available for spatial data projects. On the other hand, the monarchical system of government in KSA means that the NSDI approach chosen is highly formal and centralised. The recommendations given in this work have reflected such differences.

10.6 Final Remarks

NSDI represents much more than a technical infrastructure. Proper implementation of NSDI, as has been established in the literature review, plays a significant role in the social and economic development of nations. Moreover, the concepts on which a successful NSDI are built, e.g. collaboration and sharing, introduce and create a significant change in working practices, and the wider organisational and social culture. Also, an NSDI based on an effective collaboration, and incorporating Web 2.0 trends, presents one of the valuable opportunities to both link and promote close relationships between various, social, political, and administrative actors across the nation. Therefore, the NSDI represents more than a technical infrastructure, but would contribute to a wider exercise of nation building. At KSA and regional level, such a development would certainly result in making the region and the world a better place.

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APPENDIX 1: SURVEY QUESTIONNAIRE

King Fahad Security College	SURVEY QUESTIONNAIRE ON SPATIAL DATA IN THE KINGDOM OF SAUDI ARABIA	The University of Nottingham

INTRODUCTION

In the Kingdom of Saudi Arabia (KSA), activities involving spatial data are scattered among various stakeholders, whether public or private sector organizations. While these stakeholder organizations provide or use spatial data, sharing is perhaps not as should be. The key lies in the relationships binding public and private sector stakeholder organisations.

This questionnaire surveys the main stakeholders in spatial data, whether producers or users. It gathers information on spatial data sharing in KSA. It also seeks to explore barriers and obstacles, which hinder integration and spatial data sharing.

The survey will improve our view of spatial data sharing in the KSA currently, and inform us on how to formulate future data sharing relationships.

As clearly and accurately as you can, complete the parts applicable to your sector in this questionnaire. Please feel free to add any suggestions or comments that you feel important to the research. The researcher is grateful for any additional informational materials from your organization that can add to the knowledge this questionnaire is seeking to gather.

The researcher appreciates the time you took to help with this important study; a summary of the results will be forwarded on request. Completed questionnaires to be returned to the researcher.

Yours sincerely

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IDENTIFICATION

In case of questions or for return of summary of results please complete the section below:

Name of Organisation*	
Address	
Website	
Name of person completing	
Position	
Contact Phone Number	
Email**	

* **Note:** Organisation could be Ministry, Department, Establishment, Section, Directory, etc.

** I created a new e-group under the name of "Saudi National Spatial Data Infrastructure" which will contain the contact emails of many of the experts from different organisations in Saudi Arabia. Can I add your email to this e-group to participate and receive emails from these Saudi experts?

Yes	
No	

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1. Your Organisation

Please tick (✓) the closest option.

1.1. Your organisation is best described as…

Government	
Private	
Academic	
Other, (please specify) ..……...	

1.2. Your organisation's operations are…

International (other countries)	
National	
Local Jurisdiction (local Region or City)	
Areas of interest	
Other, (please specify) ………………....	

1.3. Your organisation handles spatial data as a…

Data Provider	
Data User	
Both Data Provider and User	

1.4. Depending on the number of employees, your organisation's size is:

Very Small (less than 150 employees)	
Small (between 151 and 750 employees)	
Medium (between 751 and 4000 employees)	
Large (between 4001 and 15000 employees)	
Very Large (more than 15000 employees)	

1.5. Your organisation has been handling spatial data for…

< 3 Years	
4 – 6 Years	
7 – 10 Years	
11 – 15 Years	
> 15 Years	

1.6. At your organisation, the persons working within the spatial data department are…

Less than 20	
21 – 50	
51 – 100	
101 – 200	
More than 200	

1.7. During these last five years, the number of persons working within the spatial data department has…

Decreased	
Stayed the same	
Increased	

1.8. In your organisation, the spatial data department or those managing spatial data are located in the…

Independent Spatial Data Unit	
Engineering/Works Department	
Planning Department	
IT Department	
Community Services Department	
No Spatial Data Unit – use a consultant where required	
Other, (please specify) ……………………………	

2. Spatial Data Types

Please tick (✓) the closest option.

2.1. Your organisation provides or uses a spatial data model which is…

Raster	
Vector	
Both Raster and Vector	

2.2. The spatial data themes your organisation creates or is interested in are…

Geodetic (national topographical reference system)	
Road networks, centre-line data	
Topography	
Hydrology, e.g. rivers or dams	
Administrative boundaries	
Utility information such as electrical lines or water pipelines	
Cadastral information e.g. land parcel mapping	
Geographical names	
Transportation	
Elevation and Bathymetry	
Environment	
Aerial or Satellite Imagery	
Vegetation	
Land use plans	
Geology	
Postal Codes	
Economic Data	
Population/ Census Data	
Climate	
Health Data	
Other, (please specify) …....……………………………...	

3. Spatial Data Aspects

Please tick (✓) the closest option.

How important do you consider the following spatial data aspects to be:

	Not Very Important	Not Important	Neither	Important	Very Important
3.1 Data Format					
3.2 Metadata[1]					
3.3 Data Pricing					
3.4 Access to data					
3.5 Absolute spatial accuracy**2**					
3.6 Relative spatial accuracy[3]					
3.7 Completeness[4]					
3.8 Currency[5]					

[1]**Metadata:** Data referring to origin, format, quality, and currency of data.
[2]**Absolute spatial accuracy:** accuracy of position relative to datum.
[3]**Relative spatial accuracy:** Local accuracy of position relative to objects/features in vicinity (e.g. railway lines placed correctly with respect to a road).
[4]**Completeness:** Datasets include all the data for the whole region.
[5]**Currency:** maintaining up-to-date datasets.

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4. Data Provider Questions

Please tick (✓) the closest option.

Part I: Policy and management:

4.1. In percentage terms, how much spatial data for your sphere of operations has your organisation created?

< 5 %	
5 – 10 %	
10 – 20 %	
20 – 30 %	
30 – 40 %	
40 – 50 %	
50 – 60 %	
60 – 70 %	
70 – 80 %	
80 – 90 %	
> 90 %	

4.2. Where your organisation maintains its spatial data up-to-date or plans to do so in future, how frequently does it do so?

Daily	
Weekly	
Monthly	
Annually	
Each 2 to 5 years	
As needed	

4.3. For spatial data access, what network arrangement is used in your organisation?

Intranet	
Internet	
LAN	
Other, (please specify) …………..	
None	

4.4. Does your organisation give others, external to it, access to its spatial data?

Yes	
Future plan	
No	

4.5. What delivery format, medium or method is used by your organisation to send spatial data to users? **(You may tick (✓) one or more boxes)**

Email	
CD-Rom	
Floppy disk	
Secured Internet (File Transfer Protocol (FTP))	
Internet download	
View online only	
Hardcopy over Counter or Mail (maps)	
Private network	
Magnetic tape	
Other, (please specify) …………………...	

4.6. Does your organisation allow others to redistribute its spatial data?

Yes, without restriction	
Yes, but some data excluded	
Yes, but most data excluded	
Does not allow	

Part II: Identification of partnerships:

4.7. What are the organisations given access to or supplied with spatial data by your organisation? **(You may tick (✓) one or more boxes)**

Own organisation (self -use)	
Local organisations	
National organisations	
International organisations	
Government organisations	
Private organisations	
Academic organisations	
Other, (please specify) …………..	

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5. Data User Questions

Please tick (✓) the closest option.

Part I: Policy and management:

5.1. What are the main sources of your spatial data? **(You may tick (✓) one or more boxes)**

Governmental organisations	
Private organisation	
Other users	

5.2. How does your organisation request spatial data from others? **(You may tick (✓) one or more boxes)**

Emails	
Official letters	
Filling forms	
Agreements	
Phone calls	
Other, (please specify) …..……….	

5.3. In your organisation, what is used to identify spatial data requested from others,? **(You may tick (✓) one or more boxes)**

Coverage area	
Main features	
Coordinates	
Cost/price	
Contents	
Other, (please specify) ……….….	

5.4. Does your organisation contribute funds jointly with others in purchase or collection of spatial data?

Yes	
Future plan	
No	

5.5. Approximately, how much does your organisation spend annually on spatial data collection or purchase?

Less than one million SR	
Between 1 and 5 million SR	
Between 5 and 10 million SR	
More than 10 million SR	

5.6. In searching for spatial data, spatial data from other organisations is…

Easily found and compatible	
Found with difficulty but compatible	
Easily found but not compatible	
Found with difficulty and not compatible	
Not to be found	

5.7. How far do you agree with each statement:

	Strongly Disagree	**Disagree**	**Neither**	**Agree**	**Strongly Agree**
Data available in compatible format					
Metadata available					
Pricing/ costing of data is appropriate					
Easy access to data					
For your organisation, absolute spatial accuracy is adequate					
For your organisation, relative spatial accuracy is adequate					
For your organisation, completeness is adequate					
For your organisation, currency is adequate					

5.8. Once the needed spatial data is found…

The owner releases it easily	
The owner releases it with difficulty	
The owner refuses to release it	

5.9. Your organisation uses spatial data for which applications **(You may tick (✓) one or more boxes)**

Mapping	
Public safety	
Transportation	
Natural resources	
Environmental	
Agriculture	
Utilities services	
Lands development	
National security	
Other, (please specify) ………	

Part II: Identification of partnerships:

5.10. For access to, or purchase of spatial data, what organisations do you deal with? **(You may tick (✓) one or more boxes)**

Own organisation (self -use)	
Local organisations	
National organisations	
International organisations	
Government organisations	
Private organisations	
Academic organisations	
Other, (please specify) …….	

6. Standards Questions

Please tick (✓) the closest option.

6.1. What spatial data standards are used by your organisation to create, update, integrate, or distribute spatial data?

International Standards Organisation ISO, Technical Committee for Geographic Information / Geomatics – TC211	
Open GIS Consortium OGC	
World Wide Web Consortium W3C	
Other, (please specify) …………………..	

6.2. Is your organisation engaged in creating and maintaining spatial metadata?

Yes	
Future plan	
No	

6.3. Does your organisation use its own standards to create metadata?

Yes	
Future plan	
No	

6.4. In creating spatial metadata, does your organisation use the same standards as other organisations?

Yes	
Future plan	
No	

7. Technical Questions

Please tick (✓) the closest option.

7.1. What software system(s) does your organisation use? **(You may tick (✓) one or more boxes)**

ESRI – ARC/INFO	
ESRI – ArcView	
ESRI – ArcCAD	
ESRI – Atlas	
ERDAS – IMAGINE	
Bentley system – Microstation	
Intergraph – FRAMME	
Intergraph – MGE	
MapInfo	
AutoDesk – AutoCAD	
CARIS	
Other, (please specify) ………...	

7.2. What range of positional accuracy is the spatial data created or used by your organisation? **(You may tick (✓) one or more boxes)**

> **1:500**	
1:500 - 1:1,000	
1:1,000 - 1:5,000	
1:5,000 - 1:10,000	
1:10,000 - 1:25,000	
1:25,000 - 1:50,000	

1:50,000 - 1:100,000	
1:100,000 - 1:250,000	
1:250,000 – 1:500,000	
1:500,000 - 1:1,000,000	
1:1,000,000 - 1:2,000,000	
1:2,000,000 - 1:4,000,000	
< 1:4,000,000	

7.3. Your organisation creates or uses elevation data to an approximate vertical accuracy of…

Less than one meter	
1 to 5 meter	
5 to 10 meter	
More than 10 meter	

7.4. In terms of geodetic reference system, your organisation uses…

International Spheroid	
WGS84	
WGS72	
**Other, (please specify) …..….. **	

7.5. For horizontal datum, your organisation uses…

Ain Al abd	
Other, (please specify) ..……….	

7.6. For vertical datum, your organisation uses…

Jeddah (1972)	
Other, (please specify) …..…….	

7.7. For map projection, your organisation uses…

UTM	
Cassini.	
Lambert conformal	
Other, (please specify) …..………...	

7.8. In terms of coordinate system, your organisation uses…

Cartesian coordinate	
Geographic coordinate	
Other, (please specify) ……..……...	

8. Partnerships and Collaborations

Please tick (✓) the closest option.

8.1. What Collaboration takes place on the basis of exchange of which resources, skills or technology? **(You may tick (✓) one or more boxes)**

Human Resources	
Data sharing	
Technology	
Technical skills	
Knowledge transfer, know how	
Commercial, product development	
Economic, improve efficiency, cost reduction	
Other, (please specify) ……….......................	

8.2. Formal collaboration with other organisations is on the basis of… (You may tick (✓) one or more boxes)

Service Level Agreement	
Legislation, Statute, Regulation…	
Registered Business	
Contract	
Memorandum of Understanding	
Ministerial Order/Direction	
Licensing (i.e. User, Provider)	
Accreditation	
Departmental/Organisation Policy	
Preferred/Authorised Supplier	
Other, (please specify) ………….........	

8.3. Informal collaboration with other organisations is on the basis of… **(You may tick (✓) one or more boxes)**

Goodwill	
Personal contacts (rapport or friendship)	
Prior history	
Culture of organisation	
Tradition	
Mutual interdependence/needs	
Networking/ colleague relations	
Membership of industry bodies	
Other, (please specify) …………...............	

8.4. In collaborating with other organisations for spatial data exchange and sharing, how important are the obstacles or barriers mentioned here?

	Not Very Important	Not Important	Neither	Important	Very Important
Data sets exchanged are not of same quality or value					
Standards for spatial data					
Absence of trust / goodwill					
No support from management or political system					
Data cost/price					
Search and access to needed data					
Intellectual property/Copyright restrictions					
Protection of privacy in data					
Cost of reaching agreement					
Network /IT & communication infrastructure					
Other, (please specify) ……………………………...					

8.5. For spatial data exchange with other organisations, how important are the following benefits for your organisation?

	Not Very Important	Not Important	Neither	Important	Very Important
Better quality data (through matching and checking)					
Reduced duplication in effort and resources					
Reduced cost & savings					
Single source of verified data					
Less demands for data by others					
Better service to rate payers					
Improved decision making					
Other, (please specify) ……..................................					

Any General Comments or Suggestions

Thank you for taking the time to fill in this questionnaire

APPENDIX 2: SURVEY QUESTIONNAIRE RESULTS

IDENTIFICATION

In case of questions or for return of summary of results please complete the section below:

Name of Organisation*	24
Address	24
Website	24
Name of person completing	24
Position	24
Contact Phone Number	24
Email**	24

* **Note:** Organisation could be Ministry, Department, Establishment, Section, Directory, etc.

** I created a new e-group under the name of "Saudi National Spatial Data Infrastructure" which will contain the contact emails of many of the experts from different organisations in Saudi Arabia. Can I add your email to this e-group to participate and receive emails from these Saudi experts?

Yes	23
No	1

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1. Your Organisation

Please tick (✓) the closest option.

1.1. Your organisation is best described as…

Government	16
Private	5
Academic	2
Other, (please specify) Utility	1

1.2. Your organisation's operations are…

International (other countries)	4
National	17
Local Jurisdiction (local Region or City)	3
Areas of interest	-
Other, (please specify) ……………...……...	-

1.3. Your organisation handles spatial data as a…

Data Provider	-
Data User	4
Both Data Provider and User	20

1.4. Depending on the number of employees, your organisation's size is:

Very Small (less than 150 employees)	3
Small (between 151 and 750 employees)	4
Medium (between 751 and 4000 employees)	8
Large (between 4001 and 15000 employees)	5
Very Large (more than 15000 employees)	4

1.5. Your organisation has been handling spatial data for…

< 3 Years	2
4 – 6 Years	6
7 – 10 Years	2
11 – 15 Years	4
> 15 Years	10

1.6. At your organisation, the persons working within the spatial data department are…

Less than 20	11
21 – 50	4
51 – 100	3
101 – 200	3
More than 200	3

1.7. During these last five years, the number of persons working within the spatial data department has…

Decreased	4
Stayed the same	6
Increased	14

1.8. In your organisation, the spatial data department or those managing spatial data are located in the…

Independent Spatial Data Unit	9
Engineering/Works Department	1
Planning Department	2
IT Department	7

Community Services Department	-
No Spatial Data Unit – use a consultant where required	2
Other, (please specify) -Maintenance Department **-Tourism Information and Research** **-GIS Unit for Teaching, Training and Research**	3

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2. Spatial Data Types

Please tick (✓) the closest option.

2.1. Your organisation provides or uses a spatial data model which is…

Raster	-
Vector	2
Both Raster and Vector	22

2.2. The spatial data themes your organisation creates or is interested in are…

Geodetic (national topographical reference system)	14
Road networks, centre-line data	21
Topography	20
Hydrology, e.g. rivers or dams	11
Administrative boundaries	19
Utility information such as electrical lines or water pipelines	15
Cadastral information e.g. land parcel mapping	12
Geographical names	20
Transportation	15
Elevation and Bathymetry	14
Environment	15
Aerial or Satellite Imagery	19
Vegetation	12
Land use plans	15
Geology	9
Postal Codes	5
Economic Data	7
Population/ Census Data	13
Climate	11
Health Data	6
Other, (please specify) – Public services **- Archeological and historical sites** **- Natural sites** **- Tourism statistical information** **- Industry**	2

3. Spatial Data Aspects

Please tick (✓) the closest option.

How important do you consider the following spatial data aspects to be:

	Not Very Important	Not Important	Neither	Important	Very Important
3.1 Data Format	-	2	2	7	13
3.2 Metadata[1]	2	1	1	8	12
3.3 Data Pricing	1	-	5	13	5
3.4 Access to data	-	-	-	5	19
3.5 Absolute spatial accuracy**2**	-	-	-	11	13
3.6 Relative spatial accuracy[3]	-	-	1	13	10
3.7 Completeness[4]	-	-	-	7	17
3.8 Currency[5]	-	-	1	7	16

[1]**Metadata:** Data referring to origin, format, quality, and currency of data.
[2]**Absolute spatial accuracy:** accuracy of position relative to datum.
[3]**Relative spatial accuracy:** Local accuracy of position relative to objects/features in vicinity (e.g. railway lines placed correctly with respect to a road).
[4]**Completeness:** Datasets include all the data for the whole region.
[5]**Currency:** maintaining up-to-date datasets.

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4. Data Provider Questions

Please tick (✓) the closest option.

Part I: Policy and management:

4.1. In percentage terms, how much spatial data for your sphere of operations has your organisation created?

< 5 %	-
5 – 10 %	2
10 – 20 %	-
20 – 30 %	1
30 – 40 %	1
40 – 50 %	3
50 – 60 %	1
60 – 70 %	2
70 – 80 %	2
80 – 90 %	3
> 90 %	5

4.2. Where your organisation maintains its spatial data up-to-date or plans to do so in future, how frequently does it do so?

Daily	2
Weekly	1
Monthly	1
Annually	4
Each 2 to 5 years	3
As needed	9

4.3. For spatial data access, what network arrangement is used in your organisation?

Intranet	9
Internet	9
LAN	15
Other, (please specify) –External Drive	1
None	1

4.4. Does your organisation give others, external to it, access to its spatial data?

Yes	7
Future plan	8
No	5

4.5. What delivery format, medium or method is used by your organisation to send spatial data to users? **(You may tick (✓) one or more boxes)**

Email	8
CD-Rom	17
Floppy disk	3
Secured Internet (File Transfer Protocol (FTP))	7
Internet download	3
View online only	9
Hardcopy over Counter or Mail (maps)	11
Private network	6
Magnetic tape	-
Other, (please specify) – DVD **- Project Based only**	2

4.6. Does your organisation allow others to redistribute its spatial data?

Yes, without restriction	1
Yes, but some data excluded	6
Yes, but most data excluded	7
Does not allow	6

Part II: Identification of partnerships:

4.7. What are the organisations given access to or supplied with spatial data by your organisation? **(You may tick (✓) one or more boxes)**

Own organisation (self -use)	12
Local organisations	11
National organisations	14
International organisations	5
Government organisations	19
Private organisations	10
Academic organisations	13
Other, (please specify) …………...	-

5. Data User Questions

Please tick (✓) the closest option.

Part I: Policy and management:

5.1. What are the main sources of your spatial data? **(You may tick (✓) one or more boxes)**

Governmental organisations	21
Private organisation	7
Other users	5

5.2. How does your organisation request spatial data from others? **(You may tick (✓) one or more boxes)**

Emails	5
Official letters	21
Filling forms	8
Agreements	14
Phone calls	4
Other, (please specify) – Visiting and Meeting	2

5.3. In your organisation, what is used to identify spatial data requested from others,? **(You may tick (✓) one or more boxes)**

Coverage area	20
Main features	9
Coordinates	17
Cost/price	3
Contents	11
Other, (please specify) – Type of use	3

5.4. Does your organisation contribute funds jointly with others in purchase or collection of spatial data?

Yes	1
Future plan	4
No	19

5.5. Approximately, how much does your organisation spend annually on spatial data collection or purchase?

Less than one million SR	6
Between 1 and 5 million SR	10
Between 5 and 10 million SR	2
More than 10 million SR	6

5.6. In searching for spatial data, spatial data from other organisations is…

Easily found and compatible	6
Found with difficulty but compatible	8
Easily found but not compatible	-
Found with difficulty and not compatible	10
Not to be found	-

5.7. How far do you agree with each statement:

	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
Data available in compatible format	2	3	7	6	6
Metadata available	5	7	3	7	2
Pricing/ costing of data is appropriate	4	3	9	4	4
Easy access to data	2	6	4	9	3
For your organisation, absolute spatial accuracy is adequate	3	4	3	11	3
For your organisation, relative spatial accuracy is adequate	3	3	4	11	3
For your organisation, completeness is adequate	4	4	4	6	6
For your organisation, currency is adequate	4	6	3	8	3

5.8. Once the needed spatial data is found…

The owner releases it easily	7
The owner releases it with difficulty	16
The owner refuses to release it	1

5.9. Your organisation uses spatial data for which applications **(You may tick (✓) one or more boxes)**

Mapping	21
Public safety	7
Transportation	10
Natural resources	8
Environmental	11
Agriculture	6
Utilities services	13
Lands development	13
National security	9
Other, (please specify) **– Planning** **- Research and Development** **- Census**	5

Part II: Identification of partnerships:

5.10. For access to, or purchase of spatial data, what organisations do you deal with? **(You may tick (✓) one or more boxes)**

Own organisation (self -use)	8
Local organisations	10
National organisations	11
International organisations	6
Government organisations	20
Private organisations	9
Academic organisations	7
Other, (please specify) – Utility organisations	1

6. Standards Questions

Please tick (✓) the closest option.

6.1. What spatial data standards are used by your organisation to create, update, integrate, or distribute spatial data?

International Standards Organisation ISO, Technical Committee for Geographic Information / Geomatics – TC211	18
Open GIS Consortium OGC	8
World Wide Web Consortium W3C	4
Other, (please specify) –Their own Data Standard	5

6.2. Is your organisation engaged in creating and maintaining spatial metadata?

Yes	10
Future plan	10
No	4

6.3. Does your organisation use its own standards to create metadata?

Yes	8
Future plan	9
No	7

6.4. In creating spatial metadata, does your organisation use the same standards as other organisations?

Yes	9
Future plan	6
No	9

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7. Technical Questions

Please tick (✓) the closest option.

7.1. What software system(s) does your organisation use? **(You may tick (✓) one or more boxes)**

ESRI – ARC/INFO	21
ESRI – ArcView	18
ESRI – ArcCAD	7
ESRI – Atlas	5
ERDAS – IMAGINE	13
Bentley system – Microstation	8
Intergraph – FRAMME	2
Intergraph – MGE	1
MapInfo	4
AutoDesk – AutoCAD	9
CARIS	1
Other, (please specify) **- Intergraph GeoMedia** **- Intergraph G/Technology** **- ESRI – ARC/Editor** **- ER Mapper**	6

7.2. What range of positional accuracy is the spatial data created or used by your organisation? **(You may tick (✓) one or more boxes)**

> 1:500	9
1:500 - 1:1,000	11
1:1,000 - 1:5,000	13
1:5,000 - 1:10,000	13
1:10,000 - 1:25,000	14
1:25,000 - 1:50,000	13
1:50,000 - 1:100,000	13
1:100,000 - 1:250,000	13
1:250,000 – 1:500,000	11
1:500,000 - 1:1,000,000	8
1:1,000,000 - 1:2,000,000	7
1:2,000,000 - 1:4,000,000	7
< 1:4,000,000	4

7.3. Your organisation creates or uses elevation data to an approximate vertical accuracy of…

Less than one meter	6
1 to 5 meter	10
5 to 10 meter	3
More than 10 meter	5

7.4. In terms of geodetic reference system, your organisation uses…

International Spheroid	-
WGS84	23
WGS72	1
Other, (please specify) ..……..	-

7.5. For horizontal datum, your organisation uses…

Ain Al abd	23
Other, (please specify) – MTRF2000	1

7.6. For vertical datum, your organisation uses…

Jeddah (1972)	22
Other, (please specify) – Jeddah (1969)	2

7.7. For map projection, your organisation uses…

UTM	23
Cassini.	-
Lambert conformal	-

Other, (please specify) – did not specify	1

7.8. In terms of coordinate system, your organisation uses…

Cartesian coordinate	9
Geographic coordinate	21
Other, (please specify) – Military GRID	2

8. Partnerships and Collaborations

Please tick (✓) the closest option.

8.1. What Collaboration takes place on the basis of exchange of which resources, skills or technology? **(You may tick (✓) one or more boxes)**

Human Resources	7
Data sharing	19
Technology	10
Technical skills	9
Knowledge transfer, know how	13
Commercial, product development	9
Economic, improve efficiency, cost reduction	5
Other, (please specify) ……………........	-

8.2. Formal collaboration with other organisations is on the basis of… (You may tick (✓) one or more boxes)

Service Level Agreement	13
Legislation, Statute, Regulation…	4
Registered Business	3
Contract	15
Memorandum of Understanding	7
Ministerial Order/Direction	8
Licensing (i.e. User, Provider)	7
Accreditation	2
Departmental/Organisation Policy	5
Preferred/Authorised Supplier	6
Other, (please specify) – Training and Research Agreement	1

8.3. Informal collaboration with other organisations is on the basis of… **(You may tick (✓) one or more boxes)**

Goodwill	14
Personal contacts (rapport or friendship)	12
Prior history	6
Culture of organisation	3
Tradition	2
Mutual interdependence/needs	9
Networking/ colleague relations	12
Membership of industry bodies	7
Other, (please specify) – Not Applicable	1

8.4. In collaborating with other organisations for spatial data exchange and sharing, how important are the obstacles or barriers mentioned here?

	Not Very Important	**Not Important**	**Neither**	**Important**	**Very Important**
Data sets exchanged are not of same quality or value	-	2	4	10	8
Standards for spatial data	-	1	-	7	16
Absence of trust / goodwill	-	1	5	9	9
No support from management or political system	-	1	1	11	11
Data cost/price	-	1	5	12	6
Search and access to needed data	-	-	1	11	12
Intellectual property/Copyright restrictions	2	1	2	7	12
Protection of privacy in data	-	2	3	6	13
Cost of reaching agreement	-	1	2	12	9
Network /IT & communication infrastructure	-	2	2	7	13
Other, (please specify) …..... ……………………………...	-	-	-	-	-

8.5. For spatial data exchange with other organisations, how important are the following benefits for your organisation?

	Not Very Important	Not Important	Neither	Important	Very Important
Better quality data (through matching and checking)	-	-	-	9	15
Reduced duplication in effort and resources	-	-	-	5	19
Reduced cost & savings	-	-	1	8	15
Single source of verified data	-	1	4	8	11
Less demands for data by others	-	-	6	10	8
Better service to rate payers	-	-	4	10	10
Improved decision making	-	-	1	6	17
Other, (please specify) ..... ……………………………....	-	-	-	-	-

Any General Comments or Suggestions

1. **Ministry of Municipal and Rural Affairs (MOMRA) –** "The MOMRA has the only legal mandate and authority to produce large-scale maps in the KSA. Thus, it tenders its own aerial and ground survey projects and map production projects, covering almost 200 cities, towns and villages all around the country. It has acquired the ISO certification and it participates actively in the TC211 meetings. As a governmental agency, it is a non-profit entity. It welcomes sharing all kinds of spatial data and information it creates with other governmental agencies through official channels. It has an established network of international advisors and consultants that work with it on full-time, part-time or freelance basis to elevate the quality (from all aspects) of its extensive spatial data and information related activities".

2. **Intergraph-** "…Consider Business process needed to maintain and share data …Political within data creation agencies and independent budgets with conflicting interests and business priorities often impact the desire and need to share data. Standards of all kinds are important to create a common framework or infrastructure needed to share data".

3. **Ministry of health –** "I appreciate your selection such topics for PhD which I think you will help to improve the GIS in our country where we face a lot of effort , time, cost restriction in developing and construction any GIS project".

4. **National Information Centre –** "I really value the time and effort spent to prepare this comprehensive questioner, thanks".

APPENDIX 3: SAMPLE SEMI-STRUCTURED INTERVIEW

Sample Semi-structured Interview

This semi-structured interview was conducted on 7 October 2009 in Ar Riyadh city at the Ministry of X. It was one hour thirty-four minutes and forty two seconds long.

Preamble:

The interviewer invites the interviewee to introduce himself and his organisation. The interviewee proceeds to introduce himself as full-time consultant with the Ministry of X responsible for GIS in the Kingdom of Saudi Arabia.

Question: *If we focus on the Ministry, what is the nature of its work and responsibilities regarding spatial data?*

Response: Regarding the Ministry, as you know the state system divides spatial data and responsibility for that into a number of spheres; all work and maps related to the Kingdom of Saudi Arabia of scale 1:25,000 and above is given over to the Ministry; as for smaller scales these are given over to the GCS (formerly known as Military Survey). There is a third sphere occupied by the SGS, which works at all map scales as needed to fulfil its functions; it is not concerned with scales rather with the applications relevant to prospecting, exploration, geology and these matters. The fourth sphere in KSA is occupied by KACST, which is the officially appointed body in KSA authorised to receive satellite information, its distribution, and is concerned with all matters related to this area of information. These are more or less the four key spheres for spatial information.

Regarding the Ministry, it has a number of Deputy Ministries, perhaps the most important two are the Deputy Ministry for Urban Planning, and the Deputy Ministry for Land and Survey. The latter is concerned with all matters related to maintaining ground control points, and producing KSA base maps. Moreover, it has another vital job, which is to keep the land and property register relating to all properties and plots in the Kingdom. The output of this Deputy Ministry, i.e. Land and Survey, is always handed over to the Deputy Ministry of Urban Planning, which is responsible for town planning and planned trends in this area across the Kingdom, and as such influences development, formulating infrastructure plans, and regional plans for every city, town, and village in KSA. We have now three levels or spheres; the Deputy Ministry of Urban Planning plans for development of every town, city and village to 1435AH [2014] and on to 1450AH [2029], and then after that it establishes another line called the limit line for development; this means that on this line there should be absolutely no development, regardless of circumstances, except in extremely exceptional cases; for example, if there is a large national project, such as a hospital or university or something along those lines, but with the express permission of the person in authority. Normally, you have short-term planning, which is to 1435AH [2014]; this is then updated in 1434AH [2013] for another five years. Based on this update, the urban extents for 1450AH [2029] are updated such that these are in synchrony with what has actually happened in terms of urban growth, and differences between towns and their development. This is more or less what is related to spatial data at the Ministry.

Question: *Regarding the Ministry, how many people are working within it?*

Response: In reality, I do not know. However, I can say that there are the two Deputy Ministries mentioned concerned with spatial information; yet these are not the only ones. There are others, for example, the Technical Affairs Deputy Ministry; development plans for any town or city must go through this Deputy Ministry to ensure that the soil and geology are appropriate; really, anything related to engineering. Sometimes, the Urban Planning Deputy Ministry may decide that a town or city would grow in this way. Technical Affairs would come and say: No! this area is geologically not suitable, so please review your plans or something of the sort. The number of employees I do not know, but perhaps I can say that the number of employees in the area of spatial information… well, the number is quite limited and the Ministry is suffering because of this; you may come to some Deputy Ministries, and you may find that not a single person is specialised in this area; this is felt by those responsible, that actually the lack in human resources is quite large in this respect. For example, in surveying there may be 30 to 40 workers, and Urban Planning, regarding spatial [information], does not even have seven people, even as a Deputy Ministry part of the main Ministry, to which are subordinated externally 14 main regional administrations in KSA, in addition to over 200 municipalities. In these regional administrations and municipalities, there are some specialised people, but other administrations and municipalities suffer a lack, from the human resources perspective, in spatial data [personnel].

Question: *Since you mention the regional administrations and municipalities, what are the work processes and procedures, as well as connections between these regional administrations and municipalities and the Ministry from your perspective, because I noticed quite sadly… you may say… sometimes in the work, there is duplication of effort?*

Response: That is true, let me start with the Ministry first; what is the level of coordination within the Ministry and its Deputy Ministries? We could say that five years ago, in terms of relations, there was no coordination and you would find that perhaps the Urban Planning Deputy Ministry would work in complete isolation from the Land and Survey Deputy Ministry; even though these are two quite important administrations. Over the last five years, huge efforts have been made, and these two Deputy Ministries sat together and began to set the essential infrastructure for coordination and reached the point of agreeing that anything related to GIS would be left to Urban Planning, while surveying and maintaining ground control points and producing base maps and dealing with aerial survey will also be the area of focus and function of Deputy Ministry of Land and Survey. These two Deputy Ministries had a meeting presided over by his Royal Highness, the Minister, and agreed that they will continue working together to ensure continuity of these efforts. Now we are working to achieve a unified portal for a unified database for the two deputy ministries such that this does not affect the work of any of them; because let me say here… let me say that politics influences a lot, and we find that a person or project may feel that another person, centre or specific project has come and taken away some of their powers and authority, and so we are working very carefully to convince others that whatever is being done in your area will not be affected, just let us agree on specifications, powers, and to have only a single reference for the same piece of information. I would not want a database or a base map existing in two places within the Ministry. This is what we have achieved up to now, and progress has been slow because of the accumulated history; but things have been moving well and I think within this coming or following month, there will be a unified portal and a comprehensive browser for the Deputy Ministry of Urban Planning jointly with all departments within this Deputy Ministry, and all other agencies would be authorised to access it. We also did a pilot project for this, applied to six regional administrations: three small and three large. Now, to go back to your question about...

Question: …six *administrations, small and large, how did you choose them?*

Response: For example, we took the regional administrations of Dammam, Madinah, and Jauf; when you compare Madinah to Jauf there is no comparison, because in Jauf there is zero spatial data as an example; while Madinah is considered the very best regional administration in KSA in terms of spatial information. If you take Dar'iyah municipality, it is quite advanced in the applications of spatial data in municipal work, and as a contrast, we took the municipality of Khamis... therefore, we took a variety...

Question: *You mentioned six administrations?*

Response: yes, six sector bodies; three regional administrations and three municipalities.

Question: *then, these were…*

Response: Yes, Dammam, Jauf, Madinah regional administrations, and Dar'iyah, Khamis, and Buraydah municipalities.

Question: *On what basis were these chosen?*

Response: we selected them on the basis of the information held by the Ministry on the activities of these municipalities, i.e. through their interaction and provision of information. The basis was their interaction and their exchange of information with the Ministry.

Question: *In the sample, was the intent to ensure that there were specialists within these administrations?*

Response: Yes, there were specialists; and we made sure that the sample was representative across all types. For example, we chose Jauf knowing that it had absolutely no activity in the spatial data area so as to ask them what they want, how do you want to move forward; we took Madinah, knowing that they are extremely advanced, and we began by saying: how do you want to liaise and communicate with the Ministry and neighbouring municipalities? So we tried to make the sample cover the full spectrum of municipal work, beginning with the regional administrations that had nothing, with those that were very advanced and in between are the intermediate ones, which are considered in the process of beginning to move forward.

Question: Y*ou mention...*

Response: …To finish your question, because it is quite good; this is an area of suffering and difficulty. You said that when you look at the administrations, you can see as though there is duplication of effort or something along those lines... when we began, and I started work here, I had to stop 6 or 7 projects. The project would be signed, implemented, and completed; however, when you come to the actual output, you find that it does not comply with the existing specifications.

Therefore, what you said is true; each administration and municipality would do what it thought was right, but in complete isolation from what is there at national level or at the Ministry level. Therefore, we began about three years ago, and prepared a unique and unified specifications manual for all municipalities in KSA; we said whoever wants to do a project then here are the specifications. Therefore, regional administrations and municipalities are not allowed to develop a project without using this manual. Within the manual, we put general but comprehensive matters, such as types of programs, specifications, maps, formats, and communications that must take place. We worked to ensure it complied with 70 to 80% of what exists in the Ministry. This seems to have reduced the amount of projects that have had to be stopped. In fact, many projects have had to be stopped after implementation had begun; these were then revised, and resubmitted. However, since we introduced the manual, problems and errors have been reduced a lot. However there is still a need for great effort.

Question: *Now, you selected six; three municipalities and three regional administrations; were the projects you stopped from all administrations or just from those in the sample?*
Response: No, from all. Now, before we chose the sample, we undertook a study, which we called the "current status study". We studied all the municipalities and regional administrations in KSA and produced a large document, which analysed the human resources, documents, programs, equipment, plans, and trends of development; these were all analysed. From the result of this study, we chose our sample. However, now our work is not with these six, which we connected directly to us, but with all the other municipalities and regional administrations.

Question: *connected?*
Response: Yes, connected directly to the Ministry. The study included everyone, but when it came to directly connecting and linking to the Ministry, we did so only with the six mentioned. As for the other bodies, the specifications manual was distributed to all of them.

Question: *Was there a directive that nothing would be done without referring to the manual?*
Response: Yes, we held a big workshop over two days, inaugurated by His Royal Highness, the Prince, to which we invited all the municipalities and regional administrations in KSA; all of them attended, and this measure was announced to them. We discussed this with them; in reality, all these things were not done in isolation from them. While the sample was being chosen, we were in constant dialogue with them; we sent representatives to them to explain what was going on, and to give them the full picture of the project. As a result, now, many municipalities and regional administrations get in touch with us, and say we have this project, but we do not want you to object to it and obstruct it, so what do you want from us. Now they contact us and are aware, because they know that if the Ministry objects then their project cannot proceed.

Question: *So why cannot there be in the Ministry, an office, committee, or reference authority with something like an application form such that the criteria can be achieved in their specifics and this committee can make sure that the criteria are satisfied; perhaps a general study taking into account all these aspects, to say what is present and what is lacking, to provide them with something even in electronic format?*

Response: This is correct and we are working perhaps with something more extensive than what you mention. First, we did this partial study and provided the specifications manual to everyone, which is perhaps more powerful than the application form. Then we have the Centre, which was endorsed by His Highness, the Minister; I gave you some documents about that. This centre functions as a reference authority; it is a consultancy, a training body, it maintains data, databases and backups for all municipalities and regional administrations at the Ministry. It is, let me say an umbrella, which is very transparent, which can monitor and support all the activities regarding spatial data in KSA for municipalities, regional administrations and the Ministry. This is what we hope to be the real reference, and perhaps could become the nucleus of something at national level, even bigger than the Ministry itself.

Question: *Now, you mentioned Dir'iyah, which has joint boundaries with the city of Ar Riyadh and is even now subsumed by Ar Riyadh. So I do not know, whether there was coordination with the colleagues at the High Commission for Development of Ar Riyadh, especially since they have a large project and have five organisations with them, including the Saudi post, the water authority, and Ar Riyadh regional administration; has there been coordination with them regarding specifications, scales, etc in this unification progress? And are you all working using the ISO-TC211 specification? And what is your opinion?*

Response: Yes, the system of municipalities is that of regions more or less, or areas. Therefore, when you speak about a regional administration, you are speaking about an area with known administrative boundaries, and when you come to spatial information, you say it has a specific polygon. When you say the regional administration of Assir, you are speaking about the area of Assir, and when you speak about, for example, Al-Namas, you are speaking about the area of Al-Namas. Therefore, when you come to Al-Dir'iyah, it is a separate region even though it may lie within Ar Riyadh, and is an independent region. It was very lucky that before coming to this Ministry, I was supervising the implementation of the GIS system in a team with members from the High Commission for Development of Ar Riyadh. We had Engineer (AF), and we also had people from King Saud University; we adopted the ISO-TC211 standard in that work, and this is now almost the common standard in use across the municipalities in KSA using the specifications that we follow.

Question: *I found people, among those who work with you, who say that they are using the standard ISO-TC211, but I found that they had their own specification, standard, coding, even though, sadly they say we are with the ISO; however, when you ask about the sample, coding, and standard, their workers will say this is the standard that we are using. In the sample, I have three examples, you will find each one having different coding in use for the same feature, their own specifications, and some have no concern for metadata and documenting features, so I do not know for you as experts and for one person, regardless, it is a huge task. Do you have an analytical study documenting what is there in the field? Has this been collected or requested officially?*

Response: No, an analytical study of the reality in the field; we do not have that, and in fact ask the same questions as you do. We are told that these are the specifications. However, from a personal perspective, I have seen what you have seen, when we come to the SGS, GCS, MOMRA, and High Commission for Development of Ar Riyadh, they will say that they are using the ISO standard. Here is the point, when you come to the detail, you will find that there are five or six GIS projects in these organisations, and these projects are implemented by companies, which in the majority are quite prominent internationally. These companies use internationally recognized standards, this does not mean that they do not use ISO-TC211, because the standard is not appropriate. However, you will find that they are using other standards. Unless the company is given specific instructions in the specifications manual to use a particular standard, then it will use the international standards it is accustomed to using; for example, the American standards or the NEMA standard in use at the GCS, for example, or the open GIS standards. Then you will find that there are specific standards in use, and when you go back to the classification of international standards, there is a large overlap between them. However, in terms of documenting, I will give an example from the Ministry here; it is very recent, and only happened yesterday. We have a manual; perhaps I have it with me here now. The Ministry established specific standards and coding, which were ratified at the highest level to differentiate land use in the kingdom. When we came to apply this, we have found many departments within the Ministry were not applying this. The company they employed was using something different, and now we came to correct this and apply what has been endorsed in terms of discussions within the Kingdom. Yes, I think you are right, we need a detailed study collecting real information to see whether or not this particular body is using the proper standards, and whether or not these are applied. This is something that must be studied, and if this is not right, and then we must implement projects to correct this situation. In reality, all are correct, no one is wrong; but the problem will come when we need to deal with each other as national groups; here is the problem. Therefore, we need to have awareness across the different sectors, where we can say that the official specifications on paper are clear, while the projects in reality may not reflect the official version. It is not so difficult to correct this situation, and we have decided that in four months, we will correct the situation. In fact, we have already started, and hopefully, we will be able to do that.

Question: *Considering that you are head of the committee for unifying specifications and measures...*
Response: This committee... perhaps it is a good idea to give a simple idea of the committee... this is known as the national temporary committee formed by directive of the Council of Ministers and formed of five sub-committees; these five sub-committees… perhaps I can mention some of them; the information sub-committee led by Dr (AS), the specifications sub-committee headed by myself, the systems sub-committee led by a colleague from MOMRA, and the financial sub-committee, in which we tried to bring on board the Ministry of Finance to support us financially, and also to become aware of the savings inherent in preventing the duplication of work; actually, we got a lot of support from them. The fifth is the networks and communications sub-committee; we really needed to understand the networks and these matters; however, we also wished to avoid confusion between systems and this committee; the other committee looks at systems, which could be legislative, and as such looks at Council of Ministers legislation, what new legislation and systems can be put in place, describing responsibilities, etc. With systems, we mean legislation etc, while with networks we mean software and hardware systems. Our committee plays a small part tasked with specifications; we looked at the different specifications in use in KSA, and recommended the adoption of the ISO-TC211 standards. This was endorsed by the temporary committee and was submitted to the Council of Ministers.

Question: *has there been... even internationally, Professor Mike Jackson says that even here in the UK if there is no force from the high level or pressure to command implementation, and ensure that there is a reference authority with control over budgets, which would strictly ensure that projects are implemented through their agreement, and would serve several sectors. However, if a body proposes a project, this would be agreed to, provided it served its own needs. However, if there are other sectors that could benefit, then that authority, would ensure that it is implemented in such a way that everyone can benefit from it. Therefore, this authority, whether committee, office, or whatever, would make sure that projects would serve the needs across the board, where simply making minor changes would enlarge the circle of benefit. Therefore, in the absence of legislation, my question is has the power of the authority or legislation been used to compel organisations in KSA to comply with specifications, and avoid this duplication of effort and waste of time and money?*

Response: this is a very good comment... the good thing about our committee is that it has brought together over 35 sector bodies from across the Kingdom. These sector bodies include the four key ones that I mentioned earlier, i.e. the Deputy Ministries in MOMRA, or the producers, in addition to many other... or let me say the effective organisations, such as Aramco, the electricity company, the communications company, those companies with great weight. Being on the committee, it is most likely and assumed that what is agreed would be compelling to them, although up to this moment, there is no legislative instrument compelling them. Therefore, we recommended that this temporary committee be made a permanent body or made an independent body, such as KACST, and they agreed or let me say that the Council of Ministers directed that to be so. Therefore, at this stage, the Institute of Public Administration should recommend a structure for this committee; if this is endorsed in final form it would have the power of law behind it. We are waiting for this now... among the things that we submitted to the higher authority, that there should be a real link, as a pilot project, between Military Survey, KACST, MOMRA, and the High Commission for Development of Ar Riyadh, as a pilot to trial what he had spoken about in the committee over the past five years...

Question: *and SGS*?

Response: including SGS... the sector bodies I mentioned, we tried to make them the sample with which to start; we specified 13 to 14 levels that would be the beginning, and specified for each body which level it should leave or provide to others. We looked for open and transparent standards, such that everyone, including the public, would access this information without caring or knowing its origin, only that it is official and correct information. They would be able to receive it, knowing its specifications, metadata, and whether it is suitable for their work. Therefore, legislation will come, and we are waiting for it. Of course, our steps are slow, but I am not surprised. You know that in the UK, it took 40 years to develop the specifications, which are still work in progress, every day you have a new chapter added. The Kingdom is starting to crawl along slowly, and hopefully will arrive at where others are at... even though time or let me say awareness of the importance of information was absent. We do not say it was absent from the specialists, but from those authorities with control over budgets.

Question: *Now, I think that the specialists are doing their effective role, among them, you. I found that you have distinguished efforts in the different bodies that you work with. You have a large role in this huge work. However, I see that there are leaders, specialists with high qualifications in* *engineering, who have not undertaken the role that they should have, compared to the few specialists, in bringing awareness to the responsible people. Because, those in authority if they are made aware of the duplication of effort... for example, projects that are implemented; I found in some organisations… Even within the same organisation, this part implements the project and the other the same project again... sadly, this is very disappointing. If the authority is aware of this, then this would not have been allowed to happen?*

Response: Yes, there is a lot of effort being done, without going into too much detail. The difficulty can be seen in where we were, let me say eight years before, and how we have struggled fiercely to bring change. Therefore, I can say that the process involved the intervention of the Council of Ministers; they formed a real committee, when the issue arose between Madinah and the GCS, until they reached a compromise. Otherwise, in the past, this sort of meeting would not happen. Therefore, we go back again to what I said earlier… when we involved the Ministry of Finance, the aim was that it would become aware of the situation. So that we say to them, if you support this committee, let me say that perhaps annually one billion, you will save 5 billion elsewhere. Why? Because these numbers and figures say that this project is implemented by MOMRA, and then the Ministry of Water comes along and implements the very same project. Then the Ministry of Health does the same, and each one does the same project at the same cost five or six times.

Question: ...and *perhaps with different coding and standards?!*

Response: Here is the problem. When you come and ask each of these sector bodies for their map, you will find that each is not applicable to reality.

Question: *Is it true that there is a shift?!*

Response: This means waste of time and there is no benefit at the end of the day. Waste of time and a waste of money, and a lack of credibility of the information. Whose map is correct?

Question: *I found in my experience… I found some specialists who said: when I came to the body that I work in now, I found that some officials refused to divulge the spatial data; after checking the spatial data, I found that it was incorrect. I feel that the official is defending the budget and money spent on such useless data, which he will continue to guard, and prevent the truth from coming out. In front of the authority in his organisation, he is presented as the person who possesses the information, and is qualified, while in reality the data in his possession is wrong and useless.*

Response: This is a problem, among the many problems. If we were to follow the system, this would not have happened. For example, let us agree that GCS is responsible for mapping 1:50,000. Then why is it that I find maps of scale 1:50,000 produced in five different organisations?! Why in the Ministry of Communications? for example. Why in the SGS, MOMRA and the Ministry of Defence? Just as an example. When you come and find the same map produced five times, in five different places, each time under a different budget, and therefore the information is different, the control points are different, the extent is different, the datum is different, the perspective is different! I would accept only one map from one body, with its errors regardless, and from there we can work at correcting it. This is what we have been trying to raise forcefully through our committee, and this has found positive response from the GCS; after they understood the situation, as well as the Ministry of

Finance, the SGS; really, all the people who sat down at the same table; I believe that they have all reached a firm conviction now that, as the saying goes "leave the making of bread to the baker, even if he eats half of it". Give him the work, let him finish it, then if there are any mistakes, then let us agree that this information has errors, and let the person responsible for it correct it.

Question: *Excellent… Now regarding the Ministry here, its dealings, as I have learned from you, are at national level. Does it have external relations, outside of the Kingdom? Or are relationships only limited to the organisations with spatial data activities that are currently involved with you?*
Response: Look… regarding the current activity, the key work or infrastructure that we are establishing is for the Ministry only, so as to bring things together; the amount of work involved is huge. The land area of the Kingdom is huge, about 2 million square kilometres , and you are talking about having infrastructure, to have strong communications. Now we have fibre-optic connections established to all 14 regional administrations in the Kingdom. In reality, we have 13 regions, but we have 14 regional administrations, one of them is duplicated in the same area, i.e. Jeddah, but Makkah, the holy city, was given a separate regional administration. So we have 14 large regional administrations.

Question: *…and now we have formal announcement of Taif regional administration?*
Response: Now you have a new way of defining regional administrations, such that a municipal administration that grows beyond a certain point will become a regional administration. However, in the past, there was one main regional administration per region with branch administrative units from each. If these units grow to a certain point then these are upgraded to regional administrations, but as small regional administrations not a main one. So we have 14 regional administrations, which have now been connected using fibre-optics for communications.

Question: *…a project from the…?*
Response: Yes, the Ministry.

Question: *…and with the Communications Ministry? Was it not involved?*
Response: Yes, with the Ministry of Communications… between the Ministry and the Ministry of Communications. This is an example of the type of relations that have been recently developed between the Ministry and other sectors of government. We are also finalising an agreement with KACST, as a body external to the Ministry allowing us direct access to their archives; the archive of images housed at KACST, so that we can use these for all the applications and land use that we have. We have sat with them several times now, and we agreed that a liaison be established. In turn, we would provide them with the information that we have, since they have a GIS for other applications in the Kingdom.

Question: *So there is now an agreement between you? This is a data sharing agreement?*
Response: Yes, yes… sharing data, this is what we are doing now, and we have started. There is also a similar thing, which has started with the Deputy Ministry for Water, along the same lines, where they have a specific share with us. Here at the Ministry, we…

Question: *The Deputy Ministry for Water in the Ministry of Water?*

Response: Yes, they require a lot of information in a variety of areas. They sometimes need information on the property sector, or along those lines. They had wanted to implement a project of their own. We said to them, you do not need that; the project exists let us unify the specifications, see what you want, and we will give you access to the database. Take what you need, and update the data that interests you, i.e. water. Therefore, we work in parallel; on the one hand, attending to the Ministry's needs, which are many, and I believe we need around 10 years to complete, and we also took into account coordinating with the national bodies. On the international level, we have consultancy arrangements; last year, there were 3-4 international meetings with well-known international parties that have applied, used or have expertise in best practice worldwide, in Europe, the US, and Africa, to benefit from these applications and experiences.

Question: *Are these commercial organisations?*

Response: We took experts, who had previously executed well-known projects internationally.

Question: *Successful projects?*

Response: Sort of, they evaluate these projects, and say well we did it this way; these are the advantages and these are the defects. We try to acquire knowledge of these things. However, in terms of contacts and information, no, we do not have such relations.

Question: *Among them Galdes Corporation?*

Response: Yes, among them Galdes; we were in contact with them, but did not reach any agreement with them.

Question: *I see that they are working with the High Commission for Development of Ar Riyadh? They will begin implementation. At the moment, they are working on the programming, and will…*

Response: In reality, Galdes were among the first in the world, I think, to develop gateways for spatial information. They are one of the main parent producer companies. It is the work of one man, but he is a great man, and very competent. So, we had some contacts, but these are not strong with them. We try to remain with an international, recognised standard that is proper, and well-formed. I mean, we prefer not to have in-house customisation at this stage, we prefer an international standard, as far as we can.

Question: *Therefore, you are all for the ISO standard?*

Response: Yes, the ISO standard, yes.

Question: *Therefore, now are you providing access to the standard? Because, I found some people saying that I don't care, I will do the work in the way that suits me, and there is nothing to compel me to adopt the standard. I am not convinced by what these experts are saying. Is there no compelling instrument, by law; everyone respects the law. So when they come, and say I will code in my way, and develop the specifications of this feature in the way I like. I spoke to some of them, and they said I like* *to do things my way. You have asked me to speak to you freely, and I am speaking to you freely. I explained to them that as a researcher, I wanted them to speak freely. One of them gave me 2 hours of his time, and said if you want, I will speak to you as I do to officials. He said: when I sit down with the experts, and hear the word "ISO", I automatically say no. I don't feel like going and accessing the ISO specification to see how they define things for each feature. I say this is not worth it.*

Response: Look, I think we have baseless fears related to ignorance of the facts; ignorance causes you to fear, as the matter is huge. Really, when you look in the ISO standard, regarding metadata you find 8 simple elements. These elements are now integrated within some well-known software applications; e.g. with ESRI, if you go back to the ISO standard, and look-up how these are structured. You will also find partners with the ISO, like us here in Saudi, while you will find those classed as active members in the standard. They pay money, and so influence the decisions, and so all that is reflected in the ISO standards is directly reflected in their software. So for example, ESRI now, part of it is known as being to ISO standard, all you have to do, is when a company comes to you, and you are using ESRI is to say to them input the metadata for me, which is now already part of the package. Many people don't know this. This is a problem, and it is educational. I believe that our public, or let me say the officials, and even teachers, if they are isolated from advances in knowledge for a year, then… you find that knowledge has moved ahead by many years. Therefore, I believe that we have a problem, in following the progress happening in the world around us, and also not conveying this, to those in authority. So now, we have this project, where we told them simply, the ISO is in the software, just fill it in. So they began to do it, step by step. This is quite easy; so I hope that every organisation in KSA knows that this is not a difficult matter at all. It is simple.

Question: *But, the problem is the awareness, and knowledge? Sadly, many are ignorant of this. Also, it is sad that there are no means to let them do things properly unless a law is issued. Since, if you leave them to their own devices, they will seek the easy way. Sadly, culture plays a role in this, Arab societies generally, and Saudi society in particular, suffer from the phenomenon that a person comes and just wants to do the job any which way, regardless of quality; the important thing is that in front of the management, he has done his job. However, to do things according to specifications and standards and make life easier for those who come after him; and to make life easier for himself as well; if only he knew that his life would be much easier as well, in future. Moreover, if there is a process of data sharing, then this will make his life so much easier; he only has to key into his system, and he will receive all the information beyond his imagination.*

Response: look, the reality is like it is now, and you are a researcher and know this. If these sector bodies do not follow standards, then you will find soon rather than later, within the span of four to five years, you will find that no one will be able to communicate with others in data; this is for sure. Therefore, we have two rules; one of them, is that all the software and programs developed, and even networks, gateways and portals must be according to specific standard. If you are not going to follow the standard, which likely is part of an international standard, then you will find that quite soon you are not able to communicate and share with others. This is one of the key pressures. The second pressure relates to information, or let us say ignorance of the information; this requires law, where the legislator is aware of what is going on in the world. We are waiting for this law, which is yet to be issued, and will take time; I expect in two years at the most, the law will be effective and in force, and we will have an official body for all sectors to know whom to contact, and who to refer to. Because, really, who do you go to? If you come to the Ministry, and said I am confused and I want to choose between this and this, your reference is yourself. Now, I will give you an example of the importance of information. There is a project housed at KACST titled "the reference horizon for spatial data in KSA", which is WGC84, and let us say ITRF2000, 2005, 2007. One of the key problems we have in spatial data in KSA is Ain al-‘Abd. This is out of date, dilapidated; so now you are producing information which is extremely accurate, and are forced to degrade it, and mutilate it, in order to refer back to ‘Ain al-‘Abd. Notice this! So we noted this problem, and I submitted a proposal to KACST, who agreed to it, and funded it with 2 million. I involved the GCS with two members (PhD holders), and MOMRA, as they are both responsible for the ground control points in KSA, and we involved KACST as a sponsor. In this study, we proposed that on the web hosted at KACST, we would put all that we can lay our hands on in terms of parameters to convert from ‘Ain al-‘Abd to ITRF 2000. So there we gave them the steps, and how to reach this information, and how if they wanted to produce a map or information with spatial data, for any part of the Kingdom, then they can communicate with the closest point and they can have a base reference from any municipality, and can work using the standard in the way that we have specified. A person only has to download these things from the Internet; nothing more. This is one of the things that are important in education; it is important that we have something educational to inform people of what you have. Sometimes, imagine, we found some sector bodies in the Kingdom which are using a specific software, let us say MapInfo, a British product, from over there...

Question: *I have some questions regarding technical problems, which I intend to ask you about; I will ask you about ‘Ain al-‘Abd and Jeddah; and also the current projection; all these things... but please finish the point you were making*.

Response: I will finish the point, ‘Ain al-‘Abd for example, at some point I was using MapInfo, which has a specific projection from its vendor. Therefore, they always had something called ED50, which refers to the European reference 50. ‘Ain al-‘Abd, which is ours, does not exist in the package. Unless you are able to program the software and place ‘Ain al-‘Abd, then you are going to use the European reference. We found that in so many cases this was the case. The point is that our specialists have not thought of actually adding this projection to the list offered internationally. Therefore, we found many maps that have been produced using this reference, which means that this information is not useful, regardless.

Question: *Now, the initiative that has been proposed by you now, your view of it in the future, within the Ministry and externally. Can you give me your view*?

Response: look, I believe that the Ministry is qualified, if you wanted to judge the success of a certain matter, then make sure that it has the necessary qualities. If we said that Saad Alshehri will be a university teacher; then for that to be the case there are specific qualities that are required, for example to speak English and Arabic, to be free of disability, and hold a PhD, etc; several qualities. If these are absent, then he cannot become a university teacher. Therefore, is the Ministry qualified to take a leadership role, and influence the trend in spatial data in KSA? We look at it from two different angles; the first relating to information, does it have the information that is sufficient to form real wealth, which can be provided to the other sector bodies? The answer is yes. Why? Because, no road, construction project, or urban expansion can be done in KSA without base maps sourced from MOMRA. Then, I would say that classifying matters according the Council of Minister directive divides spatial data into three parts; one goes to the Ministry of Defence (maps of scale 1:250,000, 1:50,000 and smaller); these are strategic maps and very few; if you count them for KSA. Regarding satellite images, these are in the custody of KACST; when you come to detailed maps, highly important, from level of parcel to neighbourhood to city, these are only found at MOMRA. This is one of the essential and key qualifications in my view, such that this Ministry must have the goodwill of others. Because the information is in its custody, and if it did not fulfil its role then others will do that for it; in an incorrect way. Therefore, the Ministry is qualified: it possesses awareness right from the top, His Highness, the Minister, right down to the lower echelons. Really the level of Deputy Ministers, which is immediately subordinate to His Highness, possesses the above average conviction that this must happen. His Highness, the Minister, directed that we must really stand up to our responsibilities and the challenge, and we must prove to others that we are indeed capable. His Highness, the Minister is fully behind this initiative; so I believe that we have the decision maker—the political will—in full agreement. The information is prepared, the budget present, and so I believe that we are qualified, unless we fail to do our work properly. Otherwise, I believe that the Ministry is well qualified, to lead in this area. Even, what has been submitted to the Council of Ministers regarding having a national GIS, I believe that the real nucleus for it must be from this Ministry. All the information is in the custody of the Ministry, and the launch must be from here. I want to make another point; previously, we sat down with the e-government people on many occasions, and said to them—the king had granted them 3 billion—a huge amount; we said to them, with this 3 billion, if you only provide simple transactions for the citizen regarding simple interaction with government administrations, for example, passports, then you have done nothing. When Canada started, it began with what you started with now, and spent 60 million dollars, predicting that usage would be around 80%. However, it was surprised to find that after five years, usage of the product of e-government was only 20% rather than 80%. They reviewed matters, and concluded that there was something missing, which was highly important in that spatial data was not the vehicle for it. So they spent another 60 million dollars to put that right, and found that usage had now risen to 80%. A simple example, if you watch your child at home they will go onto Google; a child can use it, an old person can use it, everyone can use it. Why? Because spatial data is the vehicle for it; the same for e-government. We met with them and they were very positive about the idea, and said we are ready to fund and support, and to launch ourselves from this point. Now, there is discussion between the higher national committee tasked with the national GIS and e-government in this area. Therefore, there is a sort of communication.

Question: *Did the initiative start from the Ministry by making other people aware, through conferences, and any other means, to promote the idea to people who may have a project, and that if people need any support, or a presentation explaining what the Ministry possesses, in terms of the huge amount of spatial data, and so if you want it to do anything, then do it in the same way that they do and apply with us. Is this the case or has it happened that another organisation came forward and you coordinated efforts with it, in order to exchange, or up to now things are at the early stages*?

Response: now, let me say at the level of small conferences, and really these are not small, and the level of the Gulf, and KSA, we made a presentation of what has been achieved so far, and His Excellency, the Deputy Minister, would personally make a presentation in this area. We were invited to Oman, and presented our GIS at a conference titled "Gulf countries municipal work"; we made the same presentation there as well. This is available, I think on their website, but I am not sure whether it is all available.

Question: *I did not find it. Only a few articles on GIS development by M. Rajhi; I found several articles by him, but fairly general not in detail.*
Response: No, the presentation was very powerful, and...

Question: *I will need that as a reference, in order to document the work I have done.*
Response: I will describe it to you verbally, and then perhaps you would be able to find it from the conference proceedings. I think you can find it on the Internet. However, I am not sure if we had given them the content or not.

Question: *can I have a copy of this paper*?
Response: Yes, but it was not a paper; it was a presentation. The information in it is in the public domain, although the Deputy Minister had misgivings since the content was subject to change. However, you will be able to find it under a similar title to "National GIS for the Ministry". He spoke in it about the Gulf co-operation Council; who also had another presentation in Dubai at some point. Also, the conference in the Kingdom, national GIS conference, we do many presentations on our work. However, we have not been officially tasked to publicise our work to other organisations. However, when we have the opportunity we take advantage of that.

Question: *if I were to ask---we are close to finishing--- now regarding cooperation, you need to clarify and explain to people those things that would make them more likely to co-operate, as a sort of advertising, otherwise by nature human beings continue as they are. Therefore, what are the steps that you have taken to convince people that cooperation has advantages and benefits. So what steps have you taken to convince them of this*?
Response: In the Deputy Ministry of Urban Planning there is a body called the coordination department. Its sole job is to coordinate with the different government sector organisations; water, electricity, telephones, all the other sectors. It has a motto, which is: "What do you want? And how can you benefit?" This is their ethos, really. What do you want? And how can you benefit? This department went to the Ministry of the Interior—this actually happened—and said to them what is it that you want from us, and we will tell you how we can also benefit from you. Among these things they mentioned, for example, we want the sites for fire stations, sites for different things. This is a real example. Again the Ministry of the Interior wanted to produce a map for all KSA with the parcel system. You do not need it really! Therefore, when we speak to them, we said no, we have that already. Okay, we can help you with many things. If we give you, for example, the civil protection sites, can you give us information on civil protection? This could be made available to the public. This means that I now have a database which has been verified, with information taken from

MOMRA. There are fields in the data forms that I do not need and would not ask for, but the least I would agree with you, is that you would give me this piece of information for the database, and I will give you the site. In this way, I will always keep the site up-to-date, and you update the information; so that there is a sort of exchange. The coordination department within the Urban Planning Deputy Ministry exists. We also agreed with KACST that we would have access to the images that they hold, but this is not all. On our part, will give them any updated information in vector data form we hold; this is for their GIS applications in other parts of the Kingdom. So there is an exchange system in place now.

Question: *Do they supply you with raster information only, or vector*?

Response: They will supply us with corrected raster. This is the agreement; they carry out everything, including ortho-rectification. Between you and me, we prefer that KACST provide us with corrected images. Why? Because we noted that some sector bodies take the images and attempt to correct them in a wrong way; and therefore produce incorrect vectors. We requested that KACST raises the cost a little bit for others, and produce the image at their own responsibility, with its errors or anything else. Let us say that the procedure for exchange between us and the different sector bodies is that we can benefit them with this thing, and we want to benefit from you with that thing. So there is a sort of exchange. We have implemented a marvellous project, which I consider a pioneering national project, a good practice example of co-operation, at the level of the Kingdom. This involved a project implemented over three phases costing 90 million or thereabouts for the Saudi telecommunications company. This project was implemented by KACST, MOMRA, and the telecommunications company, by agreement. The company provided the funds, while KACST supplied the images and received a copy of the output in return; MOMRA supplied the vector data for all the areas, around 100 cities in the Kingdom. It supplied them with the vector data, and requested that if any were updated during the project, these would be returned to it once again.

Question: *What was the project about? Was it a base map?*

Response: The scale used was 1:5000 for all the cities in KSA, and the project produced a digital elevation model at 5 m for all the cities in KSA, and produced a digital elevation model for the entire Kingdom at 25 m.

Question: *The digital elevation model... you know that the boundaries of the digital elevation model normally have some corruption. Has this been treated, since there are significant differences in correctness between the boundaries and the interior of the model*?

Response: Yes, this is natural and well-known. What we did was simply enlarge the extents of the digital elevation model beyond the boundaries of the city using a large buffer zone. So that this corruption is not included in the part of interest to the application. This has been done and corrected, and has been developed in different forms; for example, we also used some of the Russian products; something called the TK 30; these are balloons that are launched into space and take photos, which are then developed. The output was marvellous, and I can say to you that this project is a shining example of cooperation between sector bodies that previously had not witnessed such cooperation.

Question: *This makes me put to the question to you; what are the factors that help in achieving cooperation between the different bodies, both within the ministry and externally? In your view, what are these factors*?

Response: Let me say to you that rather than saying: what are the factors that help in achieving cooperation! You should ask what are the obstacles to that co-operation?

Question: *I will ask about the obstacles as well...*

Response: This is opposite to your question, but if you mention the obstacles, you will automatically define the factors for success in cooperation. The obstacles that we have, as appears to me; first, the absence of a law. This is a huge problem, which leaves matters open for individual initiative. For example, there may be a piece of information that could be given, but is not; or there could be a piece of information that should not be divulged, but is given out; or there could be a piece of information that was kept under wraps, but then was leaked inappropriately; therefore in all three cases there is loss. In my view, this is a huge obstacle, i.e. the absence of any system. Therefore, if we wanted to correct the situation, i.e. the factors that encourage co-operation, then first you must have a clear system clarifying that this piece of information is to be given out, while this one should not. As for the individuals, they are in a difficult situation; you could say that I can be held administratively responsible for giving out privileged information, if I were to give this piece of information. What will protect me? The law will protect you, but only if you have the law in place. In this case, you will be able to give out information without fear. The second point, let me say is transparency; we do not have transparency; meaning that you may request a piece of information from me, which I have acquired and possess at the Ministry, but I will keep it for five years in secrecy; as a result, it becomes out of date, I believe that this piece of information is useless; unless you have a firm conviction that this piece of information was produced to be used, and we have transparency, and publicise to the world that we have this piece of information. This is one of the points, i.e. lack of transparency. The third point relates to the financial aspect. I have this information, which has cost me a lot of effort and money to produce, and you as another sector body will take this information and use it. What is the problem if I were to charge you a small sum that will help me keep this information up to date in future? I am not selling it, and at the same time if the project had cost me a million; I should not charge you a million. I can take 100 Riyals from you, the same from another organisation, the same from another organisation and so on; this would help me keep the information up-to-date. This is also lacking in our financial rules; as a government sector organisation, you cannot charge other government agencies. You cannot say give me a sum of money in return for this thing. This process does not exist, and so presents a real obstacle; we have an obstacle in transparency, in the financial system to have a process for charging to maintain information up-to-date, and in the lack of a system to regulate distribution of information. We have become used to the system where you must present an official letter requesting information. No, I must have a reference hung on the wall that explains to me clearly that if the particular organisation requests information, then if 1, 2, 3 are satisfied then I hand over the information. Among these criteria, could be payment of a specified fee, or to sign a confidentiality agreement to not divulge, transfer, or sell it to others; intellectual property and copyright, etc. these are simple matters, which the National committee in future aims to successfully introduce. At the level of ministries, we can introduce this, and apply it now, once we have the Centre in place; it would be easy to implement this. However, if you come to the national level there could be an obstacle, which relates to finance was well. You as a national committee, or let me say as a national body, need to maintain the data, and to maintain it you have to have a budget; this budget must come from somewhere—perhaps as the military survey does—a map scale 1:250,000 would be sold for 750,000 Riyals; digital and very clean for the entire kingdom, quite beautiful. I think this is fair, because to undertake a project saying that I need up-to-date maps of scale 1:250,000, you will definitely need more than 750, 000, not even 10 million. Therefore if you paid 750,000 to a recognized body such as the GCS, and it took the amount from you and others; then it can update this information in future for you and others, I think this is a significant gain.

Question: *Is there a catalogue that shows the user? You have spoken about the producers but what about the user perspective, whether an organisation, or the public? Is there a catalogue of spatial data for KSA, which I as a user can access. This would describe available information and where to find it, whether at parcel level, etc.; e.g. the base map is at MOMRA, while a certain layer of information is with SGS available from GCS. This would make life easier for the user. Also, issues of user education, by ensuring that users are aware of what can be provided to them through the Ministry, and would not feel that they have to initiate new projects for information that is already available. Do you have any future plans to help users in this regard? Also, there are issues regarding qualifications of contracting companies to undertake work in the spatial data area. Do you have a view on enforcing standards for contractors in spatial data*?

Response: This is a very important question... indeed, one of the most important questions. The person possessing information is quite like a person who owns a supermarket. If there are no customers to buy your products, then you have achieved nothing. Therefore, if you are not able to market this information in a proper manner and reach everyone and enable them to choose, then you have done nothing. Now we have two levels, you asked about the Higher National Committee, which will be slow and is slow; in it we worked according to what you just said, and we agreed with the five sector bodies, and defined 14 key layers that should be made available to the public for access. Among these things submitted to the Council of Ministers, was the specification manual to execute the pilot stage of the project; part of this experimental stage is that there would be 14 information layers available to the public. They would be able to access thess, know the specifications used, and choose accordingly how to make use of it; this includes roads, infrastructure, and other things. And at the level of the ministry, there is a project that you read in the documentation you have, consisting of a browser and portal. The primary concern that we had regarding the portal was the metadata, on which basis you would decide the type of information, who holds it, how to acquire it, its benefits, how up-to-date it is, its format, when was it produced, what is the procedure to acquire it; everything that you can think of regarding information. All the information held within the Ministry relating to urban planning, will be available within four months, i.e. the GIS for the urban planning administrations, meaning the majority of urban development plans for KSA. This has actually been implemented and is part of the specifications manual that we produced, and is currently in progress. Yes, this is an important thing and we are working on it now.

Question: *At the level of the national committee*...?

Response: At national committee level, as I mentioned, we have the 14 layers, which we agreed with the four key sector bodies, and wrote it in the specification manual for implementation, and it is now at the Council of Ministers for study and perhaps it will be endorsed. If it is endorsed, then it is one step to be followed by others.

Question: *You explained to me when I showed you that report for 2007, which was raised to the Council of Ministers… I was told that it had been transferred over to the Institute of Public Administration to study. You mentioned to me that perhaps you had a decision or directive in that regard*?

Response: They formulated a fairly large proposal with all possible options, and I believe it was submitted; indeed, it was submitted. A fairly comprehensive and large report was prepared, and is to be studied by the Council of Ministers, which should endorse it as is, or choose what the committee proposes.

Question: *This report is for 2007...*

Response: No, there are two diffferent things; the report by the committee was submitted, and based on that report the Council of Ministers directed that it be transferred—because it contains recommendations—to the Institute of Public Administration, and a consultative committee at the Council of Ministers as well. Their job is to design a suitable structure and study the recommendations submitted by the committee. Therefore, as I told you, they held meetings with all the main government sectors in the Kingdom; they also met the Deputy Minister; they met me here, and I believe KACST as well. They met all the sector bodies in the Kingdom, and spent a very long time. It was a very powerful committee, which travelled abroad as well, and tried to look at best practice worldwide. They began thinking whether it should be a commission, permanent committee, or another form. Where it should be based; fairly detailed matters. They studied a wide variety of matters, and it would be premature to discuss these now, because these have not been officially endorsed yet by the Council of Ministers. However, there is a definite trend in that direction.

Question: *Would you allow me to focus now on the technical problems? Now, the main server for the Ministry's project is housed at the Ministry*?

Response: Yes.

Question: *Would you give other bodies access to the server? What is the procedure regulating the division of responsibilities and powers regarding access? Also, will there be another server housed in the custody of a different body*?

Response: Look... At this stage, access will be granted to all the administrations at the Deputy Ministry of Urban Planning, each with its own access control policy. For example, urban planning upstairs is responsible for agreeing all plans using an automated process. The process of reviewing and agreeing such plans takes one to two years. With this system, the process will now take less than a month, which is a huge leap forward. Now we have authorised them to go ahead and use the system fully. This is because the project belongs to the town planning administration. For example, land administration will be given browser access, to enter and view the information, and if it wanted to make use of a piece of information then it should complete a specific application form, then submit it to receive the information.

Question: *What about the ground control points*?

Response: This is the second point I want to make. We have agreed with the Deputy Ministry of Urban Planning that: why not introduce your layers into our portal... our database. And therefore, since you are the people with the authority, you may give this information to anyone you choose. So if I come from any other agency, and I wanted some information, all I have to do is submit an application form. Then, if I satisfy the criteria, then I will be given the information on ground control points, and so on. So far, we are still working internally within the Ministry.

Question: *Is the authority vested in a specific person*?

Response: Yes. The authority lies with the specific person responsible for the particular piece of information. This is how it should be.

Question: *Who checks the requests received, as to whether they satisfy the criteria*?

Response: It is the responsibility of the owner of the information.

Question: *How is the security aspect handled? You are no doubt aware that even highly secure installations have been hacked... the Pentagon, or others... so what is your view, and how do you maintain the secrecy of information*?

Response: First, I hope that secrecy does not lead to the baseless fears of the past that have cost us dearly. Under the premise of secrecy, everything was prohibited. However, now, what concerns us, in the first instance, is that the information is not lost or corrupted. Therefore, according to our plans, we will have several backups at different locations external to the Ministry complex. In the Ministry, there will be a specific location, outside of the Ministry there will be another, where data is backed up at regular intervals specified by the specialists here. Therefore, we have all our information as GIS, which we do not look after from the IT perspective. We have handed all that over to our IT Centre, which is under the direct authority of the Minister. The Centre looks after the firewalls, backups, maintenance, everything related to protection, networks, guarding information; for a fact, they are well advanced of us. They already have custodianship of our system, which we had handed over to them. Already, the main server is with them. It has been officially handed over to them, including the backup systems. From my own personal experience, I have noted that there is some misunderstanding between the IT and GIS people. You will notice this even in Europe and the US, where IT people as soon as they hear something called GIS, will say bring this GIS here to within our jurisdiction. This is a big mistake, and I am against this argument, and have worked to confront it on many occasions, at the Education, Interior, and Higher Education ministry, etc. Even here, when we came, the IT people said we want GIS here. We said no; I will only give you responsibility for the network, firewalls, maintenance, backups, but GIS is something else; people do PhDs in GIS, and is a specialist science that you cannot do. Therefore, we always separate between these two matters in a proper way.

Question: *Now, spatial data has different aspects; so I do not know... in your opinion, whatever data is exchanged whether between users or providers, do you think the data format is very important? So if I request spatial data from MOMRA, or any other body, do you wish it to be in the format that you usually use*?

Response: First, the existence of an intermediary or middleware regarding the data is not good. For example, one of the criticisms I have against ESRI is that they have something called SD, which is middleware between the database, e.g. Oracle, and the application itself. Therefore, you cannot interact with your data without first passing through this middleware. This middleware is usually proprietary, and introduces significant changes to the format. If you can have the arrangement where you interact directly with the data through your software application without a third party that is always best. This means that, internationally, all the specifications should be unified; internationally, not just locally. Therefore, many of the software applications, or let me say formats have become well known internationally, except in the military area. However, these may also be unified within the military sphere. However in civil applications, I believe that these should be in standard format.

Question: *Metadata as you said earlier is quite important in spatial data, which allows the data to be comprehensively documented. In fact, spatial data without metadata is like a person without identity*…

Response: Yes! So, I always define metadata as the identity of information. Indeed, data lacks an identity, if there is no metadata to describe it. In reality, what we have done in our current project, we have focused 70% of technical effort on the metadata for the spatial information. Unless search and maintenance of the data is done through the metadata, then we will not have achieved anything. Therefore, we are carrying out intensive testing in this respect.

Question: *Regarding data pricing... what do you think? Do you think the price of data may constitute an obstacle sometimes*?

Response: Yes, I believe it is an obstacle not sometimes, but always. Why is that? For two reasons; the first, there is no clear, legally-defined authority that allows you to safely set a monetary value on your data. The absence of law regulating this area constitutes an obstacle. The second, this piece of information which is given to others, usually needs to be maintained; maintenance requires a budget; the budget requires that since this piece of information can be shared by others then there should be a fee charged for it. Therefore, we need a procedure, and we are waiting for such a procedure, a fairly important one, that may come to us from the Council of Ministers. As you know, any funds, which count as income gained by a ministry or government sector organisation, must be handed over to the Finance Ministry. These funds are not given to the sector body that is responsible for maintaining the information, which is really for everyone’s benefit. Let me say that the financial aspect of handling spatial data is an area that urgently requires clear laws to address it. I would like to add, that if not, it could open the door for inappropriate practices. Unless it is regulated in a specific way such that if funds are not channelled back to the Ministry of Finance, then they should be directed to the relevant sector, with clear rules. This is an obstacle and shall continue to be an obstacle, in my view.

Question: *In terms of access to data, while we are speaking about legislation and similar matters, do you consider that this is still an obstacle? I.e. when you access any data related to the Kingdom, I think that this is still an obstacle, i.e. access to spatial data*.

Response: It is my belief that there is no real access to spatial data up to now.

Question: *So far there is no legislation addressing this area, and each body is afraid*...

Response: In my view, there is no access, and what were doing at the Ministry is to regulate the matter through the Minister, and attempting to formulate spheres of clear responsibility. However, I agree with you 100%, that up to now we do not have actual access to the data at all.

Question: *Regarding positional data, how do you consider its importance to spatial data*?

Response: It is quite important...

Question: *... accuracy relative to the datum*? *Absolute and relative*...

Response: let me speak about the accuracy... I think you are referring to positional and relative; relative as though you are speaking about semantic information... the relationship between one thing and the other. Let us divide this into two matters; the users, generally, are concerned about the relative accuracy, in that the direction is correct, and knowing that when you move from one point to another you know the relationship of each to the other. This is important, without doubt, and without it we cannot advance. Regarding positional accuracy, this is what I want to put three lines under; this is sometimes abused by specialists, or actually not specialists, let me say the clients. For example, here at the Ministry or at the Ministry of Water or Agriculture, and this is an experience I have had with the Ministry of Agriculture; the Ministry of Agriculture comes along and says I want to study the forests in Assir region. So, no problem; what do you want in terms of the project? We want the project to be as accurate as possible. We asked what sort of accuracy? They said the most accurate it can be. We said: shall we give you 5 cm positional accuracy? They said yes. This official does not know that the relationship between accuracy and cost is a non-linear relationship—exponential actually. Therefore, when you say the accuracy is 1 m compared to accuracy of 10 cm, the cost difference could be 100 million. Therefore, if the client does not know the type of accuracy that they need, then they are being unfair on themselves, positively and negatively. So, when you say to me that we have an environmental study of the forests in Assir; for this forest, there is no line on the ground at all to distinguish between Arrar and for example, Zaytoun or Talh; there is no line, so an accuracy of 200 m is acceptable, rather than an aerial survey of 10 cm accuracy that will take you a team and so cost is 10,000 Riyals compared to 200 million. Therefore, I believe that with spatial accuracy, we have a problem in the current understanding of the importance of accuracy and its relationship to budgets. Without doubt this is an existing problem. Regarding users, they do not know, and the non-specialist believes that so long as they zoom into a map, they will get the accuracy. Say a map has been produced to scale 1:1,000,000, and the user needs a scale of 1:10,000; they will say: simple, just enlarge it. Therefore, neither the client, nor the user, understand the issue. However, referring to the specialist, he must differentiate the detail in the survey; this depends very much on the expertise of the specialist leading the project. If you send me someone from the geography department or a graduate from the engineering survey department of the University, you will find that they have different mentalities on the issue of accuracy. Therefore, the surveying graduate who works on the issue of accuracy is equipped to deal with this properly and correctly. However, the others need to be made aware of this issue, because the issue here is that of accuracy and budgets. If you come to me, and said: we want to do a cadastral survey in Makkah, and take Ikonos images. Yet, these images after correction are accurate to 1: $0.5m^2$; however, 50 cm^2 in Makkah is worth 10,000 riyals roughly, and so owners there will not accept that you map out their properties, and as a result they lose 20 cm^2. This is completely unacceptable to the people there. Therefore, the application and the type of accuracy required are linked… relative is important no doubt… Obviously, relative accuracy is related to the technical aspect. When you speak of topology in GIS, you have now gone into the issue of relative accuracy. The relationship of this site to the other site—above, below, north, south... this I believe is quite important.

Question: *To have fully formed information; when you request data from a particular organisation considered a provider of this spatial data and has verified the information; do you think it is better to receive the information in full, or does it annoy you that perhaps the request is misunderstood, or the specialist has not taken the matter seriously, and has supplied you with whatever information regardless? Is this a difficulty, or what do you think*?

Response: I believe that information, especially that accompanying spatial data, must be of two types: compulsory information and optional information. For compulsory information, everyone must by necessity ensure that it is present. Among this compulsory information is that you must provide me with the reference, the intellectual property holder, the date, etc. The agreement should be that the requesting authority is given this compulsory information. Unless you provide me with this compulsory information, then I must go elsewhere. Regarding the other type of information, optional, there should be some flexibility, in terms of how important it is to the client or not. Therefore, this information is of two types; and this is exactly what is found in the standard. In the standard, we have a compulsory part, and another optional part. So the compulsory part is compulsory on everyone, while the optional part is not.

Question: *Regarding updating the information, i.e. ensuring the information is up-to-date... what is your view on its importance? Sometimes you ask an organisation for information, and they send you information that is really quite old*.

Response: Updated information is very important, but... we need to look at it from two angles; we have a standard in surveying that you know... speaking about the map; if the map is 70% updated, then we cannot say that this area is not updated. However, if less than 70% updated then that is considered out of date. Why is that? Because as a consequence there are budgets based on this, and huge costs. Therefore, if I had for example a building, in a specific place that has changed; then do I change the map? Carry out aerial survey, etc? All these things, it would not be cost-effective. Therefore, depending on the type of handling, which is important in the area of classification, i.e. classifying users. If you say that the user of this information is, for example, the electricity company, if on the map the line is not there, then it has not got a map and has not got anything out of you. If you are speaking about MOMRA, then if not all the information is present, up to 70%, then it is out of date.

Question: *Now, I will ask you the last question. Regarding information exchange, do you think that cooperation should only be in the knowledge sphere, or in terms of staff, who are able to go and work on the premises of other organisations; all this for the purpose of exchange of expertise and experience. If I share with another organisation, and I send my employee to work within the same department of the other organisation temporarily, then when they return they will come back with information. He will benefit them there by explaining our work to them, and reflect back to me the reality of the work that they do. What do you think about cooperation and its types? Whether it is in human resources, data sharing, technology, technical skills, or knowledge? What is your opinion*?

Response: First let me say that knowledge should be shareable between everyone; it is the basis on which we can advance. However, if you come to some of the internal details, there are some sector bodies that would not even allow you to be present on their premises. Therefore, this could be according to the type of context. For example, our students at King Saud University could train at the Military Survey. However, they could be restricted to specific things, while there are things that they are not allowed to even see. Therefore, the types of cooperation need to be studied and classified. Hence, well classified cooperation is important. Knowledge should be open, this is my view. The other types of cooperation, whether technology exchange, human resources, exchange of expertise, etc. These must be classified according to need. For example, if at the ministry I had planning for allocation of land. Here, this is considered a top-secret matter, and you are not allowed to know who has been allocated which plots. Therefore, you cannot ask me to send you to train on matters related to this area. However, in terms of general plans, this should be the case. Therefore, training should be properly classified, so that we return to the original channel—legislation. Legislation or systems… as a responsible person here I can exercise initiative and make mistakes, but the law will say to me come, you can co-operate with anyone in this area. In this case, I am at liberty to cooperate with others. I believe that cooperation and its proper classification is vital.

The interviewer closes the interview by thanking the interviewee, and reiterates that the information collected is confidential and will only be used for the purposes of the research. Moreover, a method of coding will be employed to ensure anonymity of both interviewee and his organisation.

[ends]

APPENDIX 4: TRAINING COURSES ATTENDED

The University of Nottingham

Certificate of Attendance

Saad Abdulrahman F Alshehri

Department of Civil Engineering

Engineering Surveying & Space Geodesy

has completed the following short Research training course(s)

LaTeX for researchers: an introduction

1 training point

Introduction to image and photo editing

2 training points

MS Excel functionality b: data exploration + analysis and graphing

2 training points

Exploiting the power of MS Word a: for individual chapters and academic papers

1 training point

Analysing interview transcripts

2 training points

Designing surveys

1 training point

Nature of the doctorate and the supervision process

1 training point

Getting into the habit of writing

1 training point

Professor Claire O'Malley
Dean of the Graduate School

This Certificate of Attendance is issued by the Graduate School, University of Nottingham for attendance at short courses offered at the University for research students. 1 training point is equivalent to half a day of tutor contact time or independent study.

The University of Nottingham

Certificate of Attendance

Saad Abdulrahman F Alshehri

Department of Civil Engineering

Engineering Surveying & Space Geodesy

has completed the following short Research training course(s)

Introduction to library skills - Engineering (advanced)

2 training points

Getting started with Unix

1 training point

Further LaTeX for researchers: developing your skills in LaTeX

1 training point

Using Nvivo© to analyse qualitative data

2 training points

Referencing and citing using Endnote and Reference Manager

1 training point

Getting started with research design and statistics

2 training points

Introduction to qualitative research

2 training points

Introduction to SPSS for researchers

2 training points

Professor Claire O'Malley

Dean of the Graduate School

This Certificate of Attendance is issued by the Graduate School, University of Nottingham for attendance at short courses offered at the University for research students. 1 training point is equivalent to half a day of tutor contact time or independent study.

The University of Nottingham

Certificate of Attendance

Saad Abdulrahman F Alshehri

Department of Civil Engineering

Engineering Surveying & Space Geodesy

has completed the following short Research training course(s)

Case studies

1 training point

Planning your research

1 training point

Professor Claire O'Malley

Dean of the Graduate School

This Certificate of Attendance is issued by the Graduate School, University of Nottingham for attendance at short courses offered at the University for research students. 1 training point is equivalent to half a day of tutor contact time or independent study.