UNIVERSITY OF SOUTHERN QUEENSLAND

FACULTY OF ENGINEERING AND SURVEYING

Geospatial Data Sharing in Saudi Arabia

A Thesis submitted by

Donald C Lee, BEng, Grad Dip Mgmt

For the award of Master of Engineering

2003

Abstract

This research started with a realization that two organizations in Saudi Arabia were spending large amounts of money, millions of dollars in fact, in acquiring separate sets of geospatial data that had identical basemap components. Both the organizations would be using the data for similar engineering purposes, yet both would be independently outsourcing the data gathering. In all probability, resources are being wasted through two organizations each developing and operating stand-alone geographic information systems and then populating the databases with geospatial data obtained separately. Surely with some cooperation, a shared database could be established, with a diffusion of economic benefits to both organizations.

Preliminary discussions with representatives from both the organizations revealed high levels of enthusiasm for the principle of sharing geospatial data, but the discussions also revealed even higher levels of scepticism that such a scheme could be implemented. This dichotomy of views prompted an investigation into the issues, benefits and the barriers involved in data sharing, the relative weight of these issues, and a quest for a workable model.

Sharing geospatial data between levels of government, between governmental and private institutions, and within institutions themselves has been attempted on large and small scales in a variety of countries, with varying degrees of accomplishment. Lessons can be learned from these attempts at data sharing, confirming that success is not purely a function of financial and technical benefits, but is also influenced by institutional and cultural aspects.

This research is aimed at defining why there is little geospatial data sharing between authorities in Saudi Arabia, and then presenting a workable model as a pilot arrangement. This should take into account issues raised in reference material; issues evidenced through experience in the implementation of systems that were configured as independent structures; issues of culture; and issues apparent in a range of existing data sharing arrangements.

The doubts expressed by engineering managers towards using a geospatial database that is shared between institutions in Saudi Arabia have been borne out by the complexity of interrelationships which this research has revealed. Nevertheless, by concentrating on a two party entry level, a model has been presented which shows promise for the implementation of such a scheme.

The model was derived empirically and checked against a case study of various other similar ventures, with a consideration of their applicability in the environment of Saudi Arabia. This model follows closely the generic structure of the Singapore Land Hub. The scalability of the model should allow it to be extended to other, multi-lateral data sharing arrangements. An alternative solution could be developed based on a Spatial Data Infrastructure model and this is suggested for ongoing investigation.

Major unresolved questions relate to cultural issues, whose depth and intricacy have the potential to influence the realization of successful geospatial data sharing in the Kingdom of Saudi Arabia.

Certification of Thesis

I certify that the ideas, analyses, results and conclusions reported in this thesis are entirely my own effort, except where otherwise acknowledged. I also certify that the work is original and has not been previously submitted for any other award, except where otherwise acknowledged.

____________________________ ____________________

SIGNATURE OF CANDIDATE Date

ENDORSEMENT

____________________________ ____________________

SIGNATURE OF SUPERVISOR Date

Acknowledgements

The success of this research program has been dependent on the researcher receiving support at various stages of the project

- in developing the technical concepts
- in researching background information
- in developing the project processes
- in providing professional encouragement
- in discussing cultural issues, nuances and subtleties of local (Arabic) culture
- in providing a support mechanism and enthusiasm across the thousands of miles that have separated him, as an expatriate worker, from his family.

These stages, whilst discrete in themselves, blend into a continuum with no discernable start and finish, other than defined by the duration of the project itself. Consequently, my acknowledgements refer to those who provided support throughout the extensive period the research has been in progress.

My thanks go to :

Dr Harry Harris, Dr Frank Young, Prof. Thanh Tran-Cong	Faculty of Engineering and Surveying, University of Southern Queensland
Dr Abu Rami El Dashan	Faculty of Engineering, King Abdulaziz University, Riyadh
Eng. Talal A Rahjab	Dept Engineering and Construction, Saudi Telecom Company, Jeddah
Eng. Abdulsalam Abdul Aal	Digitized Plans Systems, Saudi Telecom Company, Riyadh
Eng. Khalid M Al Jallal	General Directorate of Urban Planning, Jeddah Municipality, Jeddah
Brig. General Saad Al Khathlan	Atheeb Intergraph Saudi Arabia, Riyadh
Mr Paul Archer, Mr Brad Schmidt, Mr Jack Smith	Intergraph Saudi Arabia Ltd, Riyadh

Special thanks and appreciation are extended to the research supervisor, Mr Kevin McDougall, for the guidance he has willingly imparted throughout the research period.

Finally, particular expressions of gratitude are due to my wife Gillian and my daughter Kristina for providing inspiration through their own academic achievements, and encouragement in my endeavours.

Overview of Contents

Table of Contents

List of Tables

List of Figures

Acronyms and Abbreviations

Acronym	Full Term
ADA	Al Riyadh Development Authority
AH	Anno Hijrah - Year according to Islamic (Lunar) Calendar
AM/FM	Automated Mapping/Facilities Management
ASP	Application Service Provider
BT	British Telecommunications plc
CERCO	Comité Européen des Responsables de la Cartographie Officielle
CLI	Calling Line Identification
COTS	Commercially Available Off The Shelf
DEM	Digital Elevation Model
DPS	Digitised Plans System
DTM	Digital Terrain Model or Map
ESRI	Environmental Systems Research Institute
FGDC	United States Federal Geographic Data Committee
FRAMME	Facilities Rulebased Application Model Management Environment
GDDD	Geographic Data Description Directory
GDMS	General Directorate of Military Surveys
GDMW	General Directorate of Military Works
GDUP	General Directorate of Urban Planning
GIS	Geographic Information System
ISO	International Standards Organization
KACST	King Abdulaziz City for Science and Technology
KCPL	Kansas City Power and Light Company
KSA	Kingdom of Saudi Arabia
LBS	Location Based Services
LGCSB	Local Government Computer Services Board
LIST	Land Information System of Tasmania
MEGRIN	Multipurpose European Ground Related Information Network
MGIC	Montana Geographic Information Council
MOMRA	Ministry of Municipal and Rural Affairs
MOP	Ministry of Petroleum

Acronym	Full Term
MoPTT	Ministry of Posts, Telegraphs and Telephones
NMA	National Mapping Agencies
NOSWA	North of Scotland Water Authority
NSDI	National Spatial Data Infrastructure
OGC	Open GIS Consortium Inc
PBUH	Peace Be Upon Him (a benediction)
RDBMS	Relational Database Management System
ROMANSE	Road Management System for Europe
SCAG	Southern Californian Association of Governments
SCT	Supreme Commission of Tourism
SDC	Spatial Data Clearinghouse
SDI	Spatial Data Infrastructure
SLA	Service Level Agreement
SLDH	Singapore Land Data Hub
SQL	Structured Query Language
STC	Saudi Telecom Company
USAC	Urban Information Systems Inter Agency Committee
UTM	Universal Transverse Mercator Coordinate System
WMIS	Work Management Information System
WTO	World Trade Organization
XML	eXtensible Markup Language

CHAPTER 1
INTRODUCTION

1.1 Introduction

Historically, Geographic Information Systems were developed and maintained as stand-alone databases, particularly within the individual engineering departments of utilities and government authorities. But since the early 1990s there has been a dramatic growth in the importance of the Geographic Information System (GIS) environment as a strategic component of the overall Enterprise Information Systems of companies (Daratech 2002) and government instrumentalities alike. No longer can a GIS be an isolated, independent entity within an organization. Corporations should not be willing to support the development and maintenance of multiple geospatial databases and sources within various sections of the company [1].

The transition of the GIS to being an integral part of a corporation's arsenal of information has helped focus attention on the gathering and maintenance of data as "key it in once" processes, thus avoiding the replication of effort. As the advantages of a single point of entry for intra-organizational information were established, attention then turned to the flow of inter-organizational information and one-time entry of information.

Both the private and public sectors have recognized that redundancies will result from having disparate entities developing and managing their own datasets. Often the same information is used by more than one party, yet this information is acquired and maintained separately. In an effort to address this issue there has been a trend towards shared, or multi-participant GIS projects in Europe and America, particularly in the USA (Masser and Campbell 1994; Nedovic-Budic 2000) and in other regions such as Asia and Australia (Masser 2002). It would seem to be a justifiable claim that encouraging data sharing is invariably a worthwhile strategy.

Sharing spatial data usually involves electronically transferring spatial data and information between data holders. The transfers can be regular bulk deliveries of data updates, or on-demand transfers of specific data. There are numerous sub-classifications of transfer mechanisms between these two extreme positions. The

[1] Exceptions might include separations introduced deliberately to meet strategic corporate security objectives or precautions.

predisposition of organizations to become involved with data exchange and data sharing arrangements is influenced by various factors and conditions that either encourage or dissuade such involvement.

During a preliminary investigation in Saudi Arabia, several groups were identified as using similar data. So it seemed reasonable to assume that a proposal to organize data sharing would be very acceptable and that the formulation of such a proposal would be a straight forward task. It seemed to be a reasonable proposition that a business case could be developed for more effective use of geospatial data through a coordinated, cooperative sharing program.

However, in various studies it has been shown that there has been a decrease in the popularity of multi-participant systems (Masser and Campbell 1994). This factor, together with a need for caution as expressed by some senior Saudi Arabian engineering managers pointed to there being a down side to the concept of data sharing.

This prompted me to undertake research into the issues including the benefits and the obstacles experienced in previous and current schemes internationally, with a view to making recommendations in relation to geospatial data sharing specifically in Saudi Arabia.

The research was undertaken whilst I was in Saudi Arabia[2]. Until recently there was limited access to the Internet as a research tool, so the majority of the investigations were carried out during discussions that formed part of my normal work situation. Consequently, local knowledge has been accessed in some cases, and some statements represent personal points of view, assumptions and opinions formed through association with Saudi citizens whom I am privileged to count as my friends.

1.2 Research Background and Justification

This study commenced with the implementation of an Automated Mapping/Facilities Management/Geographic Information System (AM/FM/GIS) project in the Kingdom of Saudi Arabia.

The Ministry of Posts, Telegraphs and Telephones (MoPTT) had accepted a proposal for a Digitized Plans System to be the foundation for a long overdue integrated

[2] I worked in the Kingdom of Saudi Arabia for nine years between 1993 and 2002, as a specialist telecommunications engineer and GIS project manager.

Customer Management scheme. Fundamental to the adoption of this system was the conversion of geospatial information from paper-based drawings to a digitised format.

During the early stages of the project's implementation it became apparent that there were many shortcomings in the availability of accurate raw data. This led to an investigation of alternative sources of information, particularly an accurate landbase. This in turn prompted a realization that other government authorities and private organizations were facing the same dilemma.

Considering that one of the most expensive aspects of implementing a project such as this is data gathering and conversion (Holmwood 2000), and that other groups would be involved in processes focused on similar outcomes, the concept of data sharing seemed to be sensible and appealing.

The idea of sharing the effort in gathering this geospatial data was born at this stage. Reaping benefits from on-going usage of the data would be a serendipity.

The author was part of the project management team for the MoPTT AM/FM/GIS project, and became interested in the challenge of preparing a proposal for data sharing between authorities in this conservative, almost secretive society.

Technical issues aside, a major consideration became not so much the potential for cost sharing, but rather it was the retention of ownership and control-of-availability of information.

Saudi Arabia is a country where tradition and modernity have to be accommodated simultaneously. It is a country where it is illegal to install and use satellite TV receivers; where a woman is encouraged to fully veil her face in the presence of non-family males (Cuddihy 1995); where affairs of the state are determined in accordance with religious doctrine or Shari'a Law (Horrie and Chippindale 1994); where members of the Committee for the Propagation of Virtue and Prevention of Vice enforce Islamic orthodoxy as they interpret it (Robison 1993); and yet where the people are very hospitable and open to new technologies. Little wonder then that the idea of sharing data poses interesting, ambiguous challenges.

Senior officials associated with GIS activities in two organizations, Jeddah Municipality and Saudi Telecom Company, expressed interest in the concept of sharing geospatial data. The Jeddah Municipality operates under the auspices of the Ministry of Municipalities and Rural Affairs (MOMRA) and has a significant investment in geospatial data. Saudi Telecom, the Operations and Maintenance arm of the MoPTT also has a large investment in geospatial information. (Saudi Telecom has recently become an autonomous company, but its investment in GIS and commitment to its development have remained consistent.)

Officials from both organizations were keen to see a definitive study carried out into the possibility of a formal data sharing arrangement between the two organizations, thus justifying the extensive research required and subsequent documentation of proposals.

Considering that both organizations are currently involved with updating their geospatial databases, they are aware of the costs involved. In addition, both realize that with ongoing and expanded use of the organizations' GISs, future maintenance of the data bases associated with these GISs will involve significant costs. These costs could be shared if a workable arrangement were to be implemented. The potential for savings in the order of millions of dollars places significant value on the outcomes of this research.

1.3 Statement of Problem

Many organizations within the Kingdom of Saudi Arabia are gathering geospatial information that is destined for data visualization Location Based Services (LBS) both for internal use, and for client use. These LBS which are reliant on intelligent, accurate mapping, have a variety of uses including proximity information used to plan and locate service infrastructure, traffic, and community activities. Other LBS applications include business fleet and team management, as well as oil, gas, and other natural resource management.

The costs associated with gathering and maintaining this information are major components of the overall budget of the GISs which support these LBS. Yet there are common components of the geospatial information used by each of the organizations so it should be possible for the costs to be shared, if the initial data gathering and maintenance efforts were shared. Such collaborative alliances would be to the mutual benefit of the organizations involved.

To present a substantive case for implementing a Geospatial Data Sharing arrangement in Saudi Arabia, a documented evaluation of the potential technical and social benefits, the possible disadvantages of sharing the data both internally and externally, and many other issues affecting the acceptability of data sharing is required.

The problem is that although many of the advantages of integrating GIS as a management tool within individual organizations have been established and systems subsequently implemented in Saudi Arabia, no formal assessment of the implications of geospatial data sharing between organizations has been documented. This research was initiated to overcome this situation.

The implementation of geospatial data sharing in Saudi Arabia will require determination of the long-term scope or framework of arrangements. A master plan should be drawn up that could be implemented in stages – preferably with a pilot study followed by a rollout program. This master plan should be directed to maximizing the benefits to be gained through sharing the geospatial data resources of the Kingdom. Data should be accessible to governing authorities, government agencies, and local authorities, as well as utilities and service providers, with mechanisms for coordinating spatial data resources at the Kingdom-wide level. However, prior to such an extensive, all encompassing proposal being contemplated seriously, it is considered better to implement a pilot scheme. It is with this limitation in mind that the scope of this research is defined without losing sight of the longer-term objectives.

1.4 Aim

The aim of this research is to propose and validate a model for the sharing of geospatial data between organizations as a pilot scheme in Saudi Arabia.

The model should take into account various technical factors such as overseas experiences and current systems in place in Saudi Arabia, as well as social and cultural issues common in the Arabian peninsular.

1.5 Research Approach

The research has been initiated to address data sharing possibilities identified during professional project implementation activities. Consequently, there could be a tendency for the resultant report to be weighted towards practical, industry-based project oriented concerns rather than towards rigorous academic investigations and research. To help in overcoming possible limitations on the value of this paper as an academic argument, only brief references are made to the GIS projects I am involved with either at the implementation stage or at the proposal stage. Research will concentrate instead on reviewing literature on the subject together with examining case studies, to determine the feasibility of geospatial data sharing in general and the applicability of the proposed model in particular.

1.6 Research Thesis Structure

To achieve the aim of the research, the thesis is structured using guidelines suggested by Evans and Gruba (Evans and Gruba 2002) in determining the research approach.

Chapter 2 presents a discussion of geographic and cultural aspects in Saudi Arabia and a review of GISs which are either implemented or in the planning stage as stand alone systems in the two Saudi Arabian organizations being used in the research, the Saudi Telecom Company and the Jeddah Municipality.

A review of relevant issues including potential benefits and possible barriers is presented in Chapter 3. The research incorporates a review of available literature on the subject and anecdotal insights from experience in the industry in Saudi Arabia.

The research mechanism, or instrument, is defined in Chapter 4 with an explanation given of the rationale for using this mechanism compared with alternative methodology. A conceptual model is presented, and this is followed by a discussion of its applicability.

Chapter 5 presents various data sharing examples and uses these as case studies. Through an analysis of their characteristics, the research attempts to determine if these models may be appropriate for Saudi Arabia, and then suggestions for an implementation plan are proposed for the most suitable model.

In Chapter 6 the results of the research are discussed drawing on Chapters 2 and 3, which were background chapters, and on Chapter 5 which was the analysis chapter. The selected model is reviewed and conclusions drawn in each of the earlier chapters is discussed. An appraisal of the research methods used in preparing this thesis and the outcomes achieved is conducted applying SWOT analysis techniques.

As a conclusion in Chapter 7, the discussion points raised are aligned with the aim of the thesis, as stated in Chapter 1. Acknowledging the limitations of the study undertaken, further areas of research are then recommended.

Figure 1.1 provides an overview of the structure of the approach taken.

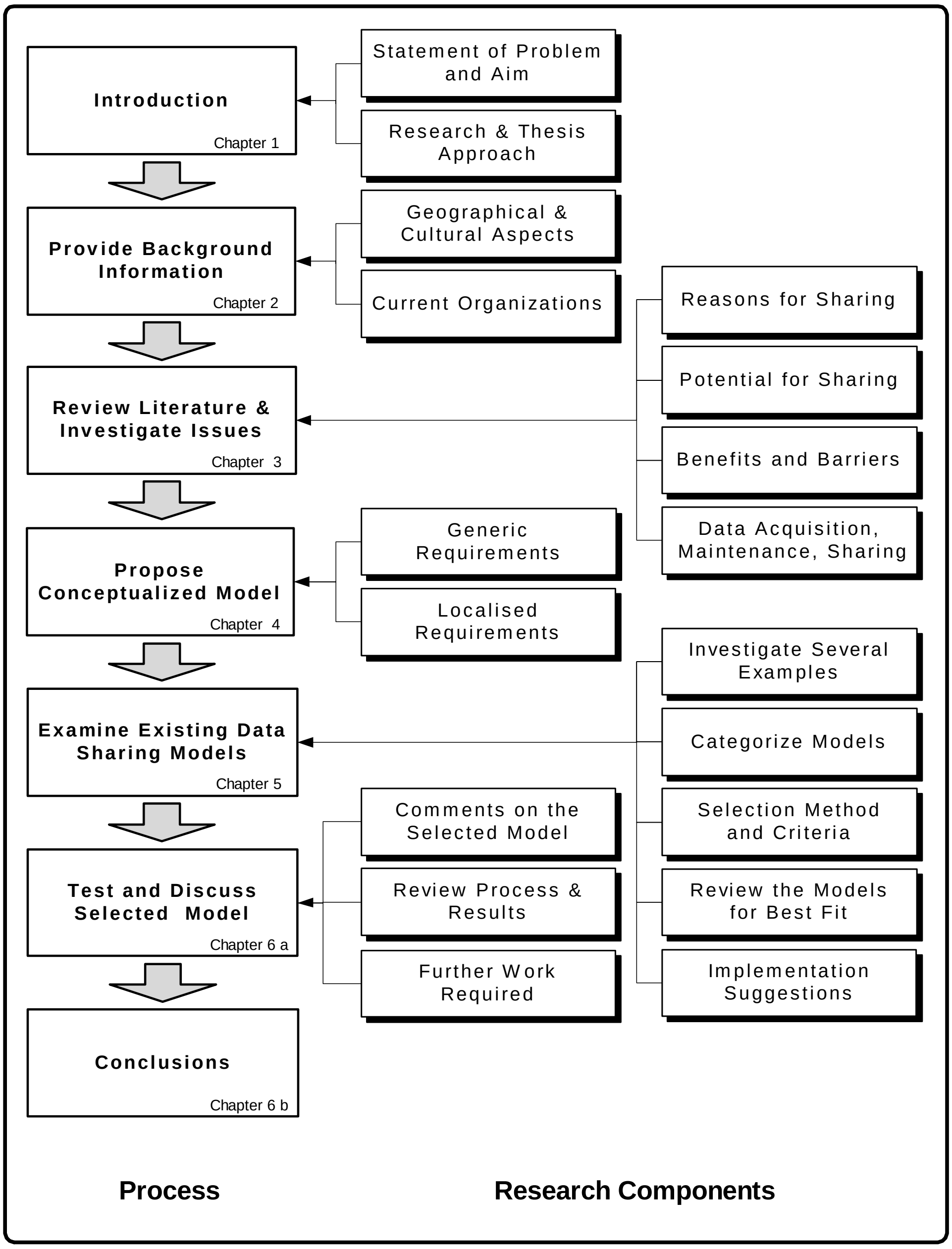

Figure 1.1 Structure of the Research Approach

1.7 Conclusion

This chapter has established geospatial data sharing in Saudi Arabia as a topic that is worthwhile examining not only because of the potential financial benefits of data sharing, but also because there may be significant obstacles to its introduction.

The research background section established the relevancy of locating the study in Saudi Arabia and a statement of the problem pointed to the need for a thorough, balanced investigation. To establish the direction of the research, the aim of the study was given followed by the thesis research structure. By having the research approach presented diagrammatically, readers of this thesis should be able to follow the logic of the argument.

The introduction leads into Chapter 2 which will provide a background to the geographical and cultural aspects of the research, and which will also give an appreciation of the organizations involved, prior to a review of available literature and the statement of the hypothesized concept to be tested.

CHAPTER 2

CULTURAL AND ORGANIZATIONAL ENVIRONMENT IN SAUDI ARABIA

2.1 Introduction

This chapter provides an overview of the geography, culture and organizations concerned with this research in order to familiarize readers with the locale. The research is focused on the use of geospatial data systems in a country with a rich assortment of needs and expertise. The research aims to improve the efficiency with which the systems are used and also to expand the availability and usability of information, so an understanding of the organizational use of the current systems is necessary. Consequently this chapter includes an outline of groups using GIS and a briefing as to what extent they share their data with other organizations.

Whilst the technology involved with the geographic information sciences is available worldwide, the way it is used and shared varies widely. This is a function not only of how technically advanced the country is, but also of social and behavioural issues. Hence cultural and organizational aspects have been included as the research, discussions and conclusions will involve these as well as technical issues. This chapter is designed to provide a backdrop for an appreciation of the local issues involved in this investigation.

2.2 Geographic and Cultural Background

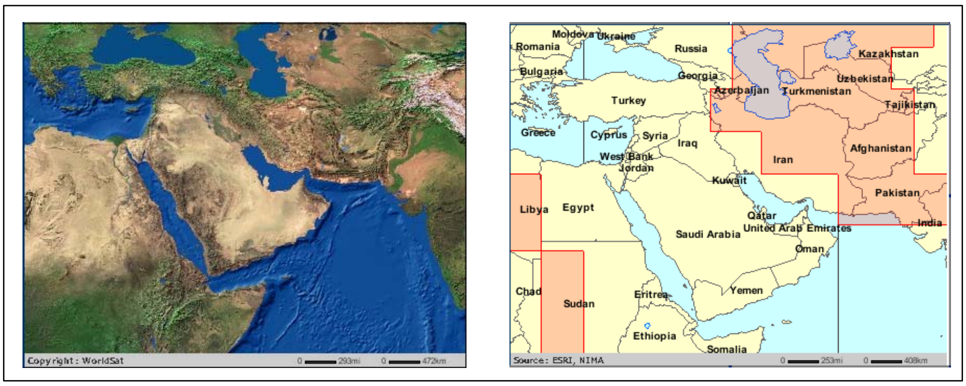

Figure 2.1 Topographic and Political Images of the Arabian Peninsular and Surrounding Areas

Sources : WorldSat; Geography Network (WorldSat 2001))

The aims of the research concentrate geographically on the Kingdom of Saudi Arabia, so this section will serve as a locational introduction, and will provide information relating to political and cultural issues.

Saudi Arabia is in the South West of the Asian continent bordering the Arabian and Red Seas, positioned in the Arabian Peninsular between geographic coordinates 16^0 $34'$ and 31^0 52'N, 34^0 05' and 55^0 $10'$ E. Thus the Kingdom is located mainly within UTM Grid zones 37 Q&R, 38 Q&R and 39 Q&R. Figure 2.1 Topographic and Political Images of the Arabian Peninsular and Surrounding Areas illustrates both the physical geography and the country borders in the region.

The Kingdom of Saudi Arabia has an area of 1,960,600 sq km (State Dept US Government 2002), approximately one quarter the size of Australia and a little larger than the State of Queensland.

The terrain is primarily uninhabitable sandy desert but with rugged mountains in the southwest. Settled habitation is limited to 5% of the country, and only 0.5% is arable. The climate is arid, with great extremes of temperature in the interior and with humidity and temperature both high along the coast. 98% of the land mass is classified as desert. Figure 2.2 Saudi Arabia - Desertification is included to indicate the extent of desertification of the country and to provide an appreciation of the huge efforts required to establish infrastructure given the sparseness of the land.

Figure 2.2 Saudi Arabia – Desertification

Source : Merriam Webster Inc (Encyclopedia Britannica 2001).

The total population is about 22.7 million of which about 6.6 million are foreign nationals. Even until recently, a significant proportion of the population was nomadic, although more than 95% of the burgeoning population is now settled due to rapid economic and urban growth. The capital city is Riyadh (population 4.3 million). Other major cities include Jeddah (2.4 million), Makkah (1.2 million), and Dammam/Khobar/Dhahran (1.6 million). These populations are estimates for 2001 (State Dept US Government 2002).

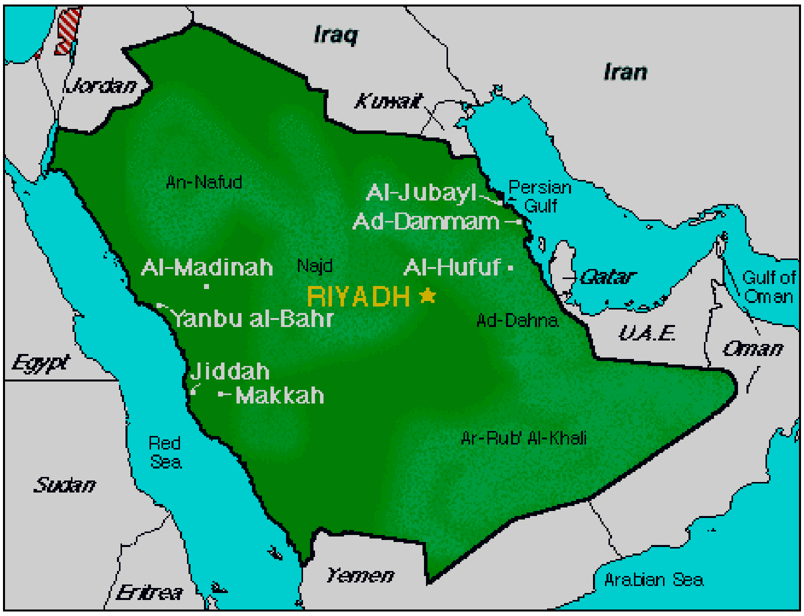

Figure 2.3 Major Commercial, Industrial and Religious Cities

Source : ABC Maps of Saudi Arabia (ITA 1997)

Figure 2.3 illustrates the relative locations for

(a) The commercial centres of Riyadh (Ar-Riyadh), Jeddah (Jiddah) and Dammam (Ad-Dammam);

(b) The industrial cities of Jubail (Al-Jubayl) and Yanbu (Yanbu Al-Bahr); and

(c) The religious cities of Mecca (Makkah Al-Mukarramah) and Medina (Al-Madinah Al- Munawarrah) .

The Kingdom [3] was established in 1932 after a 30 year effort by Abdulaziz ibn Saud to conquer and unify the 13 emirates which now comprise the nation. During 1999-2000, the country celebrated its "Centenary" of nationhood marking 100 years as measured on the Hijrah calendar since ibn Saud commenced his campaign of conquest in 1902 AD. (1320 AH.)

The nation remained very poor until the discovery of oil in the 1930s. Large scale production in the petroleum industry commenced after World War 2, resulting in substantial economic growth being evident by the mid 1960s. The economy grew

[3] The Kingdom is known locally as Al Mamlakah al Arabiyah as Suudiyah

dramatically during the 1970s following major increases in oil prices, leading to spectacular development of the nation's infrastructure. Thus the modern nation is quite young, and this is reflected in the willingness of the increasingly well educated population to accept new high technology solutions in their everyday lives. But a significant generational gap has developed and manifested through an apparent dichotomous relationship between access to globalised information systems and values, and the traditional culture.

Politically, Saudi Arabia is classified a monarchy with the King as the chief of state and head of government (State Dept US Government 2002). A Consultative Council or Shoura with advisory powers was established in 1993, although this body does not have legislative powers. The Shoura or consultative branch of the Islamic government structure provides a mechanism through which the Islamic government is accessed by the people, not as sovereigns, but as participants through consultation in government affairs (Al-Saud 2000). The Holy Qur'an is recognized as the constitution of the country (Horrie and Chippindale 1994).

Ideologically, the Kingdom is known as the birthplace of Islam, the religion which was established by the Prophet Muhammad (PBUH) prior to his death in the year 632 AD. The King, Fahad ibn Abdulaziz ibn Saud is designated Custodian of the Two Holy mosques which are in the cities of Makkah and Madinah, and as such is responsible for the safety and welfare of the millions of Muslims making pilgrimage to fulfil their Islamic obligations each year.

The cultural environment in Saudi Arabia is highly conservative, the country adhering to a strict interpretation of Islamic religious law (Shari'a). Cultural presentations must conform to narrowly defined standards of ethics. Men and women are not permitted to attend public events together and are segregated in the workplace.

Various areas of Saudi Arabia are located on ancient trade routes. For centuries it was beneficial for the local tribes people to extend hospitality to travellers who were passing through the areas, as this hospitality encouraged the travellers to use the route and to pay the levies imposed by the tribal leaders thus maximizing the benefits of their geographical position (Horrie and Chippindale 1994). Hospitality towards visitors has thus become synonymous with traditional Arabic culture. This legendary munificence is a welcome trait of the Saudi citizens of today and is traditionally extended to travellers whether they are from other parts of the Kingdom or Pilgrims from overseas attending to their religious duties. The same generosity is also extended to expatriates working in the region.

Arabic hospitality manifested through the sharing of basic shelter and other life supporting necessities **does not** however automatically lead to a willingness to share knowledge. To understand this phenomenon it is necessary to look at the way the industrialization of Saudi Arabia has taken place following the discovery of oil reserves in its Eastern province. Saudi Arabia was not formally colonized by European nations for exploitation of its natural resources the way many other countries had been in the eighteenth and nineteenth centuries. Admittedly it has a long history of being conquered by nations extending from the ancient Egyptians and Sumerians around 3000-2000 BC to the Ottoman Turks in the late in 1800s AD. But these invasions related more to acquisition of date and pearling resources and control of the holy shrine or *Khaaba* in Makkah.

During the 1920s, Saudi Arabia was a country that was severely stretched financially. With the commencement of petrochemical production that followed the discovery of oil in commercial quantities in 1938, the fortunes of the young nation were turning around. This brought numerous entrepreneurial companies willing to become involved with the nation’s development.

In addition to attracting genuine well-meaning developmental engineers, the new found wealth also caught the attention of numerous charlatans and companies whose aim was exploitation for the benefit of the company rather than for the benefit of the country. As many of these companies were receiving backing from their national governments, an economic colonialism evolved. Many development projects that were sold to the Saudis were ill conceived, or did not result in end products that matched the needs of the nation nor the cultural and physical environment. Many promises were broken, leaving low reserves of trust and goodwill. As a result, there is a natural suspicion when any project proposal is reviewed, or sharing of knowledge is suggested.

For any data sharing proposal to have wide-spread backing from Saudi engineering managers, its veracity would need to be supported by documentation indicating that it had been comprehensively researched. All issues, whether positive or negative, should be discussed, so that the authenticity of the proposal could be assessed. To localize the proposal, general reference to the status of geospatial systems existing in Saudi Arabia should be included in the research. This is the subject of the next section, followed by a more specific review of two organizations that have mature GISs installed.

2.3 Current Organizations with GIS

This section is an overview of GIS usage made in Saudi Arabia currently. It is included to demonstrate that although the industry has some mature systems in place, there is still potential for more organizations to install a GIS.

There are very few instances where data sharing is practiced even amongst the players with mature systems, and obviously none involving organizations currently without geospatial data systems. If a scheme for sharing geospatial data could be developed and adopted, there would be the potential for reducing redundancy in data collection both in upgrading the databases of existing systems, and in initial set-ups for new systems.

Numerous organizations in Saudi Arabia are either using GISs or have recognized the need to do so. Organizations that are using GIS data in Saudi Arabia and neighbouring countries include Arabian American Oil Company (Saudi Aramco), Ministry of Municipal and Rural Affairs (MOMRA), Al Riyadh Development Authority (ADA), Riyadh Municipality, Jeddah Municipality, General Directorate of Military Works (GDMW), General Directorate of Military Surveys (GDMS), Ministry of Petroleum (MOP), the Bahrain Telecommunications Company (Batelco) and Saudi Consolidated Electricity Company (SCECO).

Appendix 1 Geospatial Information and Saudi Arabian Authorities provides a listing of the availability of GIS to 32 various government related bodies and the type of geospatial data sharing that would be appropriate for each of these bodies.

This listing of 32 authorities includes :

- 3 Heads of State,
- 21 government ministries, and
- 8 government agencies/quasi government organizations.

It indicates that of these entities :

- 20 do not have a GIS,
- 7 have a GIS with limited capability, and
- 5 have a well established and functioning GISs.

It is evident from the listing in Appendix 1 that many establishments may be suitable candidates for inter-organizational data sharing. However, to keep the research to a manageable size this study has been to limited to two organizations. The **Jeddah Municipality** and **Saudi Telecom Company** have been chosen as the initial targets for testing the viability of a data sharing arrangement, with the possibility of extending the arrangement to other organizations being catered for in the formulation of the initial two party scheme.

2.4 Jeddah Municipality - Functions and Requirements

Jeddah is a port city of some 2.4 million residents, comprising an even distribution of national citizens and expatriates. It is located on the Red Sea coast 900 km west of the capital Riyadh. Jeddah is the largest city in the province of Makkah and is the second largest city in the Kingdom.

As an ancient city that grew to be a strategic port on the caravan route from Yemen and Makkah to Egypt, Jordan and Syria, Jeddah was famous for its bazaars and souks. The Islamic teachings of the Prophet Mohammad (PBUH) raised the city's importance as a staging point for Pilgrims arriving to visit the Holy Cities of Makkah and Madinah (Robison 1993). It is now a commercial centre, though most foreign diplomatic missions that it previously hosted have recently been relocated to Riyadh, thus reducing the political influence of Jeddah somewhat.

Jeddah has seen tremendous growth in the past thirty years, but in contrast to the planned development of Riyadh, the Kingdom's capital, areas close to the centre of Jeddah's "Old City" were not planned in accordance with modern town planning principles. Unlike many an ancient city that has been developed and modernised by building over its history, the old city of Jeddah has been "built around" thus retaining its beautiful old charm.

Outside the area of the previously walled city, the Jeddah Municipality has taken control of zoning, planning and urban studies, to promote orderly growth for the 1,200 square kilometres of area under its jurisdiction. Currently only 30% of Jeddah's area is built up (SAIR 2001).

Figures 2.4 and 2.5 provide a comparison between the "Old City" and the contemporary development.

Figure 2.4 View of Old Jeddah

Source : Saudi Arabia Information Resource (SAIR 2001)

Figure 2.5 View of Modern Jeddah

Source : Saudi Arabia Information Resource (SAIR 2001)

As a local government authority, Jeddah Municipality provides almost all the municipal, planning and maintenance services available in a modern city or town. These services are made available under the general direction of MOMRA which encourages the utilization of GIS (Al-Tassan 2000), and the guidance of His Excellency, Prince Abdulmajed bin Abdulaziz, the Governor of the province of Makkah.

Currently the main users of land base information within the Jeddah Municipality are the four divisions and four departments of the General Directorate of Urban Planning (GDUP).

The eight groups of the GDUP, as shown in Figure 2.6, interact with the existing hardcopy spatial database on a daily basis. The present system relies heavily upon the Plans & Maps Department to maintain the original copies of the documents and to provide these documents to the divisions and departments as requested.

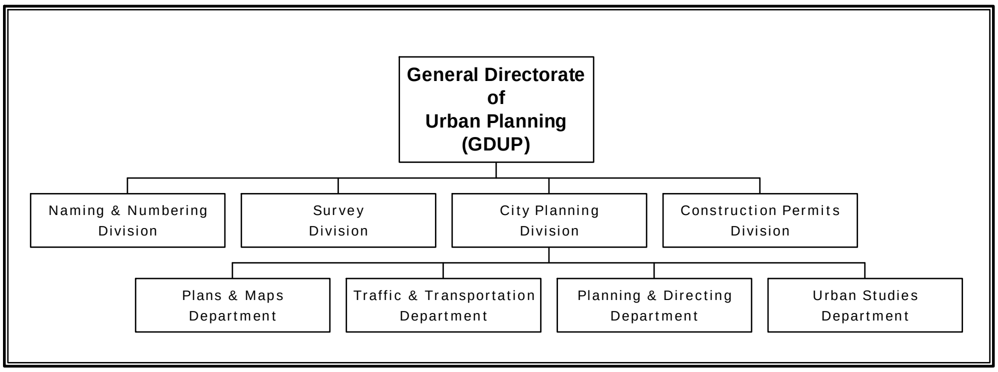

Figure 2.6 Jeddah Municipality Urban Planning Organizational Chart

The current usage of the landbase maps held by the municipality are summarised in Table 2.1 Landbase Map Usage by Departments for Regular GDUP Functions. All landbase maps are held by the Plans and Maps Department, mostly as mylar plans, though some are now being captured and stored digitally. When access to the maps is requested by other departments and divisions, they are reproduced as hard copies. Maps modified for traffic control purposes, such as detour arrangements are not held by the Plans and Maps Department, and so are not available for sharing with other departments.

The efficiency of these highly bureaucratised processes is hampered by the difficulties encountered by users, including the non-GDUP groups, in accessing the geospatial data.

Table 2.1 Landbase Map Usage by Departments for Regular GDUP Functions

Departments ➔ / **Functions 🡻**	Naming & Numbering	Survey	City Planning	Construction Permits	Plans & Maps	Traffic & Transportation	Planning & Directing	Urban Studies	Other Bodies
Zoning Regulation		✓			✓		✓	✓	
Issuance of Title Deeds		✓			✓		✓	✓	✓
Modification of Land Title Deeds		✓			✓		✓	✓	✓
Sale of Excess Land		✓			✓		✓	✓	✓
Traffic Remediation Plans						✓			✓
Traffic Detour Plans						✓			✓
Sub-Division Planning		✓			✓			✓	✓
Private Sub-Division Planning		✓			✓			✓	✓
Layout of Government Sub-Division		✓						✓	
Construction Permits – Private		✓		✓			✓		✓
Construction Permits – Government		✓		✓			✓		✓
Plot Survey Map		✓		✓	✓		✓		
Naming & Numbering	✓	✓	✓		✓				

From Table 2.1, it can be seen that other bodies are involved with the functions carried out normally by the GDUP. These other bodies include Deputy Mayor for Technical Affairs, Land Plot Division, Property Inquiry Section, Sub-Municipalities, Plots Estimation committee, Finance Department, Traffic and Transportation Coordination committee, General Directorate of Operations and Maintenance, Grant Plots Section, General Directorate of Projects, and Property Enquiry Section.

The mapping requirements within GDUP are mostly limited to accessing the appropriate data for the production of reports, whether graphic or tabular, based upon this data. Hence the primary requirement of GDUP is for a more effective means of sharing the spatial data used by its divisions, departments and sections. In addition GDUP management recognises that a centralized database which can be shared by the various groups is essential and that the high proportion of geospatial data involved with its operations points to the need for a comprehensive GIS. This technology is intended for use in infrastructure planning, site suitability assessments, land use inventories and zoning, as well as for general mapping purposes and Jeddah is upgrading its system to meet these uses.

Using a standardized methodology for maintenance, access and use, GDUP will be able to perform its functions more quickly with less duplication of effort. If the geospatial database were to be shared throughout the municipality administration, other groups could access the information directly also, reducing their dependence on GDUP manpower for information retrieval.

A data model using OpenGIS®[4] standards based GIS database modelling tools (Kottman 2001) had been developed by a consultancy team during the late 1990's. The graphics mapping definitions were developed based upon existing and defined standards established by MOMRA. These graphics features are linked through modular geographic environment (MGE) software to attribute tables maintained in an Oracle Relational Database Management System software. Using the information provided within implementation documentation, the municipality staff will be able to construct an effective and efficient GIS database for managing the planning activities at the Municipality of Jeddah through sharing the geospatial data within the GDUP.

The primary needs of the GDUP group can be met through implementing the proposed GIS. This leaves open the question of what further benefits could be derived if this data were shared with other directorates and departments of the municipality, and further more, if the data were shared with other organizations. These possibilities will be examined in the following chapters.

[4] OperGIS® standards and specifications are a development of the Open GIS Consortium Inc for geoprocessing interoperability.

Appendix 2 Functionality and GIS Requirements of Urban Planning in Jeddah presents details of the current status of GIS usage within Jeddah Municipality, and provides a basis for assessing the potential for data sharing with other agencies and authorities using GIS within the City of Jeddah.

Jeddah Municipality is also embarking on a project to upgrade its landbase. Costs associated with the project will exceed AUD 1.1 million in payments to the contractor, as well as project administration expenses within the municipality. A portion of this expenditure could have been shared with other organizations that will require similar data if a data sharing arrangement had been in place. Appendix 3 Examples of Costs for Data Acquisition gives particulars of the project being undertaken to upgrade the landbase information availability (Paragraph A3.1 Jeddah Municipality - Digital Orthophoto Mapping Project).

2.5 Saudi Telecom - Functions and Requirements

The Saudi Telecom Company (STC) is the sole provider of Public Telecommunications Network Services in Saudi Arabia. It currently has approximately 3.3 million Fixed Line customers, and 2 million Cell Phone customers. It has an extensive network, comprising copper and optical fibre cables as well as microwave and wireless subscriber links, interconnecting customers and telephone exchanges throughout Saudi Arabia, with gateways to other countries.

STC has placed a tremendous effort into expanding the fixed line network, doubling it in the past 7 seven years, and has recently announced a further 600,000 line expansion. All the cable details are recorded in an Automated Mapping/Facilities Management (AM/FM), Digitized Plans System (Aal 2000).

There have also been several projects involving the establishment of Cell Phone (GSM) systems. The location of all GSM ground facilities such as towers, exchanges and miscellaneous equipment properties have been captured into the Digitized Plans System (DPS).

STC is actively pursuing value added business opportunities in e-commerce and other Internet related fields, emergency vehicular dispatch, and Directory Assistance (including reverse telephone listings) to commercial enterprises.

Planning processes within STC closely follow the established Telco development stages shown in Figure 2.7 Saudi Telecom Company Planning Processes. The potential for in-house data sharing can be seen with many processes relying on information with geospatial data components.

TELCO PLANNING PROCESSES

1 Corporate Planning
- Corporate Direction
- Products and Services ←*
- Markets and Market Shares ←*
- Strategic Partners
- Operating Partners ←*

2 Strategic Planning
- Future Developments ←*
- Future Innovations
- Implementation Strategy and Timing ←*
- High Level Performance Specifications

3 Forward Planning
- Technological Implementation Plan ←*
- Long Term Economic Comparisons ←*
- Long Term Cost Estimates ←*

4 Financial Planning
- Incomes
  - Service Rates and Tariffs ←*
- Expenditures
  - Budgets
- Program Funding

5 Fundamental Planning & Development ←*
- International, Long Distance & Junction
  - Network Hierarchy
  - Switching Hierarchy
- Numbering Scheme
  - Number Allocations
- Switching Rules
  - Long Distance
  - Junctions
  - Customer Access Network (CAN)
- Planning Rules for
  - Long Distance
  - Junction
  - Customer Access Network
    - Fibre and Copper
    - Wireless Local Loop
    - Pair Gain Customers
    - Radio Systems
  - Bandwidth to Customers

6 Traffic Engineering Planning ←*
- Exchange Classifications (in Switching Hierarchy)
- Trunk and Junction Route Dimensioning
  - Backbone Routes
    - Routing Plan
    - Route Dimensioning
  - Alternate Routes
    - Routing Plan
    - Route Dimensioning
  - Diversity Routing
    - Routing Plan
    - Route Dimensioning
  - Disaster Plan

7 Network Planning ←*
- High Level Area Planning
- Long Distance Network Planning

8 Local Area Planning ←*
- Local Area Network Planning
  - Exchange Locations
  - Exchange Boundaries
  - Inter-Exchange Junctions
- Local Exchange Area Planning
  - Feeder Route and Area Boundary Planning
- Cabinet Locations

Figure 2.7 Saudi Telecom Company Planning Processes

←* indicates processes with geospatial component

Use of the Digitized Plans System

The recently installed Digitized Plans System (DPS) was designed to meet the geospatial data storage and access requirements of Saudi Telecom. As a core component of an Enterprise Resource Management system, the DPS would facilitate maximum efficiencies in the planning processes illustrated in Figure 2.7.

There is potential for Corporate and Strategic Planning groups to utilise the geospatial database in demographic analysis. Similarly, Financial Planning would benefit from a temporal analysis of the effects of demographics, which the geospatial database could illustrate.

In addition to these top level corporate and strategic usage potentials, the following uses are instanced :

- The DPS, and its GIS database, are used for Fundamental Network Planning and Development, detailed Network Planning and Local Area Planning.
- Customer Services as well as Operations and Maintenance activities are also linked to the DPS.
- The design of inter-exchange circuitry over copper and fibre rings is gradually being transferred to the DPS.
- Local Network Design (LND) work is done almost exclusively on the DPS. There is also considerable potential for using shared data which relates to other utilities, and information about subdivisions under the jurisdiction of the municipalities.

As an example, the LND process is illustrated (see Figure 2.8 STC Outside Plant Design with Digitized Plans System).

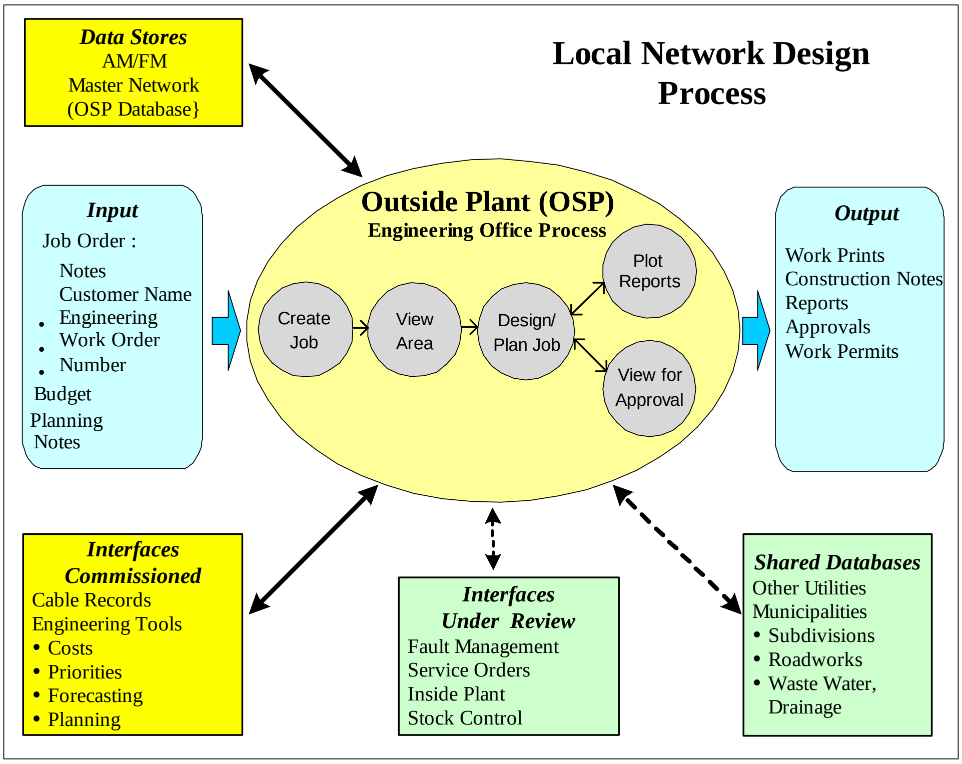

Figure 2.8 STC Outside Plant Design with Digitized Plans System

The current system for LND involves the engineering office accessing the Outside Plant (OSP) database through the *Data Stores*, and the *Interfaces Commissioned*. Each of these accesses is indicated by a solid line in Figure 2.8. However, better use could be achieved with access to the *Interfaces Under Review*, and the *Shared Databases*. These other accesses are indicated by dotted lines. The *Interfaces* shown are within the STC organization, whilst the shared databases would be external to STC.

Extending the Use of the Digitized Plans System

Attempts have been made to implement the interfaces that are listed as "under review", but there have been difficulties in gaining the necessary cooperation from other departments. For example, the stock control group will not allow the network designers on-line access to check material availability, nor to reserve material. This reluctance is not unusual within organizations, and could also be anticipated with external data sharing.

To date with the exception of some of the engineering departments, the DPS has not evolved as a resource shared widely within STC. It is not part of an Enterprise Resource Management system as was envisaged at the outset. The adoption of the DPS as an essential component of infrastructure management has been delayed partially because inaccuracies in the database have reduced the confidence of potential users . Since data quality is a concern to every engineering and GIS professional, a GIS is considered useless if the confidence in the data is low (Wampler 2000).

Another factor is the dominance of other influential groups within STC, and their reluctance to change to using GIS as a prime data source. This latter reason can be linked to efforts to retain control of data and the associated knowledge "turf", and will be discussed in Chapter 3 as an issue affecting the adoption of data sharing.

Many of the current database inaccuracies can be attributed to the difficulties faced by those laying out the paper or mylar based network drawings in mountainous areas where there are significant differences between planimetric and surface measurements (Berry 2002b). Lineal corrections and adjustments for the severe terrain slopes fell outside the skills of the draftsmen, resulting in poor correlation between strict planimetric distances and actual landline communications path lengths. As a result, a large portion of the rural areas were presented to the conversion team as "hand-drawn, not to scale" drawings with numerous inaccuracies. Through digital terrain mapping techniques available to the GIS professional, far more precise mapping of the landbase is now possible. However, confidence was lost in the converted data in some areas and users reverted back to using paper plans and the DPS project benefits were partially lost.

The landbase accuracy problem is being addressed to eliminate any technical impediments this may have brought about and to encourage maximum usage of the system. The GIS landbase will be updated in terms of accuracy and range to meet the landbase information availability needs of the current STC user groups. Costs associated with this upgrade are estimated to be AUD 15million for the whole Kingdom, including AUD 1.4million for the Jeddah sector. Appendix 3 Examples of Costs for Data Acquisition gives particulars of these costings in paragraph A3.2 Saudi Telecom Outside Plant Geographic Database Project.

2.6 Existing Systems for Data Sharing in Saudi Arabia

In Saudi Arabia, there is very limited sharing of data between organizations. The pattern used almost universally in the Kingdom of Saudi Arabia is for individual organizations to have separate, isolated databases. Often this individualization is repeated within the various Department and Divisions at group (sub-organizational) levels, each gathering and maintaining unique geospatial databases.

For example, within the Riyadh Municipality two divisions, the Naming and Numbering Division and the Operations and Maintenance Division, possess street centreline information, but these two divisions do not have a data sharing arrangement.

On the other hand, the large oil producing company, Saudi Aramco, which is headquartered in the Eastern Province city of Al Khobar, has a well integrated GIS facility that is accessed and used by many departments. This diversified use of the GIS is a reflection of the strong influence of previous United States management. The company uses geospatial data in engineering applications, such as constructing thematic maps, for location based services)to be accessed in conjunction with oil field surveys and vehicle tracking roles, and in strategic financial analysis of the company's opportunity and risk potentials. However, the company does not willingly share this data with other organizations, and there is no data sharing either from or to external bodies.

The major geospatial data sharing in Saudi Arabia is in the field of satellite imagery, but this is government controlled as all non-military imagery for use within the Kingdom has to be purchased though a central point that sources the material from various vendors (KACST 2000).

Several attempts have been made to establish a data warehouse and to acquire and maintain geospatial information for universal access. One proponent of this concept is the King Abdulaziz City for Science and Technology (KACST), a Riyadh based government sponsored centre for learning and application.

KACST is an independent scientific organization of the Saudi Arabian Government and is the closest entity to a fully fledged coordinator of the distribution of generic informatics and geographic information in Saudi Arabia. All satellite imagery used for civilian purposes within the Kingdom has to be obtained through KACST, so it is a *defacto* custodian of this imagery, and hence is positioned well to play an important role in coordination of the exchange of GIS information. This "sole distribution point" system is common throughout the Arabic Middle East. For instance, the Iranian Remote Sensing Center (IRSC) is the only legal governmental body for providing Remote Sensing data for all of the users throughout that country (Majd 2002).

Amongst the planned research and development activities for KACST is a study on the use of GIS and remote sensing for water monitoring and conservation, and the application of water conservation techniques in agriculture using remote sensing techniques. The GIS information obtained in this project will be available to and exchanged with member groups such as the Ministries of Defense & Aviation, Interior, Higher Education, Agriculture, Industry and Electricity, Petroleum and Mineral Resources and the Ministry of Planning.

In a less extensive scheme, the Supreme Commission of Tourism (SCT) under the guidance of its secretary-general Prince Sultan ibn Salman bin Abdulaziz, has signed an agreement with KACST for making use of its satellite imagery and remote sensing capabilities for producing tourism mapping (Hassan 2001). Under the agreement, KACST will provide the commission with satellite images obtained from SPOT, IRS and Radarsat sources (KACST 2000).

KACST is also sponsoring a study being conducted at King Faisal University in Dammam to design an integrated GIS database that will help municipalities to plan, develop, and manage their cities efficiently and effectively (Kubbara 2000).

Other limited schemes have been discussed for a long time. Since 1994 the Jeddah Chamber of Commerce has been sponsoring and convening seminars, aimed at establishing a coordinating committee. In 1995 a committee was established comprising representatives of various Government Departments, utilities and private entrepreneurs. Subsequently, the objectives and goals of collaborative efforts were set and published.

However, to date, none of the centres of cooperation and coordination that were established has achieved even rudimentary success. They have languished at the stages of planning and scheduling, where the allocation and acceptance of responsibilities were to be determined. There is some hope that a recent call from the Governor of Jeddah for authorities to share geospatial data will encourage pursuit of meaningful discussions (Hassan 2002b).

It is not uncommon for enthusiasm for these types of arrangements to diminish as there may be many complexities and obstacles involved prior to a successful implementation (Nedovic-Budic and Pinto 1999). In fact, joint projects have a hard time getting off the ground because of differing requirements (Middlestead 2000), control and trust problems, and assessment and distribution of the costs to be split.

2.7 Conclusion

In this chapter cultural issues have been related to geographic, historical and political aspects of Saudi Arabia. These issues help to explain why even though several organizations including Jeddah Municipality, Saudi Telecom, Aramco and the King Abdulaziz City for Science and Technology have established functioning GISs, progress made towards sharing the geospatial data has been very limited.

The descriptions of the functions and requirements of both the Jeddah Municipality and the Saudi Telecom Company have provided evidence of the need for internal data sharing, as well as inter-organizational geospatial data sharing.

Technical and financial motives need to be examined and exposed when developing a workable model for data sharing. These motives can then be weighed up with cultural, political and organizational considerations, and a balance achieved for the promotion of data sharing. This examination will be pursued in the following chapter.

CHAPTER 3

REVIEW OF DATA SHARING ISSUES

3.1 Introduction

This chapter provides results of an analysis of factors that facilitate or obstruct geospatial data sharing among organizations. The subject was researched through reviewing available literature and taking into account local knowledge acquired during several years working in the industry in Saudi Arabia.

As there are few examples of data sharing in the country, literature relating to the application of geospatial data in the Kingdom is confined to the use and potential of GISs within organizations, rather than inter-organizational uses. Consequently, most of the literature reviewed refers to situations external to Saudi Arabia.

In a later chapter (Chapter 5 Data Sharing Models Examined), several examples are considered and evaluated as case studies, leading to an assessment of the applicability and appropriateness of these cases as models for Saudi Arabia.

Overall, the research attempts to present a balanced approach to the subject through adopting a process of reviewing literature and taking into account local knowledge in this chapter, followed by an evaluation of various existing systems.

3.2 Reasons for Data Sharing

To fully realize the benefits of their AM/FM/GIS projects, utilities and government authorities in many countries are becoming involved with data exchange arrangements, making the facility and geographic information available to external organizations, and acquiring information in return from those organizations (Lonski 1997).

There are various reasons for sharing geospatial data, and there has been a considerable amount of research undertaken and documented on data sharing and data exchange, particularly between Governmental (or public) Institutions (Nedovic-Budic et al. 2001). Lesser amounts of published research relate to sharing between Public authorities and Private organizations such as utilities. However Ian Masser (Masser 2002), in reviewing the Canadian Geospatial Data Infrastructure, does discuss aspects of collaboration in geospatial data sharing involving the private sector.

Most research includes the following common issues:

- Objectives, Benefits and Incentives for Sharing Data

- Extent of Data Sharing and Levels of Contribution
- Extent of Interaction and Participation between the parties
- Standardization Agreements and Access Arrangements
- Data Control and Ownership
- Technological and Human Obstacles to Implementation

This section will concentrate on the first of these common issues, with the remaining items covered in the Issues section.

A prime consideration in gaining an acceptance of any data sharing venture between different organizations is establishing win-win scenarios for each of the parties. A second consideration is the understanding of the different expectations and requirements of the organizations involved (Nedovic-Budic and Pinto 1999).

If we take a municipality, and its governing authority on one side, and a utility, such as a telecommunications provider on the other side, it becomes obvious that though there are points of commonality, each side has requirements which bear no relation to those of the other side. Favourable consideration of data sharing arrangements will depend on being able to demonstrate a net beneficial outcome for each party. Furthermore, it will be necessary to show that a thorough examination of issues involved with geospatial data sharing in general has been made, including a consideration of localized issues.

Literature concerning the implementation of projects involving data integration and exchange across multiple agencies tends to be positive (Azad and Wiggins 1995). This is especially so if the articles are prepared by whoever is responsible for either the project concept, or its implementation. For example, the following benefits have been derived from the Singapore Land Data Hub Program (Heng 1999): ***Convenience*** *for subscribing agencies;* ***Reduced Overheads; Data Consistency; Data Availability; Data Integration;*** *and* ***Data Exchange*** *between government and private agencies.*

In analysing the pros and cons of sharing data, it is important to assess the objectives for making the data available to others (Spencer 2000), and the needs of the users of the data. That is, as well as looking at enhanced customer services, other issues that have to be discussed include an understanding of the needs of the organizations and the people who are eventually going to use the systems that could be sharing the data. This requirement leads again to a study of the organizations, their structures and their missions. The degree to which better and more integrated planning and policy development can be achieved through sharing GIS data will also be influenced by the organizations themselves.

A study of the objectives should also determine what data is to be made available, how best to make the data available, what commercial or business implications are entailed and what security risks are involved, particularly when allowing data access to third parties. This theme is covered in detail in a report on financing the National Spatial Data Infrastructure in the USA (Cahan 1999), when identifying investment mechanisms for setting up spatial information sharing arrangements.

The assessment should include an understanding of the extent to which the data is to be shared, that is whether it is to be intra-organizational sharing, inter-organizational sharing between fixed partners, or open ended sharing such as with the public, or a hybrid of these. Using this assessment to provide criteria for developing a basis for sharing geospatial data will allow participants to focus on their role better (Blyer et al. 2000).

It is important to note that a consideration of data sharing must include the business objectives rather than just data-base objectives (Rowland 1998), and that the business environment can affect the business objectives, so the literature to be reviewed should include references to non-data specific reasons for sharing. Thus an integral part of promoting the exchange and sharing of GIS data between organizations is an appraisal of the business objectives of the organizations involved, and an assessment of whether a sharing arrangement would be beneficial, either collectively, or individually, and whether sharing would be politically acceptable within the organizations' business philosophies. The structures of organizations will also often provide indications of their propensity towards the openness that is an essential element in data sharing (Pinto and Onsrud 1995).

The relative need for current, close-to-real-time, geographical data can influence the enthusiasm with which organizations will embrace, or at least consider, data sharing arrangements with organizations whose activities impact their own. Some organizations prioritise on speedy, streamlined service to the public. Through a cooperative data sharing venture with other organizations there is the potential for them to increase the information available for serving their customers, and to reduce response times in delivery of the information.

3.3 Benefits

In the early days of inter-organizational data sharing, perhaps the greatest benefit derived was the reduction of efforts in developing digital databases (Larsen 1976). Since then other potential benefits of multi-participant approaches were identified as sharing the cost of implementation among several participants, and boosting productivity and decision making through the exchange of information (Brown and Brudney 1993). There is now the potential for including added benefits such as better and more integrated planning and policy development, as well as building problem solving relationships (Dawes 1996).

GIS sharing contributes to increased availability of data, to reduced time spent in data collection and decision making , and to the availability of more diverse maps (Budic 1994). Consistency of information and enhanced predictive capabilities, are both common attributes of data sharing (Greenwald 2000). Intangible advantages and improvements such as higher staff moral , self-confidence and confidence in others should be added to the list of benefits (Nedovic-Budic and Pinto 1999).

Cautions

It should be recognized that there is contradictory evidence relating to the implications of data sharing, particularly in inter-organizational relationships.

For example, some researchers find that coordination can also generate lower confidence in other participants (Dawes 1996; Brown et al. 1998).

The confidence of those involved may be further diluted through delays in setting up. These delays may be the caused through setting in place complex arrangements when striving to maximize the benefits of data sharing. This can often result in under-delivered or even failed projects.

Throughout the analysis of the potential of data sharing, a rigorous examination of the supposed benefits will often identify the benefits as coming from the GIS of the individual organization, rather than through the act of sharing data. Conversely, without a promotion of the data sharing, many of the potential benefits would languish through management and users not being aware of the potential of their organization's GIS.

3.3.1 Reduced Costs in Database Development

For organizations that are embarking on developing a GIS, sharing the expenses with other parties that may also be at the same stage of development (and also have some commonality of geospatial database requirements) will obviously lead to reduced costs for each organization. Ideally this would be a saving of around 40% of costs after administration overheads are included, if the common isolationist approach is rejected in favour of sharing the data [5].

But what of the organizations that already have geospatial systems in place, such as the Jeddah Municipality and Saudi Telecom? Does the possibility of cost reduction apply, and if so, under what circumstances?

Many utility and government organizations have developed the base mapping for their AM/FM systems by converting their collection of hardcopy drawing sheets into digital format. This collection can include work prints, plats, engineering details, schematics, etc. Each drawing sheet may have high relative accuracy and include very precise dimensioning. However, many of the drawing sheets from which AM/FM maps are created lack geodetic control reference points or coordinate grid projections. The result is a mismatch so when seamed together on a geographic base, drawing sheets may not edge match well (Elliott 1999).

The demand for more sophisticated uses for the GIS, such as for Automated Vehicle Tracking used in advanced computer aided dispatch that Operations and Maintenance departments employ, makes it is essential that the AM/FM system support GPS positioning facilities. This means that the underlying map base must provide a high degree of absolute geographic accuracy that will relate mapped facility locations to the GPS location of vehicles (Elliott 1999). As a result, many organizations are having to revisit their base data, and update the legacy geospatial information.

It is at this stage that an agreement to share data can result in a reduction in costs to each of the data sharing partners. In general, updating the base geospatial data will be contracted out to a third party company that specializes in this process. Whilst each of the partners may have special requirements, for example in terms of accuracy, the core collection, conversion and verification process costs can be shared.

[5] The size of this saving would depend on what proportion of the total cost is related to data collection and conversion activities.

Both Jeddah Municipality and STC are currently, and separately, engaging contractors to enhance their existing base maps by supplying fully geo-referenced land base data from satellite imagery for the Jeddah area – at a cost of millions of Saudi Riyals. This is a cost that could be shared, were data sharing agreements in place. This is possible technologically.

Organizationally when one party is able to make direct contact with another party who possesses required information, there is far less likelihood of replication of effort in creating and maintaining databases. Similarly, if a synergism is developed between associates from the two participating groups, the development costs can be reduced through leveraging on the combined experience and abilities. The effect may be that an emergent property of synergism is that the resultant combined developmental skill level may be greater than the sum of the individual skills brought to the partnership.

3.3.2 Benefits to Users – Improved through Data Sharing

Information visualization is about aggregating data and attribute information into a single visual representation that allows exploration, analysis, discovery, and communication to others. GIS can analyse, manipulate and report on data as a basis for decision making. Sharing geographic data results in greater use the information, thus increasing the value of the data, without increasing the cost of developing and maintaining it. Information which is normally held as isolated and often under utilized data, can be used repeatedly for many purposes if shared.

The more data that is available, potentially the better the results. It follows then, that more comprehensive analysis and improved decision making will be possible through having access to the larger database that sharing data provides. Many of these benefits are due to having increased information and better quality data available. This section of the research addresses some applications in which data sharing has the potential for improving functionality, even though they can operate in a stand-alone configuration.

Regulatory Searches

Engineering professionals are constantly faced with the daunting task of wading through a great amount of regulatory prerequisites. Prior to beginning any planning or construction task, contractors, engineers, architects and other professionals must be well-informed of what specific forms, regulations, specifications, licenses, statutes, ordinances or codes they will need to comply with. They must contact various agencies that may be affected by work done in the agencies' jurisdiction, including those with buried infrastructure. The entire process creates a flow of information and communication that many times results in inefficient use of time and resources, loss of required information such as forms or documents.

Rather than having to contact each of the authorities or agencies, a preferred method is using a shared resource, such as an Internet Web site or other data-clearing warehouse. Provided the information is current, the use of such a system has the potential to lead to a significantly reduced duplication of effort and resources. By enabling access to valuable on-line information and the use of Web enabled GIS applications, there is a potential reduction of staff time per contract, both for the information seekers and the information providers, with a resultant increase in efficiency.

The burden of providing the most current information concerning the planning, design and construction community would rest with each of the concerned organizations as an Information Provider.

Extending this concept, in developing a partnership for exchanging and sharing geospatial data, there is an opportunity to develop standardized data entry templates for this ancillary information, with a common hierarchy of information titles or headings (Lopez and Firquain 1999). Data providers would be in total control as to what digital information would be provided to their potential users through the use of on-line security and data entry forms. If the sharing is employed on a Web, end users would have up to date information required to bid, plan and complete projects available on a 24 hour, 7 days a week time-table.

Production of Smart Maps - Data Mining

Some analysts estimate that many organizations effectively use less than 10% of the data they collect and store (Taylor and Haenni 1999). This low usage is based on traditional analysis techniques. Through the use of automated statistical analysis (or "data mining") techniques, businesses are now discovering new trends and patterns of behaviour that previously went unnoticed.

Sharing geospatial data combined with data mining techniques can offer the opportunity to produce smart maps which reveal deeper connections between things, places and people (Taylor and Haenni 1999) than may have been possible from data gathered and stored to meet the focus of each of the individual organizations. Data derived from remotely sensed images, topographical maps and origin based surveys for one organization may be used by another to determine environmental sensitivity in relation to urban and suburban residential choices (Reginster and Edwards 2001), a key factor in infrastructure planning.

Once they've uncovered this vital intelligence, it can be used in a predictive manner for a variety of applications. For the engineering departments of the Jeddah Municipality and STC, this could improve the effectiveness of their groups forecasting of infrastructure requirements

There are various techniques that have been developed for data mining, involving rule induction, neural networks and mathematical algorithms (Berry 2002a). For instance, regression is the oldest and best known statistical technique utilized by the data mining community. This can be applied to cases of continuous quantitative data, such as population growth, which leads to normalized predictions (forecasts) of infrastructure requirements.

For working with categorical data where order is not significant (like nationality, name or gender) another technique may be better chosen. For instance, in geo-demographic profiling the effects of the distribution of, say, the Al Ghamdi family members, may be considered using a shared database which includes names from the Municipality's records, and telephone connections geographically linked through the STC GIS, and then analysing the data using Classification analysis (Berry 2002a).

From this it might be found that, as an example, the Al Ghamdi family[6] has a higher probability of settling in specific locations, or that their usage pattern for various services may be significantly different from another family. The Classification analysis technique is capable of processing a wider variety of data than regression and is growing in popularity. Instead of the complicated mathematical formula given by the regression technique, classification analysis provides a decision tree that requires a series of binary decisions.

Through a combination of data mining techniques, and the larger information warehouse that data sharing provides, it would be possible to produce smart maps that take into account many more diverse considerations than would otherwise be used.

[6] The Al Ghamdi family are descendents of the Al Ghamdi tribe from the Al Baha Province.

Emergency Response

The significant usage of cell phones during and after the tragic events in the United States on September 11 2001 has raised once again the valuable role that the implementation of automatic cell phone locational advice could provide.

Throughout the United States, telephone companies have been working towards an enhanced universal emergency call service dubbed E-911, whereby calling line identification (CLI) is provided from all telephones, landline and wireless, to emergency service operators at Public Safety Answering Points (PSAP). By the year 2000, nearly 93% of the population of the United States had access to some type of 911 service (National Emergency Number Association 2000). Ninety-five percent of that coverage was Enhanced 911. From the CLI information, callers from static or fixed landlines can be located by matching the calling number with the geographic records held by the telecom infrastructure and service providers in their GIS.

Combining this access with Automated Vehicle Dispatching, emergency response times can be improved significantly. With data sharing, the amount of information available to the dispatch system, on which route and crew type selection is based, is improved.

The correlation between fixed telephone services and their location is a relatively simple matter. However, when it comes to mobile (GSM) phones, the physical location will be provided by GPS built into the telephone. Retrieval of the nature of the location, will be enhanced through smart maps that can be generated according to temporal factors. Again, shared data will aid superior decision making and option selection in relation to rescue efforts. For example, current storm water channel information provided to the Civil Defense Department emergency response team through the GIS of the Jeddah Municipality, when combined with geographic information provided through STC's system, could affect the routing of rescue efforts in a flood crisis.

In the case of the World Trade centre disaster, many calls were apparently received from the cell phones of victims shortly after the tragic events began. It is probable that location technology would have aided the search-and-rescue efforts in New York City. Had E-911 been operational, it is believed that some of the victims could have been located earlier.

A September 21 2003 filing to the Federal Communications Commission from three major public-safety organizations also called for a vigorous commitment to E-911 in the wake of this disaster (Rockhold 2001).

> "The urgency of this work has increased a thousand-fold in the face of recent terrorist attacks on our own soil," the filing states. "Life in the United States of America has changed forever. The President has alerted us to prepare for further acts of terrorism here at home. This is real."
>
> "Of one thing we can be certain: Use of wireless phones will play a vital role in reporting and responding to incidents as they occur and in preventing incidents before they occur. 911 operators will be the first to take the calls. They will be the caller's lifeline. The need for Phase II has always been clear; the need is even greater now. We no longer have the luxury of time" (Rockhold 2001).

Once operational in the USA, the techniques used will be available for other countries, with similar telephone systems, to enhance their Emergency Call procedures.

3.4 Issues

Achieving interoperability whereby users of geospatial information systems can share their information between geospatial applications is a challenging research issue that is attracting the attention of a growing number of scientists. Sharing data between partners in a closed environment, whether the sharing is intra-organizational, or inter-organizational, involves some common issues, including data ownership, responsibilities for managing and maintaining the GIS, and funding both the central resources and the data components "owned" by the parties to the arrangement (Finkle and Sanger 2000). Routinely useable tools to collate, refine, analyse and distribute information have to be developed if many decision-making processes are not to be hindered (Rhind 2002).

As well as these considerations, in developing the data sharing model to be adopted, system designers must address the real needs of the partners in terms of interfaces (Fischer 1998). These needs might involve the organizations sharing the GIS data as a resource that is accessed during the day to day operation of each organization's work management information system (WMIS) (Trotter 2000). The geospatial application and database designers/developers must examine the requirements of the users acknowledging that there will be an expansion of needs and demands associated with a growth in community usage of the system (Miller and Rhodes 2000). Users need to understand that every feature[7] they place will be considered to be part of the network and accessible by external systems, increasing their responsibility to maintain the accuracy of the database.

A proposal for data sharing must demonstrate that all the issues which might be relevant have been considered and then articulate a clear vision of the data sharing arrangements that is easily understood by the policy makers and all other proposed participants (Blyer et al. 2000).

Issues that have to be addressed can be classified as technical, organizational, or a combination of both. Whereas technical issues can be addressed logically, with an expectation of resolutions being either feasible or not, organizational issues such as cultural nuances can not always be dealt with using rational arguments or addressed as logical problems. The conflict between technical limitations and organizational goals can eventually lead to the demise of data sharing schemes (Greenwald 2000).

The challenge is to identify the issues, and differentiate between those that are purely technical in nature and those which are of a cultural or organizational nature. This will assist in evaluating the perspective to be put on each issue, and the approach to be taken in assessing the feasibility of testing the data sharing model proposed for applicability in Saudi Arabia.

In this section, issues which can be clearly defined as technical in nature will be dealt with first.

3.4.1 Standards

For utilities, AM/FM databases can prove to be very expensive if usage is limited to single-departmental solutions in accordance with an isolationist policy, especially if other departments are using separate databases with different platforms. Elimination of expenses caused by this duplication is one of the leading reasons for considering enterprise wide data sharing. Conceptually, the savings that are invoked through inter-departmental sharing can be extended to inter-organizational data sharing.

[7] Examples of geographic features include streets, sewer lines, manhole covers, accidents, lot lines, and parcels. Each feature has one or more attributes which can be selected according to search criteria to compile a sub-set of features.

For various reasons discussed later, many data owners and producers may not be either fully prepared to share data, or even if they will share, it may not be in a manner consistent with regional or national spatial data infrastructure. Many systems were built at a time when businesses didn't imagine that they would want to expose their data to anyone but their own group, so widespread access, integration and compatibility with standards were not important. Thus across many domains, users of shared geographic information struggle when they attempt to compare or integrate their data with data collected and processed by others and important insights can be lost due to this impediment (Mark 2000).

Data standards are essential, and to address this issue many advanced geospatial systems use standard hardware configurations which are integrated with enterprise-wide networks utilizing industry-standard programming languages, so that several databases can seamlessly interact with each other (Miller and Rhodes 1999). Through applying current standards, many large utilities are now ready for data sharing with local government enterprises and other utilities (Bowditch 2001).

Standardizing hardware is becoming increasingly less important as generic workstations and servers are becoming more powerful and capable of processing the extensive graphic workload inherent in GIS applications. Display and storage media and other output devices are also independent of proprietary GISs.

Turning to software, almost every GIS has its own internal file format. These formats are designed for optimal use inside the software and are often proprietary. When data is to be shared, data has to be brought in and out of the GIS software, and this is done using file transfer formats.

Virtually all of the major GIS software products have been implemented in various agencies in Saudi Arabia, including ESRI, Intergraph, MapInfo, Autodesk, Bentley, and Smallworld. Instead of discarding any of these existing systems to standardize on a single vendor platform, a consideration of a coordinating authority would be to read and write data to all of these systems. Similarly, in a data sharing arrangement between just two partners, there would still be a need to have an ability to read and write to the GIS of the individual partners.

The importance of standards for the use, sharing and dissemination of geospatial data has been recognized by various governments, including the USA (Backe and Grady

1998; Nedovic-Budic 2000) and United Kingdom (McKeon 1999c). Both the content and the structure of the data must be known (Federal Geographic Data Committee Secretariat 1999) to successfully share information. The need to maintain and advance data and metadata standards use and application is crucial to effective sharing and use of GIS data, and this was one of the recommendations from the National Spatial Data Infrastructure (NSDI) Community Demonstration Projects (Dresler and Woods 2000). Metadata standards can simply be a common set of terms and definitions that describe geospatial data, but without them, understanding of the contents and uses for a digital database may be lost, and may mean users cannot trust results generated from these data (Federal Geographic Data Committee Secretariat 1999). The Cadastral Data Transfer Standard approved by the Federal Geographic Data Committee (FGDC) for data exchange is being adapted for integrating data, developing update-locking procedures for long transactions over the Internet, and automating integrating process to minimize the requirement for enforcing standards and resolving conflicts (Tudor and Wolfe 1999).

Standards come in different forms, though. Rules developed between groups of users can become conventions, which become de facto standards created in practice. These may be very different from top-down "designed" standards, such as the FGDC standards, which are often viewed as "edicts" (Harvey 2001). The Open GIS Consortium Inc. (OGC) is a *de facto* standards organization, whose product is implementation level interface specifications that carry the consensus of its members, whereas the International Standards Organisation (ISO) [8], through its Technical Committee 211, whose title is Geographic Information / Geomatics, is classified as a *de jure* standards setting organization whose standards are written at a relatively abstract level, with room for interpretation (Kottman 2001).

With increased usage of the World Wide Web for accessing GIS data, various standards are being developed such as the OGC Web Services Initiative, which was announced recently to address a range of important interoperability topics (Harrison 2001). Meanwhile, the Web Mapping Testbed Military Pilot Project (WMT MPP) will promote collaborative development and testing of interoperable, Web-based geospatial and intelligence information infrastructures (Buehler 2001).

[8] Many OGC member organizations are also ISO Technical Committee members. This cross-membership results in cooperation in the initiatives of both organizations.

The goal, and benefit, of data sharing in systems offering shared data across a variety of government departments, or a "joined up government", is to cut down duplication of effort and resources, and help streamline service to the public (McKeon 1999a). McKeon cites the British Standard BS7666 as being a powerful contributor to standardizing data, and encouraging the resolution of the conflicts arising from sharing and merging data of variable quality.

McKeon suggests however, that even if the political problems discussed later in section 3.4.10 are resolved, and the technical issues of data quality are resolved, then the problem of data analysis may be raised, because of the lack of analysis standards and lack of expertise (McKeon 1999c).

3.4.2 Ownership and Custodianship of Data

A further issue relates to the legal rights of the owners of the databases. Database copyrights in the UK were protected for 50 years, under the 1988 Copyright, Designs and Patents Act, if the owner could show that time and money has been invested in accumulating the database. This is being extended to 70 years under copyright Directives from the EU (Rhind 1996).

Ownership of the data should be formally established, no matter what the scale of the sharing arrangement is, to protect the partners should legal disputes arise.

Custodianship of data sets relates to the responsibility of an organization "to ensure that data is collected and maintained according to specifications and priorities … in a format that conforms with standards and policies…" (Masser 2002). As with ownership, it is important that custodianship issues are properly acknowledged prior to the data becoming available to collaborative partners.

3.4.3 Data Usability

For data sharing between organizations to be successful, the same GIS and databases have to be usable towards the fulfilment of the objectives of the individual participating partners, and simultaneously utilizable for the purposes of analysis and related decision making within and between the various members (Greenwald 2000). For example, two organizations can use the same database for planning purposes associated with usage of easements or Right-of-Way (ROW) management and monitoring as well as for reconciling incompatible encroachments on these ROWs. At times such cooperative approaches may encounter political obstacles, but at least the decisions can be made with access to common data.

If usability aspects are not built into the sharing agreements, and data availability does not meet user expectations, then neither the organizations nor the users will gain the anticipated benefits (Stipes 1998). It is important then that emphasis is placed on coordination of the system requirements (Calkins and Weatherbe 1995).

Data sharing between Government authorities and utilities can be constrained by the differences in accuracies required (Middlestead 2000). In fact, even within the utilities grouping of gas, electric, water, pipe line and telecommunications companies, all may require different precisions for features recorded.

The functional diversity among various participants is also a major challenge in developing inter-organizational systems (Azad 1998), as is the management of datasets which are under the control of disparate departments or external organizations (Zumbado et al. 1999).

The value of derived information is dependent on the accuracy of the data from which the information is derived. To maximize the value of a data sharing arrangement, users in the arrangement require trustworthy data from reliable sources (Harralson et al. 1988), with clearly defined data (Dawes 1996), formats and models. These requirements have to be applied to external and internal data sources. Several instances can be cited where inconsistencies between various municipal and county maps were not eliminated for several years (Quinn et al. 1996). Thus the issue of data quality and consistency can be a barrier to successful data sharing (McKeon 1999a). Methods used in sharing, matching, merging and analysing data from disparate sources can be overly labour intensive, resulting in the benefits being far outweighed by the efforts required if clear guidelines are not established at an early stage.

The development of a large AM/FM/GIS system can often involve a variety of data sources, with complex relationships between the data elements (Zumbado et al. 1999). Source data accuracy and completeness needs to be validated through combining field and record checks (for spatial accuracy confirmation) with indirect checks for non-spatial features (Stengle 2000). This issue is compounded when the data stored is to be shared. Provided this is recognized and incorporated in the design of the database, taking into account the potential for sharing, the complexity of the relationship can be limited.

Branding or certifying the quality of a Spatial Dataset will invoke minimal metadata and content standards, such as the Content Standards for Spatial Metadata" (CSSM) produced by the FGDC. This builds user and vendor familiarity and trust in quality, accessible spatial data (Cahan 1999).

3.4.4 Dealing with Legacies

Data sharing arrangements, just like mergers and acquisitions, can result in a mixed bag of overlapping data and functionality. Therefore any plan to integrate or share data should incorporate legacy system transformation and recognition of the various applications, and in some cases, various platforms.

In computing jargon, a legacy system is any technology that has evolved over the past decades, but which is still managing information in a working production environment (Bassett and Ulrich 1999). For parties considering sharing data, the legacy systems that each has previously developed may have to be integrated. This is seen as a key component of implementation initiatives (Spencer 2000).

Several models for integration have been developed, and can be achieved through a customized interface (Lagasse 1999). In addition, a geofacilities model can be used for integrating the numerous data-centric and geospatial-centric applications (McDaniel 2000) that are the concern of both the individual, and the combined organizations. Others argue that the key to successfully sharing legacy systems lies not in the cartography, programming language or software platform currently used by various offices, but in the design of the database that connects them to each other (Butler and Dueker 1999). Whatever the process chosen, integration of the legacy information and systems should begin with developing a matrix of the data sources, the target data model, and the relationship between them (Pollock and Nash 1998). This would require an analysis of the format and content of legacy sources, implementation of appropriate source-specific conversion specifications, and selling the benefits of the new standards to a diverse user community (Newman 2000).

The development of a Distributed Information System to support the integration of the shared data should also be considered (Tram et al. 1999), but transformation of the legacy systems using tools developed for understanding and migrating the knowledge contained in these systems is necessary to unlock their full potential (Bassett and Ulrich 1999).

Technologies based on XML Java can help companies unlock the value in legacy systems by making the data they hold accessible to Web-based applications, including e-commerce applications (Robinson 2001). Because these technologies bring together data from different systems, they solve issues of integration as well as content management and Web accessibility [9].

From an organizational point of view, legacy systems may be strong in the minds of the users due to issues of familiarity, providing fuel for resistance to data sharing, but should not be allowed to influence negatively the implementation of the data sharing.

3.4.5 Synchronization and Temporal Accuracy

A geospatial database usually is comprised of a multiplicity of components. Provided the components are updated to reflect adjustments at all stages to the data lifecycle, then an advantage of a shared geospatial database is having infrastructure changes being reflected across the system in near real time, regardless of the jurisdiction (Quinn et al. 1996).

However, the currency of data is critical particularly during a crisis. Information assembled into a central repository begins to become outdated as soon as it is gathered. In addition, if the database is shared between organizations, and the components are updated at different moments in time from multiple, dynamic input sources, the database content will become asynchronous. The temporal accuracy and reliability of this data may be compromised. But if there is a means to discover information in a network of connected nodes without any need for consolidation, the most current data can be available as soon as they are collected locally and put online at local nodes.

Amongst organizations there are differences in priorities regarding the required currency of geospatial data, and the priority placed on updating data, from the user and provider view points. To give recognition to these differences and to accommodate them, the equivalent of a Service Level Agreement (SLA) should be drawn up prior to the implementation of a data sharing arrangement. Such an agreement should include references to availability of data, its scope, its currency, and the expected restoration of

[9] XML is designed to serve as a common way of exchanging data between systems, whatever proprietary software the systems uses.

these aspects if there is a system failure, or if there are other occurrences affecting the usability of the data being shared.

However, absolute synchronization may not be necessary if time-related differences are identifiable, and appropriate adjustment made (Miller 1998).

Miller and Rhodes (2000) warn that synchronization will become more difficult if commercially available off-the shelf (COTS) data and systems are employed and then modified by one of the parties to data-sharing. This can be avoided if, as intended, a COTS system has the capability to be configured to meet its purposes, rather than needing customizing. This aspect is elaborated on in Appendix 7 An Implementation Model , Section A7.4 Customise.

For data uses in situations where temporal accuracy is crucial, and inconsistencies cannot be tolerated, such as in emergency vehicle dispatch operations, inaccuracies that arise within the database may lead to bad decisions based on misinformation, which would raise the question of liability for the consequences.

3.4.6 Locational Addresses

One aspect of standardization of data that is of immediate concern in Saudi Arabia is locational addressing, as a uniform model of addressing has not been developed, or implemented there. Postal addresses in Western countries incorporate discrete units of address information such as house number, street name, suburb, city, state, postcode and country (Federal Geographic Data Committee Secretariat 2000). By comparison, in many other countries, such as Saudi Arabia, postal address information is limited to Post Office (PO) box number, City, Postcode (sometimes), State or Province (sometimes), and Country. There are international standards for mailing addresses (ISO 11180:1993, Standard for Postal Addressing); for Spatial Referencing (ISO/TC 211 19111 N934, Geographic Referencing by Coordinates) and many others (Federal Geographic Data Committee Secretariat 1999), but by-and-large these standards have not been adopted in Saudi Arabia.

Although address-matching analysis is not currently possible, an advantage presented to Saudi Arabia by this lack of locational data is that street network and locational issues are easiest to deal with at the time that an organization is implementing a complete logical data model. This eliminates having to accommodate legacy file structures.

A further challenge is presented through street and road signage often being displayed bi-lingually. As the Arabic language has a 28 letter alphabet compared with a 26 letter English alphabet, direct transliteration can prove complicated (Asfour 1991). To overcome some of the difficulties involved, the geocoding of the street names uses a "soundex" equivalent whereby a phonetic spelling (up to six characters) of a street name is used initially.

Another solution to the challenges arising from the absence of street naming and signage is to use an alternative georeferencing scheme based on a mutually accepted coordinate system. In-situ observations of features recorded that are in a database, can be entered into ruggedized, Global Positioning System (GPS)-equipped handheld devices in the field, and downloaded at appropriate intervals for updating the geospatial database. This information can then be locationally displayed according to the coordinate system, or interrogated through other applications without reference to street addressing.

3.4.7 Funding Data Sharing Arrangements

The funding of Enterprise GIS and Shared GIS can have a serious impact on the success of GIS implementation. Funding includes numerous types of contributions to the arrangement, including non-data forms such as software, hardware, space and staff (Nedovic-Budic et al. 2001). Various funding models as applied in the USA have been examined, and compared, to establish some guidelines (Finkle and Sanger 2000).

This issue will be expanded in the section dealing with Section 3.4.10 Political Considerations – User Pays.

In Australia one of the models used relates to aggregation of information from various organizations to provide a commercial product for sale and use by interested parties (McDougall et al. 2002). In profit sharing arrangements each participating party will receive an upfront fee for the information actually exchanged, with a commission paid according to the contribution made to the product sold.

3.4.8 Outsourcing Data Gathering, Storage and Maintenance

Departments and organizations responsible for using GIS data usually feel that the costs of maintaining and updating the data should be absorbed in-house, based on the perceived costs. But the true costs of in-house maintenance include not just hourly labour, but also expenses associated with employee benefits, administration equipment facilities and training. For maximized operational efficiency, outsourcing data maintenance has to be considered (Scarlett 1999). Outsourcing is a business strategy still maturing in the IT industry. The term is barely a decade old, but its main concepts - sticking to the core business and letting a specialist agency handle other business functions - have a long history (Forrstrom 2000).

Outsourcing geospatial information services can be a means of meeting budget constraints and restrictions of resources when implementing a GIS (Wilson 1999). A data sharing agreement must take into account the costs, both obvious and hidden, involved when engaging in an Outsourcing arrangement, and work with a clearly defined specification.

Application Service Providers, referred to as ASPs, are making inroads as renters of software (Sosinsky and Nguyen 2001). However as recently as 1998 it was suggested that it will probably be some years before the highly specialized GIS software is available from ASPs. Data storage and data sharing with ASPs will probably be economically feasible only further into the future. On the other hand GIS data is becoming increasingly available through private companies that have ventured into the speculative creation of landbase data sets (Nale 1998). Maryland Department of Natural Resources is amongst a number of public agencies and utilities that are acquiring large-scale digital orthophotography from commercial sources (Tilley 1999).

Whilst it is important to define, or agree on, broadly stated methods of data gathering, when outsourcing the task to contractors, care should be taken to not define how to do the work itself, as data conversion contractors are experts in this field, with years of experience in developing tools and procedures to achieve the end goals (Brelsford 2001).

3.4.9 Institutional and Organizational Considerations

Research on data sharing has shown that institutional factors are the greatest impairment in developing and sharing GISs (Onsrud and Rushton 1995). Those sharing a GIS may come from a variety of disciplines, such as cartography and computer science, together with surveyors, planners and infrastructure engineers (Harvey 2001). Thus there is constant arbitration between groups, often hindering the development of shared facilities.

Organizational politics, which is a combination of technical and human activities, often dictates that those who hold the power, and who can be most influential in determining strategy and policy, may not be the most knowledgeable. Domination of the process by such upper level managers can prevent meaningful participation of involved and affected people and inclusion of their points of view in decision making . This can result in incorrect strategies being advocated and adopted, with a less than optimal system being presented. This may further alienate those team members who are responsible for implementing the arrangements, particularly as these people may be more erudite in the discipline.

Complementarism within separate organisations involves individuals advocating different approaches and rationalities for the development and maintenance of the data-sharing system (Robbins et al. 1998). This can reduce the cohesiveness advocated and required in a successful scheme and tends to impede rather than promote an efficient arrangement. However, in considering organizational dynamics, endeavouring to limit this complementarism may have detrimental results. It may hinder management's efforts aimed at encouraging individuals to maximise development of their own potential, and result in a reluctance to participate.

3.4.10 Political Considerations

Political constraints, at both macro and micro levels can provide barriers to data sharing (McKeon 1999b). Aspects of data ownership and access, inter-departmental "turf warfare", and accountability, may lead to unwillingness of the parties to cooperate.

Government Benevolence

Over the past thirty years, the oil rich country of Saudi Arabia has been very generous and benevolent in providing services to the country's citizens. The provision of water and electricity, for instance, has been at heavily discounted prices. At one stage in the development of the country, families were granted comparatively large amounts of money towards establishing their own family homes. Amounts in excess of 300 000 Saudi Riyals (AUD 150 000) were not uncommon. This reflects the generous nature of the Arabic people, whereby sharing of good fortune is common, to the point of a host offering visitors food and gifts beyond the means of the host himself. Thus sharing of information would seem to fit in with the culture of the country. There has also been a need to spread the wealth to citizens to encourage loyalty to the ruling authorities, the Royal Family.

Recently a considerable shift in Government attitude towards subsidies has been observed, reflecting the enormous infrastructure costs involved in servicing a high population growth, fluctuations in oil prices, and the dictates imposed by the World Trade Organization (WTO). The housing grants which were previously readily available, have been both reduced in real terms, and become harder to obtain, with waiting lists of some years. This is a result of local decisions. The subsidies on electricity costs are being phased out, and the cost of gasoline is being brought closer to world parity, a requirement of WTO admission conditions.

These changes have been focused in part on seeking ever-greater effectiveness and efficiencies in the delivery of services to the citizens. Increasingly, government authorities have tried to ensure that the user - rather than the general population – pays wherever only subsets of the total populace benefit from government activity. So while data sharing could deliver economic benefits to each of the parties to the sharing arrangement, there is less likelihood that the costs of providing the data will be seen as equal from each party. If the landbase data is derived from a government source, it is now more likely that this government-provided data will not given free of charge.

User Pays

The government is developing a charging policy to be based either on recovering only the cost of copying landbase information or on seeking to maximize their revenues by selling it even to their own component bodies. The governmental authorities given the responsibility for selling information, such as MOMRA, are faced with some novel problems because landbase data has characteristics which differ somewhat from those of commodities like food or automobiles. Even so, large-scale ortho imagery has become a commodity in countries with a mature non-military geospatial industry (Tilley 1999).

If the government continues to retain control of the distribution of ortho imagery, for reasons of national security, and also seeks to recover its costs from the consumers of the imagery, such as the municipalities and utilities, it must recognize the true costs associated with acquisition and distribution. These costs include: contract costs in acquiring, receiving and accepting the imagery from the producer; administration costs in managing, archiving, marketing and packaging the imagery to meet market requirements; and sales costs in distributing the product, invoicing and payment collection.

For normal commodities, like food and automobiles with a high turnover and efficient marketing, a mark-up of 100% is needed to ensure profitability. For GIS data products, with a very limited market, particularly in sparsely populated areas, just to break even the distributor should set the selling price at several times the acquisition costs. This results in high costs of acquisition for the user, costs which have to passed on to the customers of the Municipalities and Utilities.

Consequently, it would seem better for the government to pursue a policy of recovering only the costs of copying the data. This presumes that the distributor, a government controlled body, acquired the imagery for its own use, and that the acquisition was on a purchase to own basis rather than license to use basis.

If the imagery was purchased by a user/distributor such as MOMRA through a licensing agreement with the producer, copying to a third party user may not be legal. This could influence the availability of the imagery to end users, and thus affect the viability of a GIS data sharing arrangement between parties such as the Jeddah Municipality and Saudi Telecom if part of the sharing arrangement were to include base mapping derived from ortho imagery obtained from MOMRA.

Obtaining Imagery

Another political consideration to data sharing is access to satellite derived ortho imagery. There have always been heavy restrictions on access to satellite imagery in the Kingdom, as direct access to this imagery allows groups to get correctly georeferenced drawings, free of the offsets normally introduced for military security purposes.

Now, just at a time when there appeared to be some relaxation in this approach, as manifested in the opening up of access to information from the GDMS, there are severe restrictions being imposed as a result of the US led worldwide fight against terrorism.

A considerable amount of high resolution ortho imagery used in Saudi Arabia has been obtained from the IKONOS satellites. However, under a deal struck with the U.S. National Imagery and Mapping Agency, Space Imaging Inc. cannot sell, distribute or share imagery of War Zones with anyone outside the U.S. government (Reporters Sans Frontieres 2002). Space Imaging Inc. owns and operates the IKONOS satellite, and Saudi Arabia is at times considered Earth Resources Observation Satellite (EROS). This is operated by the Cyprus based ImageSat International N.V. However, this is an

Israeli company, and the satellite is considered to be an Israeli national asset (ImageSat International 2002). As such, the EROS organization is banned from selling products into Saudi Arabia.

As a result, access to satellite imagery is potentially getting more difficult, thus increasing the need for sharing the base mapping data that is available.

3.4.11 Measuring Benefits

Criteria for assessing the benefits of a GIS, whether it involves data sharing or not, need to be identified and agreed to prior to embarking on a data sharing arrangement. This can involve short term and long term objective assessment to ensure visibility of results, a critically important point in maintaining the interest of the schemes sponsors and to counter political objections to GIS data sharing (McKeon 1999b).

Thus, just as there is a need for advance estimation of a proposal's potential costs and gains as a means of promoting the value of the project, the same benchmarks can be applied in validating the results, the points of reference against which various outcomes can be evaluated (Brelsford 2001). This introduces yet another dimension, how to measure or estimate GIS benefits.

An empirical approach to estimating GIS benefits (Gillespie 2000) could be agreed to or metrics could be developed and adopted to prove and measure results. Benefits can also be assessed in terms of perceived returns and satisfaction with data sharing, both for situations in which data is shared within an organization, and those in which data is shared externally (Nedovic-Budic et al. 2001).

These methods do not measure client satisfaction from a social perspective, and do not take into account non-technical or non-measurable issues. Once again a balance has to be drawn between technical aspects and organizational aspects that are influenced significantly by cultural concerns.

Benefits can also be assessed in terms of perceived returns and satisfaction with data sharing, both for situations in which data is shared within an organization, and those in which data is shared externally (Nedovic-Budic et al. 2001).

3.4.12 Legalities and Legislation

In addition to standardization and data gathering issues, sharing data can introduce legal and ethical issues previously faced (Stoe and Oberle 1999).

There are some concerns regarding the definition of public access (Jain 1999), and the restrictions that need to be in place particularly if the shared data is to be available on the Web. This leads to an examination of any legislative framework in existence relating to dissemination of Public Sector information. Considering the tight control that the Kingdom has placed on access to Internet sites, it is may be necessary to obtain government approval for data to be shared. One of the most visible Internet functions of the King Abdulaziz City for Science and Technology (KACST) is to prevent users in the Kingdom from accessing unsuitable websites. Through the maintenance of a black list of sites considered unsuitable, any attempt to reach a site on the list is redirected to a special web page. The black list is derived from various information sources, including Dynamic Site Analysis whereby sites are randomly analysed to determine their content and a decision as to their suitability is made based upon the words and images found on the page (Zedan 2000).

Privacy issues are raised when organizations such as local authorities and utilities include personally identifiable information in the Relational Database Management System (RDBMS) associated with their GIS (U.S. Senate Select Committee On The Judiciary 2000).

The uncertainty of the legal environment in which geographic information is produced and used is often discouraging to creative geographic information-related activities and developments (Onsrud 1995), and to their adoption in a shared data environment.

The legal jurisdiction of transactions that cross boundaries is not clear, so there is a pressing need to secure the data available so that legal redress does not result from supplying misinformation (Titterington and Bassanese 2001). This further constrains the willingness of some organizations to share GIS information.

Although data sharing can promote coordinated progress in a community, it also produces it own set of complex issues (Stoe and Oberle 1999), such as when information about a person’s residential address passes from one agency to another, without the consent or knowledge of the individual, who is liable and accountable for the inappropriate use of inaccurate data?

Legal redress can be sought if inaccurate information is provided by one of the parties to a data sharing agreement. Thus organizations providing information have to be even more careful about the accuracy, both in terms of currency and geographical correctness, than they would if the information were only for in-house use. This can add considerably to the cost of maintaining data.

Organizations providing information can gain some protection against litigation through disclaimer clauses, particularly with free-to-air distribution of data. When a form of payment is involved, as in a data sharing arrangement, accuracy levels should be agreed to and documented as a basis both for benchmarking and for the protection of the parties to the arrangement.

The question of liability of the initial provider, when inaccurate information is reproduced through data sharing, raises the legal stakes, particularly when the information is combined with disparate sets of data from various other sources to produce common visual thematic views, used in geodemographic profiling (Stoe and Oberle 1999). Just who is accountable for inappropriate use of inaccurate data?

Threats of litigation from the public against either an initial provider of information or a subsequent using organization have to be considered as a factor in sharing data.

To minimize the risks, common guidelines agreed to by self regulating e-marketing organizations require the companies to observe various constraints (Anderson Consulting 2001). These are rules that may be applicable to organizations with a high exposure to exchanging information with the public and include the following :

- Notify customers what they do with personal data such as names and email addresses
- Use the information only for the stated purposes
- Allow consumers to examine and correct data collected about them
- Give the customers a choice to forbid sharing that information for marketing purposes
- Store data in a secure manner
- Provide recourse for customers where privacy has been violated.

Organizations embarking on data sharing arrangements have to be wary, also, of restrictive license agreements that apply to the applications.

3.4.13 Types of Data Exchange

Practically, availability of data in an exchange or sharing process depends to a large degree on the extent of interaction between the parties. For example, the following different types of data exchange can result in varying levels of data availability :

- Bi-lateral exchange, where two parties both give and receive data in fully or partially shared GIS and databases.
- Cost recovery exchange, where information has a predetermined monetary value, and transferring this data results in a credit to the supplier, thus generating revenue.
- Exchange on a barter scheme, whereby data has a barter value applied, and "barter points" accumulate to the supplier, which can be traded for received data.
- Unilateral data exchange, where data is transferred in one direction only, and one of the parties either only provides data, or only receives data - an "access only" scheme.
- Open access, whereby data is available through the Public Domain to everyone, for example on the Web, and is not charged for.

In all of these examples, it is implicit that some geographic data is gathered by one party, and shared or exchanged with another, thereby having data available beyond the database of the gatherer and providing access to more diverse maps.

The availability of data, and increases resulting from the sharing arrangement, are also influenced by other aspects of the interaction, such as: how regularly, and by what means, inter-organizational communications are conducted; the extent that a shared data clearing house is used and maintained; the extent to which the data development and maintenance is shared.

3.4.14 Integrating Data, Policies, Standards and Procedures

Implementing a data sharing arrangement requires collaboration between partners in determining how costs associated with planning, building, using and financing the arrangement can also be shared. This leads to the recognition that whilst the data being shared is an essential and integral ingredient of the arrangement, there are other instruments vital to its successful implementation. These other components include the personnel involved in all stages, the institutional framework which governs administration of the arrangement, the technology which permits distribution of the data to partners, and standards underlying the integration of the data. These components could be considered as a Spatial Data Infrastructure (SDI) (Warnest et al. 2002).

3.4.15 Sharing via Web Mapping

Web based mapping products are spatially enabling thousands of Web sites throughout the world (Culpepper 1999) Consequently this method of delivery of data must be considered. Utilities are finding Internet technology to be an inexpensive and effective means of communicating and disseminating information to internal employees and to external customers (Spivey and Mizula 1998). Advanced techniques such as the use of several, identical web map and database servers to intelligently share the load, and mirror sites which replicate the service structure and contents to another geographic area, are designed to deliver faster responses to web-users (Majid and Williamson 2001).

Integrating GIS databases into consistent graphical user interfaces deployed over the web provide significant advantages to utility companies and government authorities (Dickenson 1999). The trend towards Web based solutions is a function of, amongst other things, the sheer volume of information stored by corporations (Jenkins 1999), and the challenges of maintaining the data current at all points of use (Scheffler 1999).

The availability of the Web Map Server, Web Feature Server, and other related Open GIS Consortium Inc (OGC) interfaces now gives the geospatial industry the capability for providing commercially available products that meet the needs of GIS computing over the Internet (Guerrero 2001). The interfaces that are provided enable users to access maps from multiple map servers (McKee 2001), and through the use of the Application Service Provider approach, not only is the data available, but also the associated applications can be run across the web. The FGDC is organizing its collection of spatially oriented data into a Spatial Data Clearinghouse (SDC), which operates as a series of digital catalogues based on internationally standardized metadata to enable people to effectively locate and access geospatial and non-graphic data efficiently and economically (Abashain 1998).

Sharing geospatial information (or any information) through an open Web has the characteristics of relatively high collection costs and relatively low dissemination costs (Rhind 1996). There can be a wide variety of uses, with very different values in its alternative uses, but consumption of information by one user does not reduce the availability of the same information to others. However, it must be recognized that new electronic technology is making it difficult to control access (Rhind 1996) and thus financial returns for the distributor may be limited.

An Internet site has been established by the American Public Works Association (APWA) as a conduit for a range of different types of information (Lopez and Firquain 1999). The information is provided and maintained by a variety of federal and state agencies, counties, cities, utilities and private companies.

As with most GIS related projects, it is important to maintain interest in a data sharing project, so that funding continues. Through a Web site, the progress and advantages of a data sharing programme can be incorporated and promoted (Zastava 2000), with a resultant heightened chance of success.

In his paper discussing the difference between using the Web GIS and Field GIS, Cooke (1999) examines the various methods of transporting the shared data. Inherent in the discussion is an examination of the functionality, hardware, and security appropriate in different circumstances.

3.4.16 Security

The environment in which data sharing is operating is continually evolving, and a major concern is security of data.

Data sharing can require an organization to trust people it does not really know, in the cases of sharing between partners, and people it does not know at all in sharing across the Web (Titterington and Bassanese 2001). If an enterprise-wide network is considered complex from a security viewpoint, then interactions with external organizations systems' accidental risks, multitudes of system configurations, and malicious persons both inside and outside the organization, all present very serious security assessment challenges (Chappell et al. 2000) .

Security issues must be investigated and taken into account, particularly when access to data that is stored in a corporate database is opened up to other organizations. The retention of data integrity cannot be controlled easily when write access to a database is widely dispersed even within one organization, let alone when various organizations are involved.

Setting up password protections, fire-walls, and creating search and query options that block the display of some particularly sensitive fields can be accomplished (Stoe and Oberle 1999). However, publishing 'protected' restricted information is often resisted due to doubts held as to the reliability of available methods for protecting sensitive information. In fact, recent reports indicate that most large companies are not abiding by international standards developed between the European States and the USA, and this adds causes concern to organizations that are sharing data with others (Anderson Consulting 2001).

Irrespective of which, if any, data sharing model is implemented, data security is very important. The integrity of the data can be compromised by users making unintentional mistakes, or through malicious acts such as hacking, introduction of viruses and industrial espionage.

Concerns over degradation of security when implementing a data sharing arrangement can be all but eliminated through training the system developers and users, and through proper security auditing, profiling, policy designing, and applying the solutions recommended by the security expert or consultant. The risk management studies necessary for meeting the organizations' individual security strategies can be turned into a benefit, even though it is a by-product of the sharing process.

Quality control measures are required to ensure that the integrity of the data is not compromised with additional users who are able to add as well as delete information (Laurent and Oliveira 2000). This process forms part of the security regime.

Security Auditing and Profiling

Malicious activities can harm the parties to the data sharing through theft of data, destruction of data, altering data, or even rendering useless a service available on the Internet. Consider the following :

- By adding the facility to share or exchange data regularly, or by adding a World Wide Web site and an FTP server, organizations may be unaware that they are providing an "electronic tunnel" to other non-public corporate data.
- By providing a remote access e-mail gateway, organizations may unwittingly provide a side door into their network, and this could adversely affect other organizations sharing data.

The maintenance of security goes beyond a matter of trust, with well defined, often harsh, procedures to be agreed upon and enacted, to protect the GIS database which is usually a critical resource, and which is depended on in mission critical situations. There is a need for a security audit to be carried out on each of the parties both for internal purposes, as part of a regular program, and as a due diligence process prior to allowing access to valuable data by an external party.

A typical security process, targeted to provide greater risk reduction would involve conducting an audit of the organizations' exposure to the Internet, Intranet, and Extranet. This would include scanning the network from outside to check for open inlets to the system, and checking from within the organizations intranet for internal vulnerabilities. Aspects to be assessed would include network management policies covering each element of the network – LAN, WAN, Firewall, Host's Remote Access System (RAS), Applications running, and Disaster Recovery procedures.

A security audit should lead to a report on the following three aspects,

- Perimeter Security, covering protection for the organization from the outside world at each entry and exit point,
- Communications Security, covering effective communications between shared resources and data sharing partners,
- Content Security, covering availability and integrity of the corporate information resources.

The proliferation of Peer to Peer (P2P) file swapping has added to the exposure of organizations to unauthorized access to data systems. Recent security vulnerability instances have occurred through malicious MP3 audio files, which are commonly accessed by users (Craglia and Masser 2001). In these cases, system security has been compromised if a user merely hovers over the malicious file, or opens a folder where the file is stored. It is imperative that users' access to file swapping sites is controlled, to prevent loss of integrity for all systems accessing shared data.

3.4.17 Training

One of the major concerns of partners in a joint data sharing venture is the quality of the data and the technical competence of those operating the system. To help in building the confidence between parties , the level of GIS knowledge of the participants needs to be recognized. This can be accomplished via degrees/certificates attained through academic institutions, or certification through demonstration of competency and mastery of the subject, and confirmed through peer review (Wikle 1999). Professional bodies, such as Planning Associations, need to assume a strong role in program accreditation process if the certifications issued are to be universally accepted. This implies the application of a code of ethics (Esnard 1998) to the education and accreditation process, so that the confidence levels between partners to data sharing is established.

Various aspects of training must be examined, for users, operators, and management. If training is not given a high priority, new operators may be ill prepared, and the integrity of the database can be diluted with data corruption, thus reducing the dependability of the data. This applies whether or not data is shared, but control of this facet is more difficult if two or more organizations are involved.

Comprehensive instructions are required if use of the spatial information is to be optimised and its potential realized. Education on the limitations of the arrangements as well as on-site coaching directed towards efficient system access and usage is needed (Warnest et al. 2002). The focus of the training for operators should be extended from the specific systems to how the suite of systems will interact over the course of performing their work tasks.

The Saudi government is very conscious of the need for technical training of its citizens, both for the efficient operation of infrastructure and as a vital component of its commitment to the Saudization of workplace employment opportunities[10]. It could be anticipated that proposals for training through accredited agencies would be acceptable, even welcomed, particularly if training commenced with train-the-trainer schemes so that Saudi trainers could be certified. This would ensure that ongoing training could be managed and implemented by Saudis.

3.5 Spatial Data Infrastructure - Combining the Issues

In addressing the issues raised in the sections prior to this, little attempt has been made to correlate the interaction of each issue with the others. This allowed a focussed consideration of each issue more or less in isolation. We are now in a position to examine the composite effects these issues have in data sharing collaborations.

[10] Many jobs in Saudi Arabia are filled by expatriate workers. Saudization is the term applied to the process of replacing these expatriates with Saudi nationals.

A viable data sharing system is comprised of various components including data, access networks, standards, policy etc. These components collectively comprise a "Spatial Data Infrastructure" (SDI) (Rajabifard et al. 2002). By comparison, a land transportation system consists of a range of physical components including roads, bridges, direction signs, vehicles etc. and the grouped components are designated as "Transport Infrastructure". A clear distinction between these two types of infrastructure is the inclusion of intangible components such as the individuals and institutions within the framework known as SDI, compared with mainly tangible assets in a transport infrastructure.

The United States FGDC has defined Spatial Data Infrastructure (SDI) as "*the technology, policies, standards, and human resources necessary to acquire, process, store, distribute, and improve utilization of geospatial data.*" (Mahoney et al. 2001).

Considering this definition, even if not formally recognised as such, an SDI is present at any level of data sharing collaboration, from intra-organizational and inter-organizational at a local level through to multi-national or global arrangements. There are common components to SDIs although as would be expected various jurisdictions, particularly at national level, have an assortment of definitions as to what actually comprises an SDI, or a national spatial data infrastructure (NSDI) (Leung 2002). Table 3.1 Components of National Spatial Data Infrastructure presents a comparison of national views of NSDIs and illustrates the variety of opinion and terminology.

Table 3.1 Components of National Spatial Data Infrastructure

Country	Model	Components				
Australia	ASDI	Institutional Framework		Fundamental Datasets	Technical Standards	Distributed Network
Canada	CGDI	Partnerships	Supporting Policies	Framework Data	Geospatial Data Standards	Geospatial Data Network
United Kingdom	NGDF	Collaboration		Standards		Data Access
USA	NSDI	Partnership		Framework Data	Data Standards	Geospatial Clearinghouse

Source : LEUNG Kin-wah (Leung 2002)

At local, regional and global levels there are similar disparities in the definition of SDIs though there are certain common elements. The Australian and New Zealand Land Information Council (ANZLIC) in 1996 defined a national SDI as comprising four core elements (McDougall et al. 2002; Rajabifard et al. 2002; Warnest et al. 2002), *an* *institutional framework* or policies, *technical standards* for managing interoperability issues, *fundamental datasets and a clearinghouse network.* This definition has been refined by Rajabifard (Rajabifard and Williamson 2001) to identify the importance of the dynamic inter-relationships involved between the people, users and producers, involved with a data sharing arrangement and the data within the an SDI. Figure 3.1 illustrates these defined components and their generic relationships.

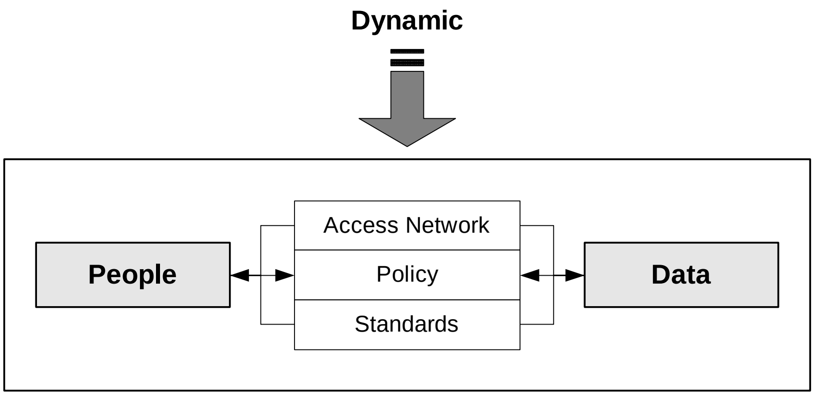

Figure 3.1 Nature of Relationships Between Components of SDI

Source : Rajabifard (Rajabifard and Williamson 2001)

Each of the issues raised in the preceding sections can be aligned with the defined components of an SDI, and in some cases several of the defined components are impacted on. For example, the issue of security impacts on the users and producers (People); on information which can be obtained (Data); on access permissions granted (Access Network); and on right-to-use, custodianship and ability to update database (Policy).

A significant issue raised now is the relationships between SDIs developed at different levels of government. For example, the elements which comprise the components of an SDI in a bi-lateral partnership between a local government authority and a utility company will be considerably different from those for a multi-party strategic partnership at the national level. The differences are not confined to technical issues, but involve complex dynamic relationships prompted by social, political and cultural issues. Consequently for potential geospatial data sharing arrangements that involve several levels of government or enterprise, it can be expected that increasing the number of these levels will increase the complexity of the dynamics that need to be resolved.

3.6 Conclusion

This chapter provides an extensive review of the issues involved with sharing geospatial data, citing information obtained from literature reviewed and from experience gained working in the industry in the Middle East.

Issues that have been investigated include a number of benefits and possible barriers associated with geospatial data sharing. Some benefits, such as reduced cost and greater availability of data, are applied directly to Section 5.6 in which the selection of an appropriate model for data-sharing is discussed. Similarly, some issues such as locational addressing, ownership and custodianship of data and political considerations are included in Section 5.7 when addressing the chosen model.

After reviewing many of the issues, it was suggested that they can be considered within a partnership model designated as an SDI.

The review shows that both technical and non-technical aspects have to be considered. The organizational, political and cultural issues are as challenging as the tangible, technical issues. This overview of the issues can now be applied to a consideration of the stated problem and the aim of the research. This will be included in the following chapter, which also enunciates the research methodology adopted in the study.

CHAPTER 4

DEVELOPMENT OF A CONCEPTUALIZED MODEL

4.1 Introduction

This chapter begins with a discussion of the research instrument chosen, as well as others available, as basis for this thesis. A description of the process that has been selected for testing the concept is then given, followed by a review of another process that was considered.

Local environmental factors were considered in the background chapter (Chapter 2 Cultural and Organizational Environment in Saudi Arabia) which reviewed the geography and culture of KSA, examined GIS in two organizations and also included an overview of data sharing for other organizations in KSA.

Issues relevant to the sharing of geospatial data have been researched in the chapter focussing on accessible literature (Chapter 3 Review of Data Sharing Issues).

In order to formulate an hypothesised model the potential for data sharing is examined initially. Following this, a solution to the stated problem is postulated in a generic sense to begin with, and then more specifically, taking into account the requirements and various operational aspects of the proposed partners as well as the issues previously discussed.

4.2 Research Instrument

Various research instruments, or methodologies, were considered for this research. The methodologies which were contemplated follow a ‘systems approach’ (Checkland and Scholes 1990; Maxwell 1996) to problem solving included the following:

1. **Interactive Planning (IP)** wherein the process centres on identifying an ‘idealised future’ solution and then creating a plan to move from the current state to that desired state.
2. **Critical Systems Heuristics (CSH)** through which a comparison is made between ‘what is’ and ‘what ought to be’ followed by a formulation of what should be the main properties of the solution taking into account the views of interested parties.

3. **Soft Systems Methodology (SSM)** in which there are two parallel approaches, logic based inquiry and cultural inquiry, with decisions made in terms of relevance to those involved.

4. **Total Systems Intervention (TSI)** the three phases of which involve Creativity, Choice and Implementation :

   - Thinking imaginatively about the possibilities for the organizations involved (Creativity),
   - Choosing a solution that will most likely tackle the problems identified (Choice) given the key dimensions of process, culture and politics,
   - Implementing the changes that actually tackle those problems (Implementation).

Each of these methodologies has some relevance, but none is an exact fit for this research. There would be a considerable effort in massaging the study process to align it with any one of the defined instruments, so a hybridised approach has been adopted incorporating significant elements of each of the formal methodologies.

The research mechanism that is being used is to: consider local environmental factors; examine the issues involved for geospatial data sharing, primarily through a review of available literature; conceptualise a model for data sharing between two organizations in KSA; and then test the concept inductively, drawing together both factual and behavioristic aspects to support the concept hypothesized.

4.2.1 Chosen Process

The research includes the following procedures :

- Analyse the environmental issues that are identified as affecting the potential stakeholders in the problem,
- Suggest reasons for data sharing and investigate what issues, benefits and barriers would be involved in sharing geospatial data,
- Use a review of literature to examine and substantiate these benefits and barriers,
- Analyse data structures existing in the Jeddah Municipality and Saudi Telecom Company,
- Conceptualise a data sharing model,

- Categorize models with potential as data sharers,
- Determine characteristics of successful data sharing models and selection methods,
- Investigate several examples and select one or more that fit the conceptualised model.

4.2.2 Alternative Process

The following concept testing process was considered as an alternative and discarded:

- Prepare a survey of industry representatives to gauge the feasibility of the model conceptualised
- Include system designers, implementation contractors and users in the sample of people to be surveyed
- Conduct extensive interviews in person or by telephone and questionnaires through mail, fax and email.

Reasons for discarding this alternative in favour of the chosen process :

- In Arabic culture, there is a tendency for those surveyed to respond very positively. However the reliability of the results is affected by a general face-saving attitude which mitigates against providing answers which could reflect negatively on a respondent's organization, or area of responsibility.
- A second reason for discarding this process involves a reluctance to participate in questioning when the answers might reveal weakness or divulge confidential aspects of their organization's intellectual property (either real or perceived).
- Thirdly, when questions are directed towards particular aspects, it indicates an advocacy of those aspects by the researcher. To the extent that such perceived advocacy is seen as a challenge, respondents may tell the researcher what he thinks the researcher wants to hear, thus avoiding confrontation (Glesne 1999). This is manifested in a pseudo "Hawthorne Effect" (Burns 2000) whereby falsely optimistic responses are provided, mitigating against accuracy of results.
- Fourthly, Saudi Arabia is a relatively young though wealthy country. It has attracted a plethora of foreign "consultant advisors" at all levels of government and private organizations. Many of these advisors send in a team of researchers

whose role it is to gather local data prior to preparing advisory reports. Unfortunately, many of the advisory reports are merely a repetition of suggestions made by those interviewed or surveyed, or else are standard solutions that have been copied from previous proposals. The reports often include recommendations that have been tried before in the organizations, or which are applicable only in countries that have major cultural differences to Saudi Arabia.

This continual procession of advisors and their expensive reports have left many Saudi managers sceptical of the value of participating in industry surveys, the result being a reluctance to spend the time required to be genuinely involved. Worse still, many of the surveys are delegated to staff who prepare answers that are sanitized and standardized.

As a consequence of these four aspects, the validity and reliability of the data collected may not be dependable enough to incorporate in the concept testing process (Burns 2000).

4.3 Analysis of Existing Data

Planners in local governments and in utility organizations have a common attraction to GIS and other geospatial technologies derived from the spatial nature of urban phenomena and from interdisciplinary nature of infrastructure development (Nedovic-Budic 2000). In a further reinforcement of the value of using GIS as a common link between organizations, Bennett of Robertson Research (Bennett 1999) suggests in his assessment of the "State of the Industry 1999" that geography will become an element of common information exchange between organizations.

Deleted:

This section of the research addresses areas where exploitation of these common interests may indicate potential for data sharing involving the Jeddah Municipality and Saudi Telecom Company, either internally or externally, and which should be investigated in an effort to promote more coordinated and systematic approaches to maximize the capabilities of this technology as a decision support tool.

The potential for sharing various geospatial information is tabled in Table 4.1 Applicability of GIS and Potential for Exchanging/Sharing Data, and this serves as a guide to the review. The table was drawn up from information obtained in informal discussions at Jeddah Municipality engineering headquarters during and a distillation of experience after many years in the telecommunications industry.

In all, 12 aspects have been considered as examples regarding GIS applicability and data sharing potential. In the table a rating has been applied to each aspect, in an attempt to rank and quantify its relative significance.

- **Mapping**

  Both organizations employ Mapping applications, and both are currently obtaining landbase information for the same areas. As this is an area of interest for both organizations, there is a high potential for exchange and sharing of this data.

  Both organizations are migrating from paper based drawings produced using CAD techniques, to digitally produced mapping involving GIS principles. In the case of STC, this involved the conversion of around 30,000 drawings in the first stage of capturing Local Network data.

- **Land Records**

  The municipality has a keen interest in Land Records as it tracks the ownership of real estate for land taxing purposes and questions over ownership disputes.

  STC's interest in Land Records is limited to marketing potential (where ownership details are important), and demand forecasting (where ownership details are not as important).

- **Community Development**

  The delivery of municipal services and economic development for the benefit of the community can be enhanced through the use of GIS much more effectively than through statistics and raw numbers. It is a powerful tool for municipal officers and managers to use when trying to get project approvals for these services and developments.

  STC also has a strong interest in this type of geospatial data and gaining access to it through a sharing arrangement.

Table 4.1 Applicability of GIS and Potential for Exchanging/Sharing Data[11]

Aspect	Jeddah Municipality		Saudi Telecom Company	
Mapping				
Applicability of GIS	High	Rating : 10	High	Rating : 10
Potential for Sharing	High	Rating : 10	High	Rating : 10
Land Records				
Applicability of GIS	High	Rating : 8	Medium	Rating : 5
Potential for Sharing	High	Rating : 8	Medium	Rating : 8
Community Development				
Applicability of GIS	High	Rating : 10	Medium	Rating : 5
Potential for Sharing	High	Rating : 8	Medium	Rating : 7
Public Safety				
Applicability of GIS	High	Rating : 8	Low	Rating : 4
Potential for Sharing	High	Rating : 8	Low	Rating : 4
Transportation				
Applicability of GIS	High	Rating : 8	Low	Rating : 4
Potential for Sharing	Low	Rating : 4	Low	Rating : 4
Water Supply				
Applicability of GIS	High	Rating : 9	Low	Rating : 3
Potential for Sharing	Medium	Rating : 5	Medium	Rating : 6
Wastewater				
Applicability of GIS	High	Rating : 9	Low	Rating : 2
Potential for Sharing	Medium	Rating : 5	High	Rating : 4
Engineering (Surveying, Street Lights, etc.)				
Applicability of GIS	Medium	Rating : 9	Low	Rating : 4
Potential for Sharing	High	Rating : 8	Medium	Rating : 6
Health and Human Services				
Applicability of GIS	Medium	Rating : 5	High	Rating : 3
Potential for Sharing	Low	Rating : 4	High	Rating : 2
Administrative & Finance				
Applicability of GIS	Low	Rating : 5	Medium	Rating : 5
Potential for Sharing	Low	Rating : 5	Medium	Rating : 5
Environmental Issues				
Applicability of GIS	Medium	Rating : 7	Low	Rating : 3
Potential for Sharing	Medium	Rating : 7	Low	Rating : 2
Telecommunications				
Applicability of GIS	Low	Rating : 4	High	Rating : 10
Potential for Sharing	High	Rating : 8	High	Rating : 8

[11] The rating given to each aspect reflects its relative significance and ranking on a scale of 1 to 10.

- **Public Safety**

The issue of public and employee safety has become a major subject of concern and debate for government and local administrations. The regulatory authorities are increasingly aware that safety depends on information about the maintenance, performance and condition of the public assets, as well as an accurate record of potential hazards and ready availability of these records. A comprehensive GIS combined with an inclusive records management system (RMS) would allow quick, visual access to the information.

STC has a lower interest in this aspect, though staff and public safety issues are a concern.

- **Transportation**

Analysing vehicular traffic patterns is vital to a multitude of city planning activities, and this can be enhanced through GIS usage. Thus there is a high applicability of GIS for Jeddah Municipality. However, due to the paucity of public transport in Jeddah, GIS-based studies, which are often used elsewhere for connecting transportation factors with urban development (or urban sprawl), would not be as valid in Jeddah.

GIS transportation data would not have high applicability for STC.

- **Water Supply**

The Jeddah Municipality is not directly involved with the main (trunk) supply pipe network carrying water from the desalination plants, which pump out and distribute some 200 million litres daily for the residents of Jeddah, as this is the responsibility of the Water Commission. However, it is interested in the location, installation and maintenance activities associated with the distribution pipelines carrying water to businesses or residences.

STC is interested in the location of the pipes and valves, with a secondary interest in civil works associated with proposed extensions to the main trunk and distribution pipes, and the operations and maintenance activities of the repair groups.

- **Waste Water**

The city of Jeddah does not have a reliable waste-water management process and is constantly under criticism from its citizens, particularly whenever there is rainfall due to localized flooding. These floods are a mixture of rainwater and sewage overflow. The Municipality has embarked on projects worth US$40 million to set up a rainwater drainage system, which will be ready by November 2004 (Hassan 2002a). It is also preparing a geo-referenced Sewer Infrastructure Management System (SIMS). Both these projects will increase the applicability of GIS in the municipality.

STC does not have a high interest in these projects, other than for coordination of infrastructure developments and plant locations.

- **Engineering (Surveying, Street Lights, etc.)**

Surveying and cadastral information are essential for the operations of the Jeddah Municipality, affecting as they do its functions ranging from major infrastructure development and maintenance to issues such as street lighting, abandoned vehicles and missed refuse collections.

Saudi Telecom does not have the same level of interest, though there is a high potential for using shared data as an adjunct to its inventory of planning and operations tools.

- **Health and Human Services**

In many countries GIS is becoming a recognized tool to assist in health intervention strategies, surveillance, and risk assessment (Shull 1998). In Saudi Arabia, health matters are generally the realm of the Ministry of Health. However, many water related health problems such as dengue fever are reported in Jeddah, and the municipality has a responsibility for the control of probable sources through applying pesticides or draining the standing-water breeding grounds of the mosquitoes that transmit the disease. Studies in other countries have highlighted the usefulness of GIS in the surveillance of similar infectious vector-borne diseases[12] (Green et al. 2000; Forbes 2003).

By spatially locating individual health events and the potential sources through geocoding processes, the municipality will be better placed to measure the significance of the interaction of disease cases in space and time and to identify the geographic extent of the problems. This will allow it to analyse action required, to target remediation efforts, and to monitor the efficacy of these remediation efforts.

As a company, STC has only a low interest in this aspect.

[12] Epidemiologists call the carrier of a disease from one host to another a "vector".

- **Administrative and Finance**

As both organizations move towards enterprise resource management the use of geospatial data will assume an increased importance. Currently management of the organizations has only a moderate amount of interest in use and sharing geospatial data.

- **Environmental Issues**

The prime responsibility for protecting and enhancing the environment, air and water quality, and wildlife habitat rests with the Saudi Arabian Meteorology and Environment Protection Administration (MEPA). However, as a local authority and through the enthusiastic support of the Mayor of Jeddah, Abdullah Al-Moallami, the municipality has assumed a direct interest in environmental issues. It accesses the orthorectified SPOT image thematics held by MEPA for environmental information purposes including evidence of increased urbanization and industrialization - factors that contribute to environmental overload.
STC has a low interest in environmental issues.

- **Telecommunications**

Regarding telecommunications, the core business of STC is directed to developing, installing, operating and maintaining the telecommunications infrastructure. Thus there is a high applicability of GIS and potential for exchanging data for STC
The Jeddah Municipality is primarily interested in the location of plant, existing and proposed, that is installed underground, with a consequent lower applicability.

This general set of possible interest areas related to GIS and the ratings applied in Table 4.1 are laid out in Figure 4.1 Congruency of GIS Application/Interests and the set of potential areas for exchanging and sharing data is illustrated in Figure 4.2 Congruency of GIS Sharing Potential.

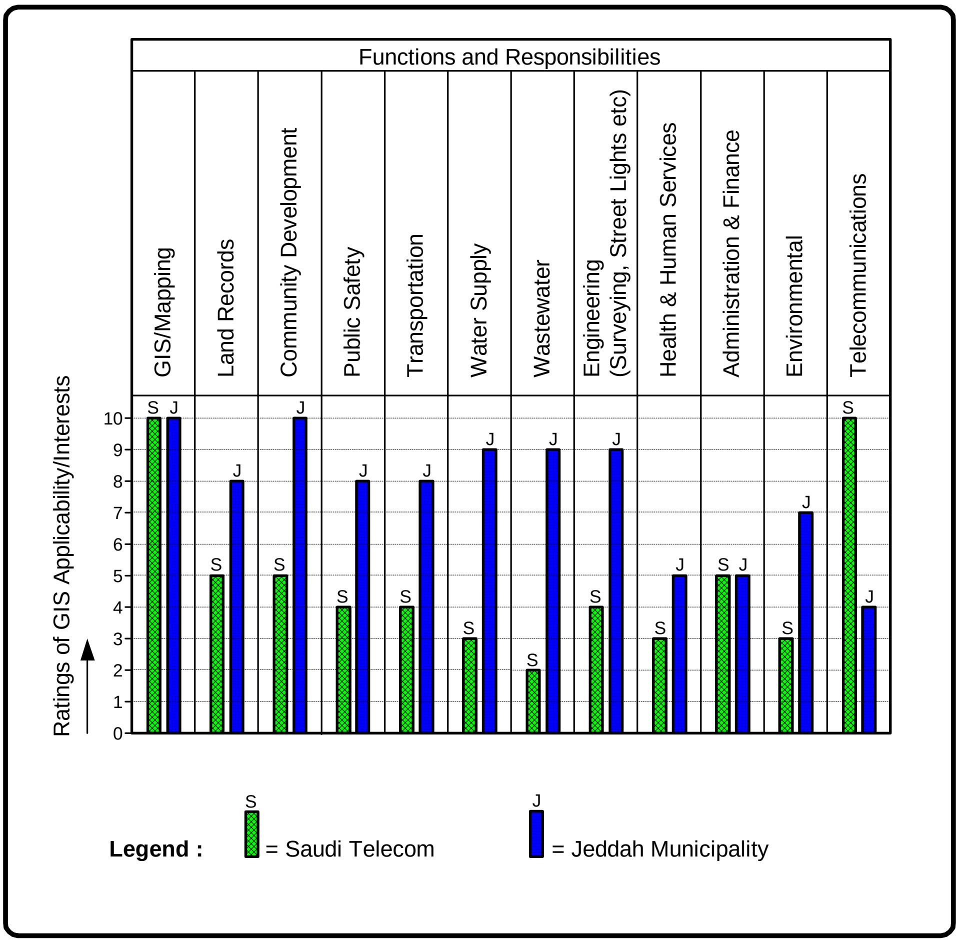

Figure 4.1 Congruency of GIS Applicability/Interests

The graph in Figure 4.1 illustrates that it is expected the Jeddah Municipality would have relatively equal or higher applicability and interest in GIS compared with that for STC, in eleven of the twelve aspects. This expectation has not been borne out in practice, with actual implementation of GIS in the Jeddah Municipality restricted to Urban Planning activities.

STC also is not maximising usage of its GIS. Appendix 4 STC Functional Units – Usage and Accessibility acknowledges that the practice of single department use of significant databases has been recognised as limiting the effective use of its GIS.

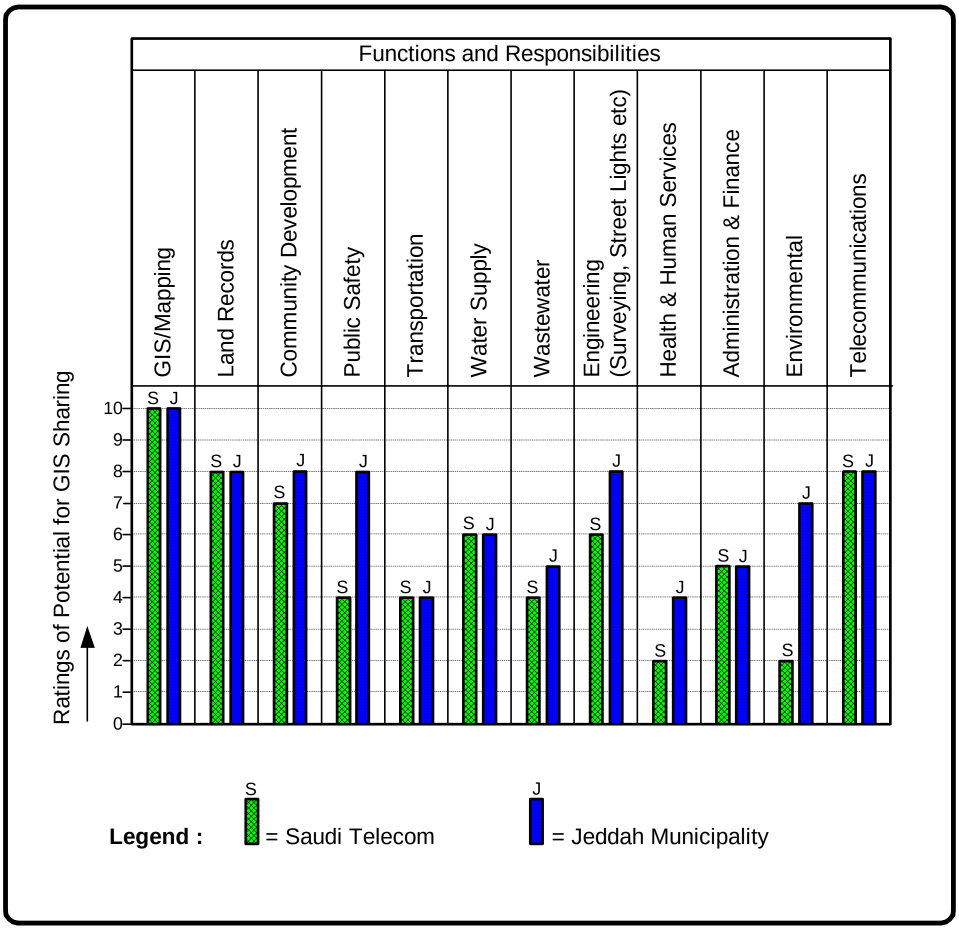

Figure 4.2 Congruency of GIS Sharing Potential.

Figure 4.2, adapted from the tabulated result given in Table 4.1 and the explanation notes, illustrates a reasonably close matching of potential for data sharing in most aspects.

Even though areas of congruency of GIS sharing potential have been established, it should still be stated that any data sharing arrangement between the two parties would be driven at least in part by financial incentives and the need for increased efficiencies, and could be considered as a reactive alliance agreement, rather than a proactive, altruistic progression.

The financial incentives (which are quantifiable) anticipated with sharing must be strong enough to outweigh continuance with the status quo - the institutional inertia (a non-quantifiable item) - if the organizations are going to participate in geospatial data exchange and sharing involving the 'adaptive collaborations for shared planning, building, using and financing spatial databases' (Masser 2002) that geospatial data sharing involves.

Deleted: .

4.3.1 Sharing Landbase Data

Due to the spatial nature of information used by both organizations, an obvious area of commonality is in the landbase. Technical and socio-political arguments can be important in explaining the collaborative alliances and associated benefits involved with sharing of data (Kumar and van Dissel 1996). When considering land management, for example, GIS acts as the key identifier of land and thus is a key component in any database associated with ownership and the required supporting infrastructure. An open flow of information regarding land or cadastral mapping is thus essential (Sinclair 2000) to land management.

The main issues here are to determine the features to be included in the landbase and the accuracy to which the landbase should be captured. Obviously, the higher the accuracy demanded, the higher the costs associated with data collection. In general, though, the costs do not rise linearly, but exponentially.

Landbase is essential to local government authorities as a backdrop for functions such as zoning issues and title searching, items which are not necessarily physically connected. For utilities, the interest in landbase is because of the geographic relationship between facilities that are connected either physically or wirelessly. So whilst both authorities have an interest in facilities management, and they both have a need for accurately recorded landbase, each will normally approach the usage of the landbase from a different perspective, and this may be reflected in the construction of the landbase.

4.3.2 Sharing Elevational Data

As in the case of landbase, the two types of authorities collect elevational data albeit for different prime reasons. So there is potential for sharing this data.

For information about the elevation of structures, STC is a prime developer and maintainer of the GIS data, as it is essential to its core business. The Jeddah Municipality would be the receiver of the information, as it has only a secondary interest, as radio communications is not one of its core business directions.

On the other hand, as access to ground surface level data is necessary for many of the Jeddah Municipality's core business units, it could be regarded as the prime developer and maintainer of this GIS data. In a data sharing or exchange arrangement, STC would conceivably be a receiver of this data as it is not really essential for meeting core business objectives.

Radio Systems

The acquisition and/or development of Digital Elevation Models (DEMs) has been of interest for STC as an essential aid to radio system designs. This has been particularly applicable to non-urban areas. Within cities and towns, elevational aspects for radio system designs have concentrated more on the height of and access to structures on which antennae can be mounted, and the elevation of structures that may interfere with possible line-of-sight radio paths.

Municipalities, too, have been interested in the relative elevation of structures for their own radio communications requirements, although internal radio communications is not a core business area for Municipalities.

Drainage and Waste Water

From the point of view of drainage and waste water infrastructure development, municipalities are very interested in relative elevations at ground level, as these influence the design of these facilities markedly. Absolute elevational information regarding pipe position slope and depth, as well as manhole depth are critical data for municipalities. Consequently, ground level and absolute elevational data are usually held in the authority's GIS.

Terrestrial Telecommunications Infrastructure

Telecommunications infrastructure providers also have an interest in the elevation of the ground surface, as this influences the design of routes for underground conduit, and the location of above ground equipment structures. Maximizing the distance over which a conduit route slopes in one direction has two minimizing effects. Firstly, it reduces difficulties associated with draining the underground facility access points (manholes). Secondly, as the tension applied to cables being hauled into conduits is a function of elevational changes, hauling down hill is favoured. Thus one criterion in conduit route design is the relative rise and fall of the conduits over the designed route. If a utility's civil engineers and draftsmen have ready access to elevational data this can assist in the production of designs which optimise route selection, and placement of access points and conduits.

4.3.3 Sharing Facilities Data

The acquisition efforts for landbase and elevational data can be shared, as can be the benefits derived from the sharing agreement. However, the acquisition of facilities data remains the responsibility of the individual partners to the data sharing arrangement. This does not diminish the value of the sharing arrangement, for often it is the only reliable source of the data. Through a knowledge of the location and functions of a partner's facilities, both existing and proposed, planners, designers and operational staff are better able to make decisions affecting their own infrastructure and that of their partner.

A data sharing arrangement will allow enhancement of the attribute information attached to centroids, whether these centroids are parcel related or building related. If it is building related then attributes such as zonal purposes could be attached by the municipality, with Telco related attributes attached by the telecommunications body. Other utility attributes could be attached by either party as the information becomes available, for example when the site is visited for any purpose. This combined centroid attribute information would present a much more comprehensive understanding and knowledge of the building and the infrastructure existing or required.

Examples

A relatively sophisticated deployment of shared data between a Telco and a Local Government body could assist in the statistical analysis of road accidents through visual presentation of data.

In this example, an animated cartogram could be produced combining three layers of temporally animated data. The first layer could be a landbase of the area to be studied (provided by either party). The second layer could be a three dimensional representation of frequency of accidents at various geographic points (supplied by the local authority), animated to reflect the changes in road accident rates at intervals over a two year period. The third could be a two dimensional representation of trench digging, combining the activities of both parties, in the vicinity of the accident sites, animated by showing the various phases of trench opening and closing over the same period as the accident statistics are compiled.

The results of this multiple layered, animated cartogram might lead to an investigation of the probability of a link between trenching operations and traffic accident rates. This could further lead to studies into: public announcements of forth coming road works (something which is not currently done in Saudi Arabia); length of time a trench is open (often very long as there is little chance of rain); what safeguards such as lighting, barricades, advance warning signage, traffic control personnel are or should be used (currently enforced haphazardly); and the quality of trench reinstatement (often adversely affected over time by the high water table in the major cities).

To construct this dynamic, visual model, both organizations would be involved in supplying graphical data. The graphical, actually locational, data would need to be available in a 3-D spatio-temporal format (x,y,t), reflecting the effects of time/date in the analysis. The data would also need to be supplied in formats recognized by both organizations.

It is felt that the impact of the model on reviewers would be far greater than with either static visual models, or tabular data presentations. Both organizations would gain from using such an example – in quantitative terms through lower restitution costs, and qualitative terms through better public relations.

Road Works Coordination and Safety

Another example of why coordination would be an advantage between a municipality and a major utility such as telephone, electric power and gas, is in consideration of road works.

One of the main factors in the increasing rate of deterioration of city roads is the installation of underground service infrastructure. If the integrity of the pavement layers can be preserved, through having proper coordination of projects minimizing the number of times that the road surface is disturbed, this rate of deterioration can be reduced. Thus, any means by which the coordination can be improved, such as through sharing GIS data held in a road and pavement asset management atlas, has the potential to improve the serviceability of the road network.

Better, more consistent safety practices such as dig-safe activities and crew protection for operations teams result from the planners and excavation schedulers of the digging authorities having access to the same information. The levels of cooperation and coordination of efforts can be improved with greater access to inter-organizational geospatial information, and demonstrate further intangible benefits of sharing of data with other utilities (Meyers et al. 1998).

4.4 Conceptualised Model

4.4.1 Generic Long Term Plan for Saudi Arabia

The proposed long term plan for geospatial data sharing in Saudi Arabia, using a generic co-ordinating node model is shown in Figure 4.3.

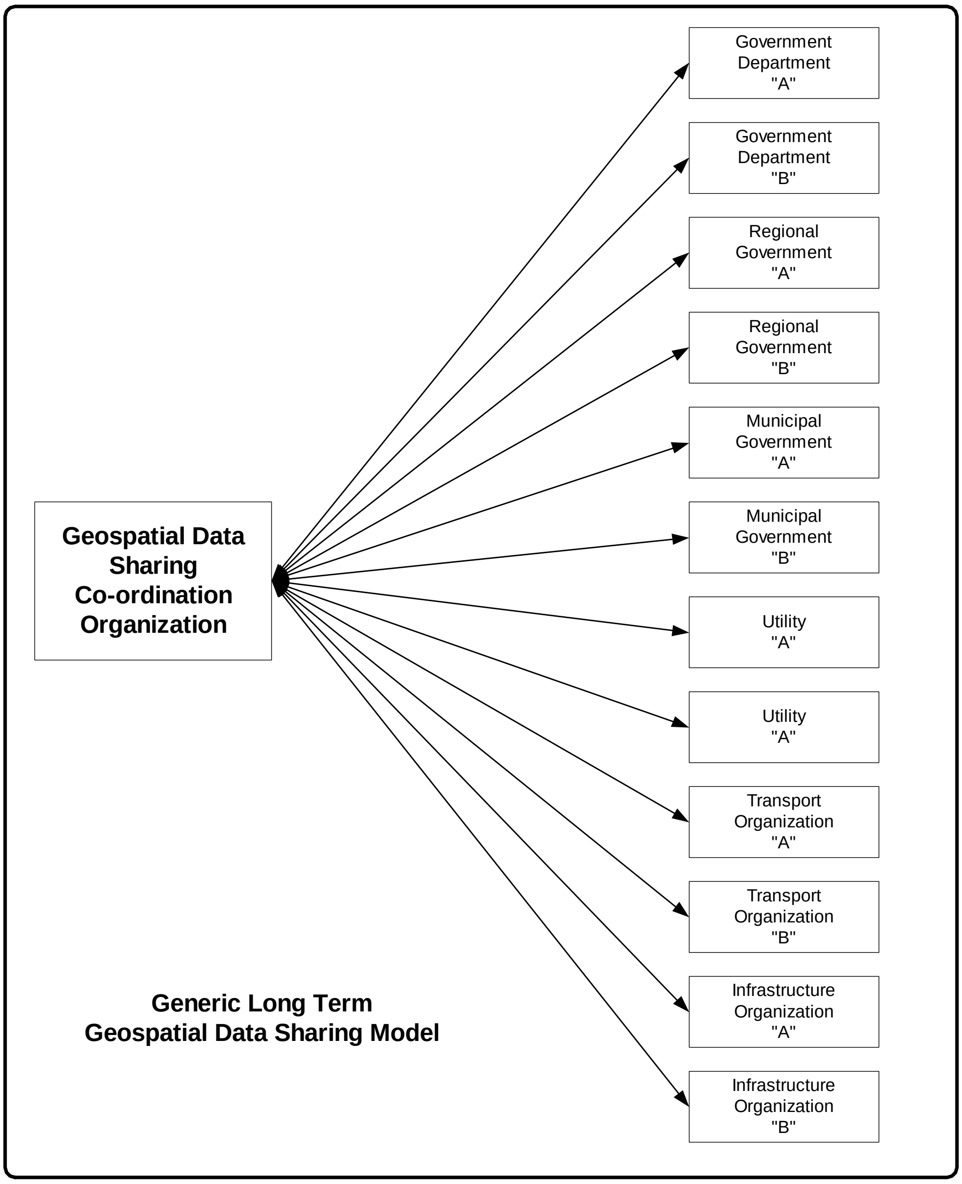

Figure 4.3 Generic Long Term Model for Saudi Arabia Data Sharing

This is a multi-participant data sharing model, with geospatial data and information being shared via a co-ordinating organization with or without a data warehousing capability. The Co-ordination Organization role could be taken up by the King Abdulaziz City for Science and Technology (KACST) as the nation's leading authority in co-ordinating Kingdom wide IT activities. Appendix 1 Geospatial Information and Saudi Arabian Authorities lists many of the Saudi Arabian authorities that would populate this generic model.

More sophisticated generic models considered involved outsourcing data storage to data warehouses controlled by commercial contractors without co-ordinating nodes. However these were rejected after taking into account previously raised issues such as: Ownership and Custodianship of Data (Section 3.4.2); Outsourcing Data Gathering, Storage and Maintenance (Section 3.4.8); and Political Considerations (Section 3.4.10).

The model chosen for use with the national borders of Saudi Arabia would involve four levels of Spatial Data Infrastructures (SDIs). These levels can be represented on in Figure 4.4 which is adapted from one presented by Rajabifard in a discussion of the dynamic relationships within different levels of SDI (Rajabifard et al. 2002).

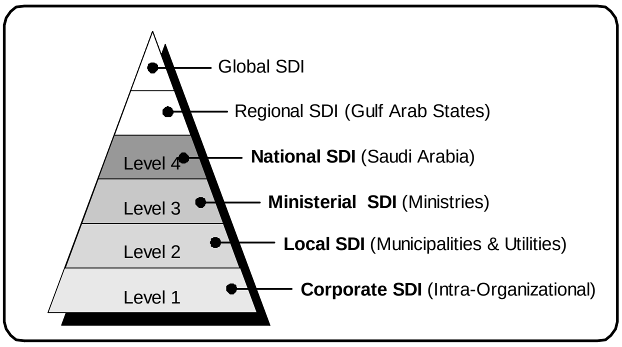

Figure 4.4 Four Levels of SDIs involved in the Generic Long Term Model

Source : Adaptation (Rajabifard et al. 2002)

4.4.2 Adapting the Generic Long Term Model

The Generic Long Term Model involves centralized processing of the data for the sharing arrangement. However, this is not needed for a bilateral pilot agreement in which the two parties have existing GIS databases containing geospatial data which are complementary and in some cases redundant.

A distributed processing system is more appropriate, with direct access between the two databases, albeit with restrictions on the extent of the shared information. This approach removes the need to set up a third party co-ordinating organization in the first instance, keeping the project to a manageable size thus reducing the lead time for implementation.

An arrangement incorporating the bilateral sharing of geospatial data is shown in Figure 4.5.

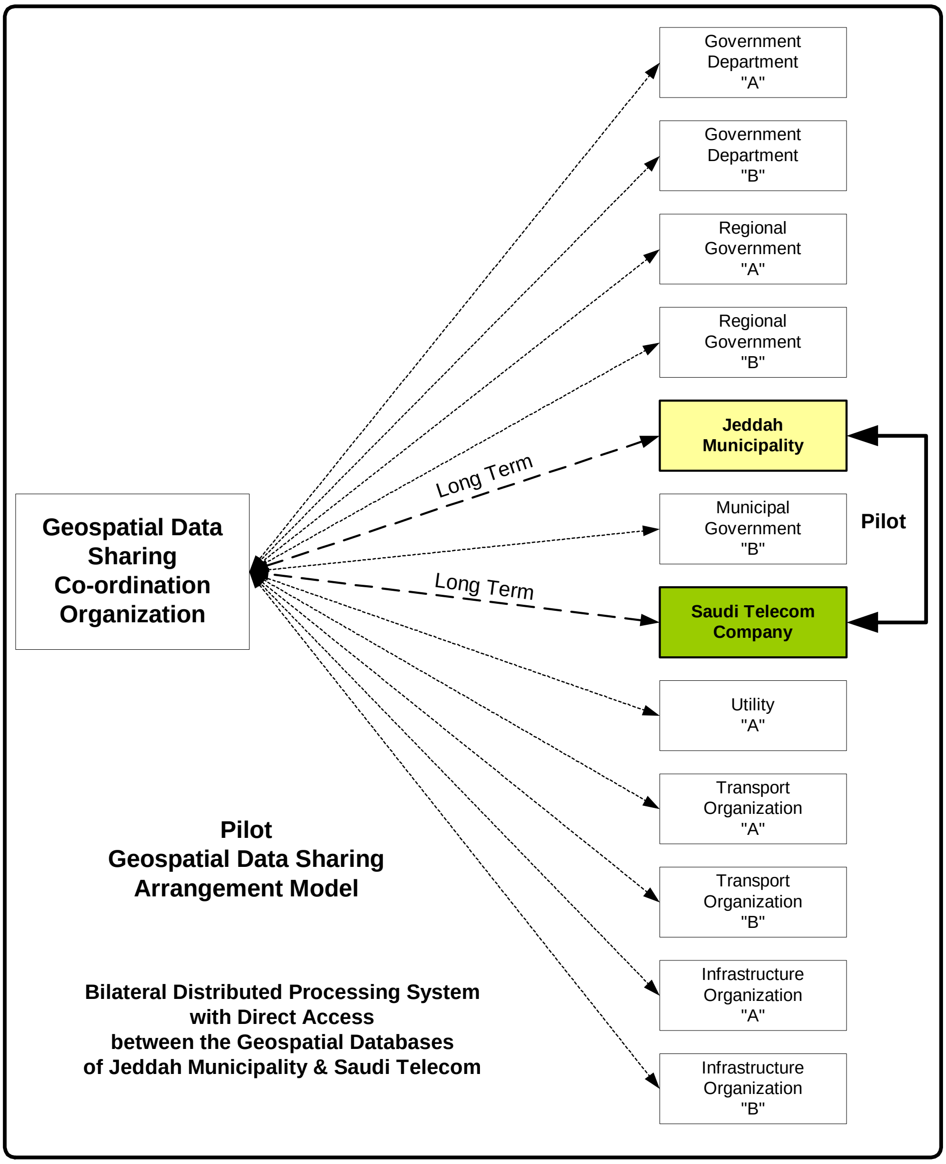

Figure 4.5 Adaptation of Generic Long Term Model for Pilot Scheme

Note that the long term arrangement would involve links with a coordination organization, and this extension beyond the pilot configuration should be considered when setting up the pilot arrangement.

The model would involve only two levels of SDIs thus involving far fewer vertical relationships. The levels involved are illustrated in Figure 4.6

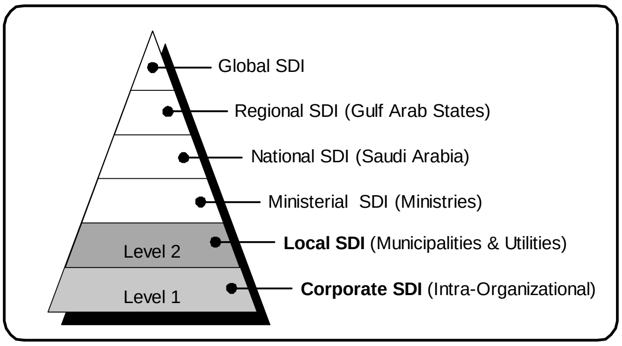

Figure 4.6 Two Levels of SDIs involved in the Bi-lateral Sharing Model

Source : Adaptation (Rajabifard et al. 2002)

4.4.3 Proposed Model for Jeddah Municipality and Saudi Telecom

Consideration of STC Geospatial Resource Management

As a utility that is trying to maximise the efficiencies available from managing its enterprise resources Saudi Telecom has recognized the value of its geospatial database, and is moving towards Geospatial Resource Management. Modules and systems to be integrated to maximise the value to be gained from utilization of the functionality of the enterprise information system include the following :

- Document Management System
- Work Management System
- Land Information System
- Enterprise Resource Planning Module
- Outage Management System
- Customer Information System
- Workforce Management System

- Distribution Management System
- Geofacilities Management System

Appendix 4 STC Functional Units - Usage and Accessibility provides details of the major components of these applications and business processes, indicating internal access arrangements appropriate for STC, and access points for the Jeddah Municipality to these applications.

The limited data access model is illustrated in Figure 4.7.

Model Proposed for bi-lateral data sharing between Jeddah Municipality and Saudi Telecom

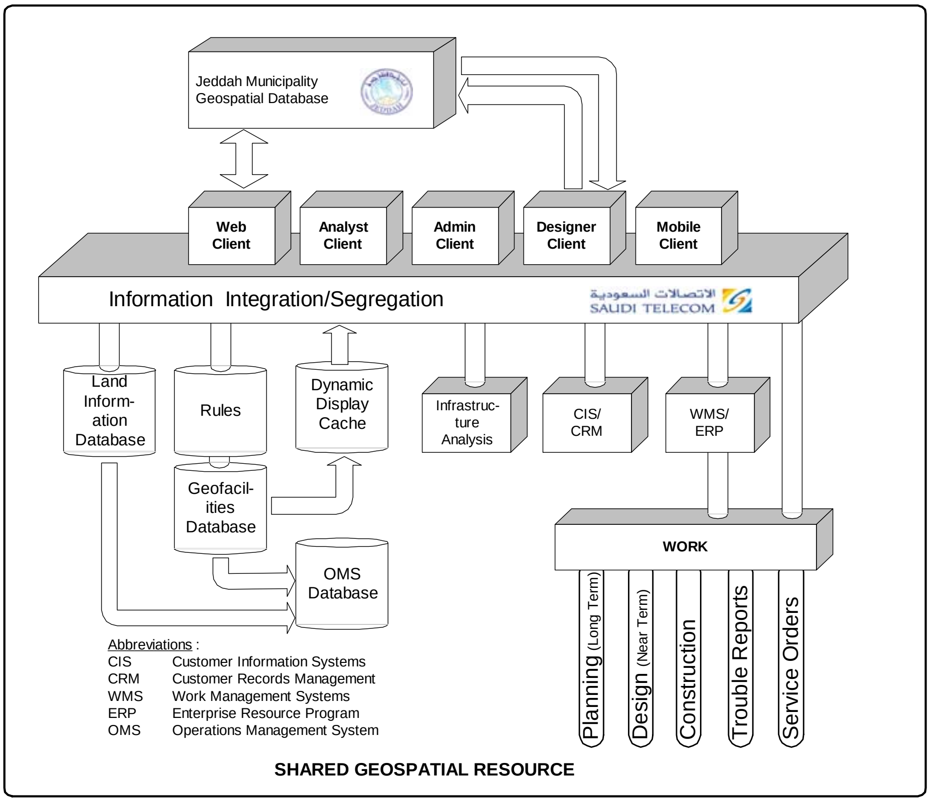

Figure 4.7 Dynamic Two Party Data Sharing, with Access Limitations[13]

[13] This diagram has been adapted from the description of a Geospatial Resource Management system being installed within Saudi Telecom. Connections to Jeddah Municipality shown above the Information/Segregation portal have been inserted to illustrate a bilateral sharing configuration.

It is this basic two party, limited access configuration that will be tested as a Data Sharing Model.

The geofacilities database model consists of :

- Metadata tables and objects in the database (which describe the facility model)
- Data tables and objects in the database (which comprise the facility model)

Within Saudi Telecom the geofacilities database is accessible to various internal clients:

- Web Client for FRAMME WebView access in Customer Service Centres and Engineering Offices
- Analyst Client for Strategic Planning groups
- Administration Client for Financing and Stock Control
- Designer Client for Engineering and External construction groups
- Mobile Client for Installation and Repair groups.

Other interfaces are maintained for Plant Analysis, for Customer Information Systems and Customer Records Management, as well as Workforce Management as described in Appendix 4.

Limited Integration of Jeddah Municipality data with STC data

For Jeddah Municipality in a pilot GIS sharing arrangement with Saudi Telecom, access to the STC geofacilities database would be similar to internal STC clients. This would involve access through the Web Client and Designer Client modules, using a combination of Web access and data CDs. The elements appropriate for access would be negotiated, but could be determined by referring to Table A4.1 Access to Applications and Business Processes. Similar arrangements would apply for STC's access to Jeddah Municipality geofacilities database.

Selected aspects can be segregated, limiting access of the partners in accordance with the agreements reached.

The STC data tables to be accessible to the Jeddah Municipality would be subject to negotiation, but could be defined using the requirements given in Appendix 4, Table A4.1 "Access to Applications and Business Processes". Similarly, reciprocal arrangements for STC to access data held by Jeddah Municipality could be negotiated.

4.5 Conclusion

This chapter deals initially with administrative matters concerning this thesis including the research processes considered and the conceptualised data sharing model to be tested. The discussion on the research methodology chosen touches also on some of the cultural aspects that have to be considered in formulating and examining the models presented later in this paper.

A long term strategic model for the nation is given in broad terms but the intricate patterns of data availability and quality combined with attitudes, policies, and abilities regarding geospatial data sharing are going to make difficult any attempt to weave together a basic, coherent nationwide network of data producers involving multiple levels of SDIs. Thus such a model could not be applied within a reasonable timeframe and therefore this was not the subject of further discussion.

A conceptual model for a data sharing arrangement, which would provide the Jeddah Municipality with access to the STC Enterprise Resource System was developed as a pilot scheme. This takes into consideration the possibility of more wide spread data sharing schemes in the future. But by restricting the pilot model to a bi-lateral agreement, complexities that would be introduced in a multi-lateral, multi-level arrangement are avoided.

Using the research instrument that has been chosen, testing of the conceptual model will be pursued in the following chapter through a comparative research into systems in use elsewhere, determining if any are applicable, and critically examining the results.

CHAPTER 5

EXAMINATION OF DATA SHARING MODELS

5.1 Introduction

This chapter examines a variety of arrangements currently used for the exchange or sharing of geospatial data in other countries. The purpose of the examination is to test the feasibility of applying various arrangements in Saudi Arabia. A model is then selected as having the most potential and for comparison with the one conceptualised in Chapter 4.

Background information is included concerning a number of organizations in countries that have well developed and institutionalised GIS structures, such as the USA and the UK, as well as countries with less developed GIS structures, such as some of the former Eastern Block countries. From these organizations ten have been chosen as models (or case studies) for closer scrutiny.

The models examined range from completely open systems that use the Internet as the primary tool for obtaining required GIS data freely, to highly controlled data exchange systems.

Processes for evaluating the models are developed to provide a framework whereby these arrangements can be used for inductive testing. A match with the model conceptualised in Chapter 4 is attempted from a technical viewpoint first with instances of congruency and disparity discussed. This is followed by consideration of geographic and cultural issues.

The procedures used for examining and evaluating the models selected as case studies are illustrated in Figure 5.1.

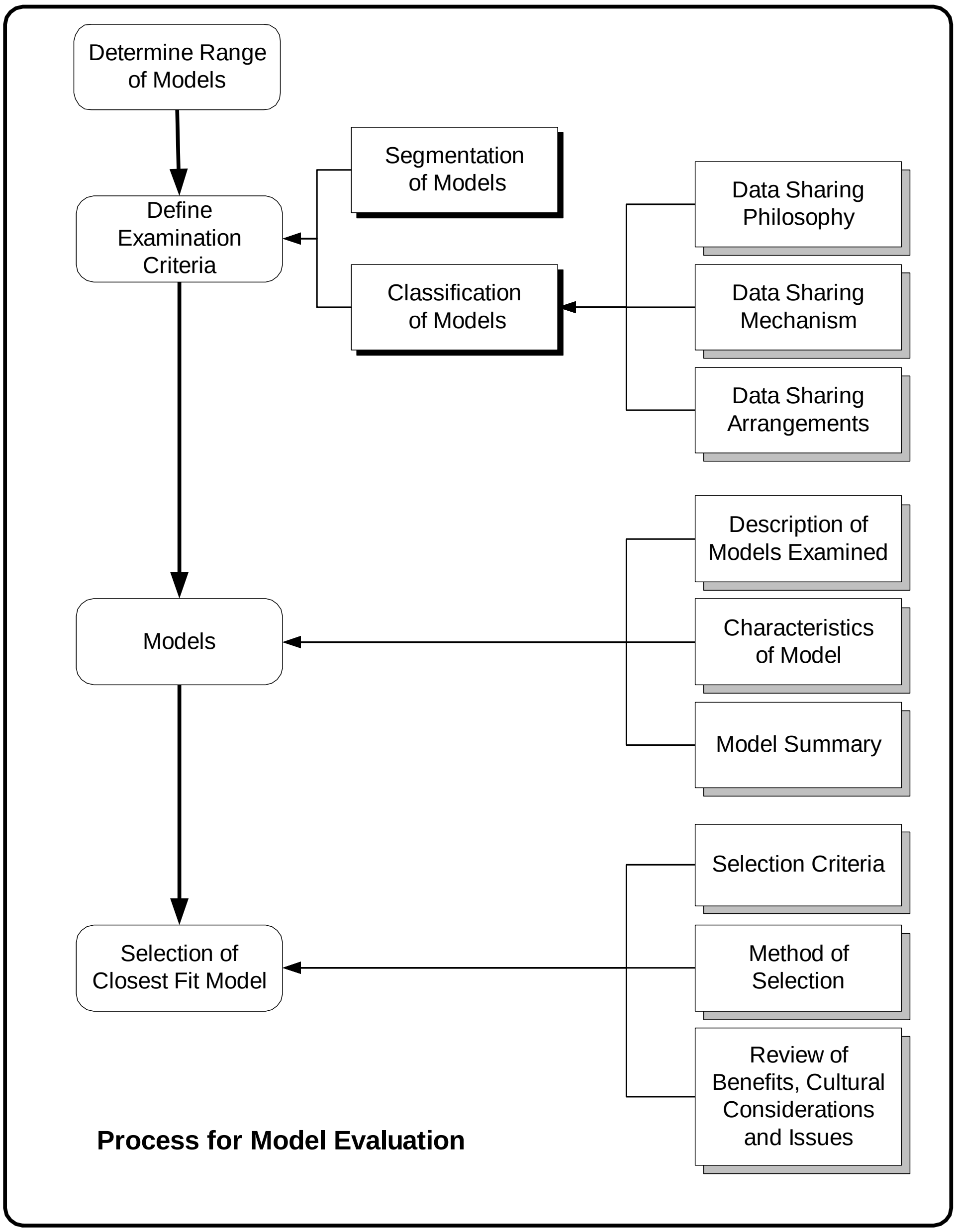

Figure 5.1. Model Evaluation Process

5.2 Overview of Some Examples

Examining data sharing only in the Middle East does not present a wide range of samples. Consequently, prior to making recommendations regarding viable and effective exchange and sharing of data within Saudi Arabia, it is necessary to refer to the experiences of organizations in other countries. Examples will be drawn from countries that have well developed, mature GIS infrastructure, as well as from countries with less developed GIS structures. The examples range between systems in use at various levels : regional; national; provincial; counties; local authorities and cities; utilities; and private companies. The examination will be refined in Section 5.4 Models Investigated, following a discussion on the criteria to be applied in Section 5.3 Range and Classification of Models Investigated.

The wide diversity of examples chosen represent a comprehensive range of systems to be assessed for appropriateness in the development of a spatial data infrastructure for Saudi Arabia.

5.2.1 USA

Utilities, Cities, Counties and States

The deregulation of the utility industries in the US has lead some multi-utility organizations towards data sharing and consequent integration of information to improve the efficiency of individual sectors (Quimbo 1998). The City of Tallahassee found ways to optimise existing resources through sharing the GIS information gathered by its six utilities. For Michigan Consolidated Gas, the completion of its conversion to digital orthophotography for its AM/FM applications, combined with the corresponding Digital Terrain Models (DTMs), led planners from other utilities to share its database in identifying optimum routing based on terrain analysis (Contrucci and Grillo 1998). Northeast Utilities of New England has seen productivity and effectiveness increased since providing map locator aids to power linesmen, environmental officers and asset managers, and sharing data between departments through a wireless/mobile infrastructure (Gates 2001). It is now extending the applications to street light maintenance, enhanced automated vehicle location and new service requests, sharing the data with county authorities.

In the case of a merger between two organizations, difficulties in merging the geospatial databases can present many of the same challenges faced in data sharing between separate organizations. To empower the legacy corporate data, First Energy of Ohio which was formed through a merger between Ohio Edison/Penn Power Company and Centerior, created ‘keys’ between the legacy databases and the two AM/FM/GIS soon after the merger (Miller 1998).

In implementing a base map GIS project, and making it available on a LAN and desk top, the City of Lubbock, Texas, found there was new interest generated for an expanded use of geospatial information in all departments and in other organizations (McGaughey 1999). 73,000 Planning parcels, essential for use within the City, and useful to others were linked directly to the City's database.)

Kansas City Power & Light Co. (KCPL has entered into data sharing arrangements with seven government agencies in the Kansas City Metropolitan area, and periodically receives detailed updates to its landbase information (Benassi 2001). It utilizes an open platform to facilitate data sharing requirements of its geographic resource management system, as well as the requirements of the organizations sharing the data.

Montana Legislature realized that information retains its value best when it is easy to access. Through the Natural Resources Information System (NRIS) (Montana State Library 2002), it provides affordable and accessible geographic information to citizens, resource managers, and decision makers throughout Montana, and enhanced information to state and federal natural resources agencies (Stimson 1999). Appendix 6 Sample of Costs for Accessing Shared Databases provides the fee structure applied by this major coordinator of data sharing.

In expanding its enterprise GIS, Nassua County, Florida (Jones 1999) found that increasingly, smaller, single purpose entities are realizing the advantages of using the County GIS and their numbers have been the fastest growing aspect of the multi-participant program.

Multi-jurisdictional

In the USA, various data sharing arrangements have been attempted involving different levels of government. Two large-scale multi-jurisdictional schemes that were designed to harness cooperative computing beyond the local level, provide examples and case studies in multiple user systems.

The first was the 1970s scheme sponsored by the U.S. Department of Housing and Urban Development. Known as the Urban Information Systems Inter-Agency Committee (USAC), this scheme was established for organizing municipal records, and for national assisting in research. It was not truly GIS based, but introduced multi-jurisdictional computing at the local level. The conflict between technical limitations and organizational goals eventually lead to the demise of this scheme, though many lessons were learned from the experiences of this committee (Greenwald 2000).

The second, sponsored by Southern California Association of Governments (SCAG), was designed to facilitate the transmission and analysis of geospatial data between various levels of government (Southern Californian Association of Governments 2000). Known as SCAG ACCESS, it is envisaged that this scheme will significantly increase the level of communication and information sharing among jurisdictions within sub-regions and the State and Federal governments.

5.2.2 Europe

Multiple Countries

CERCO (Comité Européen des Responsables de la Cartographie Officielle) was founded more than 20 years ago to represent the Heads of Europe’s National Mapping Agencies (NMAs). By the year 2000 membership had increased to 37 countries and the organization provided a useful forum for the wider Europe at which experiences were shared and common problems resolved to the mutual benefit of all NMAs. In January 2001, EuroGeographics was formed out of CERCO, with the aims of facilitating better and more accessible geographic information for Europe through collaboration with other producers, and with all those who need such information (EuroGeographics 2001).

The European Commission (EC) also has a proposal to create legislation to guide and develop national and regional spatial data infrastructure through a project named INSPIRE, INfrastructure for SPatial InfoRmation in Europe, and ongoing activities of the Open GIS Consortium.

Single Countries

In Ireland, the Government established a Local Government Computer Services Board (Department of Environment Ireland 1996). This board made the decision in May 2001 to adopt a WebMap to support its strategies of providing GIS information to all the local governments, and effectively open data sharing to the public (Local Government Computer Services Board (Ireland) 1998).

There is a high degree of awareness of the importance of digital information in Hungary (Craglia and Masser 2001). The National Geographic Information Strategy which was completed in 1998 has lead to a national policy on data access and sharing, which addresses issues such as development of Core Data and Metadata, providing access to wide range of geographic information. This recognizes the constitutional right of everyone to "know and disseminate data of public interest".

OrdSurvey UK

Britain's Ordnance Survey was established in the late eighteenth century to carry out Military Mapping (Ordnance Survey 2000), and has developed into a government mapping agency with a very comprehensive set of geospatial information available. It is a government department as well as being an executive agency of the British Government, and has a responsibility to share data, but also with the responsibility to make a profit (Keeble 2002).

Through geospatial data sharing arrangements, it is involved with activities as diverse as emergency vehicle dispatch, planning transport links, environmental investigations, crop yield assessment, utility infrastructure management, and accident investigations.

In the United Kingdom, Ordnance Survey (Ordnance Survey 1999), gives a case study of the North of Scotland Water Authority (NOSWA) as just one of many British utilities that have discovered the benefits of using shared data. By using GIS information, NOSWA is able to work more closely with other utilities, sharing information about the location of pipes, treatment works and pumping stations. This information is particularly useful for highways agencies and other utilities carrying out road works.

British Telecom

British law requires that British Telecommunications plc (BT) provide maps to about 25,000 organizations that need to know the location of underground plant (Causey 2001). This data sharing is increasingly being done by registered bodies making requests to the BT GIS through emails, and the maps then being dispatched through emails.

5.2.3 Asia

Singapore

The Singapore government has implemented a comprehensive digitised land data system, integrating land data from various sources. It enables data sharing and distribution to 13 government agencies, numerous registered utilities, and to the general public via through the Internet (Ministry of Law Singapore 2000). The scheme, Land

Data Hub 21, incorporates a network for distributing land data, a data warehouse for integrating land information, and an address point data set which integrates postal addresses with other land base records (Heng 1999).

Thailand

Thailand as an emergent nation has been involved with developing and using GISs for some years. For example, GIS is an essential tool in urban planning of many cities. Historically though, the geographic information set-up for Thailand has not been well coordinated within government agencies or corporate bodies despite efforts by the Cabinet appointed National GIS Coordination Committee. The usual problems related to unwieldy growth in the industry has been evident, with duplication of GISs, non-standardised data systems and limited sharing of data and resources.

The Geo-Information and Space Technology Development Agency (GISTDA) was established in 2000 to organize the development and usage of geospatial data (Vibulsresth 2002). The objectives of GISTDA include serving as a core centre for collection, distribution and standardization of this geospatial data. Fundamental Geospatial Data Sets (FGDS) have been compiled using data from all the major commercial suppliers and the government's own Royal Thai Survey Department (RTSD) and GISTDA.

A national spatial data infrastructure (NSDI) is being implemented to provide the technologies, people, and policies necessary to promote sharing geospatial data held in the FGDS. The NSDI will provide access to all levels of government, academic institutions, private and non-government agencies (NGAs) and comprises the four core units of Institutional Frameworks, Technical Standards, Fundamental Datasets and Access Network/Clearinghouse (Vibulsresth 2002).

5.2.4 Australia

At a national level, the Commonwealth Office for Spatial Data Management has responsibility for promotion and coordination of aspects of geospatial data relating to natural resource management, management of environmental issues, infrastructure development through utilities and quasi governmental authorities, socio economic variables and provision of community services. It carries out these responsibilities in conjunction with state and territorial authorities. These organizations are brought together through intergovernmental cooperation using the Australian New Zealand

Information Council (ANZLIC) as the vehicle for this co-operative approach (Masser 2002), striving for consensus in standards and protocols. The members of ANZLIC have developed the framework for the Australian Spatial Data Infrastructure (ASDI) to facilitate national geospatial data sharing. This framework is not a fully structured model as dynamic relationships are involved, but it can be generalized as discussed previously (see Section 3.4.18 Spatial Data Infrastructure - Combining the Issues).

The importance of geospatial data sharing has been recognized as a key component of the Australian Government's "Investing for Growth" strategy.

States

Various systems such as LANDATA in Victoria and Land Information System Tasmania (the LIST) allow the public to search and view cadastral and related information from government databases over the web (Majid and Williamson 2001). For Victoria, this has been achieved through various initiatives which reconcile the databases of local government agencies with the state's digital cadastral database (Masser 2002).

Until recently Land Victoria has been delivering updates to its data subscribers using CD-ROMs that are cheaper and easier compared to the Internet but increased availability of broadband access has made web access to the data more viable.

Local Government Organizations and Agencies

Agencies in Australia are being compelled through legislation to share data (Gallagher 1999). This is having "knock-on" advantages for local government organizations such as Yarra Ranges Council, by enabling front line customer services staff to retrieve information from other organizations databases, as well as making information more available from within their own organization.

Utilities

Western Power Corp., which serves the equivalent of one-third of Australia's land area, has installed sophisticated enterprise resource planning software, integrated with its GIS (Hurley and Causey 2001). Its maps, including street directories, can be shared with qualified organizations through Web Mapping.

5.3 Range and Classification of Models Investigated

As a broad indicator of the expansion of GIS data sharing that is occurring globally, consider that of the 192 countries in the world, over 120 countries are involved with the development of NSDI arrangements in order to promote access to and sharing spatial data (Mahoney et al. 2001). This points to there being a very large number of data sharing arrangements which could be examined.

The range of models investigated is aimed at finding examples that could be applied in Saudi Arabia. This will assist in determining: whether multi-participant data sharing arrangements would be feasible; if data sharing considerations should be targeted at a bi-lateral arrangement between the Jeddah Municipality and Saudi Telecom Company; or if an arrangement involving public access to geospatial data supplied from just one of these organizations would be the most practicable approach.

Thus, the selection of models to be investigated ranges from cases involving many nations and groups to cases involving very localized participants, and these are organized according to industry segments. A range of models for the integration and exchange of data are to be investigated, considering the following features:

- The use of an internationally maintained Spatial Data Clearinghouse accessed via Internet connection,
- Highly controlled Web Mapping systems targeted at a well defined group of Users,
- A closed relationship between two organizations, each sharing responsibility for specific tasks.

As an aid to analysing their appropriateness, the models are related to purpose or reason for sharing, the arrangements in place and the mechanism of sharing.

Criteria involved in selecting feasible and appropriate arrangements include consideration of the broad issues raised in Chapter 3 Review of Data Sharing Issues, as initial filters. These criteria include specific cultural issues that could impact on the adoption of any of the models.

5.3.1 Segmentation

The models examined represent the following segments suggested in “Beyond Maps : GIS and Decision Making in Local Government” (O'Looney 2000).

- Multi-national, multi group cases,
- Public - Private Multi-agency,
- Public information exchange organizations, both non-profit and for-profit,
- Multi-departmental,
- Shared GIS dominated by single department or agency.

Each model is described, putting it into a segmental context.

5.3.2 Classification of Models

The models are then classified by the following three criteria

(1) Data Sharing Purpose or Structure;

(2) Role in Data Sharing Arrangement; and

(3) Data Sharing Mechanism.

The classifications were chosen in the absence of previously published distinguishing attributes and assessments, as described in Section 1.3 Statement of Problem.

Each of the models is described in sufficient detail to allow an assignment of classifications, and these are presented in tabular format, for ease of assessment and comparison.

Many of the models may fit more than one sub-classification. For instance, the main reason behind British Telecom (BT) sharing data is for internal intra-departmental use. This category "*Data Sharing within an Organization*" is considered the primary sharing purpose. Yet due to governmental regulations, BT must share data with various prescribed external bodies. Thus a secondary sharing purpose for BT is "*Providing Data to Commercial Interests - Restricted*".

Only the primary classifications for each model are presented with the models. However when reviewing the models secondary and tertiary sub-classifications will be included where appropriate as a way of getting a better analysis of the most suitable model for this investigation

Classification Based on Sharing STRUCTURE

The purposes of data sharing arrangements for the models selected are examined for suitability in the context of data sharing in the Middle East. There are many reasons for sharing data, but in general each arrangement has a primary purpose, a secondary purpose, and in some cases, a third purpose of lesser importance.

The sharing Structure categories chosen are :

- Providing Data to the Public – Unrestricted
- Providing Data to Commercial Interests – Restricted
- Data Sharing within an Organization or between Fixed Partners
- Data Sharing both within and outside the Organization, including for Customer Service

Classification Based on ROLE in Data Sharing Arrangement

The roles of the participants in the data sharing models are categorized as :

- Coordinator
- Data Gatherer and Disseminator
- Data User
- Data Gatherer/User

Classification Based on Data Sharing MECHANISM

The methods of sharing the data are sorted using the following categories :

- Simple File Transfer (Peer-Peer asynchronous)
- Field Application (Thick Client in Client Server)
- Web Application (Thin Client in Master Slave)

5.4 Models Investigated

The range of models being investigated excludes clearinghouses, as these are generally established primarily as facilities for providing information (metadata) about available digital data. Future studies of models may have to include these facilities, as many clearinghouses are moving towards giving direct access to digital data.

5.4.1 EuroGeographics Model

When established over twenty years ago, CERCO (Comité Européen des Responsables de la Cartographie Officielle) was more of a network of Mapping Authorities than a Data Sharing body. However, since its merger with the Multipurpose European Ground Related Information Network (MEGRIN) in 2000 it has progressed towards being a provider of shared databases, as well as providing Web based metadata services. The merged organization, EuroGeographics, has as its mission "*to represent Europe's National Mapping Agencies (NMAs) working for the European Geographic Information*

Infrastructure…by working to make the data bases of European NMAs interoperable, and widely available" (EuroGeographics 2002). This mission is being accomplished through the establishment of the Geographical Data Description Directory (GDDD), which is a descriptive listing of all the principal geographical databases available from the official National Mapping Agencies of Europe (MEGRIN 2000).

Since 1996 the main part of the information contained in the Geographical Data Description Directory has been freely accessible on the Internet. The GDDD provides metadata information including technical aspects such as specifications, data source, content, update information, accuracy and other quality parameters, organizational aspects such as short descriptions of the NMAs providing the data, commercial aspects such as geographical extension, conditions of sale, restrictions of use, format, and general aspects such as textual description, and contact information.

Tables A5.1 and A5.2 in Appendix 5 list most of the current member organizations participating in this group, which essentially has become a pan Europe data sharing organization. The listings indicate the wide variety of countries represented in it, and that the majority of the organizations are the governmental mapping arm of the countries concerned.

EuroGeographics Model Summary

The Multi-national CERCO model, and its later version, EuroGeographics, are characterized as for-profit organizations, with a strong coordination role, having most of their data sharing business conducted over the Web.

Table 5.1 EuroGeographics Data Sharing Model Characteristics

Classification	**Primary (Basic) Characteristic**
Sharing Structure	Providing Data to Commercial Interests - Restricted to paying customers and fellow sharers.
Role in Data Sharing Arrangement	Coordinator
Sharing Mechanism	Web Application (Thin Client in Master Slave)

5.4.2 Ordnance Survey Model

Britain's Ordnance Survey was established in 1791 with Military Mapping as its primary function. It began by producing first 1": Mile, then 6": Mile, and then 25": mile survey maps, and is now a highly sophisticated repository of digitised versions of over 230,000 maps (Ordnance Survey 2000; Keeble 2002).

Through geospatial data sharing arrangements, it is involved with activities as diverse as emergency vehicle dispatch, transport links planning, environmental investigations, crop yield assessment, utility infrastructure management, and accident investigations. Ordnance Survey® data, including 3-D terrain models, Land-Line®, ADDRESS-POINT™, and Boundary-Line™, can be used for base map layers to which various organizations can add their own data. This data may be derived in turn from information from a variety of sources such as the Post Office, utilities, and environmental agencies with which there are data sharing arrangements.

Deleted:

As an example, computerized road mapping from Ordnance Survey (OrdSurvey) is playing a pivotal role in keeping traffic on the road network moving. By providing a common and consistent base for exchanging road related information, this digital mapping system is used in tandem with automatic vehicle location systems and route tracking data to help monitor traffic flows minute by minute.

Digital mapping is used to give an overview of the entire transport system. Integrated layers of transport information give comprehensive geographical and statistical data which is then displayed live on its Strategic Information System and stored in the system's database. Messages about traffic conditions can be passed to travellers via radio broadcasts, roadside message signs, bus information displays, Public Access Terminals information display units and the World Wide Web.

In a project that started in 1992 in Southampton, the Road Management System for Europe (ROMANSE) provides current information about road conditions, and aims to change people's travel choices by promoting public transport as a viable alternative to the car. The data provided by ROMANSE comes from a variety of shared sources such as OrdSurvey geospatial databases, motoring organizations, the police, other local authorities, utilities, and regional and local news broadcasters.

Another example is the joined-up government exercise in which OrdSurvey data is used by three local authorities in the Forth Valley of central Scotland to support frontline services (Scottish Enterprise 2002). These three councils – Stirling, Falkirk and Clackmannanshire share their geospatial data through Intranet connections for managing services such as bus route planning, property development zonings and building permit controls. The geospatial data sets are also made available for sharing with other public sector agencies such as health care providers, to further participate in the joined-up government approach.

OrdSurvey is a for-profit organization deeply involved in e-business and which shares data on a commercial basis. It also meets certain community service obligations through having vast amounts of information available free to the public.

Ordnance Survey Model Summary

OrdSurvey is a model of a single source public information exchange organization, with geospatial information stake-holder status. Formerly, its primary role was the gathering of mapping data, and reproducing it on a commercial basis. Its role has changed so that it now makes the information available through the Web, both on for-profit and on not-for-profit bases. This is therefore different from the model of a utility whose GIS was developed for internal use, but which recently branched out to exchange geospatial data with other utilities and Government authorities.

Table 5.2 Ordnance Survey Data Sharing Model Characteristics

Classification	Primary (Basic) Characteristic
Sharing Structure	Providing Data to Commercial Interests - Restricted to paying customers and fellow sharers.
Role in Data Sharing Arrangement	Data Gatherer and Disseminator
Sharing Mechanism	LAN and WAN, with Web links

5.4.3 British Telecommunications Model

In the United Kingdom, British Telecommunications plc (BT) has a very extensive Geospatial Information System. The External Plant Records (BT/EPR) system is designed to provide the company with a GIS based application to maintain image, spatial and attribute data in a central ORACLE database (Rigg et al. 2001). BT now has all maps and related documents digitised and stored in computers as raster information and all vector data is stored in Oracle database. All the previous paper maps were digitised and attribute data attached.

Historically, this GIS has been used to support infrastructure development, operations and maintenance, and administration, largely through intra-organizational data sharing. The application developed helped the network planner in laying of cables, ducts, creating exchange areas, finding the shortest / optimal path of laying cables and the printing of maps..

British law now requires that certain organizations must have free retrieval rights to maps of BT's physical external plant for use by these organizations. BT established the Street Works Act Management Point (SWAMP) help-desks where inquiries could be lodged by phone or fax from registered groups such as engineers working for gas, electricity, water, and telecommunications utilities (KAN International 2000). Recently this process has been automated to the point where inquiries are made using a Web interface for the front-end, enabling engineers to identify the geographical location they are interested in. The map data requested is then returned via email.

The maps that are shared with these organizations are put to various uses :

- Planning complementary utility services
- Protecting underground network infrastructure better
- Determining legal matters concerning the physical network more easily
- Selecting business sites taking into account the availability of infrastructure

British Telecommunications Model Summary

This model represents a multi-departmental private company that gathers, owns and maintains data in a GIS database for its own internal use, and which by law is forced to share the data with other organizations, including its competitors.

Table 5.3 British Telecommunications plc Data Sharing Model Characteristics

Classification	**Primary (Basic) Characteristic**
Sharing Structure	Data Sharing within an Organization or between Fixed Partners
Role in Data Sharing Arrangement	Data Gatherer and Disseminator
Sharing Mechanism	Web Application (Thin Client in Master Slave)

5.4.4 LGCSB Ireland Model

The Local Government Computer Services Board of Ireland (LGCSB) was established over twenty five years ago to coordinate the use of computers throughout the network of Local Authorities (Local Government Computer Services Board (Ireland) 2001). The role did not include the coordination of geospatial data sharing. In fact, data sharing occurred as a result of common reporting to, and extracting information from, the Ministry for Local Government.

The use of GIS as a planning tool has been recognized for many years by the local government authorities, but despite the coordinating role of the LGCSB, these authorities developed their GIS on a variety of platforms. The platforms in use include numerous disparate data sources such as MapInfo, AutoCAD, Arc View, MicroStation, and FRAMME.

With easy access to the Internet as a spatial data sharing tool, the strategic plan of the LGCSB has been amended so that it provides a stronger coordination role in the sharing of geospatial data. It has recently selected a Web-based map visualization tool that provides real time links to one or more GIS data warehouses. This is consistent with the National Internet GIS (IGIS) initiative. The map visualization tool brings the data into a single application, and links it with Microsoft SQL Server to integrate and publish the data. The solution benefits 30 local authorities within the Republic of Ireland including the city corporations of Dublin, Cork, Limerick, and Galway, and the rural local authorities of Meath, Kildare, Waterford, and Donegal County Councils.

For local authority staff and for other trusted users, LGCSB offers an extensive information and knowledge source through its data sharing arrangements. Access for the general public is on a more restrictive basis.

External data sharing is achieved through an association with Ordnance Survey of Ireland.

LGCSB Ireland Model Summary

This is principally a model of a multi-participant national coordination authority, providing links to city and county GIS most of whom are using different platforms.

Table 5.4 LGCSB Ireland Data Sharing Model Characteristics

Classification	Primary (Basic) Characteristic
Sharing Structure	Data Sharing within an Organization or between Fixed Partners
Role in Data Sharing Arrangement	Coordinator
Sharing Mechanism	Web Application (Thin Client in Master Slave)

5.4.5 City of Tallahassee Model

In Florida's capital, the city of Tallahassee located in Leon County, the current GIS was established through a combination of the individual datasets maintained by the city's utility groups (City of Tallahassee 2002). The data sharing arrangement allowed for a reduction in cost for the development and maintenance of the databases. These savings were increased through data sharing partnerships with the Leon County and the Property Appraiser's office (Quimbo 1998).

Data sharing within the City is coordinated through the GIS Strategic Planning Team. Base maps of varying scales are acquired suiting the various needs of the utilities and the general administration departments. This coordinated approach has help to overcome one of the barriers of Sharing Data – competing needs and variations in policies.

The City's GIS developed as LAN based system, providing a vehicle for information flow within the City's jurisdiction. It has, more recently, been providing information through its Web Site http://www.state.fl.us/citytlh/

The way it has developed can be likened to the manner in which the Jeddah Municipality could develop, bringing together various Departments in a Data Sharing arrangement, followed by sharing data with other organizations.

City of Tallahassee Model Summary

This is multi-participant data sharing arrangement, whereby data is shared internally and with other closely associated agencies, with all the agencies using the same base GIS application, thus avoiding problems associated with data translations. However, as the City also shares data with the State and Federal government, it uses a standardized Open platform.

Table 5.5 City of Tallahassee Data Sharing Model Characteristics

Classification	Primary (Basic) Characteristic
Sharing Structure	Data Sharing both within and outside the Organization, including for Customer Service
Role in Data Sharing Arrangement	Data Gatherer and Disseminator
Sharing Mechanism	LAN and WAN, with Web links

5.4.6 City of Lubbock Model

The Texas municipality of Lubbock shares its data within and between its departments, and with various other government authorities. Some partners, such as the Emergency Operations Center, have a stand-alone system with links to the primary GIS. This allows the EOC to take advantage of the sharing arrangement, yet leaves it free to handle emergency situations if isolated from the Central GIS.

The city has based its data sharing arrangements internally and externally on an open GIS system, taking geographical and non-geographical legacy databases and linking them through an Oracle RDMS (McGaughey 1999).

The city has established the "City of Lubbock Cooperative GIS Data" website (City of Lubbock 2002). The website allows a Web surfer to browse for detailed geospatial information, including links to a general planning parcel GIS, a thematic parcel-value GIS, a land use GIS, and an example of a percentage change in value GIS which allows the thematic ranges to be adjusted from an input form. There are also several look-up forms which provide access to the general planning parcel GIS by address, owner name and tax reference number. Each GIS is also cross-referenced with digital photography and the web site of the Lubbock Central Appraisal District.

City of Lubbock Model Summary

In this multi-participant agreement, data sharing arrangements are somewhat more advanced than for some other examples, yet indicate again how the Jeddah Municipality could develop its own GIS, with either a bi-lateral data sharing arrangement between it and a utility, or with a multi-lateral exchange with other agencies and government authorities.

Table 5.6 City of Lubbock Data Sharing Model Characteristics

Classification	Primary (Basic) Characteristic
Sharing Structure	Data Sharing both within and outside the Organization, including for Customer Service
Role in Data Sharing Arrangement	Data Gatherer and Disseminator
Sharing Mechanism	Web Application (Thin Client in Master Slave)

5.4.7 Montana Model

In its Strategic Plan for Information Technology published in 2002, the State of Montana recognizes the importance of sharing data. In preparing the Plan, which was based loosely on similar plans drawn up by Texas and North Dakota, it also acknowledged that a geographic component exists in 80 percent of the business of government and the private sector. Thus sharing geospatial data forms an essential plank in the Strategic Plan (Montana Information Technology Services Division 2002).

The state examines points of common interest with local citizens, tribal groups, and private entities, other states and the federal government, with an eye to improving communication and cooperation through data sharing. It sees this sharing of information and technology as leading to minimization of unwarranted duplication in services, and improvement in the services provided to its customers. As a consequence, Montana has various GIS Organizational bodies, including the Montana GIS Interagency Technical Working Group, the Montana Local Government GIS Coalition and the Montana GIS Users Group

The Montana Geographic Information Council (MGIC) which was established in 1997, sets the direction for the use of geospatial technologies, and has developed a Spatial Data Infrastructure Strategic Plan. This plan is incorporated into the Strategic Plan for Information Technology. Data sharing is promoted by the MGIC, together with providing wide and easy access to geospatial data for citizens, state agencies and federal agencies such as the FGDC.

In the mid 1990s, the Montana Natural Resource Information System (NRIS) Geographic Information System (GIS) was established to act as a clearinghouse for GIS databases. It provides services to State, Federal, Private, Non-Profit, and Public groups or individuals needing access to GIS technology. Private users of the data and services are charged a fee in an effort to recover the service cost incurred for staff time and other expenses to deliver data. Appendix 6 Sample of Costs for Accessing Shared Databases provides a listing of these costs.

The NRIS GIS also promotes the development and use of GIS databases in Montana through facilitating cooperation among GIS users. It is a cooperative partner to the MGIC.

Montana Model Summary

The Montana Model, differs from others examined in that it is State sponsored, is covered by state legislation, and is highly geared to data sharing. It is considered to be adaptable to the environment of the Jeddah Municipality, and due to the extensive networking developed through the MGIC, this multi-participant model is extendable to include other partners such as Utilities. Thus this model falls into the short list of models to be considered for an arrangement between Jeddah Municipality and Saudi Telecom.

Table 5.7 Montana Data Sharing Model Characteristics

Classification	Primary (Basic) Characteristic
Sharing Structure	Data Sharing both within and outside the Organization, including for Customer Service
Role in Data Sharing Arrangement	Data Gatherer and Disseminator
Sharing Mechanism	LAN and WAN, with Web links

5.4.8 LIST Model

In Tasmania, Australia, the Land Information Coordination Committee has established an integrated land information infrastructure named the Land Information System Tasmania (the LIST). Using standards recently developed through the Open GIS Consortium, geospatial data stored on The LIST is readily accessible to other government departments, utilities, professional service providers such as solicitors, special interest groups and the general public. The information is generally available utilizing web technology (LICC 2002).

Both vector and raster data are available through a simple Internet mapping interface, allowing the retrieval of geo-referenced data[14]. 50 layers, with attributes, are available for viewing. Royalties are payable if a licensee uses the raw digital data to build derivative value-added products.

[14] Data is protected by Crown copyright and issued under Data License Agreements

LIST Model Summary

This multi-participant model represents a class of coordination agencies, providing data warehousing facilities.

Table 5.8 LIST Data Sharing Model Characteristics

Classification	Primary (Basic) Characteristic
Sharing Structure	Providing Data to Commercial Interests - Restricted to paying customers and fellow sharers
Role in Data Sharing Arrangement	Coordinator
Sharing Mechanism	Web Application (Thin Client in Master Slave)

5.4.9 Singapore Land Hub Model

In the mid nineteen eighties, the Singapore Land Authority had developed an Integrated Land Information Service (Inlis), to make land information available to a wide range of organizations and individuals. This allowed government authorities to share data via an organization called the Land Information Network Infrastructure (LandNet). Over 60 corporate customers also joined to purchase this information (Heng 1999). Although information was distributed using data tapes, leading to problems of currency and update costs, the scheme was still moderately successful as an embryonic geospatial data sharing arrangement. In 1989, the Singapore Land Data Hub (SLDH) was conceived to allow for a more efficient process of data collection, storage, and distribution by government agencies and corporate entities. The concept was implemented with financial assistance from the United Nations in less than three years. LandNet has now gone live, thus allowing government departments to share land data online.

More than fifteen public sector agencies capture and maintain the data, whilst around thirty government agencies and ten private sector corporations, in addition to the public use the data. Various Government and quasi Government organizations participate in this centralized data distribution system coordinated by the Ministry of Law.

These organizations include :

- Government Departments of Surveying, Environment
- Ministries of Defence, Justice, Home Affairs, Communications, National Development, Finance, Environment
- Statutory authorities such as Land Transport Authority and the Jurong Town Corporation (JTC)
- Utilities such as Singapore Telecom (SingTel) and Singapore Post (SP), Public Transport Council, Singapore Mass Rapid Transport (SMRT)

The Land Data Hub contains information (statistics, descriptions, maps etc) on cadastral boundaries, building outlines, and topographic data as well as sewerage, drainage and telephone networks. By avoiding work duplication and data inconsistencies, substantial cost savings have been made. The agencies meet regularly to agree on common policies and procedures.

Standardized data can now easily be integrated with local data kept by each agency. SingTel, for example, can extract 70 per cent of the data for its base map from the hub.

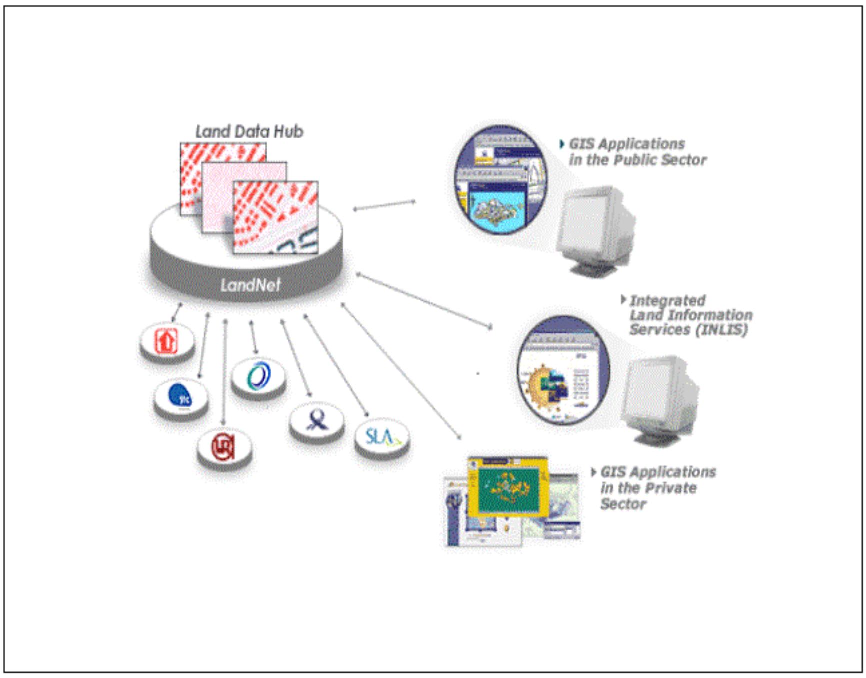

Figure 5.2. Singapore Land Data Hub Concept

Source : Adapted from “Wealth of Benefits” (INLIS 2001)

SLDH as it is currently configured, can be represented as in Figure 5.3

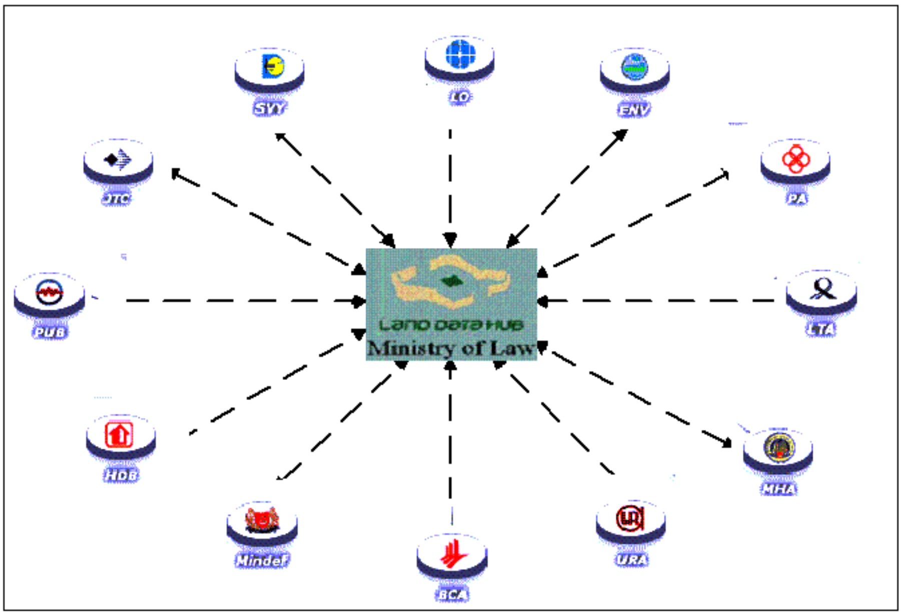

Figure 5.3. Singapore Land Data Hub (SLDH) Model

Source : GEO Asia Pacific Magazine (Heng 1999).

Singapore Land Data Hub Model Summary

In this multi-participant model several governmental and non-governmental organizations have contributed to a central repository for an accurate, comprehensive Land Data Hub which is available at various levels, ranging from the general public to industrial, business and governmental agencies. Ownership of the primary landbase data is vested in the Ministry of Law, with other entities maintaining ownership of their primary databases.

Table 5.9 Singapore Land Hub Data Sharing Model Characteristics

Classification	Primary (Basic) Characteristic
Sharing Structure	Data Sharing within an Organization or between Fixed Partners
Role in Data Sharing Arrangement	Data Gatherer and Disseminator
Sharing Mechanism	Web Application (Thin Client in Master Slave)

5.4.10 Kansas City Power and Light Co. Model

The Kansas City Power and Light Co. (KCPL) has deployed an AM/FM/GIS system as an element of its corporate distributed automation approach for data sharing and exchange throughout the internal environment of the company.

The AM/FM/GIS is on an open platform that places data and graphics into a corporate Oracle database. Using Field Office viewing facilities and Web Technologies, KCPL has achieved enterprise-wide data access, as well as the ability to share and exchange GIS data with seven government agencies in the Kansas City metropolitan area. Through the data sharing agreements, KCPL receives regular updates of detailed and accurate land base data from its partner agencies. Other authorized organizations can access GIS data from KCPL that is updated on a daily basis.

Internally, key system business components are linked to the AM/FM/GIS. These include functions such as the outage management and emergency dispatch, customer information and billing, and design engineering .

Data can be accessed and applications attached without the need to know, or convert, GIS-centric code, or for users to know proprietary GIS coding. A module is included in the system that allows for the distribution of the AM/FM data set to in-truck mobile computers. Both internal users and authorized vendors and agencies have Web based query/review and geographic display capabilities via the company’s extranet.

Recently Great Plains Energy was established as a holding company for KCPL, and two other companies were brought under the group holding. The other companies in the group are Great Plains Power, and KTL Inc.

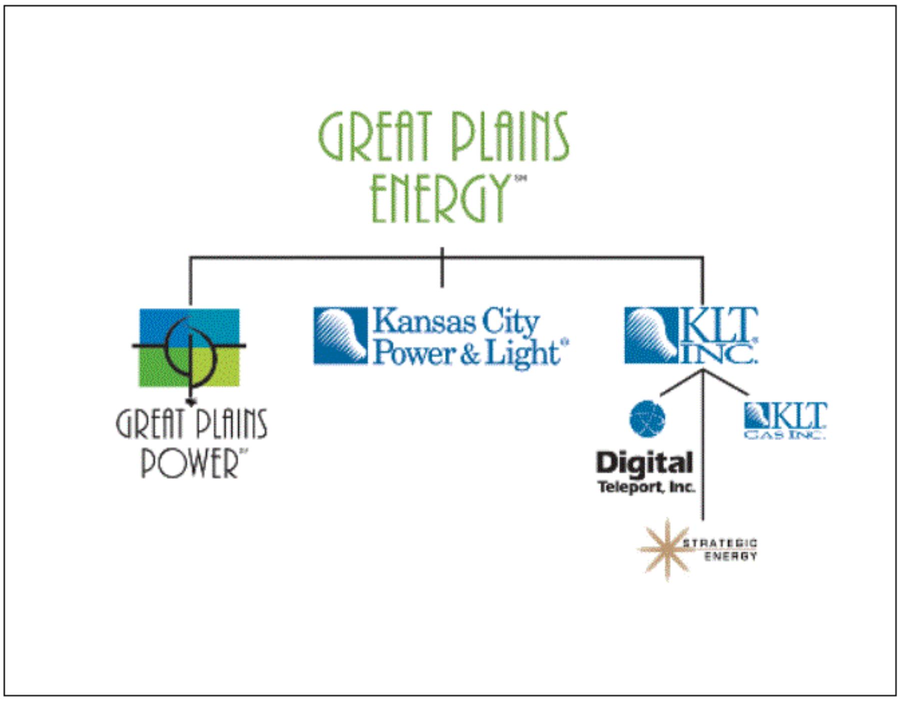

Figure 5.4. Components of Great Plains Energy

Source : Great Plains Energy (KPL&C 2001).

The companies expanded operations range from retail energy distribution (KCPL) to power generation (Great Plains Power), from rigorous geologic and engineering analyses (KLTG) to energy management services (Strategic Energy), and also wholesale focused, nationwide carrier provisioning of high-bandwidth transport services (Digital Teleport Inc).

This has lead to a significant exposure to diversified operational requirements, and placed increased importance on access to the GIS established by KCPL, and to the data sharing arrangements incorporated in the system. The existing systems included detailed locational mapping components whose value could be leveraged if shared.

Merging these disparate companies and establishing a mechanism for sharing the geospatial data did however necessitate resolving legacy issues inherent in the extensive GISs in place in these companies.

KCPL Model Summary

The Kansas City Power and Light Co example is a model of combining GISs from separate organizations which had different reasons for developing their GIS. It presents an example of the scalability of geospatial data sharing, and the flexibility that can be achieved in sharing data within a closed group, with other agencies within an enlarged corporate structure, with other external agencies, and with customers and the general public.

Table 5.10 Kansas City Power and Light Co Data Sharing Model Characteristics

Classification	Primary (Basic) Characteristic
Sharing Structure	Data Sharing both within and outside the Organization, including for Customer Service
Role in Data Sharing Arrangement	Data Gatherer and Disseminator
Sharing Mechanism	Web Application (Thin Client in Master Slave)

5.5 Classification Based Review of Models Investigated

Ten organizations have been used as models, with a loose co-reference to Jeddah Municipality and Saudi Telecom.

Of these models, three are examples of data sharing by organizations set up primarily as coordinators (EuroGeographics, Local Government Computer Services Board of Ireland and the Land Information System of Tasmania). Five are classified as Data Gatherers and Disseminators (Ordnance Survey UK, the Cities of Tallahassee and Lubbock, Singapore Land Hub and the Kansas City Light and Power Company). The remaining two (British Telecom and the State of Montana) are primarily Data Gatherers and Users.

In recognition of the fact that in each classification, most of the organizations would have a secondary characteristic, and in some cases a third, tables have been drawn up to reflect these various characteristics. See Tables 5.11, 5.12, and 5.13 below.

Using the same criteria of assigning a primary data sharing role, Jeddah Municipality and Saudi Telecom would currently be rated as Data Users providing data to commercial interests (albeit reluctantly), using simple file transfer mechanisms for the distribution of geospatial data such as zoning boundaries (Jeddah Municipality) and proposed underground installations (Saudi Telecom).

Table 5.11 Classification Based on Sharing Structure

Basic Structures		Primary	Secondary	Tertiary
1	Data Sharing within an Organization or between Fixed Partners	LGCSB Singapore *(Jeddah Municipality)* *(Saudi Telecom)*	British Telecom KCPL LIST	OrdSurvey
2	Providing Data to Commercial Interests (a) Restricted	EuroGeographics LIST OrdSurvey		British Telecom LGCSB Singapore
3	Data Sharing both within and outside the Organization, including for Customer Service	British Telecom KCPL Lubbock Montana Tallahassee	LGCSB Singapore OrdSurvey	
4	Providing Data to the Public (b) Unrestricted		Montana	LIST

Table 5.12 Classification Based on Role in Data Sharing Arrangement

Basic Role		Primary	Secondary	Tertiary
1	Data Gatherer and Disseminator	KCPL Lubbock OrdSurvey Singapore Tallahassee	British Telecom LGCSB	LIST
2	Data Gatherer/User	British Telecom Montana *(Jeddah Municipality)* *(Saudi Telecom)*	LIST Singapore	KCPL OrdSurvey
3	Data User		KCPL Lubbock	Montana Singapore
4	Coordinator	EuroGeographics LGCSB LIST	Montana OrdSurvey	British Telecom Singapore

Table 5.13 Classification Based on Data Sharing Mechanism

	Basic Sharing Mechanism	Primary	Secondary	Tertiary
1	Web Application (Thin Client in Master Slave)	EuroGeographics KCPL LGCSB LIST Lubbock Montana OrdSurvey Singapore *(Jeddah Municipality)* *(Saudi Telecom*		British Telecom
2	Field Application (Thick Client in Client Server)	British Telecom Tallahassee	KCPL LGCSB Singapore	OrdSurvey
3	Simple File Transfer (Peer-Peer asynchronous)		British Telecom EuroGeographics OrdSurvey	KCPL

5.6 Selecting an Appropriate Model for Data Sharing.

Selecting the most appropriate model for data sharing for Saudi Arabia involves a consideration of the relative importance of the three classifications analysed in Section 5.3.2, as well as the availability of data, and constraints imposed politically and culturally.

5.6.1 Assessing the Applicability of the Models

The geospatial data industry in Saudi Arabia is a dichotomous mixture of sophistication and relative immaturity. The sophistication has been brought about through the introduction of military based applications by the US, British, and French particularly after the Gulf War in 1991. The relatively immature is the manifestation of a natural preponderance towards secrecy borne of a deeply religious, tribal culture. But at neither of these extremes, is geospatial data shared by the civilian population to any substantial extent.

The immaturity of the geospatial data industry in Saudi Arabia is reflected in the paucity of availability of accurate, non-military base maps. The major potential users of geospatial data recognize the importance of acquiring base mapping, but are choosing to develop their own, rather than sharing the costs with other organizations. The potential for sharing basemap data is one aspect of assessing the applicability of the models.

Another major item for consideration is which models would be most appropriate, both technically and culturally, for integrating the information and getting the best usage of the geospatial data contained in the basemaps, once they have been acquired. Integrating information associated with spatial locations will involve records, images, drawings, maps and documents so that multiple users all have access to the same database. Using the information includes various functions such as incorporating the data into business processes, updating the data and keeping it as a clean database according to rules, and retention of ownership of particular data sets.

Multi-participant Data Sharing Arrangements

The majority of the examples chosen as models can be considered as being involved with multi-participant data sharing. In some cases, the participants are independent organizations, whilst others belong to the same organization or group of organizations.

The arrangements modelled in the “Coordinator” organizational examples referred to in Table 5.12 are not applicable to a bi-lateral data sharing arrangement between Jeddah Municipality and Saudi Telecom. These arrangements would be more appropriate for a centralized coordinating authority, similar to the King Abdulaziz City for Science and Technology (KACST). This organization is already responsible for authorizing any non-military use of satellite imagery in the Kingdom. It is also responsible for the use and censorship of Internet activities within the Kingdom. As a pivotal force within the six member Gulf Coordination Council (GCC), Saudi Arabia through KACST could host such a data sharing coordination organization. However, currently it is recognized that despite its wealth and larger population, the Kingdom is the least advanced of the GCC countries in the IT field in general and in adopting GIS as an information source. So the example set by the “Coordinator” organizations, EuroGeographics, LGCSB of Ireland, and the LIST, would be difficult to apply in Saudi Arabia.

The five organizations classed as Data Gatherers and Disseminators are also involved as multi-participant geospatial data sharers. However, the examples of the Cities of Tallahassee and Lubbock, and the Singapore Land Hub could be adapted to bi-lateral data sharing arrangements. The Kansas City Light and Power Company model could be applied to either to bi-lateral data sharing, or to an arrangement for public to access a single source for information not related to other organizations (a non-joined up situation).

Bi-lateral Data Sharing Arrangements

As a long-range plan, there would be many advantages if the Jeddah Municipality and the Saudi Telecom Company could form part of a network of associations sharing geospatial data throughout the Kingdom. This idea should be kept in mind, but as a first step, a bi-lateral data sharing arrangement should be considered. The examples of the Cities of Lubbock and Tallahassee, and the Singapore Land Hub, could be scaled down and provide guide lines for a bi-lateral agreement between Jeddah Municipality and STC.

The Singapore Land Hub model, in particular, is an example of a planned approach to coordinating the efforts of various providers and users of geospatial information. If a government authority such as the Ministry of Municipality and Rural Affairs were to set up a group to prepare a strategic plan that could be implemented incrementally then a data sharing arrangement, based on a stripped down version of the models examined, between Jeddah Municipality and STC could provide a pilot for nation wide geospatial data sharing.

Public Access to Single Source Geospatial Data

The Ordnance Survey UK model demonstrates that provided a very large information base is available, and there is strong government backing during the development stage, one organization can stand out as a single source for providing geospatial information to the public and higher level geospatial information to industry. However, this model would not be applicable in Saudi Arabia with its large unpopulated areas, its paucity of non-military geospatial information, and culturally significant resistance to open exchange of information.

The model represented by Kansas City Power and Light Co. could be applied, not for multi-corporation data sharing as in the corporate conglomerate, but as a multi-departmental arrangement, bringing together disparate information systems in use, and linking them through a geospatial information system available for access by all departments.

5.6.2 Selection Using Technical Criteria

In the absence of predefined methods for evaluating how closely the case-study models fit the conceptualised model, a rating or scoring scheme has been derived. This numerical scoring system is based on allocating points to a model according to the relative closeness-of-fit of its classifications to the preferred characteristics of the conceptualised pilot scheme model described in Section 4.4.2. This conceptualised model is a two party limited access data sharing arrangement.

Scoring is in one point increments over a range from 15 (best) to two (worst). The spread of 15 increments was chosen to facilitate the required level of discrimination of characteristics between the models.

In assessing the closeness of fit, maximum points are allocated to a model whose Primary Basic Structure is "Sharing Data between Fixed Partners" (Points = 15), and reduced points are allocated where the Primary Basic Structure is "Providing Data to the Public" (Points = 6). The minimum points are allocated where the Tertiary Basic Structure's classification is "Providing Data to the Public" (Points = 2).

Points allocated are cumulative for Primary, Secondary and Tertiary levels within the Basic classifications.

Table 5.14 Scoring/Rating System

Preference Order ↓	**Points Allocated (According to Classifications in Section 5.3.2)**		
	Primary	**Secondary**	**Tertiary**
1st Preference Sharing Data between Fixed Partners	15	11	8
2nd Preference Providing Data to Commercial Interests	11	8	6
3rd Preference Data Sharing within and outside the Organization, e.g. for Customer Service	8	6	4
4th Preference Providing Data to the Public	6	4	2

The classification criteria were identified in Section 5.3.2 Classification of Models.

The preferred model will be selected initially by compiling a matrix (Table 5.15) comparing the attributes of the proposed solution and the attributes of the models examined, and then the conformity of these examples will be rated numerically, using the scoring system shown in Table 5.14. Following that rating filtration process, additional criteria will be applied, both from the traits of the individual models and from previous studies in Chapters 2 and 4 which included geographic and cultural aspects.

In determining the intrinsic value of data sharing, changes in both efficiency and effectiveness have to be considered. That is, data sharing models should be assessed on which allows the agencies to work better, not just which allows the agencies to work cheaper.

Table 5.15 Scoring Chart for Pilot Arrangement

↓Preferred Order	Selection of Model for Pilot Criteria ↓ Model →	British Telecom	EuroGeographics	KCPL	LGCSB (Ireland)	Land Information System of Tasmania	Lubbock City	State of Montana	OrdSurvey (UK)	SLDH	Tallahassee City
Basic Structures of Sharing											
1	Between Fixed Partners	11	0	11	15	11	8	0	0	15	0
2	Data to Commercial Interests	6	11	0	6	11	0	0	11	6	0
3	Data within and outside the organization	8	0	8	6	0	8	8	8	6	8
4	Providing Data to the Public	2	0	2	0	2	2	4	0	2	2
Basic Role in Sharing											
1	Data Gatherer and Disseminator	8	11	15	11	8	15	0	15	15	15
2	Data Gatherer/User	11	0	6	0	8	0	11	6	8	8
3	Data User	6	0	6	0	0	6	4	0	4	0
4	Coordinator	0	6	0	6	6	2	4	4	2	2
Basic Sharing Mechanism											
1	Web Application	8	15	15	15	15	15	15	15	15	8
2	Field Application	11	0	8	8	0	0	0	6	8	11
3	Simple File Transfer	6	6	0	4	0	0	0	6	4	0
	Totals :	**77**	**49**	**71**	**71**	**61**	**56**	**46**	**71**	**85**	**54**

This selection process based on technical criteria indicates the government controlled, purpose built Singapore Land Data Hub (SLDH) example as the preferred model. The British Telecom privately owned system has been ranked next in the order of preference, when applying the quasi-quantitative selection process.

Non-technical criteria will be addressed in the next section "Applying Organizational, Geographic and Cultural Aspects to Models".

5.6.3 Applying Organizational, Geographic and Cultural Aspects to Models

Taking into account the prevailing organizational and cultural environment, several criteria are considered relevant to a pilot scheme for sharing geospatial data. From an organizational point of view the model should have the following attributes :

- Should provide motivational incentives, including economic and financial rewards and enhanced social outcomes
- Should be scalable, capable of supporting a dynamic move from a bilateral relationship to multifaceted relationships
- Should not involve too many parties, and these should have previously established interdependencies or interagency collaborations.
- Should involve parties with familiarity with GIS – but potential for growth of GIS usage – for organizational opportunities for group leaders and managers (Incentive)
- Data exchange should be controllable, either restricted to specified partners, or channelled via a central authority
- Adequate security measures must be definable from the outset.

Introducing a pilot scheme will involve a considerable amount of marketing, negotiation and formal memoranda of understanding between the parties prior to the implementation stage. Thus the organizations involved should preferably be located within a reasonable distance of each other to facilitate face to face meetings. There are only a few cities in the Kingdom where GISs have been established to a sufficiently large size to warrant a data sharing arrangement, and also in which a scheme would involve an ample mixture of implementation challenges for use as a pilot. Considering the distances between these cities it would be prudent to have the potential partners located in the same city.

The selection of a city in which to establish the pilot includes the following considerations:

- Saudi Telecom has regional headquarters establishments in Jeddah, Dammam, and Abha, as well as the national headquarters in Riyadh.
- Establishing a pilot scheme in Riyadh would probably involve national aspects on a grand scale, and would not be immune from the distractions of national issues, defeating the chances of setting up a manageable system with limited disruptions and political influence.
- The city of Abha has serious problems with the accuracy and extent of geospatial data content in systems established by the municipality and STC, due to a combination of two factors. The terrain of this south western area is mountainous and notoriously difficult to map and localised data collection was subject to tribal rivalries.
- Both Jeddah and Damman/Al Khobar have well established GIS held by the local government authorities and Saudi Telecom. It would be relatively easy to quarantine a pilot scheme to either of these two cities.
- The Jeddah Municipality has given firm indications in the past that it is willing to consider to a data sharing arrangement with Saudi Telecom. The governor of Jeddah has recently directed all authorities in the city to examine the feasibility of geospatial data sharing, and to participate wherever possible.

The AM/FM/GIS system implemented by STC is a national system. However, except for national planning aspects, access is limited to the individual regional groups. Information relating to telecommunications infrastructure in the city of Jeddah is available to, and restricted to, the STC regional staff involved with Jeddah. Thus it is possible for a data sharing arrangement with the Jeddah Municipality to be isolated and contained. This helps to overcome cultural challenges which may arise through "outsiders" getting involved in the pre-implementation development of the scheme.

On the technical evaluation criteria discussed in previous sections, the SLDH model is considered to be a suitable model for the pilot implementation in Saudi Arabia. Application of the organizational, geographic and cultural aspects discussed in this section would not preclude selection of the same system as a suitable model. Consequently, based on these two sets of criteria, the SLDH has been selected as a suitable model for a pilot bilateral geospatial data sharing system.

5.7 Applying the SLDH Model

The selection of the SLDH as a model for a pilot scheme, although made on a criteria based process, must take into account the possible extension into a long term arrangement. That is, is the pilot model scalable?

The generic long term model was described briefly in Section 4.4. The illustration given for this model can be redrawn as Figure 5.5 Generalised Reconfiguration of SLDH Model. Though reflecting the Singapore Land Data Hub illustration presented in Figure 5.3 Singapore Land Data Hub (SLDH) Model, the essential elements of the suggested long term, coordinating node model for Saudi Arabia are retained.

Similarly, Figure 4.3 Adaptation of Generic Long Term Model for Pilot Scheme can be redrawn as Figure 5.6 Adaptation of SDLH Model for Pilot Scheme. Provided that the long term objectives are taken into consideration during the implementation planning stage for the pilot scheme, there should be no problem technically with expanding the scope of the arrangements so other organizations can participate later, though the implications of cultural aspects have to be included when considering scalability.

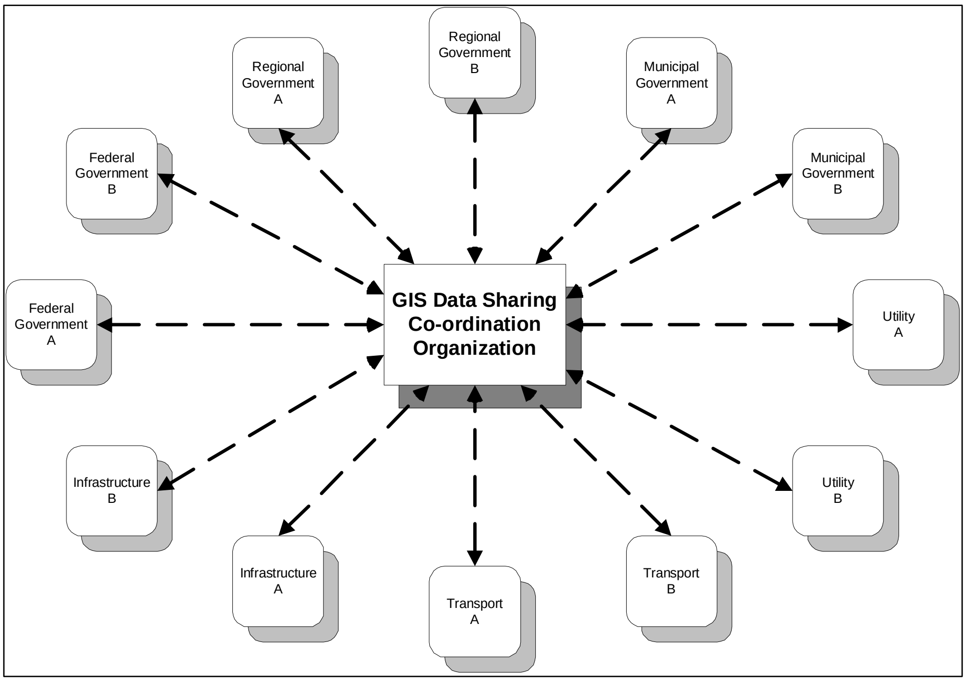

Figure 5.5. Generalised Reconfiguration of SLDH Model

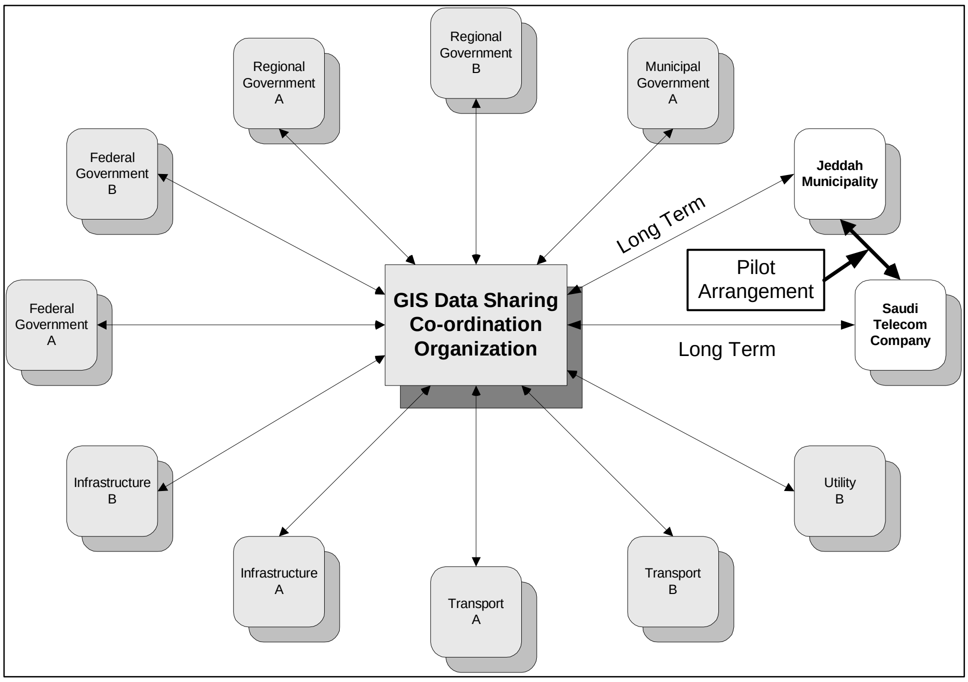

Figure 5.6. Adaptation of SDLH Model for Pilot Scheme

These transpositions of the generic Long Term and Pilot scheme layouts indicate a good match with the SLDH. This match will be further tested in Chapter 6 in which the conceptual and SLDH models will be discussed. This will provide a theoretical evaluation of the feasibility of adoption of the model, but practical testing would require actual implementation of the scheme. An implementation model is provided Appendix 7, though it is outside the parameters of this research.

5.8 Conclusion

This chapter has exposed various instances of geospatial data sharing worldwide. Examples with specific characteristics have been analysed from a technical data centric viewpoint to establish a model that correlates with the model conceptualised in Chapter 4. This technical analysis suggests that the SLDH model is a close fit to the long term model for the Kingdom, and that it could be scaled down to match the model being tested for feasibility.

To maximize the potential for successfully implementing a pilot data sharing arrangement, the data should be shared between fixed partners that have established GIS. Establishing an arrangement between partners in the same city was shown to meet non technical criteria such as geographic, political and cultural, and the city of Jeddah is considered suitable.

Cross-correlation of the SLDH example with the conceptual model of Chapter 4 has shown that there is a similarity between them. Since the SLDH system is very successful, it indicates that the conceptual model can serve as a pilot, taking into account possible expansion to a national scheme.

It remains for the conceptual model to be tested against the list of expected benefits and possible issues. This will be done in the following chapter by aligning the SLDH model with the benefits and issues to determine the closeness of fit, and thus answer the question “Is the conceptualised basic two party, limited access configuration data sharing model valid?”

CHAPTER 6

DISCUSSION OF RESEARCH RESULTS AND CONCLUSION

6.1 Introduction

This chapter will present an analysis of the model conceptualised for a Dynamic Two Party Data Sharing arrangement introduced in Section 4.4.3 Proposed Model for Jeddah Municipality and Saudi Telecom. This will determine the extent the model accommodates the issues raised as possible barriers to a pilot geospatial data sharing arrangement. It will also deal with how the potential benefits can be realized through implementing the model.

Through these discussions it will be possible to assess the degree to which the aim of the research has been satisfied, and whether the problem that was stated in the introductory chapter has been adequately addressed.

The chapter will also include an appraisal of the research methodology used and the outcomes obtained, using SWOT techniques. The appraisal forms part of the validation strategy for the thesis.

The conclusion will review the problem that was identified in the opening chapter and the consequent aim of the research. It will also review the research undertaken together with the results, and make recommendations for ongoing actions.

6.2 The Conceptualised Model

The pilot model conceptualised is a Dynamic Two Party Data Sharing arrangement with access limitations imposed.

The major components of the requirements for intra-organizational data sharing within STC were identified in Section 2.5 Saudi Telecom - Functions and Requirements. Section 4.4.3 dealt with geospatial resource management within STC, with Appendix 4 addressing detailed requirements for many business applications involved with management of sectors such as landbase information, work flow, workforce, documentation, outages, geofacilities, enterprise resource planning, and customer information systems.

Detailed requirements have been addressed for intra-organizational data sharing within STC for many business applications. These applications are involved with management of sectors such as landbase information, work flow, workforce, documentation, outages, geofacilities, enterprise resource planning, and customer information systems. The major components of these requirements were previously identified in Section 2.5 Saudi Telecom - Functions and Requirements. Geospatial resource management within STC was dealt with in Section 4.4.3 Proposed Model for Jeddah Municipality and Saudi Telecom under "Consideration of STC Geospatial Resource Management" and in Appendix 4 STC Functional Units - Usage and Accessibility. Figure 4.7 Dynamic Two Party Data Sharing, with Access Limitations illustrated how these requirements can be met.

Similarly, but on a broader scale, the geospatial related requirements of Jeddah Municipality have been addressed in Section 2.4 leading to an understanding of the potential for intra-organizational exchange of data.

The proposed model evolved after taking into account the areas of involvement for both STC and the Jeddah municipality, and consequently, the data streams within STC that should be available for exchange with the Jeddah Municipality in an inter-organizational arrangement. The model emphasises components of data flows within STC, reflecting its progress towards geographic resource management. (With further investigations, a similar emphasis could have been assigned to data management with Jeddah Municipality.) Having identified the STC databases available for access by both parties, detailed arrangements for exchanging data can be negotiated and agreed upon. However, these detailed provisions are not a critical issue in the generic development of the dynamic two party data sharing.

6.3 The SLDH Model – Is it Comparable with the Pilot model?

Chapter 5 involved an overview of data sharing scenarios in other countries culminating in a selection process to determine which, if any, of the arrangements in place either matched, or could be adjusted to match, the conceptualised model for a pilot scheme in Saudi Arabia. Although the SLDH scheme has developed into a multi-participant data sharing arrangement, its architecture has the potential for being segmented into modules as illustrated in Figure 5.6 Adaptation of SDLH Model for Pilot Scheme, provided that issues of access and ownership can be resolved in the resultant restricted pilot model. Once the pilot has been evaluated as a success, the long term architecture can be modelled on the current version of the SLDH.

6.4 Attaining the Benefits

Throughout the earlier chapters of this dissertation, various benefits have been attributed to geospatial data sharing. Some of these beneficial expectations have been anecdotal, others have been proven outcomes of arrangements implemented elsewhere and some are highly conditional on the local operating environments. This section deals with some of the benefits expected from introducing geospatial data sharing, and whether these can be attained with the model proposed.

Reduced Effort Developing Digital Databases.

It is expected that there will be a cost reduction in acquiring landbase data, as this is an obvious area of duplication. From the examples provided in Appendix 3 Examples of Costs for Data Acquisition, for projected expenditure on obtaining separate landbase data, there is the potential to save significant amounts of money. Using the proposed model, this could be achieved. The savings achieved from sharing data on other "static" features such as building locations, thoroughfare identification and infrastructure could also be significant, with the reduced incidence of duplicated field verification activities. However, the actual savings achieved through advance knowledge of planned developments of subdivisions, and the accompanying infrastructure through better and more integrated planning and policy development are tempered by extensive rescheduling of projects undertaken by the authorities, and the apparent lack of control the municipality has over the timing of approved commercial developments.

Other Benefits

Other benefits that have been identified in Chapter 3 and which are achievable with the proposed model include the following :

- improved data quality, consistency and availability of information
- improved decision making through the exchange of information and the intangible benefits of coordination
- improved staff moral; user satisfaction; self-confidence and confidence in others
- improved emergency response resulting from availability of location related data and team work built through cooperation engendered through sharing information.

6.5 Addressing the Barriers and Obstacles

Many of the issues raised as possible obstacles to adopting geospatial data sharing in general, and the proposed model in particular are solvable provided they are recognised at the stage of initiating project feasibility studies. These should be addressed again during the detailed design stage of the implementation process, as suggested in an implementation model which is presented in Appendix 7.

Technical Issues

Issues which are principally technical in nature, and which are mostly solvable and thus applicable to the pilot model include adherence to standards; defining the ownership and maintenance of specific data segments; data exchange mechanism; data and network security; training requirements; metrication of achievements; dealing with legacies; data synchronization; multiple concurrent user management, particularly during long transactions; and when defining data content.

Non-Technical Issues

Issues which are not so easily resolved, and which may impact on acceptance of the model include cost sharing arrangements; legal issues of privacy, copyrights and freedom of information; political decisions; institutional and organizational considerations; implementation timeframe and the management/participant interest retention implications.

The success or otherwise of a project based on this model will depend in no small way on an early recognition of these issues, and an acceptance that they must be addressed prior to embarking on a change from the status quo.

The broad guidelines provided in the pilot project implementation process contain suggestions for including evaluations of benefits achieved and other issues encountered, both technical and institutional. The assessment made of the pilot program to determine its post implementation status and the feasibility of a broader, multi-participant arrangement will be influenced by these factors, particularly those of a cultural, political and organizational nature.

6.6 Using the Models Examined

The object of reviewing a range of geospatial data sharing arrangements other than in Saudi Arabia was to find an existing arrangement that could be used as a case study for either direct application in testing the conceptualised model. Failing that, the review was aimed at finding a “nearest fit” system which could be theoretically modified for testing purposes [15].

The array of case studies examined was extended to include models from a range of segments (as described in Section 5.3.1). This was aimed at reducing bias which may have resulted from experiential knowledge. By extending the range of choices examined, under the triangulation technique (Maxwell 1996) of assessing information from a variety of sources, the resultant outcomes should be easier to validate.

What also resulted from the review was more than expected. The diversity of the systems examined has enriched the perception of the scope and advantages of geospatial data sharing. This should be used in helping to market a data sharing proposal to all the participants, both potential and actual.

6.7 Reviewing the Stated Problem

The early stages of the thesis presented the problem as being a lack of availability of information on which to base an argument for the feasibility of geospatial data sharing. It was recognised that the advantages of using geospatial data though a GIS within an organization had been well documented. However, to support the anecdotal perception that data sharing would be to the overall advantage of the participants, comprehensive research was required to address and highlight not only the perceived advantages, but also other issues which might present obstacles, barriers and impediments.

In an attempt to address this stated problem, this research aimed to propose and validate a model for the sharing of geospatial data between organizations as a pilot scheme in Saudi Arabia.

Through the processes that were undertaken to validate the conceptualised model, the concerns raised in the problem statement were recognised and the information now available should be sufficient to initiate a proposal for geospatial data sharing.

6.8 Assessment of the Research Instrument and Outcomes

This section assesses whether the approach has been successful in reaching the aim of the research or would another approach have been better, and resulted in a different result. The assessment is primarily through the SWOT analysis technique, examining the strengths, weaknesses, opportunities and threats inherent in both the research

[15] The SLDH arrangement was chosen following an examination process which demonstrated that this model reflected the bilateral limited access model proposed.

instrument and the outcomes of the research. Similarly, a SWOT analysis of the chosen model is undertaken including a comparison with other possible models.

The validity of the outcomes is assessed through the triangulation strategy (Maxwell 1996) of testing against three independent approaches – analysis of case studies (the method used in the research), feasibility of the outcome meeting framework criteria as a valid SDI, and an examination in the light of experiential knowledge.

6.8.1 SWOT Analysis of the Research Instrument

The research mechanism used was to consider local environmental factors; review available literature to understand the issues involved for geospatial data sharing; suggest a model for data sharing between two organizations in KSA; and then to test the concept inductively, drawing together both factual and behavioristic aspects to support the concept hypothesized.

Strengths

The background review of local geographic, social and cultural conditions established the environmental context of the stated problem. Without this it would be difficult to see why a simple needs-analysis approach, common in many societies, would not be appropriate in this research.

Reviewing available literature provided a facility of looking at the issues involved from a broader perspective not confined to local experience and conditions.

The review also allowed an extensive examination and documentation of the issues involved. This was an important stage as it addressed a fundamental reason for undertaking this research paper. That is, the previous lack of this type of formal assessment has discouraged organizations from becoming involved in geospatial data sharing with others.

The inductive testing process, by which the conceptualised model evolved from a generalization and supported by a series of comparative examples, was able to be sustained throughout the research. Had a deductive testing regime been attempted there would have been less chance of a successful outcome due in part to the subjective nature of the non-technical issues involved. Alternatively, had abductive reasoning techniques been used (Peirce 1958), each one of the models case studied could have been construed as appropriate [16].

Weaknesses

As a result of the methodology chosen, the study does not provide a strong focus on all sections of the industry inside the Kingdom of Saudi Arabia. During the review of cultural issues, some of the difficulties that would be encountered when attempting to obtain valid information were touched on. The potential difficulties cited included a reluctance by some authorities to publish information relating to progress in GIS implementation, as such information may potentially reveal non-complimentary aspects of the bureaucracy's management.

Selecting the chosen methodology has resulted in a less rigorous definition of the problem than may have been produced had a thorough needs analysis been possible. This reduced the chances of optimising the value of the recommendations. An alternative methodology incorporating appropriately designed research survey questionnaires and interviews with closer alignment to the requirements of the stakeholders may have produced better results.

Opportunities

The research combines a process oriented approach in the review of literature with a case study approach and a statement of some aspects affected by significant cultural attributes. Alternatively an opportunity does exist for the problem to be approached using a generic SDI as the conceptualised model and then to build a pilot model taking into account the issues identified in the review of literature analysis.

Threats

A "Systems" approach used rather than "Scientific" approach was attempted, resulting in subjective, qualitative appraisals being tested against quantitative indices to obtain comparative assessments. Thus the hypothesis could not be rigorously tested.

The inductive testing approach relied on having some local knowledge to influence the choice of model to be tested and the relative weighting applied to the closeness-of-fit rating system. If the research were to be repeated in the absence of this local knowledge, and a different model conceptualised, markedly dissimilar results could have been possible, and justified. This lack of consistency presents doubts as to the

[16] Abductive reasoning consists of studying facts and devising a theory to explain them.

repeatability of the results, and hence the value of the methodology itself, given that it relies on non-scientific, qualitative knowledge.

The validity could be gauged through a testing technique such as triangulation whereby a range of approaches are used and the results compared, but this is outside the scope of this paper.

6.8.2 SWOT Analysis of the Outcomes

Strengths

The bi-lateral model chosen can be implemented reasonably quickly as it avoids complexities of relationship dynamics that would be introduced if several levels of an SDI hierarchy were involved.

As shown by the study, the Jeddah Municipality and the Saudi Telecom Company are at relatively the same stage of development in terms of GIS usage, making the adoption of the bi-lateral data sharing model more attractive than if there were a large disparity. In addition, there is a commonality between the GISs of both organizations as both are based on geospatial applications supplied by Intergraph Saudi Arabia Ltd.

If the model chosen is implemented as a pilot, it will remain viable as a working geospatial data sharing system irrespective of whether long term models involving other organizations are put into operation or it maintains a separate existence.

Weaknesses

The chosen model does not address all the issues raised in the research chapter. For example it does not have any reference to a training component nor does it address the issue of measuring the benefits. It does not make suggestions about all the components of the inter-organizational SDI that needs to be developed.

When this research commenced some of the key infrastructure requirements of an NSDI, for example, pervasive telecommunications and Internet access, were not widely available in KSA, this limited the application of leading edge NSDI technical solutions. This limited the selection of a conceptualised model.

Opportunities

The model chosen has the potential to become part of Homeland Security information system through having shared data available, allowing more complete pictorial analysis of crisis situations.

The model retains its viability within the environment of a national geospatial data sharing arrangement. In addition, the model is recursive as the same viable system principles may be used to model a sub-system or a supra-system

Threats

There is a risk of entropy reducing the acceptability of the outcomes if feedback from stakeholders is not monitored and acted on because of procrastination. The concepts espoused in the recommended system have to be continually re-energised to avoid entropy which is itself a normal process that leads to system decline.

Culturally the model is at risk from being considered a “bottom-up” approach which may be rejected in a predominantly patriarchal society such as Saudi Arabia. It also involves exposure to potential loss of control of the data, equating to loss of power.

6.8.3 Validity Checking

The validity of the outcomes can be tested theoretically using one or more of the strategies recommended by Maxwell (1996) for assessing qualitative research processes. The strategy chosen is the triangulation technique of testing against three independent approaches.

An alternative strategy which could have been employed, given the quantitative components inherent in the assessment of examples in the case studies, is the Quasi-Statistical method (Maxwell 1996). This was rejected as the sample size involved was not sufficiently large to obtain statistically reliable results.

Using the triangulation strategy, the three approaches selected are:

1. Feasibility of the outcome meeting framework criteria as a valid SDI
2. Examination in the light of experiential knowledge
3. Analysis of case studies (the method used in the research).

It should be recognized that there are a multiplicity of arrangements that could satisfactorily address the aims of this research. Indeed, it has been shown that in Australia at the local-state level partnerships have evolved in various SDI configurations with varying degrees of success long term (McDougall et al. 2002). The conceptualised model and a scaled down SLDH model could both be represented by a two level SDI framework.

Applying experiential knowledge as an adjudication tool for assessing the validity of the outcome involves the risk of biased judgement. However, this approach cannot be dismissed given the years of involvement with both the Jeddah Municipality and the Saudi Telecom Company in implementing the respective GISs. Experiential knowledge provides qualified support for the outcome reached.

Analysing the case studies for closest-fit with the conceptualised model has produced a result which is sustainable, although if the selection criteria were skewed with different weightings on the classifications, the outcomes could have been altered.

In essence, the validity of the result of the research is confirmed due to it being one of many that could have been reached. However, this does not affect the integrity of the research methodology nor the result achieved.

6.9 Conclusion

This research began following an observation that two large organizations in Saudi Arabia were simultaneously assembling geospatial databases with a significant amount of common data. Although the management of these two organizations, the Jeddah Municipality and the Saudi Telecom Company were issuing statements from time to time supporting a vague notion of sharing the common data, neither had made meaningful attempts to engage in geospatial data sharing. The organizations were aware of anecdotal evidence that data sharing would have the potential for significant savings in circumstances such as this, however no clear strategy had been advanced for promoting such a scheme. Reasons for this apparent impasse were difficult to define but seemed to point to the organizations not having sufficient information about the issues involved. Nevertheless a review of the functions and requirements of the organizations provided evidence of the need for exchange of geospatial information throughout and beyond each of the enterprises.

The problem was identified as the lack of a formal, documented assessment of the implications of geospatial data sharing, although many of the advantages of integrating GIS as a management tool within individual organizations have been established and systems subsequently implemented in Saudi Arabia.

Cultural considerations peculiar to this region mitigated against successfully applying a normal “needs analysis” approach to determining what system would be most relevant. Consequently a different research approach was required to assess issues involved.

The problem has been addressed through a process of reviewing literature relating to geospatial data sharing, and an appraisal of geographical, social, cultural and political issues. The literature review revealed that issues are not confined to technical matters, but also include organizational aspects. When the issues and their inter-relationships were considered together, they were shown to be consistent with the components of a shared data infrastructure comprised of data, access networks, standards, and policy.

The aim of this research was to propose and validate a model for the sharing of geospatial data between organizations as a pilot scheme, taking into account various technical factors such as overseas experiences and current one-party systems operating in Saudi Arabia, as well as social and cultural issues common in the Arabian peninsular.

To demonstrate the applicability of the data sharing concept, issues raised in the literature background reviews were applied to developing first a generic multi-lateral model based on long-term strategic requirements, and then to conceptualising a model applicable to a bi-lateral sharing arrangement. Examples of data sharing schemes in other countries illustrated that success could be achieved in various arrangements and these were examined as case studies to determine their applicability for a pilot scheme in Saudi Arabia.

In the absence of pre-existing testing mechanisms, a comparative process involving both qualitative and quantitative assessment was adopted. Through this process it was determined that a scaled down version of the Singapore Land Base Hub model represented a reasonably close fit with the conceptualised model. To further validate this assertion, guidelines for implementing the proposed pilot scheme were developed so that its feasibility could be tested and to identify potential problems. This implementation process has been included as Appendix 7 An Implementation Model.

Thus the aim of the research has been accomplished, both in proposing a model for an arrangement between the Jeddah Municipality and the Saudi Telecom Company, and in adapting the model of the Singapore Land Base Hub to fit a generic bi-lateral data sharing arrangement for theoretically testing the proposed model.

The research thesis structure used has resulted in a thorough investigation of the possibility of implementing geospatial data sharing in the Kingdom of Saudi Arabia. By presenting a conceptualised model for feasibility testing and acknowledging the influencing factors and investigating other arrangements, this thesis has been able to address the problem previously encountered – a paucity of information to support a geospatial data sharing proposal.

Technical issues have been discussed thoroughly and can be dealt with to reach solutions that would result in effective improvements over the current mechanisms used in the geospatial information industry in Saudi Arabia. Many cultural, political and organizational issues have also been identified, and though some of these can be addressed successfully, in the long term the outcomes which are influenced by these factors cannot be predicted.

It is recommended that the results of this research should be presented initially to the management of both the Jeddah Municipality and the Saudi Telecom Company for review and comment, particularly in regard to the cultural issues involved. In considering the responses received, the direction of further research can be established so that a submission can be made to the governing councils for adopting a comprehensive geospatial data sharing scheme.

--ooOoo--

References

Aal, A. A. (2000). “Geographic Information Systems (GIS) Recognise the Location.” Saudi Telecom Journal 16: 23-24.

Abashain, P. (1998). "GeoEngineering and the Internet: Collaborative Computing Finds its Connective Environment." AM/FM Conference 1998, San Jose, California.

Al-Saud, F. (2000). "Islamic Political Development: A Conceptual Analysis". The Middle East: Politics and Development, United Association for Studies and Research, Inc. (UASR). Occasional Papers Series, No. 18.

Al-Tassan, A. (2000). "An Assessment of the Utilization of GIS : The Experience of the Holy City of Makkah, Saudi Arabia." URISA 2000, Orlando, Florida.

Anderson Consulting (2001). "Study : Web Sites Fail Global Privacy Standards." E-Commerce News, 16 August, 2001.

Asfour, M. (1991). Arabic in Three Months. East Kilbride, Scotland, Hugo's Language Books Ltd.

Azad, B. (1998). Management of Enterprise-wide GIS Implementation: Lessons from Exploration of Five Case Studies. Cambridge MA, Massachusetts Institute of Technology.

Azad, B. and L. L. Wiggins (1995). Dynamics of Inter-Organizational Geographic Data Sharing: A conceptual Framework for Research. New Brunswick, NJ, Center for Urban Policy Research.

Backe, K. and R. Grady (1998). "The Development of National Standards For Large-Scale Geospatial Data : Utilities." AM/FM Conference 1998, San Jose, California.

Bassett, P. and W. Ulrich (1999). "Legacy Systems Transformation: An IT Strategy for the New Millennium." Advanced Technologies (ADT) Magazine, Nov 1999, www.adtmag.com.

Benassi, F. E. (2001). "AM/FM/GIS: Cornerstone of a DA Initiative." Energy IT, Vol 6 No 2, March/April 2001.

Bennett, I. (1999). "State of the Industry 1999." GEO Europe, Feb 1999.

Berry, J. K. (2002a). "Spatial Data Mining Allows Users to Predict Maps." GeoPlace, January 2002.

Berry, J. K. (2002b). "Use Surface Area for Realistic Calculations." GeoPlace, December 2002.

Blyer, N., K. Burns-Brailow, C. Clarke, H. Garie, B. McKenzie, J. Moeller, B. Spear, G. TeSelle and L. Weiss (2000). "Improving Federal Agency Geospatial Data Coordination Report for Design Study Team to Federal Geographic Data Committee." Federal Geographic Data Committee.

Bowditch, D. (2001). "BC Hydro Reaps GIS Benefits across the Enterprise." GEO World, May 2001.

Brelsford, K. (2001). "Who Should You Hire for Data Conversion?" GEO World, April 2001.

Brown, M. M. and J. L. Brudney (1993). “Modes of Geographic Information System Adoption in Public Organisations: Examining the Effects of Different Implementation Structures.” Annual Meeting of the American Society for Public Administration (1993)

Brown, M. M., L. J. J. O'Toole and J. L. Brudney (1998). “Implementing Information Technology in Government: An Empirical Assessment of the Role of Local Partnerships.” Journal of Public Administration Research and Theory:

Budic, Z. D. (1994). “Effectiveness of Geographical Information Systems in Local Planning.” Journal of the American Planning Association Vol 60 No 2.: 244-63.

Buehler, G. (2001). “Interoperatibility Program.” OGC News (May 2001) http://ip.opengis.org/ows/rft.htm.

Burns, R. B. (2000). Introduction to Research Methods. Frenchs Forest NSW, Pearson Education Australia.

Butler, J. A. and K. J. Dueker (1999). “Implementing the Enterprise GIS in Transportation Database Design.” URISA Journal Vol 13 No 1(Winter 2001)

Cahan, B. B. (1999). "Financing the NSDI: Aligning Federal and Non-Federal Investments in Spatial Data, Decision Support and Information Resources." Urban Logic Inc.

Calkins, H. W. and R. Weatherbe (1995). “A Case Study Approach to the Study of Institutions Sharing Spatial Data.” URISA Proceedings 1995:

Causey, W. B. (2001). "E-mailing Maps in London." Energy IT, Vol 6 No 2, March/April 2001.

Chappell, C., G. Titterington and P. Bassanese (2000). "E-Business Security: New Directions and Successful Strategies - An Ovum Report." Farnham, Surrey, UK.

Checkland, P. B. and J. Scholes (1990). Soft Systems Methodology in Action. Chichester UK, Wiley.

City of Lubbock (2002). "Lubbock Virtual City Government". 03 May 2002, http://www.ci.lubbock.tx.us/.

City of Tallahassee (2002). "Technology Integration Project". May, 2002, http://talgov.com/citytlh/utilities/ubcs/index.html.

Contrucci, K. M. and T. J. Grillo (1998). "The Use of Digital Orthophotos in Automated Mapping/Facilities Management Systems." AM/FM Conference 1998, San Jose, California.

Craglia, M. and I. Masser (2001). “Geographic Information Policies in Central and Eastern Europe: Four Case Studies.” URISA Journal Articles Currently Under Peer Review(Version 09/11/01)

Cuddihy, K. (1995). Saudi Customs and Etiquette. Riyadh, Peregrine Publishing.

Culpepper, R. B. (1999). "Weave Maps Across the Web." GEO Asia Pacific, Feb 1999. www.geoplace.com/asiapac/1999/0299/299web.

Daratech (2002). "GIS Markets & Opportunities". 10 October 2002, www.daratech.com/gis/markets_&_opportunities.

Dawes, S. S. (1996). “Interagency Information Sharing; Expected Benefits, Manageable Risks.” Journal of Policy Analysis and Management Vol 15 No 3: 377-94.

Department of Environment Ireland (1996). "Better Local Government: A Programme for Change." Dublin, Ireland, Dept of Environment.

Dickenson, O. A. (1999). "Web-Based GIS: Front Ends for Enterprise-Wide Management Systems." GITA 1999, Charlotte, North Carolina.

Dresler, P. and A. Woods (2000). "National Spatial Data Infrastructure NSDI Community Demonstration Projects - Final Report." Federal Geographic Data Committee.

Elliott, B. (1999). "Preparing AM/FM Databases to Support Vehicle Tracking." GITA 1999, Charlotte, North Carolina.

Encyclopedia Britannica (2001). Saudi Arabia. Springfield, MA, Merriam Webster Inc.

Esnard, A. (1998). “Cities, GIS, and Ethics.” Journal of Urban Technology Vol 5 No 3

EuroGeographics (2001). "EuroGeographics - Past, Present and Future". www.eurogeographics.org.

EuroGeographics (2002). May, 2002, http://www.eurogeographics.org.

Evans, D. and P. Gruba (2002). How To Write A Better Thesis. Melbourne, Melbourne University Press.

Federal Geographic Data Committee Secretariat (1999). "The Value of Metadata - Managers Brochure." Federal Geographic Data Committee.http://www.fgdc.gov/publications/documents/metadata/metabroc.html.

Federal Geographic Data Committee Secretariat (2000). "Address Data Content Standard - Public Review Draft." Washington, Federal Geographic Data Committee - National Spatial Data Infrastructure.

Finkle, R. W. and S. S. Sanger (2000). "Managing a Non-Centrally Funded GIS: How The City of Fort Worth and other U.S. Cities Manage." GITA 2000, Denver, Colorado.

Fischer, J. L. (1998). "Integration in a Changing IS World." AM/FM Conference 1998, San Jose, California.

Forbes, M. (2003). "GIS Takes a Bite Out of the West Nile Virus." GeoWorld, May 2003.

Forrstrom, R. (2000). "Is Outsourcing in your GIS Department's Future." GITA 2000, Denver, Colorado.

Gallagher, K. (1999). "Yarra Ranges Council Tackles Information Service Needs." GEO Asia Pacific, April 1999.

Gates, L. (2001). "Northeast Utilities Rolls Out Mobile Infrastructure to Enhance Field Performance." Application Development Trends, Vol 8 No 4, April 2001.

Gillespie, S. R. (2000). “An Empirical Approach to Estimating GIS Benefits.” URISA Journal Vol 12 No 1(Winter 2000)

Glesne, C. (1999). Becoming Qualitative Researchers - An Introduction. New York, Addison Wesley Longman.

Green, J. B., F. J. Escobar, E. Waters and I. P. Williamson (2000). "Australian Experiences of the Uptake of Geographic Information Systems for Public Health: Issues and Solutions". Jan 2003, www.sli.unimelb.edu.au/research/publications/ IPW_online_publ.html.

Greenwald, M. J. (2000). “Beyond City Limits : The Multi-Jurisdictional Applications of GIS.” URISA Journal Vol 12 No 1(Winter 2000)

Guerrero, I. (2001). “Commitment to an Open Systems Philosophy, Open GIS Consortium Newsletter.” Open GIS Consortium, Inc:

Harralson, J., R. Sheldon and R. J. Wilson (1988). Handbook of Information Resource Management. New York, Dekker.

Harrison, J. (2001). “Interoperability Program.” OGC News (March 2001) http://ip.opengis.org/ows/rft.htm.

Harvey, F. (2001). “Constructing GIS: Actor Networks of Collaboration.” URISA Journal Vol 13 No 1(Winter 2001)

Hassan, J. (2001). Tourism Commission Gains Access to KACST's Mapping Expertise. Arab News. Riyadh**:** 2.

Hassan, J. (2002a). Rainwater Drainage Plan. Arab News. Jeddah**:** P2.

Hassan, J. (2002b). National IT Plan to be Formulated. Arab News. Jeddah**:** P 3.

Heng, C. J. (1999). "Singapore Land Data Hub 21 Vision for the Future, Land Support Unit, Ministry of Law (Singapore)." GEO Asia Pacific, Aug 1999.

Holmwood, T. S. (2000). "Data Quality: Defining an Achievable Standard." GITA 2000, Denver, Colorado.

Horrie, C. and P. Chippindale (1994). What is Islam? London, Virgin Books.

Hurley, G. and W. B. Causey (2001). "Pushing the GIS Envelope Down Under." Energy IT, Vol 6 No 2, March/April 2001.

ImageSat International (2002). "EROS : ImageSat International N.V.". http://www.imagesatintl.com/aboutus/partners/partners.shtml.

INLIS (2001). "Singapore Land Hub 21 - Vision for the New Millenium". 3 April, 2002, http://www.sla.gov.sg/.

ITA (1997). "ABC Maps of Saudi Arabia". http://www.theodora.com/ita.html.

Jain, C. (1999). “Public Access Terminals : Privacy vs Efficiency.” URISA Proceedings 1999:

Jenkins, B. (1999). "A Beginner's Guide to Building an Intranet Based GIS - Why Internet/Intranet Technology." GITA 1999, Charlotte, North Carolina.

Jones, J. T. (1999). "Expanding Enterprise GIS into Regional GIS." Urisa Annual Conference 99, Chicago, Illinois.

KACST (2000). "The Saudi Center for Remote Sensing". 31 May 2002, http://www.spot.com/home/system/introexp/station/kacst/kacst.htm.

KAN International (2000). "British Telecom - Maps by E-mail (MBE)". http://www.kaninternational.com/english/portfolio/case_studies/bt.html.

Keeble, S. (2002). “Government-owned Status Proposed for Ordnance Survey.” ESRI (UK) News (No 9 New Year Edition 2002) http://www.esriuk.com/OurCompany/Newsletter/.

Kottman, C. (2001). “OGC and ISO: How We Work Together.” OGC News:

KPL&C (2001). "Building on Our Strengths". http://www.greatplainsenergy.com/overview.html.

Kubbara, F. S. (2000). "Design of an Integrated GIS Utility Database for Municipal Use." URISA 2000, Orlando, Florida.

Kumar, K. and H. G. van Dissel (1996). “Sustainable Collaboration : Managing Conflict and Cooperation in Interorganisational Systems.” MIS Quarterly Vol 20 No 3

Lagasse, D. (1999). "Integration Cost Savings." GITA 1999, Charlotte, North Carolina.

Larsen, B. (1976). Land Records: The Cost to the Citizen to Maintain the Present Land Information Base: A Case Study of Wisconsin. Madison W I, State of Wisconsin.

Laurent, R. and L. Oliveira (2000). "Benefits of Integrating Engineering Applications." GITA 2000, Denver, Colorado.

Leung, K. W. (2002). “Metadata Clearinghouse a Vital Component of Spatial Data Infrastructure.”:

LICC (2002). "About the List, Land Information System Tasmania". 13 June 2002, http://www.thelist.tas.gov.au/docs/about.html.

Local Government Computer Services Board (Ireland) (1998). "Strategic Plan 1999-2003." Dublin, Ireland, Local Government Computer Services Board.www.lgcsh.ie.

Local Government Computer Services Board (Ireland) (2001). "Local Government Computer Services Board: STRATEGY". May 2002, http://www.lgcsb.ie/html/about_strategy.htm.

Lonski, T. (1997). "Database Integration: Criteria and Techniques." AM/FM Conference 1997

Lopez, T. and C. Firquain (1999). "APWA Infolink Pilot Sets Sights on Becoming Nation Wide Information Hub." GITA 1999, Charlotte, North Carolina.

Mahoney, R. P., R. A. McLaren and J. Ryttersgaard (2001). "Spatial Information for Sustainable Development." The Nairobi Conference on Spatial Information for Sustainable Development, Nairobi, Kenya.

Majd, M. S. (2002). "DEM and DSM generation of Iran : Frequency Bureau Project (Radio Communication Administration)." Map Asia 2002, Bangkok, Thailand.http://www.gisdevelopment.net/education/papers.htm.

Majid, S. A. and I. P. Williamson (2001). “The Delivery of Spatial Data on the World Wide Web.” Article Currently Under Review for URISA Journal:

Mark, D. M. (2000). “Geographic Information Science: Critical Issues in an Emerging Cross-Disciplinary Research Domain.” URISA Journal Vol 12 No 1(Winter 2000)

Masser, I. (2002). "Report on A Comparative Analysis of NDSIs in Australia, Canada and the United States." Sheffield, University of Sheffield.

Masser, I. and H. J. Campbell (1994). "Monitoring the Take-up of GIS in British Local Government." 32nd Annual Urban and Regional Information Systems Association (URISA)

Maxwell, J. A. (1996). Qualitative Research Design An Interactive Approach. Thousand Oaks, California, SAGE Publications Inc.

McDaniel, K. E. (2000). "An Application View of Integrating Geospatial Technology for Utilities." GITA 2000, Denver, Colorado.

McDougall, K., A. Rajabifard and I. Williamson (2002). "From Little Things Big Things Grow: Building the SDI from Local Government Up." Joint AURISA and Institution of Surveyors Conference, Adelaide, South Australia.

McGaughey, D. (1999). “The Promise of Open GIS.” URISA Journal Vol 19 No 2(Spring 1999)

McKee, L. (2001). "Geography Connects Cyberspace with the Real World." GEO World, Feb 2001. www.geoplace.com.

McKeon, A. (1999a). "BS7666 - Helping the Move to "Joined Up Government"." GEO Europe, March 1999.

McKeon, A. (1999b). "Data Sharing, Politics and GIS." GEO Europe, Aug 1999. www.geoplace.com/ma/1999/0499/499bs.

McKeon, A. (1999c). ""Joined Up Government" Takes to the Streets." GEO Europe, April 1999.

MEGRIN (2000). "GDDD Overview". http://www.megrin.org/GDDD/Overview.html.

Meyers, J. R., M. J. Daniels and C. C. Killpack (1998). "Costs and Benefits: Implementing an AM/FM/GIS." AM/FM Conference 1998, San Jose, California.

Middlestead, J. A. (2000). "Making a GIT Tossed Salad. Cost Sharing Opportunities Between Government Utilities." GITA 2000, Denver, Colorado.

Miller, G. S. and M. T. Rhodes (1999). "Integration of Legacy, COTS, and Map Data." GITA 1999, Charlotte, North Carolina.

Miller, G. S. and M. T. Rhodes (2000). "Addressing Multiple-Scale Output Requirements." GITA 2000, Denver, Colorado.

Miller, K. W. (1998). "The Middle Age Crises." AM/FM Conference 1998, San Jose, California.

Ministry of Law Singapore (2000). "Landhub News Flash - Singapore Land Hub 21". 17 Jan 2002, www.gov.sg/minlaw/lssu/about_lssu/speeches/landhub_2.html.

Montana Information Technology Services Division (2002). "Discovering Montana". 15 May 2002, http://www.montana.gov.com.

Montana State Library (2002). "The Montana Natural Resource Information System (NRIS)". May 2002, http://nris.state.mt.us/gis/gis.html.

Nale, D. K. (1998). "The Future Of GIS Landbases - Is Owning One a Thing of the Past?" URISA Conference 1998, Charlotte, North Carolina.

National Emergency Number Association (2000). "The Development of 9-1-1". 10 Nov 2001, http://www.nena9-1-1.org/PR_Pubs/Devel_of_911.htm.

Nedovic-Budic, Z. (2000). “Geographic Information Science Implications for Urban and Regional Planning.” URISA Journal Vol 12 Number 2(Spring 2000): 81-87.

Nedovic-Budic, Z. and J. K. Pinto (1999). “Understanding Interorganisational GIS Activities: A Conceptual Framework.” URISA Journal Vol 11 Number 1(Spring 1999): 53-64.

Nedovic-Budic, Z., L. Warnecke and J. K. Pinto (2001). “GIS Database Development and Exchange: Interaction Mechanisms and Motivations.” URISA Journal Articles Currently Under Peer Review

Newman, S. (2000). "Addressing the Records Standardization Challenge." GITA 2000, Denver, Colorado.

O'Looney, J. (2000). Beyond Maps - GIS and Decision Making in Local Government. Redlands, California, ESRI Inc.

Onsrud, H. J. (1995). “The Role of the Law in Impending and Facilitating the Sharing of Geographic Information.” The State University of New Jersey:

Onsrud, H. J. and G. Rushton (1995). Sharing Geographic Information. New Brunswick, NJ, Center For Urban Policy Research.

Ordnance Survey (1999). "Utilities, OS Agree on New Deal." GEO Europe News, Jun/Jul 99. www.ordsvy.gov.uk.

Ordnance Survey (2000). "From revolution to e-volution". http://www.ordnancesurvey.co.uk/oswebsite/aboutus/history.html.

Peirce, C. S. (1958). Collected Papers of Charles Sanders Peirce. Cambridge MA, Harvard University Press.

Pinto, J. K. and H. J. Onsrud (1995). Sharing Geographic Information Across Organizational Boundaries: A Research Framework. New Brunswick N.J., Center for Urban Policy Research.

Pollock, N. W. and J. Nash (1998). "Data Conversion - Many Sources, One Target." AM/FM Conference 1998, San Jose, California.

Quimbo, J. M. (1998). "Integrating and Coordinating a Multi-Utility GIS Program." AM/FM Conference 1998, San Jose, California.

Quinn, B. R., R. Allen and M. Sweeney (1996). "Moving Maintenance into the Mainstream: The CAGIS Integrated GIS and Permit Management System." Cincinnati, CAGIS White Paper.http://wwwcagis.hamilton-co.org/CAGIS/p444.htm.

Rajabifard, A., M.-E. Feeney and I. P. Williamson (2002). “The Cultural Aspects of Sharing and Dynamic Partnerships Within an SDI Hierarchy.” Cartography Vol. 31 No 1

Rajabifard, A. and I. P. Williamson (2001). "Spatial Data Infrastructures: Concept, SDI Hierarchy and Future Directions." GEOMATICS '80, Tehran, Iran.

Reginster, I. and G. Edwards (2001). “The Concept and Implementation of Perceptual Regions as Hierarchical Spatial Units for Evaluating Environmental Sensitivity.” URISA Journal Vol 13 No 1

Reporters Sans Frontieres (2002). "War in Afghanistan : News under Tight Surveillance". 25 May 2002, http://www.enduring-freedoms.org/article.php3?id_article=315.

Rhind, D. (1996). "Economic Aspects of the Collection, Dissemination and Integration of Government's Geospatial Information. A report arising from work carried out for Ordnance Survey by Coopers and Lybrand.".www.ordsvy.gov.uk/literatu/external/geospat/hsecii.

Rhind, D. (2002). "Lessons Learned from Local, National and Global Spatial Data Infrastructures". 12 Nov 2002, http://www.gisdevelopment.net/policy/international/interna010c.htm.

Rigg, S., J. Tindle and S. Brewis (2001). "An AI method to Anticipate and Localise Faults within Telecommunication Networks". http://www.nd.com/application%20summaries/app-lacn.doc.

Robbins, S. P., B. Millett, R. Cacioppe and T. Waters-Marsh (1998). Organisational Behaviour - Leading and Managing in Australia and New Zealand. Sydney, Pearson Education Australia Pty Limited.

Robinson, B. (2001). "Speaking a Global Map Language: Geography Markup Language would Enable Agencies to Better Exchange Map Data". http://www.fcw.com/geb/articles/2001/1203/web-gml-12-03-01.asp.

Robison, G. (1993). Arab Gulf States. Hawthorn, Victoria, Lonely Planet Publications.

Rockhold, J. (2001). "E-911: Hero to Be." Wireless Review, 01 November, 2001.

Rowland, E. B. (1998). "TVA's Automated Land Information System." AM/FM Conference 1998, San Jose, California.

SAIR (2001). "Jeddah Information". 21 August 2002, www.saudinf.com/main/a851.htm.

Scarlett, J. R. (1999). "Making a Case for Data Maintenance Outsourcing." GITA 1999, Charlotte, North Carolina.

Scheffler, P. (1999). "Taking your Enterprise AM/FM/GIS on the Road." GITA 1999, Charlotte, North Carolina.

Scottish Enterprise (2002). "Forth Valley". May 2002, http://www.scottish-enterprise.com/about/lecs/forth.

Shull, K. (1998). "Automation Process for Developing Vital Health Information at Census Tract Level." URISA 1998, Charlotte, North Carolina.

Sinclair, S. (2000). "The Mystique of Land Management and Government in Asia Pacific." GEO Asia Pacific, Sept 2000.

Sosinsky, B. and C. T. Nguyen (2001). "Are ASPs Unsinkable?" Application Development Trends, Vol 8 No 3, March 2001. http:\\www.adtmag.com.

Southern Californian Association of Governments (2000). "About Access". 19 Feb 2002, http://www.scag.org/public_docs/d62.htm.

Spencer, B. (2000). "Beyond the Enterprise." GEO Asia Pacific, Aug/Sept 2000, September 2000. www.geoplace.com/asiapac.

Spivey, K. H. and L. Mizula (1998). "Untangling the Net - Utility GIS/Internet Technology." AM/FM Conference 1998, San Jose, California.

State Dept US Government (2002). "Background Notes - Saudi Arabia". 30 May 2002, www.state/gov/r/pa/bgn/.

Stengle, R. G. (2000). "Application Integration in Data Conversion Quality Measurement." GITA 2000, Denver, Colorado.

Stimson, J. (1999). "Montana's Natural Resource Information System (NRIS) Streamlining Access to Important Information." Surveying And Land Information Systems Vol 59 No 3: 175-178.

Stipes, A. J. (1998). "Usability from the User's Perspective." AM/FM Conference 1998, San Jose, California.

Stoe, D. and S. Oberle (1999). "SASCI: Data-Sharing: Legal, Ethical and Cultural Issues Associated With a Multi-Agency GIS." URISA Proceedings 1999:

Taylor, R. and U. Haenni (1999). "Data Mining - Database Vendors Open The Doors To Enterprise GIS." GEO Europe, July 1999.

Tilley, G. (1999). "Base Mapping - I'd Rather Be a User." URISA Conference 1999, Chicago, Illinois.

Titterington, G. and P. Bassanese (2001). "e-Business Without Security is not an Option." Application Development Trends, Vol 8 No 2, Feb 2001. http:\\www.adtmag.com.

Tram, H., L. Engelken and A. Gay (1999). "Strategy for Spatially Integrated Distribution Information System in Energy Delivery Utility Mergers." GITA 1999, Charlotte, North Carolina.

Trotter, R. L. (2000). "Economic Justification: Work Management and AM/FM/GIS Systems." GITA 2000, Denver, Colorado.

Tudor, G. S. and C. Wolfe (1999). "Washington State Cadastral Framework Project: Implementing the FGDC Cadastral Data Content Standard and Integrating Data from Multiple Sources." Surveying and Land Information Systems Vol 59 No 3

U.S. Senate Select Committee On The Judiciary (2000). "Know the Rules. Use the Tools - Privacy in the Digital Age." Washington, U.S Senate.http://judiciary.senate.gov/privacy.htm.

Vibulsresth, S. (2002). "Development of NDSI in Thailand (Key Note Address)." Map Asia 2002, Bangkok, Thailand.

Wampler, S. (2000). "Garbage or Good? Quality Assurance and Quality Control for Data Confidence." URISA 2000, Orlando, Florida.

Warnest, M., A. Rajabifard and I. P. Williamson (2002). "Snapshot of SDI Development in Australia: Models, Partnerships and Lead Agencies Advancing Implementation." Joint AURISA and Institution of Surveyors Conference, Adelaide, South Australia.

Wikle, T. A. (1999). “GIS Education Through Certificate Programs.” URISA Journal Vol II No 2

Wilson, J. M. (1999). "Making a Case for Outsourcing." GITA 1999, Charlotte, North Carolina.

WorldSat (2001). ESRI GIS Reference Library. Ontario, WorldSat International Inc.

Zastava, D. (2000). "Measuring Actual Project Benefits - How to Maintain Your Project Profile and Funding." GITA 2000, Denver, Colorado.

Zedan (2000). "Use of the Internet". 31 May 2002, http://www.riyadh-today.com/internet/i(201).htm.

Zumbado, J. A., P. A. Naecker and W. H. Iller (1999). "Have Data, Will Travel: A Data-Centric Approach to Enterprise Systems Development." GITA 1999, Charlotte, North Carolina.

Appendix 1

Geospatial Information and Saudi Arabian Authorities

Most authorities within Saudi Arabia would benefit from access to locational information. The following tables indicate whether a GIS has been established, and the type of sharing that might be appropriate. The appropriate type of data sharing for each authority is classified according to its role in the arrangement, with added notes when applicable.

The Roles of participant organizations in data sharing arrangements are categorized as :

- Coordination
- Data Gather and Disseminator
- Data User
- Data Gather/User

These criteria were established Section 4.3.2. Classification of Models. It should be noted duel categories may be applicable to some organizations.

Table A1.1 Status of GIS - Heads of State

<table>
<tr><th>Heads of State</th><th>GIS Availability (Current)</th><th>Appropriate Type of Sharing*</th></tr>
<tr><td>Diwan of King Fahad ibn Abdulaziz, Custodian of the Two Holy Mosques and Prime Minister</td><td rowspan="2">Nil directly
(Ad hoc access via other authorities is available.)</td><td rowspan="2">Role : Data User
Notes : Should have unlimited access to the National Geospatial reference system.</td></tr>
<tr><td>Diwan of HRH Prince Abdullah ibn Abdulaziz, Deputy Prime Minister and Head of the National Guard</td></tr>
<tr><td>Office of HRH Prince Sultan ibn Abdulaziz, Second Deputy Prime Minister and Minister of Defense and Aviation</td><td>Nil directly
(Ad hoc access via other authorities is available.)</td><td>Role : Data User
Notes : Should have access to the National Geospatial reference system for matters of State within his areas of responsibility.</td></tr>
</table>

Table A1.2 Status of GIS - Ministries

Ministry	**Functions**	**GIS Availability (Current)**	**Appropriate Type of Sharing**
Agriculture and Water	Implementation of economic plans and programs for agriculture. Water development, desalination, irrigation, conservation of scarce water, fisheries, animal resources and locust control	GIS facilities available through Environmental Protection Agency (MEPA).	Role : Data Gatherer/User Notes : Use of Geospatial data is essential, and sharing data is recommended.
Commerce	Quality control of foodstuff, consumer protection, companies and commercial agents' registration, labelling regulation standards, international exhibits, hotels, bilateral trade agreements, and world trade organization	Nil	Role : Data User Notes : Demographic modelling and marketing tool.
Communication and Transportation	Design, building and maintenance of road network. Coordination of surface transportation, including railroads and bus systems	GIS with restricted functionality	Role : Data Gatherer/User Notes : Essential tool for planning , Operations and maintenance.
Defense and Aviation	Army, Navy, Air Force, construction of Military bases, civilian airports and meteorology. Economic Offset programs	Well developed GIS capability	Role : For security concerns, data sharing not expected with non-military organizations.
Education	Provision of free general education in primary, intermediate and secondary schools. Royal Technical Institute programs for the handicapped. Antiquities and museums.	Well developed GIS in use	Role : Data Gatherer/User Notes : Kingdom wide facilities - could be using data obtained from MOMRA.

Ministry	**Functions**	**GIS Availability (Current)**	**Appropriate Type of Sharing**
Finance and National Economy	Government finance, including budgeting and expenditure of all ministries and agencies. Control of national economic growth. Zakat, income tax, and Customs. Central department of statistics, and national computer centre.	Nil	Role : Data User Notes : Access to geospatial data would assist in economic modelling.
Foreign Affairs	Political, cultural, and financial international relations. Monitors diplomatic relations between the Kingdom of Saudi Arabia and the outside world	Nil	Role : Limited role Notes : Not a significant user of Geospatial data.
Health	Development and maintenance of hospitals, clinics and primary health care units.	Basic GIS used	Role : Data Gatherer/User Notes : Uses common landbase data – prime candidate for data sharing.
Higher Education	Universities and higher learning institutes	GIS with limited functionality in use	Role : Data Gatherer/User Notes : Kingdom wide facilities - could be using data obtained from MOMRA.
Ministry of Industry	Development of industrial infrastructure and power projects. Foreign capital investment, industrial licensing, protection and encouragement of national industry, industrial statistics, industrial cities and SABIC.	Nil	Role : Data Gatherer/User Notes : Has heavy reliance on maps – needs the currency of temporally accurate Geospatial data.
Information	Television and radio broadcasts, publication of newspapers, magazines and relations with foreign press.	No GIS Installed; No GIS access	Role : Data Gatherer and Disseminator Notes : Current geospatial data helpful in providing accurate information, quickly.

Ministry	Functions	GIS Availability (Current)	Appropriate Type of Sharing
Interior	Public security, coastal guards, civil defence, fire stations, border police, special security and investigation forces, criminal investigation and traffic control	Basic GIS facilities installed	Role : Coordination; Data Gatherer/User Notes : Access to Geospatial data is essential, and data sharing recommended
Islamic, Endowments Call (Dawa) and Guidance Affairs	Administration of land controlled by religious trust.	Nil	Role : Data User Notes : Widespread distribution of control officers and mosque locations.
Justice	Administration of Shari'a Law and provision of legal services for all citizens of the Kingdom	Nil	Role : Data User Notes : Crime and Demographic mapping aided by Geospatial data aggregation.
Labor and Social Affairs	Labour relations, manpower planning and general monitoring of employment. Labour permits and work visas, labour disputes, inspection, health and safety. Provisions of social development and reform and security	Nil	Role : Data Gatherer/User Notes : Sharing data with Ministry of Interior essential.
Municipalities and Rural Affairs	Administration of municipalities throughout the Kingdom. Planning of cities and towns. Development of roads and basic infrastructure.	Well developed GIS facility	Role : Coordination; Data Gatherer/User Notes : Landbase data already available to Municipalities and some utilities
Petroleum and Mineral Resources	Administration and development of the Kingdom's oil, gas, refineries and mineral resources in conjunction with the General Petroleum and Mineral Organisation.	Uses Aramco geospatial data	Role : Data Gatherer/User Notes : Data sharing with Aramco essential.

Ministry	Functions	GIS Availability (Current)	Appropriate Type of Sharing
Pilgrimage	Provision of facilities for the annual visit of pilgrims to Makkah, Madinah and other Holy places in the Kingdom.	Nil – *ad hoc* access to some Geospatial data from municipality	Role : Data User Notes : Layout of Pilgrims' journeys assisted with data shared with other organizations.
Planning	National planning.	Nil	Role : Data Gatherer/User, Coordination Notes : Access to Geospatial data is essential, and data sharing recommended
Posts, Telegraph and Telephone	Development and maintenance of telecommunications and postal services	Digitised Mapping facility installed.	Role : Data Gatherer/User, Disseminator. Notes : Uses data common to other organizations.
Public Works and Housing	Supervision, construction and maintenance of public sector projects. Public housing, evaluation of tenders, allocation of contracts and classification of contractors	Nil	Role : Data User. Notes : Geospatial data would improve decision making.

Table A1.3 Status of GIS - Government Agencies and Quasi Government Organizations

Government Agency	Functions	GIS Availability (Current)	Appropriate Type of Sharing
King Abdulaziz Center for Science and Technology (KACST)	Centre for learning and application	Extensive GIS facility	Role :Data Gatherer/User; Coordination Notes : Major coordinator of GIS for Kingdom.
Saudi Basic Industries Corporation (SABIC)	Participates in joint ventures with foreign firms for heavy industries and the industrial cities	Nil	Role : Data User Notes : Would benefit from access to landbase and infrastructure information.

Government Agency	**Functions**	**GIS Availability (Current)**	**Appropriate Type of Sharing**
Saudi Consulting House (SCH)	Conducts market research and industrial feasibility studies, prepares and publishes data on industrial development	Nil	Role : Data Gatherer/Use; Disseminator Notes :
Saudi Fund for Development	Development project loans to foreign countries	Nil	Role : Nil Notes : Not appropriate for overseas funding.
Saudi Government Railroad Organization	Runs the Dammam – Riyadh railroad, participates in development of other major railway route proposals	Basic CAD	Role : Data Gatherer/User Notes : Would benefit from access to landbase and infrastructure information.
Saudi Industrial Development Fund (SIDF)	Provides loans to Saudi or Saudi/foreign joint industrial ventures	Nil	Role : Data Gatherer/User Notes : Powerful marketing and feasibility analysis tool
Saudi Red Crescent Association	Emergency Health Care	Nil	Role : Data User Notes : As part of emergency services industry needs access to LBS database.
Supreme Commission of Tourism (SCT)	Promotes Tourism throughout the Kingdom	Relies on KACST	Role : Data Gatherer/User Notes : Powerful marketing tool.
Youth Welfare Organization	Sports complexes, cultural and folkloric clubs	Nil	Role : Data User Notes : Management and Planning of facilities would benefit.

Appendix 2
Functionality and GIS Requirements of Urban Planning in Jeddah

A 2.1 Introduction

In 1998 the Jeddah Municipality issued a Request for Proposal (RFP) for a Geographic Information System to be used by the General Directorate of Urban Planning. In responding to this, companies were required to undertake a review of the functionality of the groups within the GDUP, to review the current status of GIS usage within Jeddah Municipality, to determine the requirements for future GIS deployment, and to recommend an integrated solution which addressed these.

The investigations involved in acquiring the framework and details mandated for this proposal were catalytic in the commencement of research into the potential for geospatial data sharing in Saudi Arabia, and a determining factor in including the Jeddah Municipality as a potential partner in the data sharing model to be developed.

This appendix draws heavily on research done prior to preparing a proposal to meet the requirements stipulated in the RFP. It provides an indication of the bureaucratic processes involved with various urban planning activities, and in doing so it also provides a basis for assessing the potential for data sharing with other agencies and authorities using GIS within the Municipality of Jeddah.

A 2.2 Research Scope

The functions and requirements of the four divisions and four departments of the General Directorate of Urban Planning of the Jeddah Municipality are covered in this review. It is limited to the main office standard functions of these groups. The requirements of sub-municipal office bodies have not been included as the communications infrastructure is not available to support an on-line GIS outside of the main municipality offices.

The divisions and departments covered are shown below :

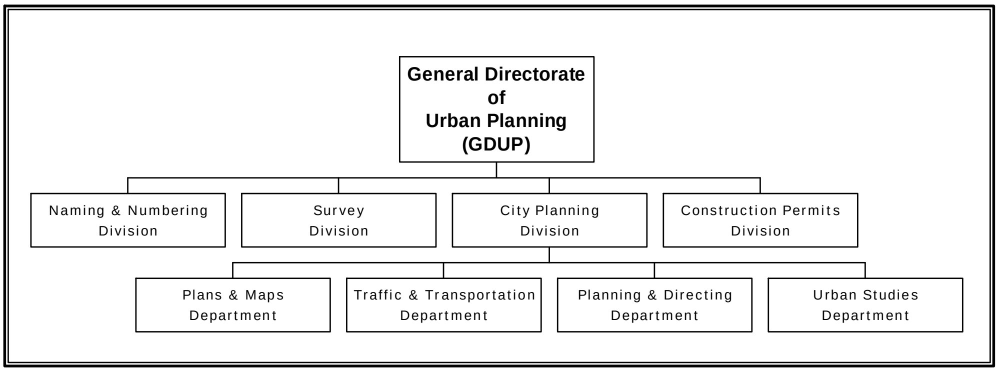

Figure A2.1 GDUP Organizational Chart

As well as presenting the results of research, this document has been developed to guide the users at the Municipality in setting up the required GIS technology at the Municipality. It has been designed with the intent to be compatible with existing Kingdom-wide MOMRA standards, while still remaining extendable to meet the unique needs of the Municipality of Jeddah.

A 2.3 Requirements for GIS within GDUP

The primary objective of any GIS is the effective use of spatial data in the end users workflow. To do this all GIS are capable of the capture, storage, management, analysis and visualization of spatial data. These capabilities are enabled through the combined processing of graphical and tabular data. At present there are three data formats in which this spatial data is contained. These digital data formats closely mirror their traditional hardcopy data predecessors.

- **Raster Data -** Commonly referred to as imagery. This data is usually a digital representation of satellite imagery or aerial photography. This form also includes the scanned files of hardcopy maps and documents.
- **Vector Data -** This data is a digital representation of line work documents. Linear features such as roads are represented graphically by a series of mathematical points, which form a line. Point features (i.e. a street lamp) are represented through the use of a single mathematical point. Area (or polygonal) features are represented graphically through the combination of a series of lines and a single point as the area centroid.

- **Tabular Data -** This alphanumeric data includes all the descriptive data about a spatial feature. This is commonly joined in the database to the vector data to form a 'feature' and its attribute table. Examples of the tabular data would be a street name, a street lamp inventory number and a district polygon name.

It is the synthesis of these disparate data types which enables a GIS to process data with the dimension that is unavailable to a standard RDBMS, i.e. the spatial data.

The design of a data model for a GIS entails the selection of the GIS software environment. This is required as portions of the data model design hinge directly upon the capabilities and requirements GIS software. The GIS software used for GDUP data model is the MGE software from Intergraph Corp. This GIS software is based upon open and published file formats. The capabilities of MGE and its open file formats will allow the transfer of the data model and any associated data to another system, if this is so required by GDUP or the Municipality of Jeddah.

Using this data model document as a guide, GDUP will be able to construct a GIS, which will enable their data users to interact with a centrally administered GIS database. Data will flow quickly and efficiently through the system giving all end users the most up to date information available. Data to support decision-making will be available in a more timely fashion. Decisions will be supported with the best information available in the municipality organization.

A 2.4 Functional Description - City Planning Division

A2.4.1 Planning & Directing Department

The Planning & Directing Department's primary functions revolve around the issues of zoning and land use. The main functions can be summarized as :

- Preparation of the zoning regulations for the Municipality of Jeddah. These are commonly referred to as the 'planning & directing' maps.
- Modification of land title deeds.
- Issuance of Title Deeds.
- Directing the sale of land in excess of the municipality's requirements.

Zoning Regulation

The Planning & Directing Department adds additional information to its existing 'planning & directing' maps through the following procedure:

A citizen applies for a construction permit at a sub-municipality. The Survey Division performs its usual tasks to support this procedure (see sections on Construction Permits & Survey for complete information). When it is noted that the plot exists outside of existing 'planning & directing' maps, the detailed site usage plan, or 'qroukie' as it is called, is sent to the Planning & Directing Department.

The engineer responsible for the area reviews the existing large scale planning maps for the area. At this point a transaction number is assigned to the plot for future section reference. The engineer draws the zoning line work over the survey plan of the area. At the same time he adds the plot boundary into the existing 'planning & directing' maps along with the transaction number.

A copy of all documentation and the plan are forwarded to the Plans & Maps Department for archiving.

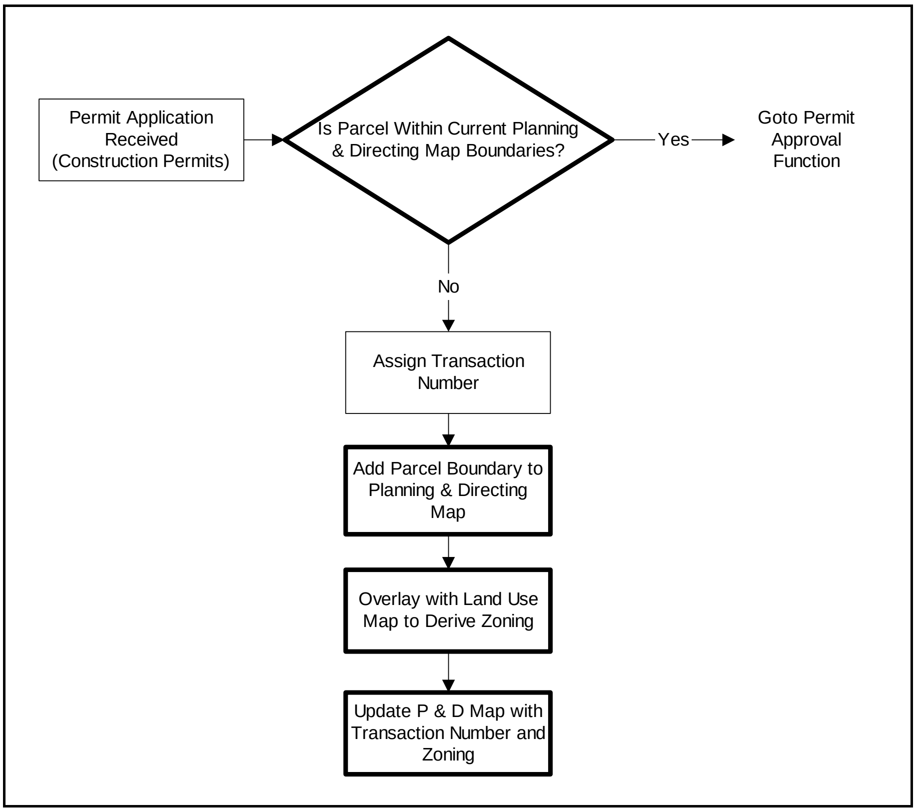

Figure A2.2 Zoning Regulation Workflow

Issuance of Title Deeds

A citizen requests the court to issue him a title deed for land which he has been occupying or cultivating. The court sends a request to process the request for title deed to the municipality via the Title Deed Division. From the Title Deed Division, the request is sent to GDUP where it is transferred to the Planning & Directing Department.

The Planning & Directing Department requests the Survey Division to prepare a detailed site usage plan, or qroukie, for the plot in question. This information is then sent to the Property Inquiry Section who check the actual ownership of the land. The file is then transferred back to the Planning & Directing Department, which then numbers the plot and adds the plot to the 'planning & directing' maps.

The file is then transferred back to the Director of Urban Planning, who in turn forwards it to the Deputy Mayor for Title Deed Affairs. The Deputy Mayor finally transfers the file back to the court, which in turn issues a title deed.

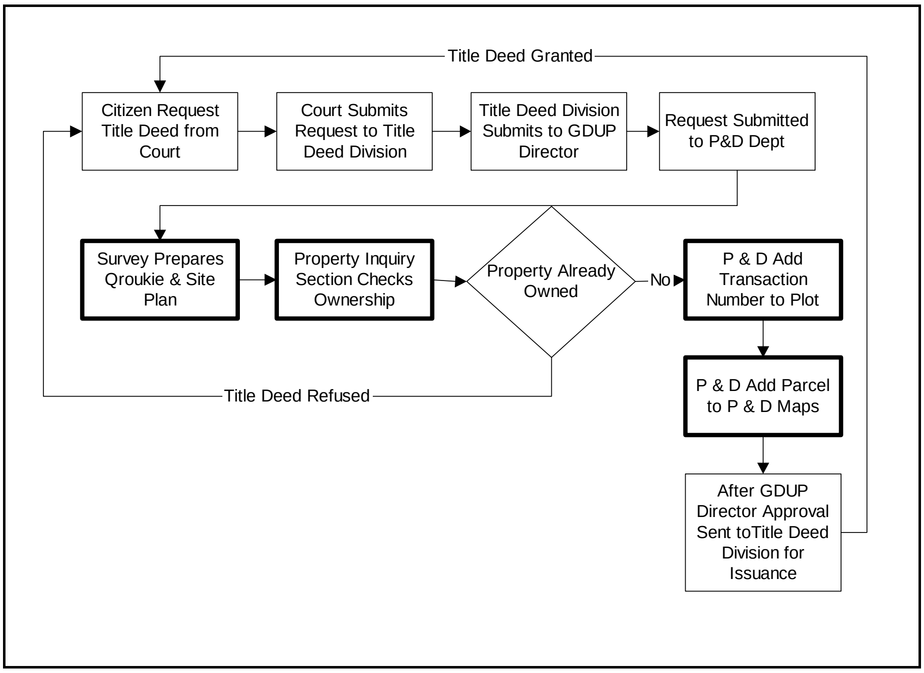

Figure A2.3 Issuance of Title Deed

Modification of Land Title Deeds

A citizen (or group of citizens) submits a title deed that is inconsistent with the as-built of a plot or group of plots. This submission is to either the sub-municipality or the Director of Urban Planning. Once the submission is forwarded to the Planning & Direction Section, it requests the Survey Division to perform a survey and prepare a survey plan for the area in dispute.

The Survey Division prepares the site survey plan and submits this to the Planning & Directing Department. Engineers at Planning & Directing study the area to develop a solution which is amenable to all parties concerned. The possible solutions are:

- Compensation through granting of additional land.
- Modification of adjacent streets to allow for the modification of the questionable plots, thereby increasing their area to the citizen's rights.
- Notifying citizens that their title deeds are incorrect and changing these to reflect the correct area of the plots.

The solution is forwarded to the Deputy Mayor for Technical Affairs for approval. Once his approval is received, the sub-municipality notifies the concerned citizens to receive their consent.

If the citizens agree to the solution, the Survey Division is requested to mark the necessary plot changes with concrete marker blocks. Planning & Directing sends the solution to the Land Plot Division which processes the changes with the Notary Public. All solutions and necessary documentation are kept in the Plots archive.

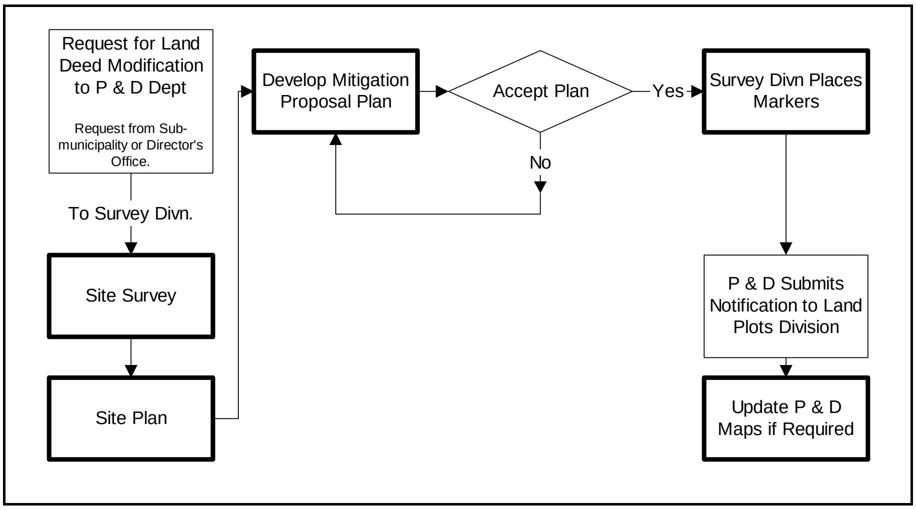

Figure A2.4 Modification of Land Title Workflow

Excess Land Sales

A citizen submits a request to purchase a plot adjoining a property he presently owns. This request is submitted either to the Mayor's Office or the Director of Urban Planning. This request must be accompanied by a copy of his Title Deed and his *tabiya* (Citizen Identification). Planning and Directing requests the Survey Division to perform a survey of the site in question. The Survey Division prepares a qroukie (see Survey Division for information on qroukie) for the site.

The qroukie is forwarded to the concerned sub-municipality for information regarding the site and any existing buildings. The sub-municipality sends back a report which contains information of the plot and its adjoining plots. Information on existing construction permits for the site or adjoining sites are also contained in the report.

Planning and Directing then examines all pertinent information on the site and makes its recommendation. The section can recommend the sale of the plot, the designation of the plot as a public facility or simply not to sell the plot to the requesting citizen. Recommendations are sent to the Mayor's Office for his approval.

If the sale is approved, Planning & Directing requests the Land Plots Division to complete the required sale procedures. In conjunction with the Planning & Directing Department and the Survey Division, the Land Plots Division develops the land sales application. The completed land sales application is sent on to the Plots Estimation Committee for a valuation of the land in question. The committee sends the valuation of the land back to the Land Plots Division. The Land Plots Division advises the Finance Department of the amount to be collected from the citizen in return for the land.

The final stage is for the citizen to submit a copy of his receipt from Finance to the Plots Dispute Section, who in turn notify the Notary Public to modify the Title Deed for the plot in question. A complete record of the transaction is kept at the Plots Division.

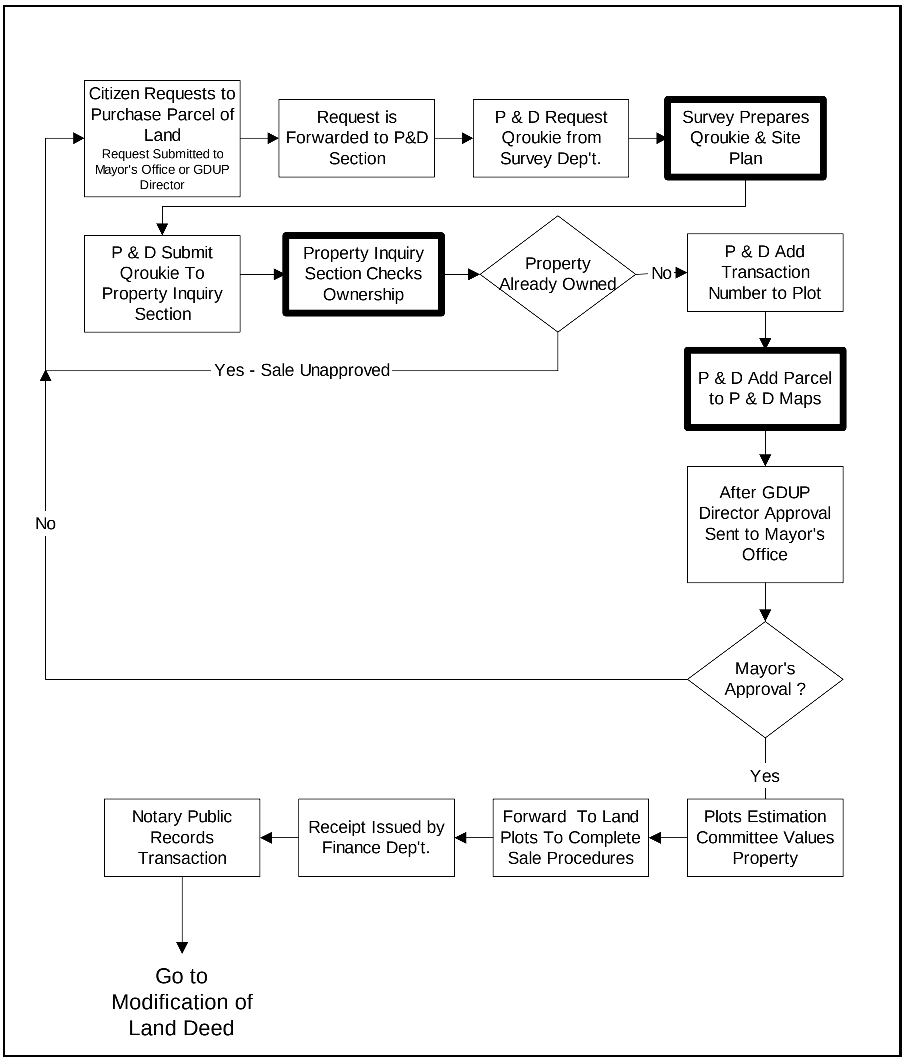

Figure A2.5 Excess land Sales Workflow

A2.4.2 Plans & Maps Department (Archive)

The primary activity of this department is to maintain and control access to all the original documents used throughout the GDUP in its interactions with its clients, be these citizens or other government departments. The department generates no data or documents independent of other GDUP bodies.

Despite this lack of data or documents generated, this section is central to the activities of GDUP. It is through the information storage and retrieval function that decisions can be made based upon previously collected information. It is the function of this section to ensure that all users at GDUP are provided the relevant information in a timely and efficient manner.

A2.4.3 Traffic & Transportation Department

The functions of this department can be summarized as follows:

- Developing traffic remediation plans to attempt to rectify safety problems with existing roadwork designs.
- Performing the traffic surveys periodically with the assistance of a consulting firm.
- Developing a plan indicating the traffic lights and signals locations.
- Reviewing the traffic flow detouring plans during the implementation of the maintenance works.

Development of Traffic Remediation Plan

The first step towards development of a traffic remediation plan is for the section to receive notification of a traffic problem. This notification can come from either the Traffic Department of the police or from a concerned citizen. The second step is for the appointment of an engineer from the municipality and the police to study the situation. These studies are usually of an informal nature and involve the engineers visiting the site in question and using their experience to assess the situation. After the site assessment, the municipal engineer will prepare a proposed solution. These proposed solutions are drafted upon photocopies of the municipality base maps. The photocopies are rarely (if ever) complete copies of the map in question. Usually they are partial copies made on standard A4 office photocopy paper. These documents are of no standard scale. Once the engineer is satisfied with his solution, it is submitted to the Traffic & Transportation Co-ordination Committee for consideration. The committee may accept the solution or send it back for further study. Once the solution is accepted it is forwarded to the competent authority for execution. All designs and correspondence in relation to each traffic remediation plan are filed for future reference. At present these files are kept at the Traffic & Transportation Section, and are not in the main archive.

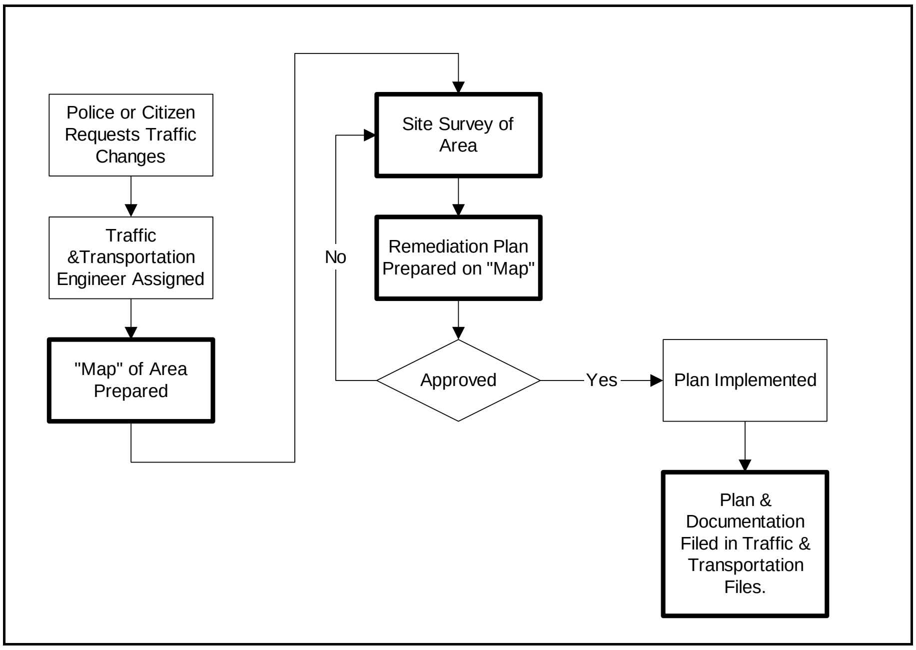

Figure A2.6 Traffic Remediation Plan Workflow

Traffic Surveys in Conjunction with Consulting Firms

This task is not a standardized function of this section. Its completion follows no set format, and so it cannot be documented for the purpose of this document.

Developing a plan indicating the traffic lights and signals locations.

This function is not a standardized function of this section. Its completion follows no set format, and so cannot be documented for the purpose of this document.

Review & Development of Detour Plans for Maintenance Work

This function mirrors the tasks as performed for a traffic remediation plan. The General Directorate for Operations & Maintenance informs the Traffic & Transportation Department of an intended long-term maintenance procedure, which will necessitate detouring traffic for the duration of the maintenance. An engineer from the Traffic & Transportation Department will be appointed to assess the needs for a detour plan, the Operation & Maintenance may also appoint an engineer to assist. These studies are usually of an informal nature and involve the engineers visiting the site in question and using their experience to assess the situation. After the site assessment, the municipal engineer will prepare a proposed solution. These proposed solutions are drafted upon photocopies of the municipality base maps. The photocopies are rarely (if ever) complete copies of the map in question. Usually they are partial copies made on standard A4 office photocopy paper. These documents are of no standard scale. Once the engineer is satisfied with his solution, it is submitted to the Traffic & Transportation Co-ordination Committee for consideration. The committee may accept the solution or send it back for further study. Once the solution is accepted it is forwarded to the competent authority for execution. All designs and correspondence in relation to detour plans are filed for future reference. At present these files are kept at the Traffic & Transportation Section, and are not in the main archive.

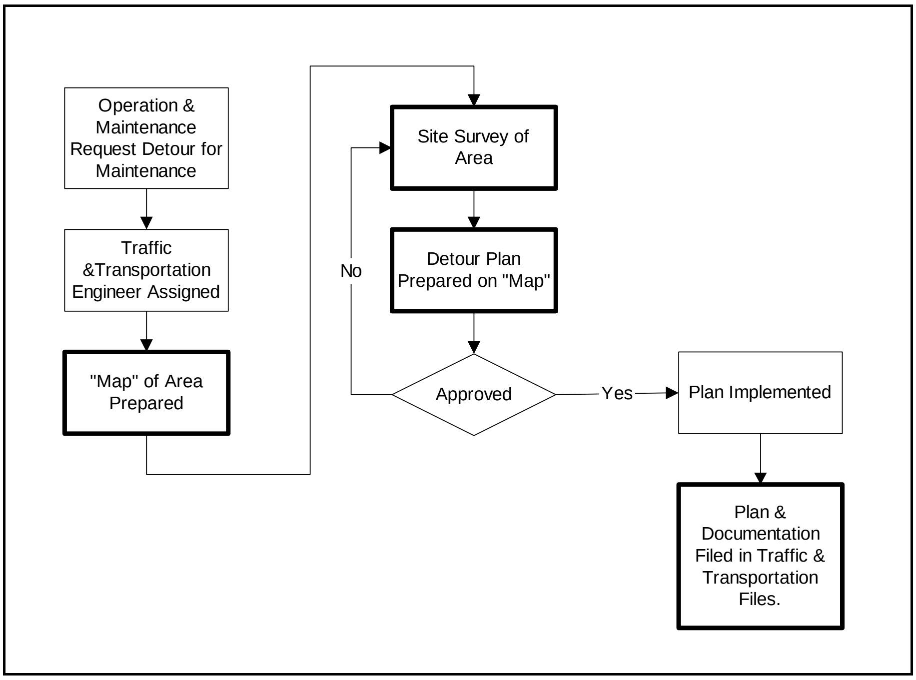

Figure A2.7 Detour Plan Workflow

It should be noted that this department presently performs its responsibilities in an *ad hoc* manner. The primary functions are performed through the actions of the Transportation and Traffic Co-ordination Committee. The Traffic Department itself or other relevant authorities implement all solutions developed by the department and approved by the committee.

Urban Studies Department

The Urban Studies Department is very similar in function to the Planning and Directing Department. The delineation of duties is often unclear, even within the minds of GDUP officials. The Urban Studies Department is primarily entrusted with the duties concerning the creation of sub-divisions, whether the sub-divisions are privately developed or developed by the government. The Urban Studies Department activities can be summarized as:

- The planning, studying and creation of municipality administered sub-divisions.
- The studying and approval of privately developed sub-division plans.

Planning of Municipality Administered Sub-divisions

The municipality distributes land plots to citizens as directed by higher government authorities and in reparation of land expropriated from citizens by governmental departments. These plots come from sub-divisions that the municipality has developed on some of its excess land. The process for developing these sub-divisions is as follows.

The Urban Studies Department request the Survey Division to perform a survey of the site in question and prepare a survey plan of the area. The Survey Division sends the survey plan to the Urban Studies Department which forwards the survey plan to the Properties Inquiry Section. The Property Inquiry Section advises the Urban Studies Department on the legal status of the site and advises of necessary changes.

Once the site boundaries and ownership are verified by the Properties Inquiry Section, the Urban Studies Department assigns the site to the engineer responsible for the area. This engineer drafts onto the survey plan the main boundary streets and landmarks. Further he adds the zoning regulations and their boundaries along with requirements for public facilities and services. The final stage is to add in the plot lines.

Once the plan is developed, the plan is submitted to the Director of Urban Planning. Following his approval, the plan is sent to the Mayor for his approval, who in turn forwards the plan to the Ministry of Municipal and Rural Affairs for approval. Following the necessary approvals the plan is forwarded to the Granted Plots Section for disbursement to citizens.

The Survey Division is requested to place the plot markers while the Projects Directorate is requested to build streets and install street lighting. A copy of the plan along with all correspondence is placed in the care of the Plans and Maps Department. The concerned sub-municipality is also given a copy for future reference.

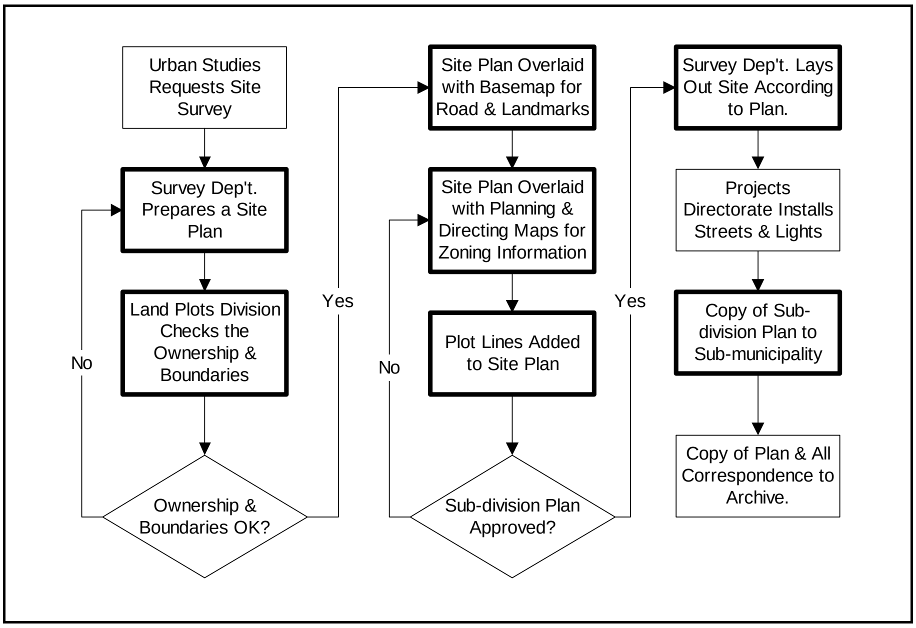

Figure A2.8 Planning Municipal Sub-division Workflow

Approval of Privately Developed Sub-divisions.

The process for the approval of a privately developed sub-division plans is as follows. A citizen who wishes to sub-divide his property submits his request and copy of the Title Deed to the Urban Studies Department. The Urban Studies Department requests the Survey Division to prepare a new survey of the plot in question and to prepare a survey plan of the site. Once the Urban Studies receive the survey plan of the site, it is forwarded along with the Title Deed to the Property Inquiry Section to verify the ownership and boundaries of the site.

Once the site boundaries and ownership are verified by the Properties Inquiry Section, the Urban Studies Section assigns the site to the engineer responsible for the area. This engineer drafts onto the survey plan, the main boundary streets and landmarks. Further he adds the zoning regulations and their boundaries along with requirements for public facilities and services.

The citizen at this point is given a copy of the survey plan which has been amended to include the Urban Studies information for the area. The citizen uses this plan as a basis for the development of his sub-division plan. These plans are usually developed for the citizens by approved consulting offices. Once the sub-division plan has been developed, it is resubmitted to the Urban Studies Department.

Urban Studies will then check the plan to ensure that it meets the municipality zoning requirements. Areas of plots, provision for public facilities and conformation to zoning regulations are all checked. If the plan meets requirements the plan is forwarded to the Mayor's office. If requirements are not met, the plan is sent back to the citizen with comments on changes required to get approval.

Once the Mayor has approved the plan, the citizen is notified to perform the preliminary civil engineering work on the site. This includes street construction, street lights and demarcation of the plots with concrete markers. Once these works are completed the citizen will request the Urban Studies Department to give him approval to sell plots.

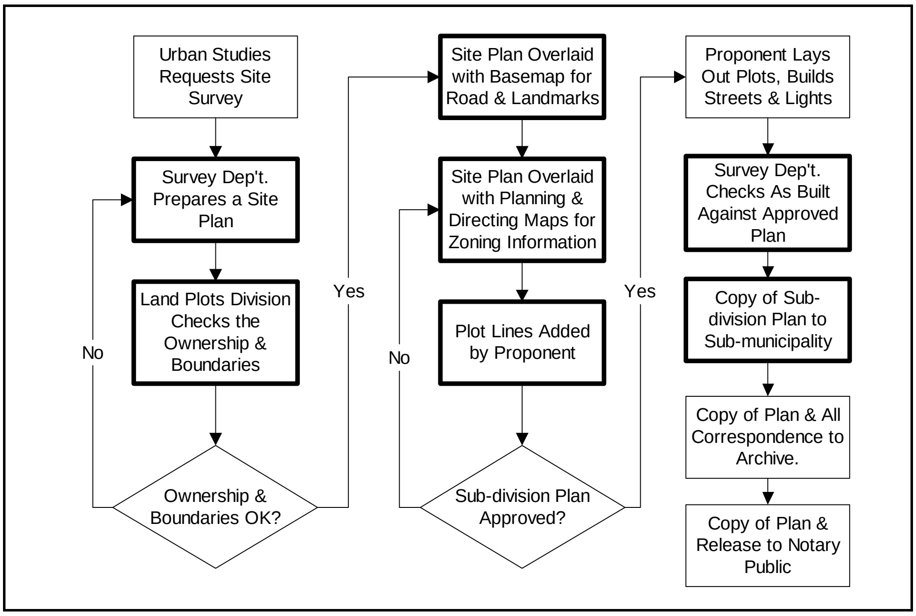

Figure A2.9 Approval of Private Sub-division Workflow

Prior to granting approval for the sale of plots the Urban Studies Department will request the assistance of various municipal sections to check the conformation of the as-built to the approved plan. The Survey Division will check that the plot markers have been laid out according to the plan. The General Directorate for Projects will inspect the street construction and street lighting to ensure conformation to the approved plan. These departments will send notifications to the Urban Studies indicating approval or disapproval of the as-built sub-division. In cases of non-conformity, the Urban Studies

Department advises the citizen of the required changes and the process of conformation checking is started again.

If the plan has been executed as per the municipality requirements, the Urban Studies Department will prepare a letter which is sent along with a copy of the approved plan, to the Notary Public. This will allow the citizen to initiate sales of his plots. All documents prepared in this process are copied and filed with the Plans & Maps Department. Further, a copy of the approved plan is sent to the concerned sub-municipality for reference.

A 2.5 Functional Description - Construction Permits Division

The functions of the Construction Permits Division can be summarized as follows:

- Registration of approved architects, contractors and engineers.
- Oversight and approval of construction plans for buildings greater than three floors in height or located directly along a major thoroughfare.
- Issuance of construction permits for governmental buildings, mosques or for buildings whose construction will be supervised by another government body.
- Modification of previously issued construction permits.
- Supervision and oversight of sub-municipal construction permit procedures.
- Preparation of standard summary reports for the Ministry of Municipal and Rural Affairs.

Registration of Approved Professionals

The Construction Permits Division performs the task of registering approved construction professionals and tracking the buildings which they have designed, supervised or constructed. The division enters the relevant biographic information into the corporate IBM SQL database through the use of a custom developed Arabic front-end package, interfaced through a standard IBM 3270-type terminal. In addition to this task, the department also tracks approval signatures through a card index. Sample signatures from all AEC professionals are kept, indexed manually by company name.

The registration of an architect entails the assignment of an ID number by the database program. All architect IDs range between 37000 through to 39000. ID numbers are unique and have yet to be reused. An architect is not required to be a Saudi. He is registered to develop and certify designs from his office.

A construction engineer is registered through the program with an ID number greater than 39000. The construction engineer is not required to be a Saudi national. The construction engineer is registered to develop and certify construction plans for his office.

An architecture/construction engineer is registered through the database front-end with and ID number greater than 30000 through to 36999. The architecture/construction engineer is required to be a Saudi national. The architecture/construction engineer can develop and certify both architectural designs and construction plans from his office.

A consulting engineer is registered with an ID number greater than 10000 through to 29999. The consultant engineer is required to be a Saudi national. The consultant engineer is expected to retain the services of an architect, a construction engineer and an electrical engineer. The consultant engineer can develop and certify the full spectrum of AEC plans. The consultant engineer is ultimately responsible for all plans & designs which are certified by his office staff.

Oversight & Approval of Construction of Municipal Wide Significance

It should be noted at the outset that the majority of construction permits with the Municipality of Jeddah are issued at the sub-municipal level. It is only projects which are deemed of municipal-wide significance which must have their construction permits issued through the Construction Permits Division office at the main municipal offices.

The first stage is the development of a qroukie for the site in question. The qroukie is developed by the Survey Division. Once the qroukie has been developed this information will be forwarded to the Planning & Directing Department for recommendations based upon conformity to zoning regulations.

Once all the necessary information on the plot, its surrounding land use and the pertinent zoning regulations is assembled the information will be forwarded to the Mayor's office with a recommendation for approval or denial of approval.

The Mayor's office will forward to the Construction Permits Division its decision on the permit for the site in question. All documents are copied and filed for future reference. The citizen is then either issued a construction permit for his site or a response letter from the Mayor's office explaining the reasons for the denial of a permit.

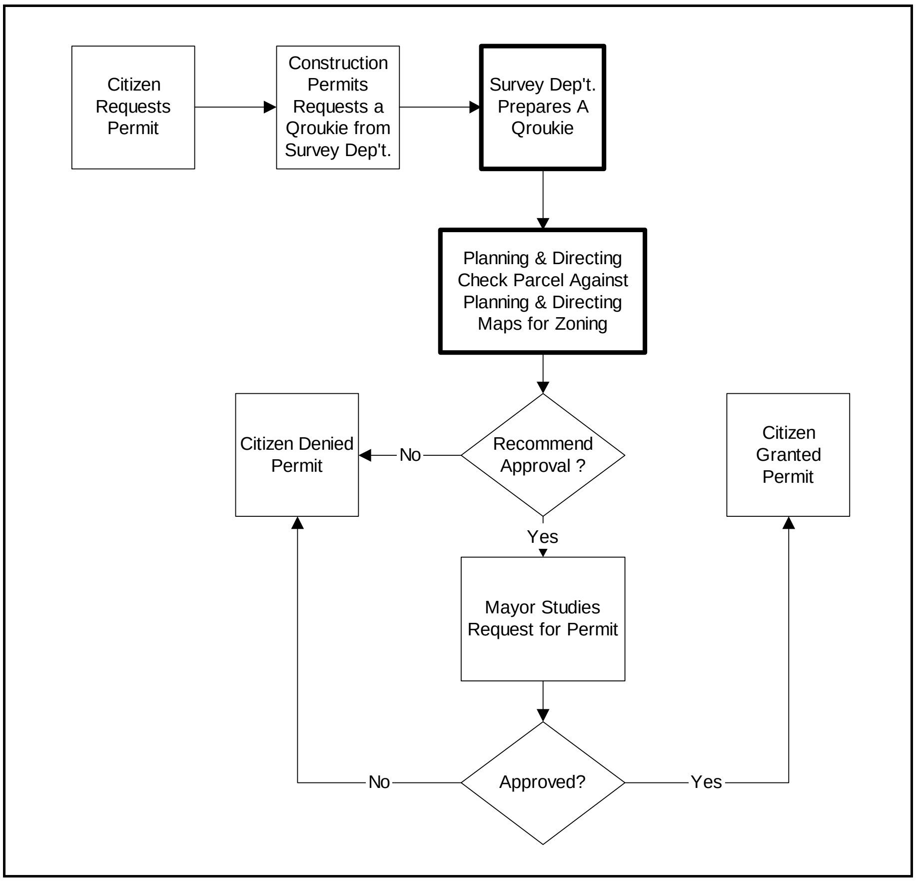

Figure A2.10 Main Office Construction Permit Workflow

Issuance of construction permits for governmental buildings, mosques or for buildings whose construction will be supervised by another government body.

This procedure follows the procedure for a permit to be issued to a private citizen. It is only projects which are deemed of municipal-wide significance which must have their construction permits issued through the Construction Permits Division office at the main municipal offices.

The first stage is the development of a qroukie for the site in question. The qroukie is developed by the Survey Division. Once the qroukie has been developed this information will be forward to the Planning & Directing Department for recommendations based upon conformity to zoning regulations.

Once all the necessary information on the plot, its surrounding land use and the pertinent zoning regulations are assembled the information will be forwarded to the Mayor's office with a recommendation for approval or denial of approval.

The Mayor's office will forward to the Construction Permits Division its decision on the permit for the site in question. All documents are copied and filed for future reference. In cases where the approval for the permit is not recommended, the Construction Permits Division will work with staff at the concerned government department and other municipal staff to find a suitable area for the proposed development.

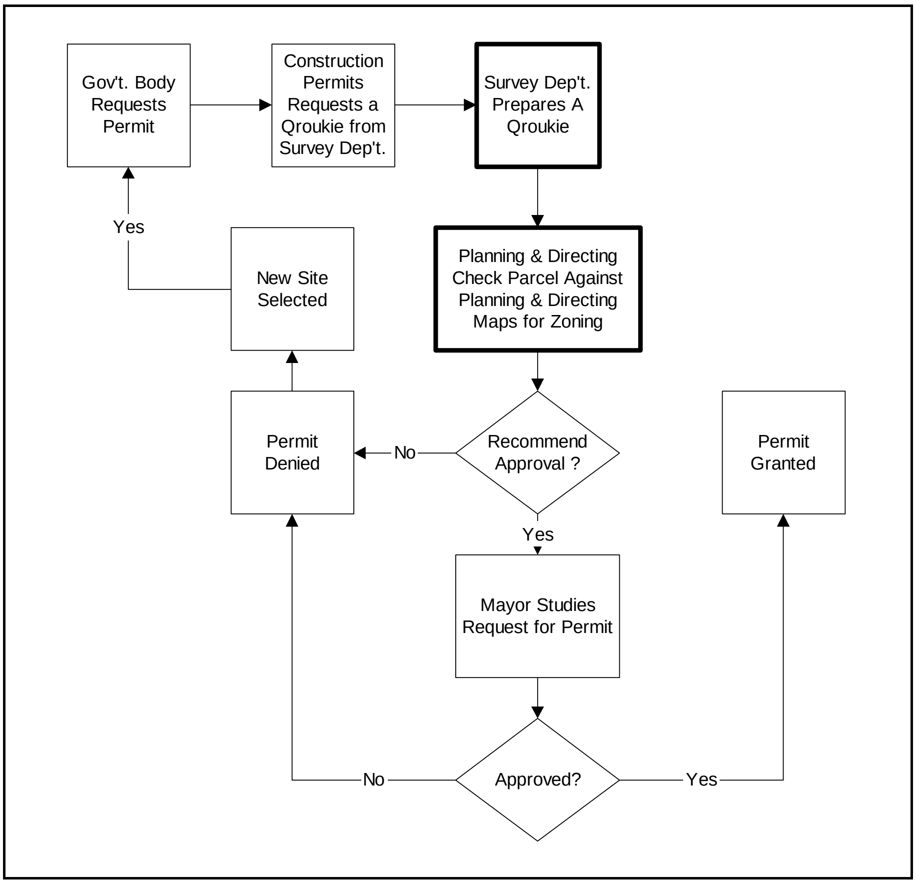

Figure A2.11 Construction Permit for Government Workflow

Modification of previously issued construction permits

The modification of a previously issued construction permit follows this process. The citizen submits a request for additional work on his building, attaching his previously issued construction permit and a copy of his deed. Upon receipt of the request, an engineer is assigned to inspect the building in question.

The engineer goes to the site and performs a site survey including adjoining buildings and plots. The engineer develops a plan for the area. This plan will usually be based upon the municipal base maps. The engineer prepares a report on the building in which recommendations on the application are made. At this point the request is forwarded to the Mayor's office for approval.

Once the mayor has approved the request, notification is sent to the Construction Permits Division. Copies of the documentation in support of the application are filed and the sub-municipality is notified to issue an amendment to the original permit. In cases where the mayor declines to approve the request, copies of the documentation are filed along with a response letter from the Mayor. The original of the response letter is forwarded to the citizen, through the sub-municipality.

Supervision and oversight of sub-municipal construction permit procedures

This function primarily entails auditing the permitting procedures at the sub-municipality offices. As such it is more an internal office administration procedure and not of interest to the intended audience of this document.

Preparation of Standard Summary Reports for the Ministry of Municipal and Rural Affairs.

The Construction Permits Division prepares standardized reports for submission to MOMRA. according to the schedule as defined by MOMRA. These reports are prepared through the use of predefined routines that have been developed by the Computer Center and its contractors. The reports are produced in hard copy format only and are shipped to MOMRA. headquarters in Riyadh. There is no functionality for *ad hoc* queries nor is there any spatial capabilities, other than the pre-defined Sub-municipality divisions.

Reports issued on a quarterly basis are:

- Total construction permits and the area covered by construction. This broken down according to the Sub-municipality, which in turn are broken out according to the development plan phases for Jeddah Municipality. These development phases are existing urban area, first development phase, second development phase and beyond the urban boundary.

Reports issued on a monthly basis are:

- Total construction permits classified by sub-municipality and compared graphically (bar chart) to previous months.
- Total construction permits classified by the sub-municipality and further classified by the type of permit (new construction, renovation or fencing).
- Total construction permits classified by sub-municipality and building type. Each classification is summarized on area.
    - Commercial/residential centres
    - Commercial centres
    - Warehouses
    - Work shops
    - Petrol Stations
    - Governmental
    - Mosques
    - Additions
    - Renovations
    - Fencing
    - Other
- Total area (for the Jeddah Municipality) covered by each type and use of permits issued in the previous month.

A 2.6 Functional Description - Naming & Numbering Division

The functions of the Naming & Numbering Division can be summarized as follows:

- Assigning city districts a unique identifying number.
- Assigning sectors within city districts an identifying number unique within the district.
- Assigning city streets identifying numbers, which are unique within the city district.
- Assigning unique identifying numbers to the main transportation arteries of the city.
- Assigning identification numbers to plots which are unique within the city.
- Assigning new city districts approved names.
- Assigning streets with unique identifying names.

- Selecting companies to implement the work of naming & numbering new areas of the city.

Detailed Functional Description of the Numbering Process

The Naming & Numbering Division bases its work upon the maps provided to it by the Survey Division. All numbering work is done in relation to the practical centre of the city. The 'city centre' has been identified as Al Bayan Square, which marks the intersection of Al Madinah Al Munawarrah Road and 'Old' Makkah Al Mukarramah Road. The method used by this division to implement the orderly numbering of the municipality is as follows:

The Naming & Numbering Division receives the base maps (provided by the Survey Division) upon which the City Planning Division has indicated the boundaries and names of new districts. In general the districts are bounded by main thoroughfares; referred to in the municipality as Main Planning Streets.

A unique numeric code is assigned to the new district.

The district is sub-divided into roughly rectangular sectors. Sectors are bounded by main thoroughfares. Sectors are numbered parallel to the nearest main city axis. The sector closest to the 'city centre' is identified as sector one.

Streets within each sector are assigned an identifying number that is unique to that sector only i.e. each sector starts street numbers at one. Streets which run north-south are given odd numbers, while streets which run east-west are assigned even numbers. Exceptions are streets that pass through multiple district sectors and streets that pass through multiple districts. Streets that pass through multiple sectors are assigned a number that is unique throughout the district. Streets that pass through multiple districts are assigned numbers that are unique throughout the municipality. These numbers start at 1000 and continue sequentially. It should be noted that there are exceptions to this rule, for which there seems to be no reason.

Along each street the plots are numbered with a number that is unique along the street. In cases where the street crosses multiple districts, the parcel numbering pattern should continue across districts. Odd plot numbers are assigned on the right hand of the street, while even numbers are assigned to the plots on the left hand side of the street. The street is assumed to begin at the end which is closest to the 'city centre.' Numbers are assigned upon the reality of the development or expected development. Where only one building exists, then one number is assigned. In cases where more than one building is expected on a plot, the requisite numbers will be reserved and the sequence resumed at the next plot. Plots can be uniquely identified through a combination of district-sector-street-parcel numbers.

Streets are assigned names based upon criterion developed at the Ministry of Municipal and Rural Affairs. The Division performs this task through a committee. It should be noted that this function has very little discretion assigned to it by the Ministry of Municipal and Rural Affairs.

At the completion of this numbering & naming process for a district, the Division provides this information to the Survey Division for inclusion city base maps.

A 2.7 Functional Description - Survey Division

The primary responsibility of the survey division is to support the functions of various municipal organizations, which require accurate spatial data. The division maintains a comprehensive base map of Jeddah Municipality. This series of maps is commonly referred to throughout GDUP as the 'aerial survey maps.' These maps prepared originally by Hunting Surveys of the United Kingdom range in scale from 1: 500 through to 1: 2500, depending upon the area of the city in question. There are at 1: 10000 as well which are more appropriately used for larger scale decisions support or simply for located the correct map sheet for the 1: 1000 mapping.

The basic functions of the Survey Division can be summed up as:

- Survey of plots, especially those plots that are beyond the capabilities of the surveyors at the sub-Municipalities. These could include privately developed sub-divisions, government developed sub-divisions and plots with boundaries in question.
- Updating of the municipal base map fabric to include information generated through the activities of the Survey Division.
- Field layout of government developed sub-division plans.
- Field surveys to update documents or databases for other GDUP organizations.

Survey of a Plot

The Survey Division receives a request from either Planning & Direction Section or the Construction Permits Division to survey a plot. The Survey Division then initiates a qroukie for the plot. Information pertaining to the size and location of the plot is taken from the Planning & Directing maps and the municipal base maps. The survey department then adds the co-ordinate information for the plot as surveyed at the site by a divisional surveyor. This surveyor will also note the existing land uses surrounding the plot. The completed qroukie, which is a detailed site plan including all this information, is then forwarded to the requesting group for their use.

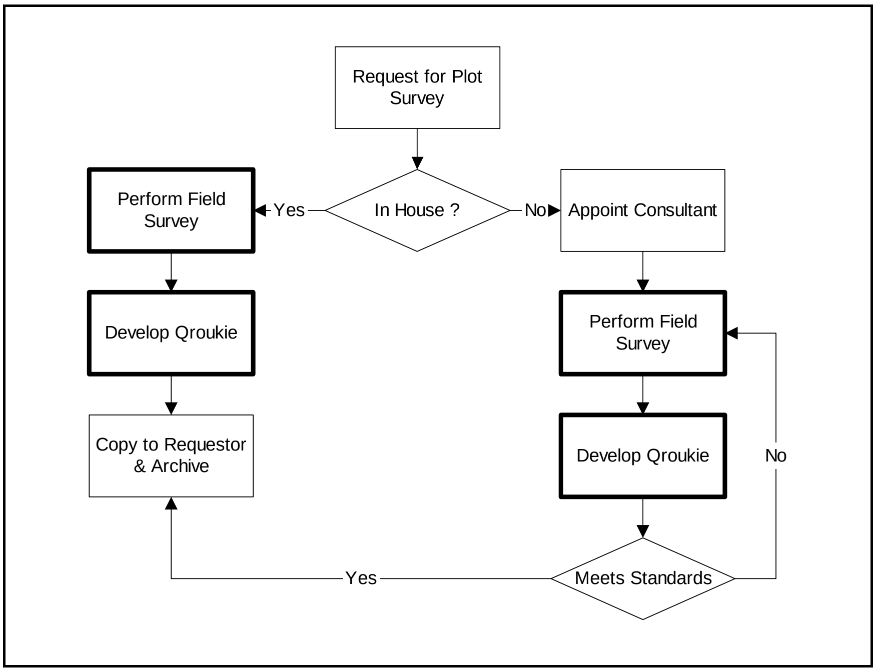

Figure A2.12 Qroukie Creation Workflow

Updates to Municipal Base Maps

In this process one of the data clients of the Survey Division alerts the division to the need to extend the municipal base map beyond its present limits. In these cases the Division decides to either do the work itself or appoint a qualified survey consultant to perform the work.

In consultation with the client, the Survey Division develops a specification for the additional mapping. This specification will define the following for the project:

- accuracy requirements;
- data requirements (what information needs to be collected);
- temporal requirements.

Once the specifications are made and accepted by all concerned parties, the survey party goes into the field and makes the required observations. Once in the office the data is downloaded from survey instruments with EFBs or reduced from hardcopy field books.

Plans are drawn from the field data and either entered onto a copy of the pertinent base map sheet or drawn on a sheet of mylar in cases where no base map exists. This drafting process is manual, although some contractors may deliver AutoCAD files in conjunction.

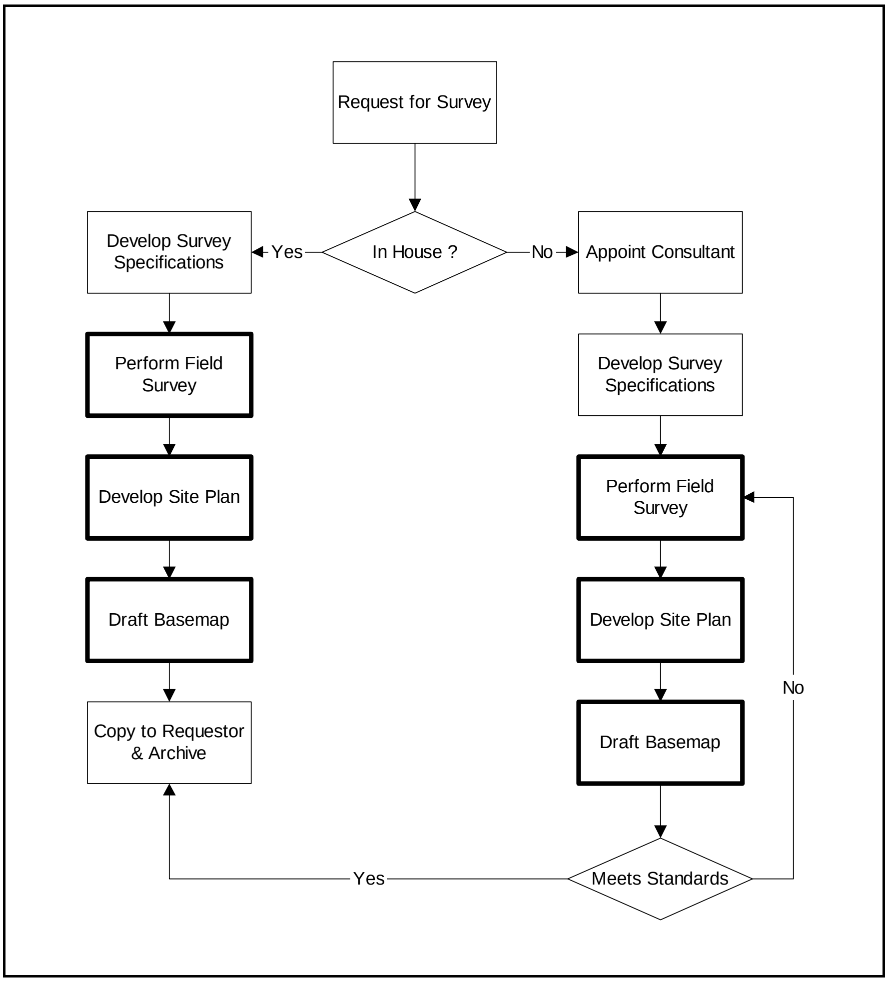

Figure A2.13 Update of Basemap Workflow

Field Layout of Government Sub-divisions

In this process the Survey Division receives the approved sub-division plan from the Urban Studies Section along with a request to perform the layout of the plan. The

Survey Division will appoint a municipal survey team (or a private survey contractor) to go and place marker blocks to coincide with the sub-division plan. As this process does not generate any further information at the municipality, a detailed description of the process is not required.

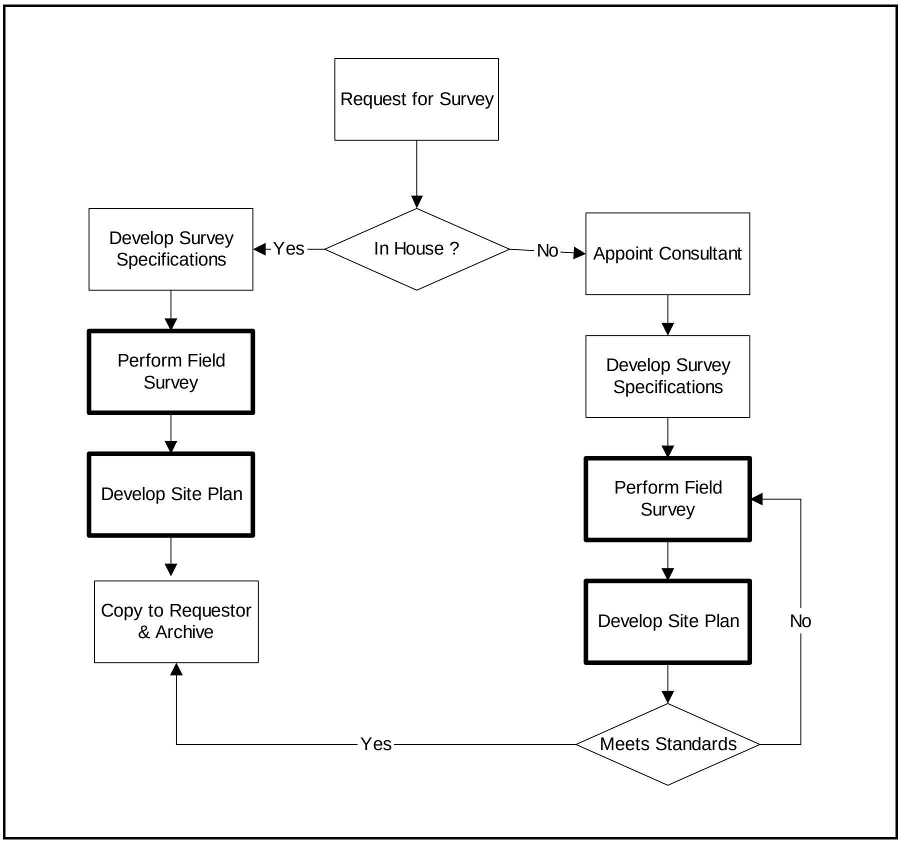

Figure A2.14 Layout of Government Sub-division Workflow

Field Surveys

This is an *ad hoc* process and does not lend itself to the development of a standard requirement specification. In general, a municipal organization will find itself requiring mapping or plan information for an area of the municipality in which information is non-existent. The Survey Division will work with the concerned organization (and perhaps a survey consultant) to provide a plan or map which fulfils the needs of the requestor. This process varies based upon information required and the intended end-user.

A 2.8 Notes on Scope of Research

It must be noted that the research is based upon an "unlimited resource" scenario. Obviously the municipality must take into consideration its budget and manpower limitations before deploying any GIS technology. In a real world situation, the municipality may only be able to deploy a fraction of the recommended resources.

A data model has been assumed using OPEN GIS standards based GIS database modelling tools. The graphics mapping definitions would be developed based upon existing and defined standards established by the Ministry of Municipal and Rural Affairs. These graphics features would be linked through the MGE software to attribute tables maintained in the Oracle Relational Database Management System Software.

The acquisition of geospatial data will be solely by GDUP resources employing both internal records and outsourced data providers, and use of the data will be restricted to GDUP users. This study did not include the possibility of geospatial data sharing with external organizations.

The municipality staff should be able to construct an effective and efficient GIS database for managing the planning activities at the Municipality of Jeddah using the information provided within this research study.

A 2.9 Summary

GDUP has eight groups which interact with the existing hardcopy spatial database on a daily basis. The present system relies heavily upon the Plans & Maps Section to maintain the original copies of the documents and to provide these documents to the sections as requested.

Most of the requirements for GIS within GDUP are simple needs to access the appropriate data and produce reports (whether graphic or tabular) based upon this data. Certain sections, notably the Construction Permits Division, require a custom front-end application to allow the interaction with the spatial database to be performed in a consistent, efficient manner and to produce standard reports.

As illustrated the primary requirement of GDUP is for a more effective means of sharing the spatial data used by its divisions and sections. GIS technology can be used to create a centralised database which can be shared by the various groups within GDUP. With a centralised database, using a standardized methodology for maintenance, access and use, GDUP will be able to perform its functions quicker with less duplication of effort.

--ooOoo—

Appendix 3
Examples of Costs for Data Acquisitions

Both Jeddah Municipality and Saudi Telecom Company are in the process of obtaining updated base mapping to be used in infrastructure development with the city of Jeddah. The Municipality requires updated base mapping for 6,672 km^2 , whilst Saudi Telecom currently requires updated base mapping for urban areas comprising 4,830 km^2 . Many of the requirements of the two organizations are the same, yet each party is financing separate projects for the work.

A 3.1 Jeddah Municipality

Digital Orthophoto Mapping Project

The Ministry of Municipal and Rural Affairs recently awarded a contract on behalf of the Jeddah Municipality to assist in the development of the new Master Plan and City Water and Sewer Management. The city has major problems associated with inadequate sewage and storm water management, and although numerous claims are made through press releases that these problems are being solved , the absence of reliable, accurate landbase information and utility infrastructure routes increases the difficulties of the planning authorities.

The objective of the project is to use 1:45,000 scale digital raster aerial photographic images supplied by the municipality the following processes :

- Perform Aerial Triangulation,
- Generation of a Planar Rectified Photo Mosaic,
- Collection of Digital Terrain Model,
- Generation of an Ortho-rectified Photo Mosaic.

The municipality will provide all the relevant Ground Control Points and Airborne Global Positioning System information pertaining to the aerial photography acquisition mission, and a sample of an orthophoto map sheet layout.

The contractor will carry out the triangulation works, using digital photogrammetric stereo workstations. All the planar rectified images will be mosaiced and output into files, each covering an area of 8km by 6km, at a resolution of 80cm GSD. The DTM collection will involve grid points at approximately 100m intervals, amounting to approximately 5,000 points per model. The ortho-rectified photo mosaic will be derived from the planar rectified images, the orientation resulting from the aerial triangulation process, and the elevational data from the DTM collection process.

In all, approximately 286 photos will be supplied from each of the processes.

The total value of the project is in excess of AUD 1.1 million.

A 3.2 Saudi Telecom

Outside Plant Geographic Database Project

Saudi Telecom has been issuing contracts in connection with a project that will deliver the following items, for 9 cities within the Kingdom of Saudi Arabia :

- Street Centrelines and Street Names
- Centroids for Parcels
- Digitization of Sub-Division Plans
- Georeferencing of Sub-Division Plans
- Overlay of Telecom Network

Saudi Telecom will provide Orthorectified IKONOS satellite imagery, subdivision plans, and STC network information to the contractor.

The contracts recognize that aerial photography imaging is available for the capital city Riyadh, but all other areas (including Jeddah) will be using high resolution satellite imagery.

A 3.3 Summary

If a geospatial data sharing arrangement were in place between Saudi Telecom and Jeddah Municipality, common information, currently being derived from satellite imagery and aerial photography, could be utilized in a non-competitive alliance.

Under an assumption that the base imagery for 4,800 km^2 covering STC requirements in Jeddah would cost approximately AUD 300,000, and base map processing cost would be half of the total cost of the Jeddah Municipality project, a resultant shared saving in excess of AUD 850,000 could be achieved.

Appendix 4

STC Functional Units - Usage and Accessibility

The Saudi Telecom Company has been involved with the development of independent applications for various departmental functions for the past decade or more. These applications and business processes have some overlapping functionality, just as the departments themselves have been having difficulties operating within defined unique roles and responsibilities. One of these applications is the so called Digitized Plans System which contains an extensive geospatial database. To date only sections of the engineering department have made use of the Digitized Plans System. This single department use of a significant database is a common practice right through the organization.

STC has recently sought to implement an Enterprise Resource System to draw together these independently developed applications for use throughout the organization but to date this has not happened, partially due to inaccuracies in the land base component of the geospatial database converted from the paper drawings used previously, and partially because of turf issues within various departments.

As STC is now poised to update its land base and has indicated its preparedness to pursue the implementation of an Enterprise Resource Management system this report takes into account the processes that have been planned to integrate the systems in use throughout the enterprise. STC has recognized that it is imperative to analyse the potential system overlaps in order to design compatible and adaptable ongoing strategies, and to hold in check expansion of existing systems with the generation of software that could hinder future integration

This integration of systems, processes and applications will result in a considerable amount of intra-organizational data sharing. Examination of the applications in use as well as the major components and uses for the applications has made possible the identification of which components of the databases could be shared with the Jeddah Municipality provided suitable restrictions to access can be established.

The applications and processes identified as in use or under development in STC include:

Land Information (Land Information Systems and Geographic Information Systems)

- Landbase
- ROW/Easement
- Demographics
- Assessor's Records
- Satellite Images
- Photo Images
- Spatial Analysis

Document Management

- Integrated Document Manager
- Document-Image Warehouse
- Visual Workflow
- Report Capture

Work Management

- Compatibility Units
- Job Estimates
- Workflow Management
- Crew Management
- Job Scheduling

Enterprise Resource Planning

- Financial Accounting (General Ledger, Accounts receivable/payable, financial control, financial resource management)
- Fixed Asset Accounting (Investment control, asset management)
- Project System (Planning, forecasting)
- Materials Management (Purchasing, warehouse, inventory, invoice)
- Plant Management (Work order cycle, maintenance)
- Quality Management (Inspection planning & management)
- Sales Distribution (Order processing, shipping, billing, sales support)
- Human Resources (Organization, Administration, time, travel, payroll)
- Workflow (Integration with optical archiving)

Customer Information

- Customer Service
- Customer Relationship
- Service Orders
- Account Management
- Services Addresses
- Portfolio Management
- Service Point/Retail Point
- Rates Management
- Usage Management/Load Data
- Billing Management

Outage Management

- Distribution Network Management (Supervisory Control and Data Acquisition)
- Trouble Call Taking
- Outage Analysis
- Operational Model
- Crew Management
- Crew Scheduling
- OMS Dispatch

Geofacilities Management

- Geofacilities Model
- Engineering Design
- Network Analysis
- O&M Management
- Asset management
- Facilities Mapping
- CAD, Photos and Details
- Spatial Analysis

Workforce Management

- Crew Management
- Crew Scheduling
- Computer Aided Dispatch
- GPS/AVL
- Mobile Data Computing

The following table indicates the access to these applications and processes appropriate for internal STC users, and elements appropriate for access by the Jeddah Municipality.

Table A4.1 Access to Applications and Business Processes

Application ⇩	**Major Components** ⇩	**Users**										
		STC Internal Access										
		Geofacilities Model	Image Management	Job Workflow	O&M/ Ops Analysis	Asset Management	GeoAnalysis	Trouble Calls	Crew Management	Job Scheduling	Dispatch	**Jeddah Municipality**
Land Information (LIS/GIS)	Land base	✓	✓				✓				✓	X
	Forecaster's Records	✓	✓			✓						
	Spatial Analysis	✓	✓				✓					X
	Photo Images		✓				✓	✓				X
	Satellite Images	✓	✓				✓				✓	X
	Demographic Information	✓	✓				✓			✓		X
	ROW/Easement Information		✓				✓					
Work Management (WMS)	WMS Crew Management								✓			
	WMS Job Scheduling									✓		
	Job Estimating				✓							
	Compatible Units Management				✓		✓		✓			
	Job Work Flow Management			✓						✓		
	Forecaster's Records	✓	✓			✓						
	Spatial Analysis	✓	✓				✓					X
	Photo Images		✓				✓	✓				X

Application ⇩	Major Components ⇩	Users										
		STC Internal Access										
		Geofacilities Model	Image Management	Job Workflow	O&M/ Ops Analysis	Asset Management	GeoAnalysis	Trouble Calls	Crew Management	Job Scheduling	Dispatch	**Jeddah Municipality**
Enterprise Resource Planning (ERP)	Financial Accounting					✓		✓				
	Production Planning				✓				✓			
	Human Resources								✓			
	Supply Chain Management			✓				✓	✓	✓	✓	
	Sales and Distribution	✓		✓						✓		
	Plant Maintenance	✓			✓	✓					✓	X
	Asset Management	✓			✓	✓	✓					
	Plant Tax Reports				✓	✓						
	Maintenance Work Dispatch				✓					✓	✓	
	Materials Management		✓	✓						✓		
	Maintenance Work Scheduling	✓	✓	✓					✓	✓		X
Workforce Management (WFMS)	Computer Aided Dispatch	✓								✓	✓	
	Full Job Scheduling	✓	✓	✓	✓					✓		X
	Full Crew Management	✓							✓		✓	
	Mobile Data Computing											X
	GPS/AVL											X

Application ⇩	Major Components ⇩	Users										
		STC Internal Access										
		Geofacilities Model	Image Management	Job Workflow	O&M/ Ops Analysis	Asset Management	GeoAnalysis	Trouble Calls	Crew Management	Job Scheduling	Dispatch	**Jeddah Municipality**
Customer Information (CIS)	CIS/CSS Customer Information	✓			✓			✓			✓	
	Routine Dispatch Work								✓		✓	
	Routine Work Scheduling	✓		✓	✓			✓	✓	✓		X
	Customer Call Handling	✓	✓		✓			✓				
	Automated Meter Reading					✓		✓				
	Voice Response Unit							✓				
Document Management (DM)	Historic Work Order Archives		✓									
	Document Workflow Systems			✓								
	Document M'gement Systems		✓									
Outage Management (OMS)	Trouble Call Taking	✓						✓				
	Outage Analysis				✓			✓		✓		
	Operations Facilities Model	✓			✓		✓				✓	X
	OMS Dispatch	✓									✓	
	OMS Crew Management							✓		✓		
	SCADA (Supervisory Control & Data Acquisition)							✓				X

Application ⇩	**Major Components** ⇩	**Users**										
		STC Internal Access										
		Geofacilities Model	Image Management	Job Workflow	O&M/ Ops Analysis	Asset Management	GeoAnalysis	Trouble Calls	Crew Management	Job Scheduling	Dispatch	**Jeddah Municipality**
Geofacilities Management (GMS)	Design Engineering	✓	✓	✓				✓		✓		X
	Geofacilities Model	✓	✓	✓		✓	✓					X
	Network Analysis	✓			✓	✓	✓	✓				
	O&M Management				✓				✓	✓		
	Asset Management & Reporting				✓	✓					✓	
	Facilities Maps & Schematics						✓	✓		✓	✓	X
	CAD, Photos & Detailed Drawings	✓	✓		✓			✓		✓	✓	X
	Spatial Analysis	✓	✓		✓	✓	✓					X

Appendix 5

Membership of EuroGeographics

Table A5.1 Active Memberships of EuroGeographics

Country	Organization	Membership Status
Armenia	State Committee of the Real Property Cadastre (SCC) of the Government of the Republic of Armenia	Active Member
Belgium	National Geographic Institute - Belgium	Active Member
Croatia	State Geodetic Administration of the Republic of Croatia	Active Member
Cyprus	Cyprus Department of Lands and Surveys	Active Member
Denmark	National Survey and Cadastre - Denmark	Active Member
Estonia	Estonian National Land Board	Active Member
Finland	National Land Survey of Finland	Active Member
France	National Geographic Institute	Active Member
Germany	Federal Agency for Cartography and Geodesy	Active Member
Great Britain	Ordnance Survey Great Britain	Active Member
Greece	Hellenic Mapping & Cadastral Organization	Active Member
Hungary	Institute of Geodesy, Cartography and Remote Sensing	Active Member
Iceland	National Land Survey of Iceland	Active Member
Ireland	Ordnance Survey Ireland	Active Member
Latvia	State Land Service of the Republic of Latvia	Active Member
Lithuania	National Land Survey under the Ministry of Agriculture	Active Member
Luxemburg	Administration du Cadastre et de la Topographie	Active Member
Moldova	State Agency for Land Relations and Cadastre	Active Member
Netherlands	Topographical Service of the Netherlands	Active Member
N. Ireland	Ordnance Survey of Northern Ireland	Active Member
Norway	Norwegian Mapping Authority	Active Member
Poland	Department of Cadastre, Geodesy and Cartography	Active Member
Portugal	Portuguese Institute of Cartography and Cadastre	Active Member
Slovakia	Geodesy, Cartography and Cadastre Authority	Active Member
Slovenia	Surveying and Mapping Authority of Slovenia	Active Member
Spain	National Geographic Information Centre of Spain	Active Member
Sweden	National Land Survey of Sweden	Active Member
Switzerland	Federal Office of Topography	Active Member
Turkey	Ministry of National Defense, General Command of Mapping	Active Member

Table A5.2 Associate and Pending Memberships of EuroGeographics

Country	Organization	Membership Status
Austria	Federal Office of Metrology and Surveying	Associate
Czech Republic	Czech Office for Surveying, Mapping and Cadastre	Associate
Italy	Italian Military Geographic Institute	Associate
Albania	Institut Studimit Tokave	Pending
Belarus	The State Committee on Land Resources Geodesy and Cartography	Pending
Bulgaria	Ministry of Regional Development and Construction	Pending
Romania	National Office of Cadastre, Geodesy and Cartography	Pending
Russia	Federal Service of Geodesy and Cartography of Russia	Pending
Ukraine	State Service of Geodesy, Cartography and Cadastre	Pending

Appendix 6

Sample of Costs for Accessing Shared Databases

The following information is provided as an example of the fee structure applied by a major coordinator of data sharing. The information is available on the Web site of the Montana Natural Resource Information System (NRIS) Geographic Information System (GIS) (Montana State Library 2002). This organization " *acts as a clearinghouse for GIS databases and provides services to State, Federal, Private, Non-Profit, and Public groups or individuals needing access to GIS technology"*.

NRIS/HERITAGE Fee Policy

POLICY STATEMENT:

The Natural Resource Information System (NRIS) and the Montana Natural Heritage Program (NHP) will charge a fee to private users of the data and services in an effort to recover the service cost incurred for staff time and other expenses to deliver data.

FEE STRUCTURE:

Basic Charge: $30.00 Access Fee per request

Includes one hour of data manager's time to clarify data need with user, conduct computer search and retrieval, quality assurance, and assembling and mailing completed data request, etc.

Materials Charge: $0.25/page of computer printout; $5.00/floppy disk

Staff Charge: $25.00 per hour, rounded to the nearest half-hour

Applies to data analysis, manual searches and map interpretations, technical assistance in defining needs, preparing special reports with the data, etc.(for staff time beyond one hour included with basic charge)

EXEMPTIONS AND RELATED POLICIES:

1) Charges only apply to private users of the NRIS/Heritage program. Private users are defined as "Any business, entity, or individual using, directly or indirectly, the data and services as part of a potential for-profit activity."

2) No charges to government agencies, non-profit organizations, contractors and consultants on retainer to government agencies, or members of the general public.

3) The NRIS Director reserves the right to waive user charges when a data request requires less than one hour of response time and no data is provided relevant to user's request.

4) Invoices submitted with responses; payable in 30 days.

5) All revenue is deposited into appropriate grant/contract accounts.

For more information about the user fee policies, contact:

Montana State Library

1515 East Sixth Ave.

Helena, MT 59620.

(406)444-5355

jimhill@state.mt.us

Figure A6.1 Example of Fee Structure (Montana State Library 2002).

Appendix 7

An Implementation Model

The implementation of the model in itself does not form part of the testing of the model conceptualised in Section 4.3. However, until the installation of the scheme is executed and its operation evaluated, its real-world appropriateness will remain unproven.

Consequently, guidelines are provided here for implementing the model. The suggested stages follow simple project management procedures, covering the aim of each step, the expected outcomes, and the processes involved.

A 7.1 Project Initiation

Aim : To obtain agreement with the concept.

Exit Criteria : Memorandum of Intent to proceed with developing a bilateral geospatial data sharing scheme.

Processes :

1. Convene a preliminary meeting to outline the proposed pilot geospatial data sharing project. A seminar format would be appropriate, allowing higher level management participation.
2. Invite attendance of Jeddah Municipality management, Saudi Telecom Regional managers, MOMRA GIS advisors, KACST GIS management, independent consultants.
3. Arrange a concept presentation by an independent consultant. It is important to have an enthusiastic, well informed and supportive response at this stage to maximise the success of the system.

A 7.2 Define Project Parameters

Aim : Establish Frameworks

Exit Criteria : Functional Requirement Statement

Processes :

1. Form a steering committee comprised of senior managers from both STC and Jeddah Municipality.
2. Establish working groups to consider technical and organizational concerns
3. Review all the issues raised in the concept proposal, and take into account other potential issues. This will lead to the creation of a Scope of Work, defining the

limitations imposed, so that management expectations of the results from the data sharing arrangements are realistic.

4. Determine type of sharing, considering whether multi-participant or bi-lateral sharing arrangements and what mechanisms are most appropriate.

A 7.3 Design Pilot

Aim : Refine the project technical details

Exit Criteria : Detailed Design Document

Processes :

1. Determine the status of the existing databases.

   As part of the process involved in determining a suitable model for data sharing, a GIS Data Availability Survey should be conducted. This would provide an inventory of digital GIS data resources. The survey should include an assessment of related data policies of the owners of the data. The structure, analysis medium, sampling process and degree of detail for such a survey would need to be considered.
2. Determine the features and attributes that are required and whether or not they have been captured in the geospatial databases held by either party. (It is essential that potential system users and administrators are given the opportunity to be involved.)
3. Determine the hardware and software requirements, including networking components, to implement the scheme. Bills of material and quantities (BOM & BOQ) and performance criteria should be defined.
4. Determine detailed requirements of the sharing mechanism.

A 7.4 Customise

Aim : Preparation of System

Exit Criteria : Verification by consultants and advisors

Processes :

1. Prepare and build the applications. These may be COTS requiring configuration only of customised applications.
2. Prepare Training and Operations support documentation.
3. Prepare Memorandum of Understanding defining financial, technical and organizational responsibilities. Criteria for preliminary and final acceptance testing (PAT & FAT) should be documented

A 7.5 Implementation

Aim : Installation of Pilot System

Exit Criteria : System Handover and Acceptance

Processes :

1. Conduct familiarization meetings for management and staff (system users and administrators) with sufficient information to ensure they are aware of the limitations of the system. The meetings must also make clear the responsibilities of team members.
2. Install the hardware (and software) on site, configuring all devices and networking components.
3. Populate the databases with geospatial data available.
4. Conduct training customised to match the responsibilities of the individual positions. Management level training will focus more on the capabilities and organizational aspects of the arrangements, whereas training for users and administrators will be focussed on more technical issues.

A 7.6 Pilot Project Evaluation

Aim : To determine the success of the arrangement and potential for expansion.

Exit Criteria : Presentation of Evaluation Report

Processes :

1. Conduct a review of the schemes operation. This should take the form of an examination of the benefits and problems resulting from sharing the data. Benefits to be considered should be actively measured and include quantifiable financial benefits with tracked metrics as well as qualitative aspects such as improvements to the levels of service level to clients and the public and improvements within the organizations. The list of problems should include identification of any security issues, staff moral and "turf" issues, and other aspects as discussed in the early chapters of this thesis.
2. Examine the potential for expansion of the scheme to other organizations, and the reconfigurations required when adapting a bi-lateral sharing arrangement to a multi-lateral arrangement working through a centralised coordinating authority.
3. Prepare and evaluation report for presentation to the higher management of Jeddah Municipality and Saudi Telecom. As the success of the pilot scheme and

a recommendation for expansion could be of national importance, the report should also be presented the Minister of Interior (in a suitable format). In addition, the report should be available to participants in the scheme, though appropriate discretion may be required for aspects which are commercially sensitive.

The implementation process guidelines are summarised in Figure A7.1 Outline of a Implementation Model .

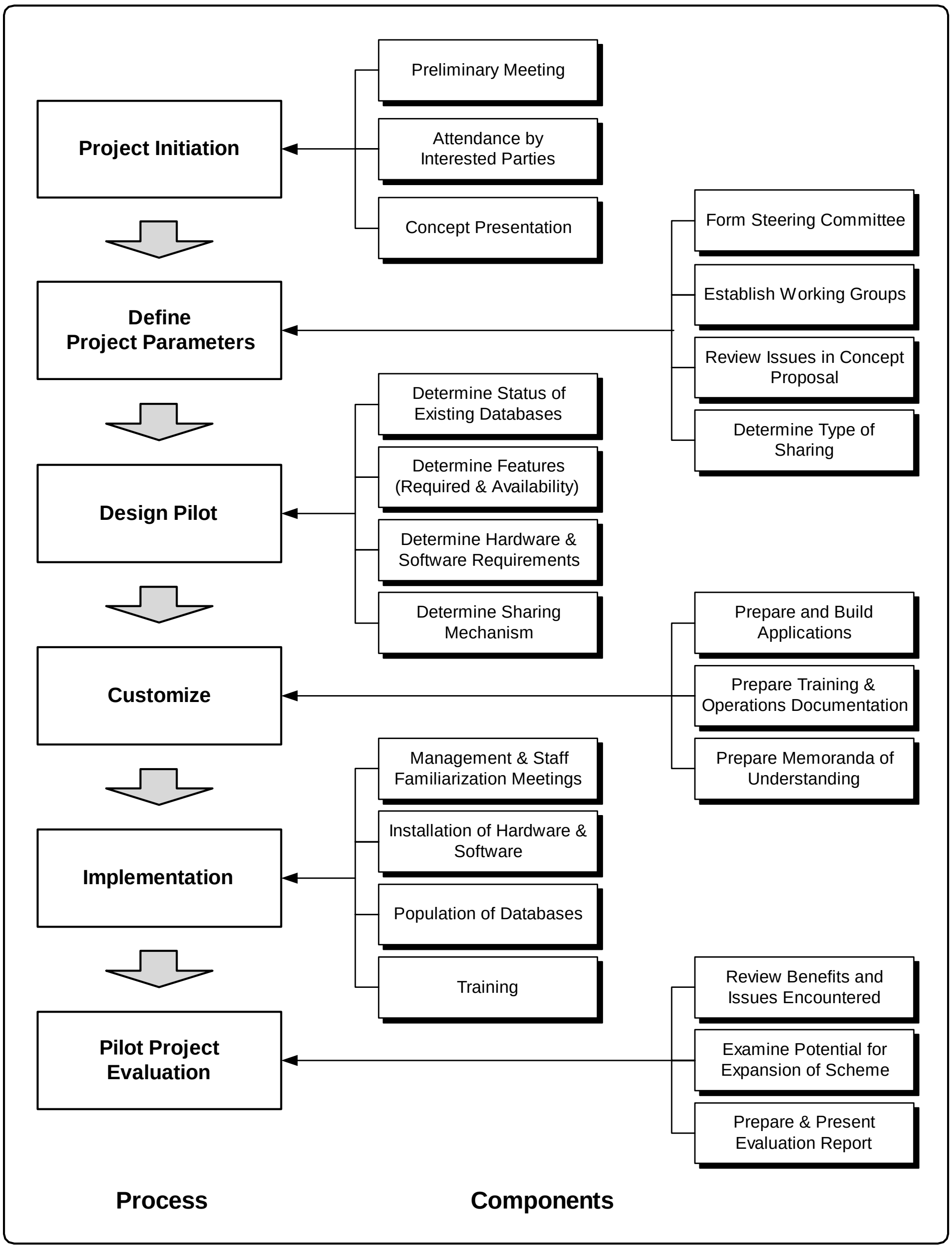

Figure A7.1 Outline of an Implementation Model

--ooOoo—

Index

E.

F.

G.

H.

I.

J.

K.

L.

M.

N.

O.

P.

X.

Y.

Z.

--ooOoo--