University of Southern Queensland

Faculty of Engineering and Surveying

THE PRIVATE SURVEYOR AS A SPATIAL DATA CUSTODIAN IN THE LOCAL COMMUNITY

A Dissertation submitted by

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towards the degree of

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ABSTRACT

With approximately 2200 land surveying businesses in Australia service differentiation is increasingly focused on the implementation and use of Geographic Information Systems (GIS) as a business enabler. However the surveying profession does not appear to be using the available tools to leverage their extensive spatial knowledge to the benefit of their clients and the local community.

The aim of this project was to investigate the feasibility of value added spatial data services being provided by the private survey industry. The research approach looked at the experience of related industries, collecting information on a range of measures from surveyors through a questionnaire and analysing the results to develop appropriate conclusions and recommendations.

Any issues raised in the questionnaire that appeared to indicate constraints on the surveyors ability to undertake these types of services were investigated to determine if the constraint could be relaxed or removed. All of this information was then compared with the academic and professional literature to draw out lessons for the industry, consider the impacts on the profession, look at the role of digital data in the community and consider any implementation issues with GIS.

The project demonstrated that it is feasible for surveyors to implement GIS using the project toolbox model. However diffusion of GIS technology is not yet pervasive in the industry meaning the wider goal of demonstrating custodianship capability for the local community is not yet achievable. While there appear to be a number of constraints to implementation, they are predominantly within the control of the surveyor.

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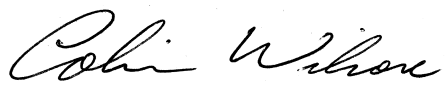

Signature

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CHAPTER 1 INTRODUCTION

A search through the Online Yellow Pages indicates that there are approximately 2200 businesses in Australia advertising their services as Land Surveyors (Sensis, 2004). As technology has improved in the surveying field, these businesses are increasingly compelled to consider the real costs and benefits of introducing a technology such as a Geographic Information System (GIS) in a competitive business environment where service differentiation can be a major business enabler.

Many of the major software vendors also see the surveying industry as a major opportunity to grow their business by enhancing their products to meet the needs of surveyors. Just as the major GIS vendors are adding surveying field data capture and reduction tools to their digital data analysis and presentation tools, the Computer Aided Design (CAD) vendors are expanding their ability to integrate and analyse digital data. The survey firm must therefore weigh the benefits to be gained from a full GIS against the expansion of capability in traditional CAD products.

Conversely, members of the surveying profession are the original spatial professionals, however private survey firms don't appear to be leveraging their extensive spatial knowledge and collected information to create valued added services for their clients or the community. Many of the software vendors would say that the profession has the tools available to rectify this omission.

By definition, a custodian is seen to be the curator, guardian or caretaker of the item involved (Johnston, 1976). In the context of spatial datasets, this is the person or organisation responsible for the collection and ongoing maintenance of the data such that it retains its attributes of accuracy, timeliness and availability to at least a defined

community of interest. For the local surveyor to be a custodian they require the infrastructure to be able to undertake the collection and maintenance of digital data such that value added services can be developed and they become recognised in the community as holding valuable information.

1.1 Outline of the Study

In broad terms the research project looked to investigate the feasibility of the private survey practice engaging in the provision of value adding spatial data services. The surveyor is recognised in the spatial community as a significant source of up to date and accurate spatial information and many survey practices are involved in providing spatial products to their clients.

A review of the academic literature indicated that for a survey firm to provide this type of service a GIS would need to be a key business system. This raised a number of questions about practice size, services offered and data sources necessary to support this type of system.

In establishing feasibility, the study looked at the technical aspects of feasibility as a first step upon which others can build in further research. In particular, the wider questions of what products and services can be offered in the marketplace by the surveying firm is a very individual problem that will need research over a much longer timeframe than was available for this project.

1.2 Research Aim and Objectives

The research aim was: To investigate the feasibility of the private survey practice providing value adding spatial data services to their clients and the local community.

The research objectives were:

1. Research the experience of other industry sectors in Australia and overseas, as it applies to this problem, where they have engaged in the provision of value added spatial data services.

2. Investigate the key constraints that exist to establishing such a service within the private survey practice, and whether these constraints can be relaxed or removed easily.
3. Ascertain the necessary characteristics of a survey practice that would make it possible to engage in the provision of value added spatial data services.
4. Analyse the issues raised and any methods proposed to address them.
5. Develop appropriate conclusions about the feasibility of value added spatial data services based on this research.

1.3 Research Approach

As defined by the Project Aim, this project was an investigation to establish the feasibility of valued added spatial data services by the private survey sector. The methodology for the project utilised five phases.

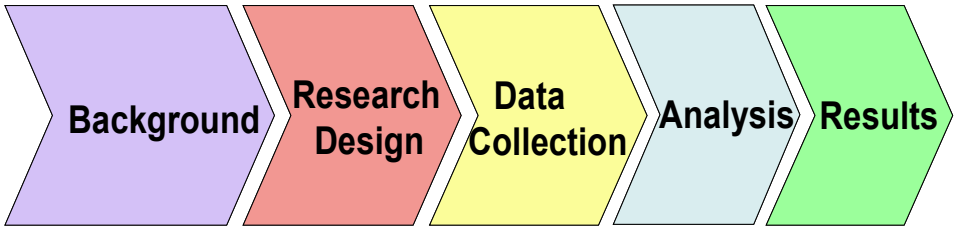


Figure 1.3.1 Research Approach

1. **Background** - the key outcome of this phase was the Literature Review, being a research activity to draw upon current knowledge within the industry and connect the problem to related work previously undertaken by others. The Literature Review offers a more detailed understanding of the problem through its various dimensions and informed the Research Design phase in developing an approach to solving the problem.

2. **Research Design** – building on the background research the problem was reviewed and the approach to solving the problem developed. The initial approach was to understand the issues affecting this problem through the conduct of a survey with a sample of private survey practices.

From the literature review I found Harvey (2000) successfully used a survey by questionnaire methodology to develop a Local Government perspective on vertical integration in the United States National Spatial Data Infrastructure (NSDI). This survey achieved a high response rate that Harvey reported was due to the initial phone contact. Participants in Harvey's survey were offered the choice of completing it directly over the phone or having it sent to them. From this initial survey Harvey conducted follow-up sessions with a selection of the survey participants.

Reflecting this knowledge, the survey for this study was developed to have the following characteristics:

i. Be developed as both a telephone questionnaire and a written survey.

ii. Be initiated through direct telephone contact.

iii. In addition to the necessary quantitative information provide an opportunity to gather qualitative information that will provide the basis for follow-up contact with selected participants.

iv. Be tested and refined through a pilot stage with personally known local surveyors before undertaking a wider survey.

In a study of this type, feasibility will almost always have a component related to the size of the organisation before a specific technology can be economically supported. While the survey was designed to capture some practice size related information, analysis would be benefit from access to comparative information across the industry, similar to that referenced by Durgin (1990) for the American National Society of Professional Surveyors. A data collection task was to attempt to discover if this information exists in any form in the Australian context.

In addition to any questions in the survey related to data sources, the literature review indicated a wide range of differences in data access policies. The research phase was to gather information on the availability and restrictions on the use of data by private surveyors, from both public sources and under their common services contracts with clients.

3. **Data Collection** – in this phase data was collected based on the research design, using the questionnaire and completed as either a telephone interview or as a written survey. The survey was targeted to collect information in the following broad groupings:

    i. Size of the survey practice.

    ii. Current technologies used.

    iii. Types of client services undertaken.

    iv. Sources of basic data, especially electronic data.

    v. Where they see their business and the wider industry moving in the medium term future.

    vi. Spatial data infrastructure and the potential involvement of surveying firms.

    A few of the respondents were contacted for further information based on their responses. In each case this provided some greater depth of qualitative details around the use or potential use of GIS software in the firm.

    Collection of comparative statistical information on the size of survey firms across the industry was explored, along with collection of information on data access and data licensing policies from key public organisations.

4. **Analysis** – responses from the questionnaire were tabulated into a spreadsheet where basic statistical techniques could be used to compare and contrast the survey results. Similarly the collected information on data access policies and digital data costs were summarised in both textual and tabular forms to allow comparison of features between the different organisations.

    Discussion of the results of this research were brought together in a critical analysis that merged the issues identified in the literature review with the data collected. This lead to the development of appropriate conclusions and recommendations.

5. **Results** - reporting of the results from the project has been in two stages

    - By presentation at the USQ Eng 4903 Project Conference in September 2004.

    - Formally through this Project Dissertation.

1.4 Conclusion

Having defined an approach for researching the problem to meet the stated aim and objectives, the next chapter connects the project problem to the external environment and places it into context through a review of the academic and professional literature.

CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

While there is considerable research and discussion in the area of spatial data services and data custodianship in relation to the national tiers of government around the world, there appears to be little consideration of the role of the private corporation in the spatial data infrastructure (SDI) hierarchy. The role of surveying in particular appears relegated to the traditional measurement science, although Williamson (1997) does consider the position that surveyors are well placed to contribute in the wider land administration sphere.

This review considers the state of current knowledge with regard to the continuing role of the surveyor and the survey practice, the spatial infrastructure, organisational issues, data ownership and access. Research sources were chosen for their direct reference to the private survey practice or because the research undertaken is in a complimentary industry sector from which lessons can be extrapolated to the private survey practice. In most cases the complimentary industry sectors are the local and state government sectors which are the subject of significant research effort as key participants in national Spatial Data Infrastructures.

2.2 The Continuing Role of the Surveyor

This project can be viewed as an attempt to further ease the transition of GIS technology into the business community, in this case the private survey practice. The area of research that covers the take up of innovations is that of diffusion, which is concerned

with the process of communicating an innovation over time to members of a potential user population. Campbell & Masser (1995) propose that GIS is an innovation that departs from the classical diffusion theories in so far as it is adopted by an organisation, or section of an organisation, and not by an individual user. Because a GIS is a multi-purpose tool it offers advantages to many different classes of users from utilities to scientists and service delivery and diffusion will therefore progress in relation to the perceived advantages to the organisations in each class (Onsrud & Pinto, 1991).

GIS is one of many technological innovations that have impacted on the business of the private surveyor and been discussed by Durgin (1990), Williamson & Feeney (2001), Fenwich & Mayr (2002) and others. Williamson (1997) concludes that the strengths of the surveying profession provide advantages in the spatial marketplace as measurement science becomes spatial information science. This is reinforced by Fenwich & Mayr (2002) which provides an overview of the market for spatial information services and contrasts this with the strengths of the cadastral surveying firm. Coleman et al. (1997) see the growth of National Spatial Data Infrastructures as opportunities for surveyors to expand into the knowledge-based society with new applications and potential new markets. Durgin (1990) differs in this respect, seeing surveyors having a limited role in GIS, but does conclude that through action and education surveyors could make a more significant contribution. After considering the various possible roles, Durgin (1990) concluded that surveyors were best suited to the role of local champions for the implementation of GIS for the recording of public land records. While this may have been true when the diffusion of technology was in its early stages, technology in the survey office is now in a mature stage for survey related tasks. It would appear from the later research of Williamson & Feeney and Fenwich & Mayr that surveyors have taken up the challenge of playing a more significant role in using GIS.

2.3 Spatial Infrastructure

GIS is described in the literature as a geographical business information system (Campbell & Masser, 1995; Grimshaw, 1994) with three common elements being computer resources, people and procedures. For the private survey practice to exploit GIS fully it must become the core information system for the business. In relevant research that may allow the extrapolation of experience, Campbell and Masser (1995)

have explored GIS from the organisational perspective, using British local government as the case study, concluding with discussion on the considerations for technology, organisation and information management. Grimshaw (1994) has taken the approach of looking at the operational, tactical and strategic applications of GIS in the private sector. In these two cases the overriding theme is GIS as an integral part of the business not as a specific service delivery toolbox. Chan & Williamson (1996) take this further, stating that an 'organisation-wide GIS is an integral part of the organisation's production infrastructure ...'. This paper by Chan & Williamson identifies a broader approach to cost-benefit analysis of GIS implementation where GIS is not to be a project toolbox but the organisations operating paradigm.

One aim of this project relates to value added spatial data services for the community. This brings into focus the extensive research on SDI, which evolved from data sharing and coordination efforts (Coleman et al., 1997). Some of these early efforts have been reported by Beattie & Bell, (1990); Loukes & Nandlall (1990); McLaughlin (1991) and Masser (1997). There is also an extensive range of relevant writings on the 'facilitation and coordination of the exchange and sharing of spatial data between stakeholders from different jurisdictional levels in the spatial data community' (Rajabifard & Williamson, 2004 p1), including Coleman et al. (1997); McDougall et al. (2002); National Research Council (1994); Warnest et al. (2003); Williamson & Feeney (2001); Harvey (2003).

Williamson & Feeney (2001) describe the core components of SDI as 'policy, access networks, technical standards, people (including partnerships) and data...' (pg7) and provides this diagram (Figure 2.3.1) from Rajabifard et al. of the levels of interaction in a SDI hierarchy. This acknowledges the underpinning provided by the corporate sector to the development of further levels of SDI and provides a logical relationship for the private survey practice in the progress of this project.

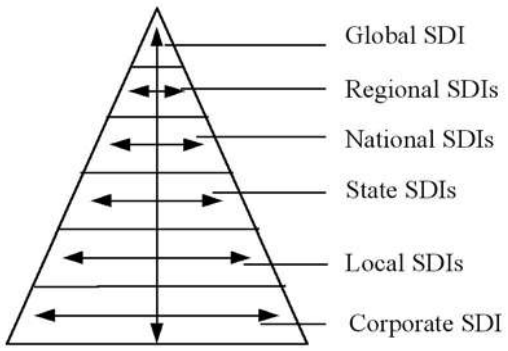


Figure 2.3.1 The complex SDI relationships within and between different levels

This corresponds with the concept of vertical integration explored by Harvey (2000 & 2003) in relation to Local Government involvement in the United States National

Spatial Data Infrastructure (NSDI). Harvey uses the Federal Geographic Data Committee (FGDC) model of the relationships in the NSDI to introduce the federal structure of the NSDI and the fact that it involves 'multiple producers, multiple users and various geographic data products' (2003 pg 31).

These models of SDI interaction provide the context for research into the sharing of geographic information between the many producers and users. Warnest et al. (2003) discussed collaboration under the SDI model, where the collaboration could be a formal partnership or an informal transaction, and the people, skills, information and/or knowledge is shared between two or more organisations. The collaboration concept is similarly discussed by the National Research Council (1994), Madziya & Willis (1990), Jacoby et al. (2002), and McDougall et al. (2002). Harvey (2003) has contributed the term 'organisational trust' (2003 pg 30) to refer to the willingness of people to trust a relationship with another organisation over which they have no control. Consistent with the hierarchical model in Figure 2.3.1, Warnest et al. (2003 pg 10) propose that while the lower levels of the hierarchy contribute to the developing SDI at the higher levels, there is also a return contribution from the higher levels to the lower levels if equal partner relationships exist.

2.4 Obtaining Data

It is recognised that geographic data at the local level has the finest resolution, the greatest detail and accuracy and is therefore the most expensive to produce (Harvey 2003 pg 31), but is also of high value in the upper levels of an SDI. This corresponds with results from studies into the maintenance of cadastral data in the land title and digital cadastral systems that are increasingly seen as the basis for SDI development at state and national levels. As noted by Williamson & Feeney (2001), it is important that cadastral mapping moves from a single organisational concern to being an integrated part of the digital environment, contributing to the development of the various levels in the SDI hierarchy.

One of the limitations of data acquisition is identifying the existence of specific data of interest and establishing from where, and at what cost, it can be acquired. Pienaar & van Brakel (1999) propose that once data has been discovered there are three main evaluation criteria for its inclusion in a GIS:

1. Digital data that is consistent, of necessary quality and can be relied upon for long term use.

2. Is available in standardised geographic files.

3. Where the price is affordable (Wilson 1997, as cited in Pienaar & van Brakel, 1999).

They also note that the ability to on-sell digital data at a profit can be restricted where the data is considered to be in the public domain. This is similarly discussed by Masser, (1997), adding that the terms under which data is collected may often preclude its general release and that private sector data products will rarely be free to potential users. We are also introduced by Pienaar & van Brakel (1999) to the concept of the value of data, since while data does not diminish with use the value can still diminish with time. Pienaar & van Brakel (1999) leave us with the conclusion that there is no shortage of digital data, just the ability to locate and access it, and that whether data has to be paid for or is free, it is still considerably less expensive than creating it again from the field.

Access to basic data is also discussed by many authors in relation to SDI, because most of the core data sets are in the custodianship of government bodies and there is a widely divergent set of policies for the use of these data sets across the world. An insight into the policies followed when charging for government spatial data across Europe, North America and Australia is provided by Grimshaw (1994). European policy in 1987 is described as a market cost policy with the ability to charge at marginal rates or discount rates depending on the organisation receiving the data. The North American policy for TIGER data is based on a philosophy of only recovering the costs of distribution for US Government data since the US taxpayer had funded the collection and analysis. Australian policy has been set through the 1992 ANZLIC papers which recognise the concept of data custodianship and recommend the establishment of licensing as the basis for charging for spatial data. Masser (1999) makes similar comments and refers to the

obvious conflicts experienced by various governments between promoting open government and operating in cost recovery mode.

The Australian situation, where data distribution is business model driven with data sold to a customer base for the revenue stream to maintain the data, is discussed by Warnest et al. (2003) who cites Azad and Wiggins simple topology for spatial data sharing, being Type 1: One-way provision, Type 2 One-way provision moderated by user demand, and Type 3: Two-way mutual provision. They go on to note that the business model based on revenue collection restricts the opportunities for collaboration even between public agencies.

In addition to the issues of data identification and acquisition there are both technical and organisational issues in providing access to spatial data. The Center for Technology in Government (1995) discuss in detail all of these themes of access to spatial data, looking at value to the community of spatial information and the barriers and solutions for spatial data sharing. However de Montalvo (2003) takes the view that most studies in spatial data sharing have not been empirically based and don't provide a relevant framework for analysis. The concern is expressed that the composition of studies done to date have concentrated on those who have shared as opposed to the community of potential sharers. From the research results discussed by de Montalvo (2003) there was a conclusion that while facilitation of the technical issues of data sharing were necessary, it could not be extrapolated that their resolution would remove the obstacles to data sharing because of the organisational and cultural issues.

2.5 Organisational Aspects

Exploring the feasibility of the private survey practice providing value adding spatial data services will require an understanding of the size of the survey practice necessary to both establish and maintain GIS as the operating paradigm. There appears to be no comparable research to that reported by Durgin (1990), which referenced a 1984 study of members from the American National Society of Professional Surveyors (NSPS) where 52% of respondents 'worked in firms with six people or less' (pg 4). From this study it was concluded that a typical NSPS member was likely to be a relatively small business servicing a relatively small geographical area. While this is now an old study,

anecdotally it appears to be still relevant in the Australian context, where a majority of survey firms seem to be small businesses in their local region. The case studies presented by Fenwich & Mayr (2002) show that survey practices that have taken on GIS as one of their service offerings usually need to grow to properly support this technology.

The second organisational aspect is the implementation of GIS and its impact. With reference to GIS implementation in government, Sieber (2000) repeats that while there are a considerable number of technical issues to be faced in implementation, the organisational issues will equal or surpass them. Sieber has reiterated the definition of implementation by Onsrud and Pinto as the "activities necessary to put the innovation into practice and incorporate it into existing and developing operations" (Sieber, 2000 pg 15). The effects on the organisation are also discussed in terms of the flexibility required by the organisation to be able to re-invent itself, because while the technology will be adapted to suit organisational needs, the organisation will also be modified by the technology (Sieber, 2000 pg 16). Coleman et al. (1997) make similar observations about the impact of NSDI on organisations, particularly in the context of expanding communications and connectivity, where individuals are empowered to seek new information and an organisations products are expected to be available to the international community.

2.6 Conclusion

This review has examined a wide selection of the available material which provides an indication of the complexity involved in introducing spatial data services across even relatively large organisations such as local, state and national governments. While this project cannot address all of the issues necessary to demonstrate feasibility in the private survey practice, consideration of the key points from this review, along with data gathered from the industry, will allow experiences to be extrapolated and conclusions drawn.

CHAPTER 3 RESEARCH METHOD

3.1 Introduction

The Research Approach to this project was based around the development and distribution of a questionnaire to land surveyors in private practice. The questionnaire approach was chosen when initial information gathering indicated this was an area that had not previously been the subject of research and even basic information was not readily available. The completion of the literature review confirmed this lack of available information and reinforced the decision to prepare a questionnaire.

While the questionnaire was developed both for respondent completion and as a guide to conducting an interview, the ability to gather information by interview techniques was severely limited by available time and by the availability of selected surveyors. Therefore I developed a questionnaire that was both straight forward and relatively short in length so surveyors did not perceive the completion as a difficult and time consuming task.

This research method describes in detail the questionnaire, its distribution and the collection of other supporting materials. The range of problems encountered in the research process are described to provide a link to the recommendations for further work.

3.2 Questionnaire

To be successful the questionnaire needed to be succinct in gathering the maximum amount of information from the selected surveying firms. The questionnaire also had to be useful as a tool to guide the conduct of an interview where a respondent may prefer to provide information over the telephone. It was also important that the questionnaire contain some background information on the project and the student so that the firms receiving it understood this project was a legitimate educational exercise.

In meeting these varied requirements a questionnaire form was designed to fit within two A4 pages using a two column layout to maximise the number of questions that could be asked. Twenty questions were asked with extra information requested depending upon some responses. A copy of the questionnaire form is included as Appendix B for information.

An important consideration in collecting information from any private business is maintaining privacy of that information from their commercial competitors. While each questionnaire collected specific details about each firm, I undertook to ensure that all information was only reported as statistical aggregates, thereby maintaining the privacy of the individual firm. This undertaking was published on the questionnaire.

In preparing the questionnaire I considered the types of questions I was trying to answer, and used these points as a guide:

1. Is there a correlation between firm size and the use of GIS software? Can a statistical point be found where the firm size makes use feasible? How does this correlate to the use of other software?

2. Is there a correlation between firm size and the range of surveying services offered? That is, do larger firms differentiate through their range of services? I am more interested in the breadth of services generally and not specific services.

3. Is there a correlation between the range of services and the software available?

4. Is there a correlation between firm size and the deliberate use of GIS to value add to a product or service? Is there a statistical point where firm size makes this feasible?

5. If GIS is in use, is it also used as a knowledge management tool for the business, not just as as analysis / presentation tool for products? Again does this correlate with firm size or any other firm attribute?

6. Is access to electronic data sets important to the products of the firm? What are the main sources?

7. Is sharing of data, both the firms and others, an important part of the business?

8. Where is the traditional surveying firm going in terms of services, staff, IT and the role of the senior surveyor? That is, how do they see their part of the industry changing?

A draft of this questionnaire was distributed to a number of people including some ACT surveyors for their comment. This resulted in some useful feedback and a number of questions changed from simple yes / no answers that led the respondent nowhere, to questions that asked the respondent to rank the importance of the item in question. It was through this process of review that the questionnaire changed from a relatively qualitative set of questions to one with many more quantitative aspects. The final questionnaire was completed as a form in Microsoft Word with fields available for the respondents to add their comments against the questions.

3.3 Selection of Participants

The questionnaire form had been specifically designed to be emailed to selected surveying firms and could be completed using standard office software for return by email. On the basis of comments I received from the draft questionnaire, I realised that I needed to target those surveying firms who were larger than the one or two surveyor operation. For ease of conducting any follow-up interviews I restricted my selection to surveyors in NSW and the ACT and in the absence of access to a listing of all surveying firms in these areas I decided to use the Online Yellow Pages to guide my selection.

The online Yellow Pages was chosen for a number of reasons:

i. It provides a quick search for those firms that are actively engaged in the surveying profession since the yellow pages is an advertising medium and any surveyor who is not actively seeking business would be unlikely to purchase this advertising space.

ii. Larger firms will generally have a larger presence through listing of the range of services they provide.

iii. Some firms will note their staff size as a component of their online advertising.

iv. The online listing will contain their email and telephone contact details.

3.4 Questionnaire Distribution

The questionnaire was distributed to thirty one surveying firms, with fifteen responses collected. This gives a response rate of forty eight percent (48%) which is a good result for a survey of this type and compares well with the response rate reported by Harvey (2000).

While the original intent had been to initiate telephone contact before sending the survey this was not done. The piloting of the questionnaire indicated that this was unnecessary since people gained sufficient understanding from the succinct introduction on page one of the questionnaire. A telephone call was subsequently made to many of the firms who received the questionnaire and follow-up emails were sent to remind people. This did contribute to many more responses being received than before the follow-up actions were taken. Many of the surveyors contacted indicated that the volume of survey work available meant that anything requiring time in the office and away from client work was almost impossible to complete.

Direct discussions were held with a number of ACT region surveyors, principally in the questionnaire pilot phase, that contributed to a greater understanding of their responses. Follow-up questions were also sent to two NSW surveyors requesting expanded comments on the possible application of GIS in their business, changes in staff skills and use of digital data. A single response for these questions was received.

3.5 Other Materials

The questionnaire had specifically requested information on the respondents views about the availability, use and sharing of digital data. A number of the responses indicated this area was a constraint and further information was gathered in an attempt to validate these views. A range of papers were sourced from the Internet, particularly in relation to spatial data availability and licensing policies. This was completed using appropriate search engines and uncovered a large amount of information on digital data availability and derivative product licensing within the government bodies at national and state levels.

Similarly, copyright was seen as an issue in data sharing, particularly when one party was a government body. While there is a limited amount of information currently published, there is some important work being undertaken in Australia relevant to surveyors that was found through an Internet search.

I had proposed in the research approach to attempt to discover if there was any research or statistical information on the make-up of the surveying profession and the relative size of surveying practices in Australia. Through an extended search of library resources and the Internet I was unable to find such information. My one other approach was to the Association of Consulting Surveyors Australia, but I was unable to establish contact with this body to explore the question.

3.6 Problems Encountered

There were no intractable problems encountered, just the expected limit on the time available to collect information. With surveyors being unusually busy for the time of year, responses took more time and effort than originally envisaged.

Despite numerous attempts, getting any response from some of the industry organisations was impossible. For many the only contact details are email, and these were never answered. This may be an effect of the current merging of spatial organisations, but it does not present well to the profession when the industry representatives cannot be contacted through their public channels. I was not in a position

to investigate contact through less formal channels and had to accept the lack of response.

3.7 Conclusion

The research method I have discussed did generally deliver the results I was expecting. The questionnaire in particular was a successful medium for gathering a range of quantitative and qualitative information that provided indicators to constraints that necessitated further investigation.

Having distributed the questionnaire and received a good range of appropriate responses the next chapter collates these results for analysis.

CHAPTER 4 RESULTS

4.1 Introduction

The fifteen questionnaire responses provided a range of results for each particular question and these results were tabulated for comparison of commonalities and differences. The purpose of this chapter is to present the results in a form that maintains the privacy of the individual respondents, while maximising the possibilities for analysis and the drawing of conclusions.

The questionnaire collected information in the following broad categories:

i. Survey practice size.

ii. Range of client services.

iii. Current computer technologies used.

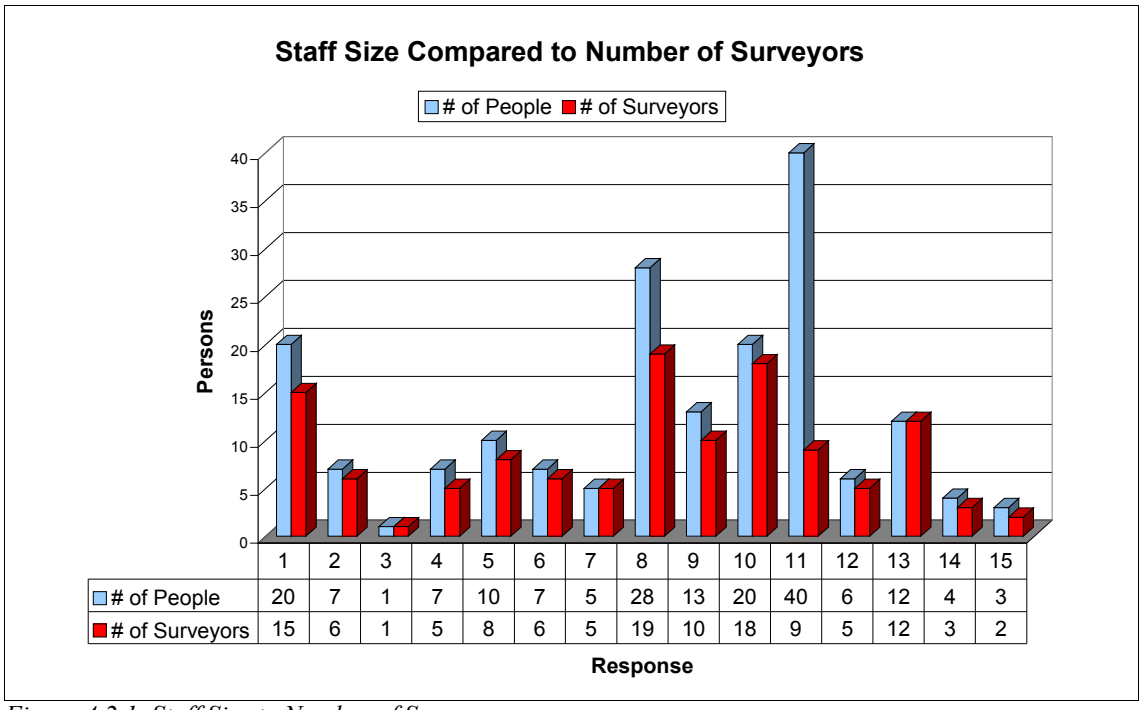
iv. Sources of basic digital data.

v. Spatial data infrastructure.

vi. The future of their business.

4.2 Practice size

The fifteen responents have a range from one to forty staff with one to nineteen surveyors. Figure 4.2.1 shows the number of staff and number of surveyors side by side for each response.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
# of People	20	7	1	7	10	7	5	28	13	20	40	6	12	4	3
# of Surveyors	15	6	1	5	8	6	5	19	10	18	9	5	12	3	2

Figure 4.2.1 Staff Size to Number of Surveyors

A few respondents indicated that they had other professionals in the firm, apart from surveyors, but as Figure 4.2.2 shows, this percentage was low. Of the other professionals noted the majority were in related land management professions of planning, valuation and engineering. One respondent said they had a GIS manager.

The chart of Staff Size to Number of Surveyors (Figure 4.2.1) shows one response at eleven that does not match the pattern of other responses, being significantly larger in staff size to the number of surveyors. Further information provided by the respondent indicated that surveying is only one of the many equally important services provided by the firm through their large staff of other professionals.

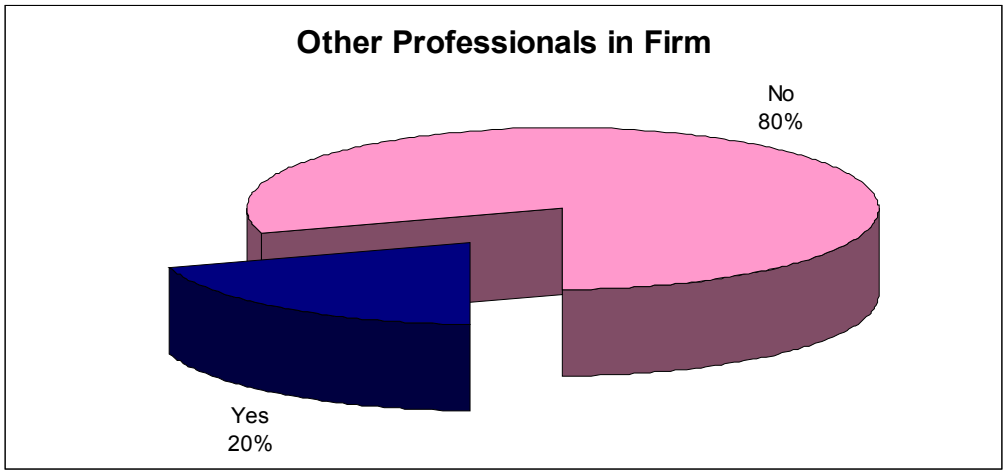


Figure 4.2.2 Other Professionals

4.3 Surveying Services

In answering the question on services offered by their firm, respondents generally noted surveying services that can be classified under the broad categories of cadastral, subdivision, engineering, building construction and control surveys. Others added project management, hydrographic surveying and land title consulting as additional services.

4.4 Computer Technologies

In this section of the questionnaire respondents were asked to rank the importance of Survey Reduction, CAD and GIS software to their business and provide an indication of the number of licences held for each type of software. In all cases survey reduction software (Figure 4.4.1) ranked as a five (very important) and CAD software (Figure 4.4.2) ranked as a four or five (important to very important). All respondents had a number of each type of licence. GIS software responses (Figure 4.4.3) ranked from zero to five (not used to very important), with those ranking it highly being the ones who owned GIS software licences.

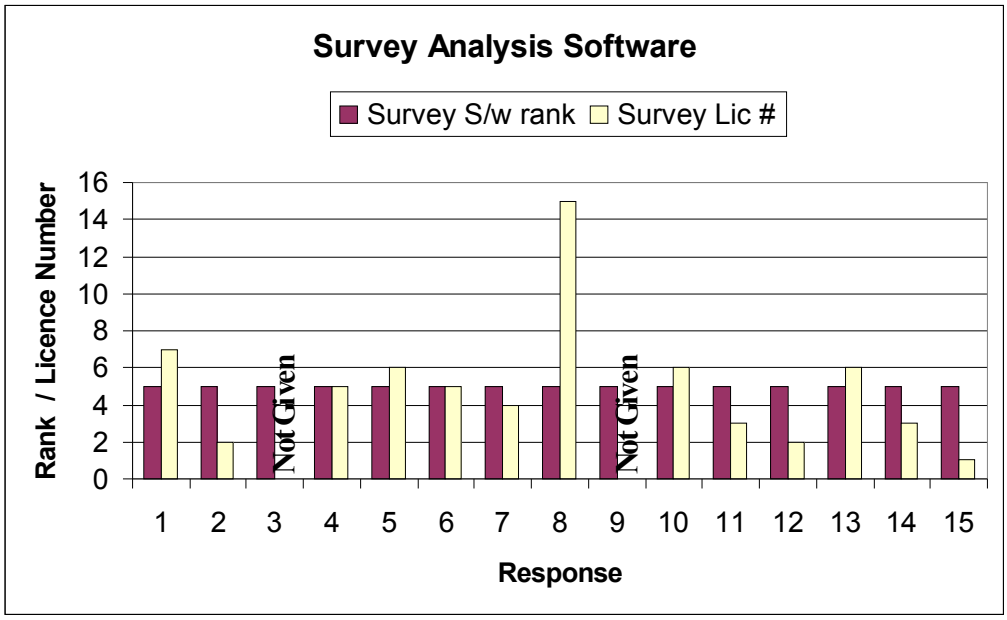


Figure 4.4.1 Survey Analysis Software

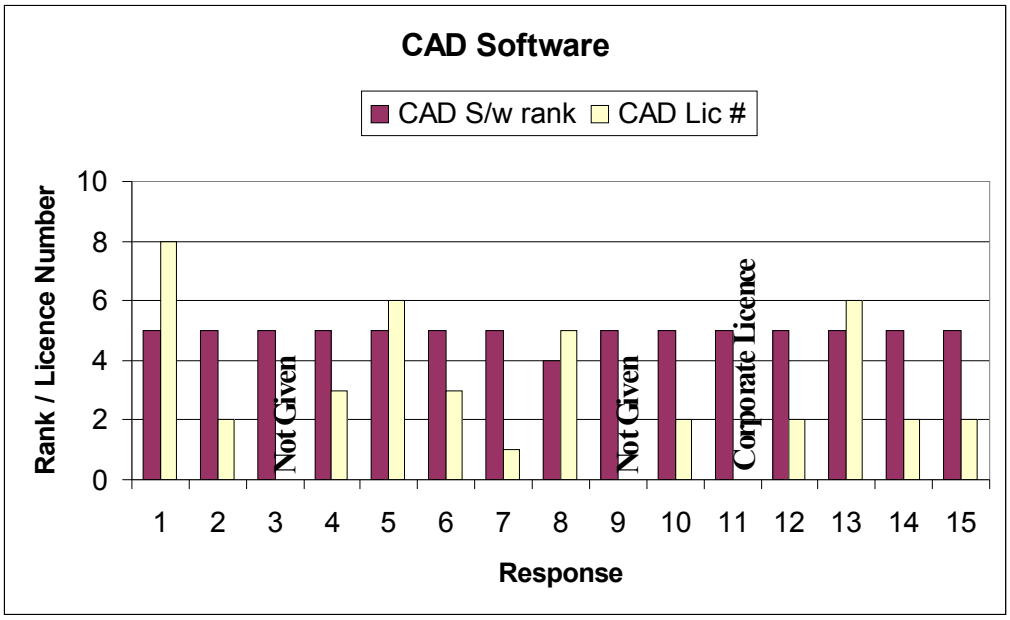


Figure 4.4.2 CAD Software

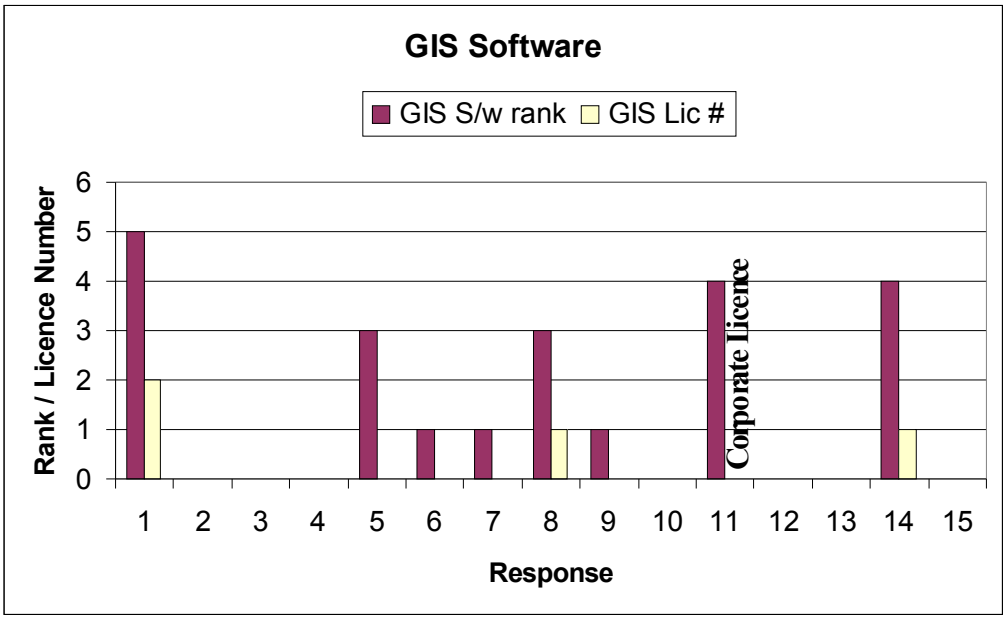


Figure 4.4.3 GIS Software

Since Chan & Williamson (1996) consider that to be an effective part of the spatial infrastructure GIS should be an integral part of the firm's operations and not just another toolset, further questions were asked on the use of GIS software. These questions returned three positive responses for analysis and presentation as the exclusive use. The second part of this question on knowledge management use had only one response indicating this use in addition to analysis and presentation.

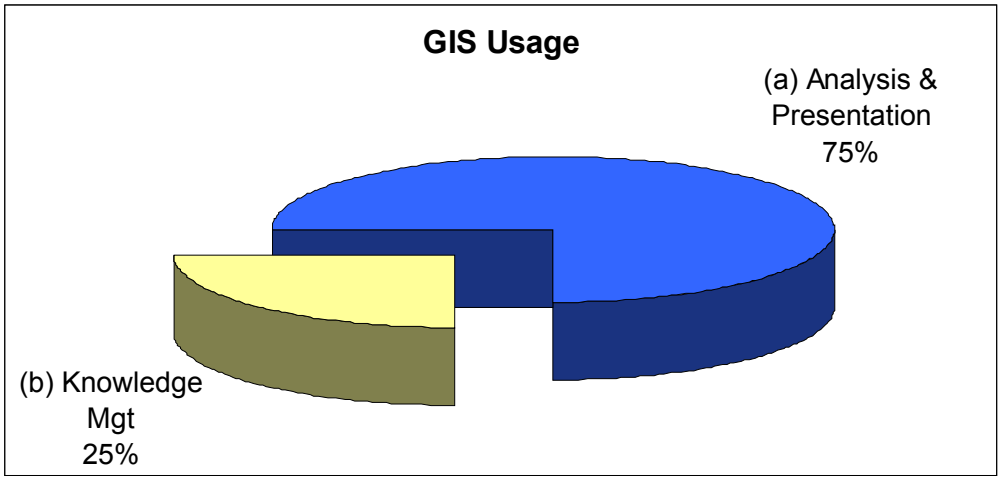


Figure 4.4.4 GIS Usage

As indicated in the introduction, software vendors also see the surveying industry as a growth area. To understand if surveyors were experiencing this in their business a question was asked on the merging or consolidation of software used by surveyors. A majority of respondents did not think there would be a merging or consolidation of the surveyors software toolsets in the near future, with a number of comments that having separate packages was often advantageous irrespective of the capabilities of some software packages.

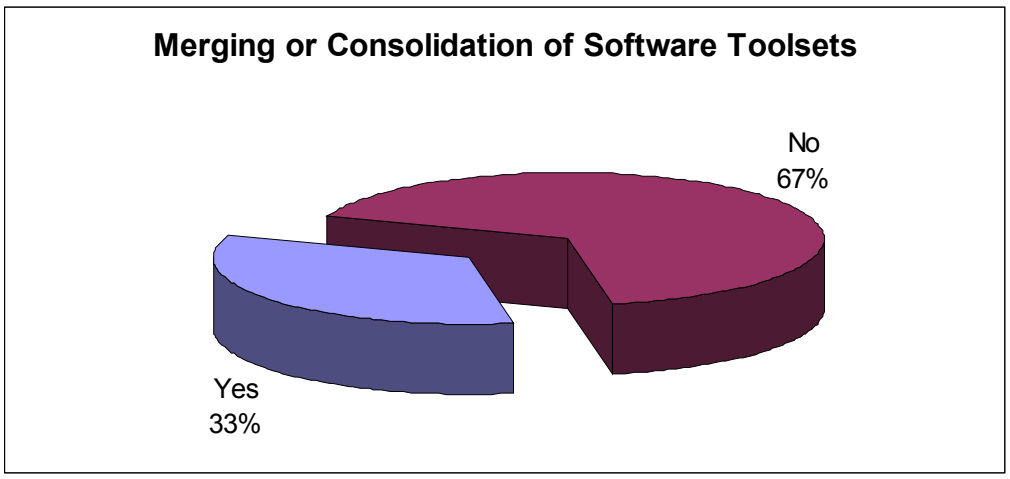


Figure 4.4.5 Merging or Consolidation

4.5 Sources of Basic Data

The questions in this section of the questionnaire asked about the importance of base electronic data to the firm, the use of base digital data to value add to survey products, the sources of base data and data sharing with other organisations.

The importance of base electronic data ranked no lower then a three in all responses (Figure 4.5.1) and eleven of the respondents indicated they had used base data to create a value added product for a client (Figure 4.5.2).

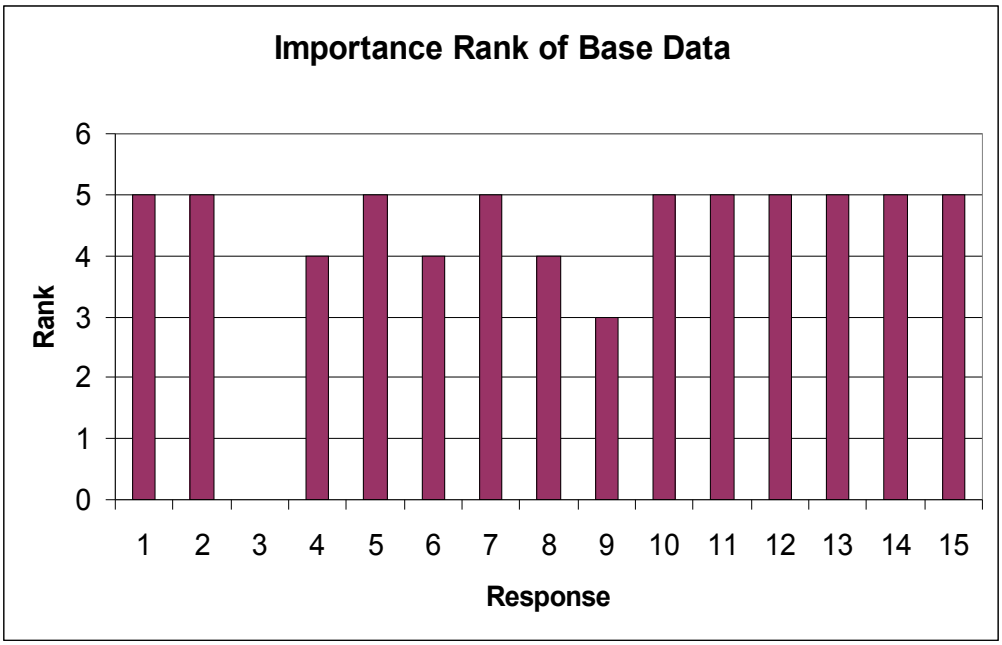


Figure 4.5.1 Importance of Base Data

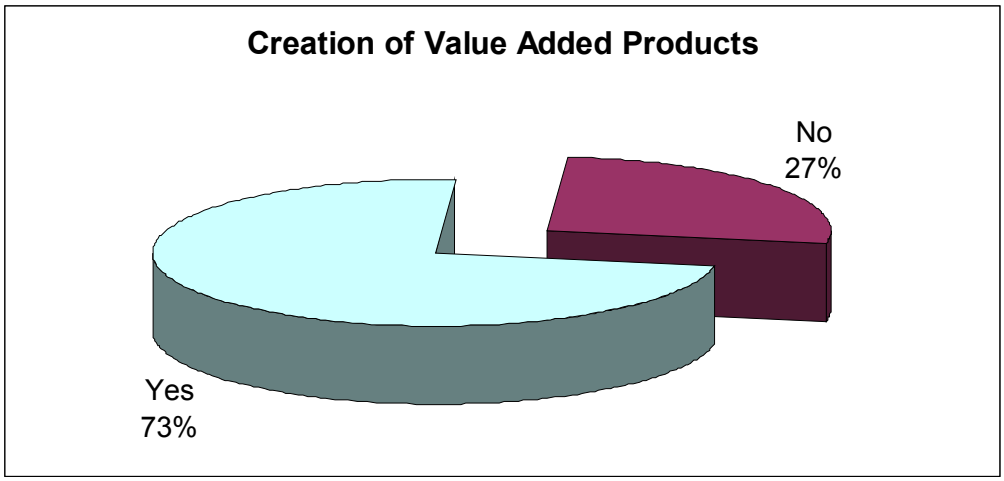


Figure 4.5.2 Value Added Products

The question asking from which organisations they sourced base data received a general response to the State and Territory land registration and mapping agencies. Only one respondent indicated that a local council was a source of data. Seven of the respondents indicted that they share data with other organisations (Figure 4.5.3), and follow-up

questions indicated that this is usually with architects and engineers of the particular client when related to a specific client project.

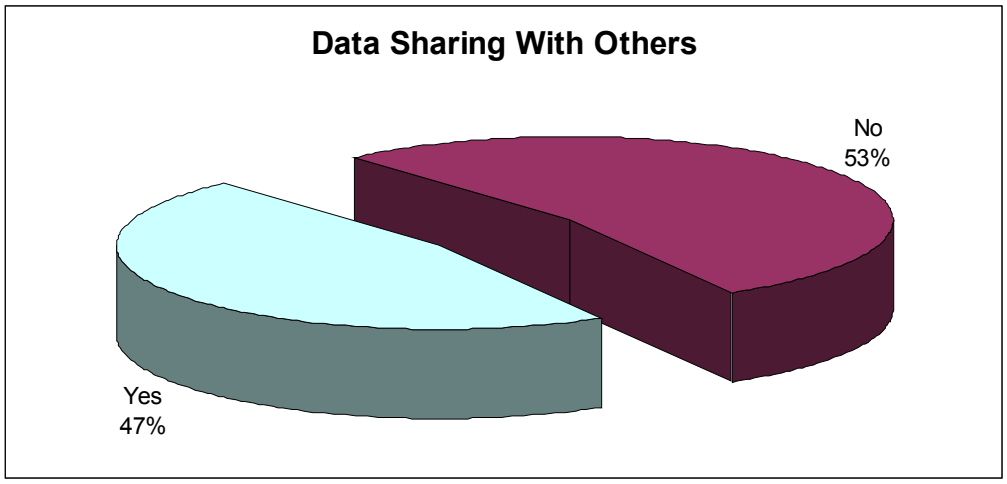


Figure 4.5.3 Data Sharing

The question on what factors would be necessary to facilitate a culture of data sharing produced a wide range of responses. Some of the concerns mentioned include:

i. Recognition of intellectual property.

ii. Renumeration for use.

iii. Ongoing liability.

iv. Trust and communication.

4.6 Spatial Data Infrastructure

With extensive effort being undertaken at state and national levels of government to build spatial data infrastructures, two questions were presented to gauge if the spatial data infrastructure initiatives were impacting the business of surveyors. Only six respondents indicated that they were aware of the SDI initiative (Figure 4.6.1) and none indicted they they had any knowing involvement with it.

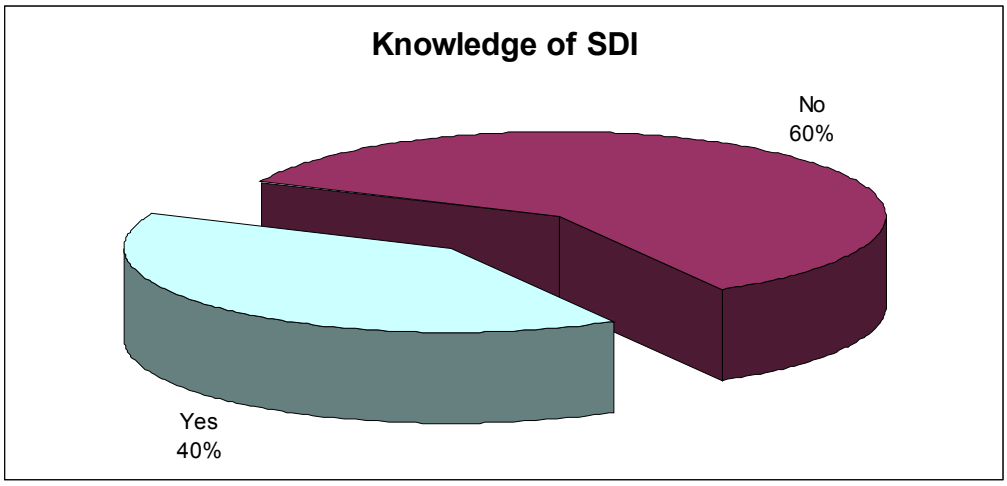


Figure 4.6.1 Spatial Data Infrastructures

4.7 Business Futures

The final set of questions were an attempt to get respondents to forecast the future of their business, the role that technology would play and the role of the principal surveyor in the firm.

Two key themes came from responses to the first question on business futures, being that most firms were looking to consolidate in the traditional surveying roles, adopting new technology where appropriate, and the difficulty attracting qualified staff. A few considered they would grow into more spatial and GIS related services while using the traditional survey practice as a base. Ten of the respondents indicated that their computing infrastructure would need to grow as the firms services changed.

The final question on the principal surveyors role again produced a wide range of responses including managing data, managing technology, providing leadership and a changing focus away from the traditional field based survey work. Some respondents indicated their principal surveyors were already almost totally office based managers.

4.8 Conclusion

The questionnaire responses have provided a good selection of both quantitative and qualitative information upon which to conduct comparative analysis. The next chapter will take these results and discuss their relevance in the context of the questions to be answered by the project.

CHAPTER 5 ANALYSIS AND DISCUSSION

5.1 Introduction

The purpose of this chapter is to consolidate the results from the questionnaire and thereby answer the questions posed by the aim and objectives of the project, as described in the Research Method. At this point the other materials collected in support of the project will be discussed in the context of the questionnaire results.

It is acknowledged that the questionnaire provided a relatively small sample size, meaning the analysis and any conclusions drawn may be a simple reflection of the sample and not of the wider surveying industry. However, this analysis still provides a useful starting point for further investigation using a larger sample to gather a targeted set of information.

A number of the questions received almost identical responses which made further analysis difficult and discussion of these will be addressed first. Using the data collected from the questionnaire I then prepared a number of analyses, covering firm size, GIS use, surveying services and digital base data, to assist with developing conclusions to answer the questions described in chapter three.

As discussed in chapter four, questionnaire responses indicated the use of GIS software is still used strictly as an analysis and presentation tool for survey products in the private practice. Only one respondent used GIS as a knowledge management tool and this was because they were part of a larger organisation who used GIS in this manner. All other resondents do not use GIS to manage the storage and retrieval of their corporate knowledge related to their work and products. This means that geographic information

systems in the survey practice are still a project specific service delivery toolbox and have not diffused into the organisation as an operating paradigm in any way that would be recognised by Campbell and Masser (1995), Grimshaw (1994) and Chan & Williamson (1996).

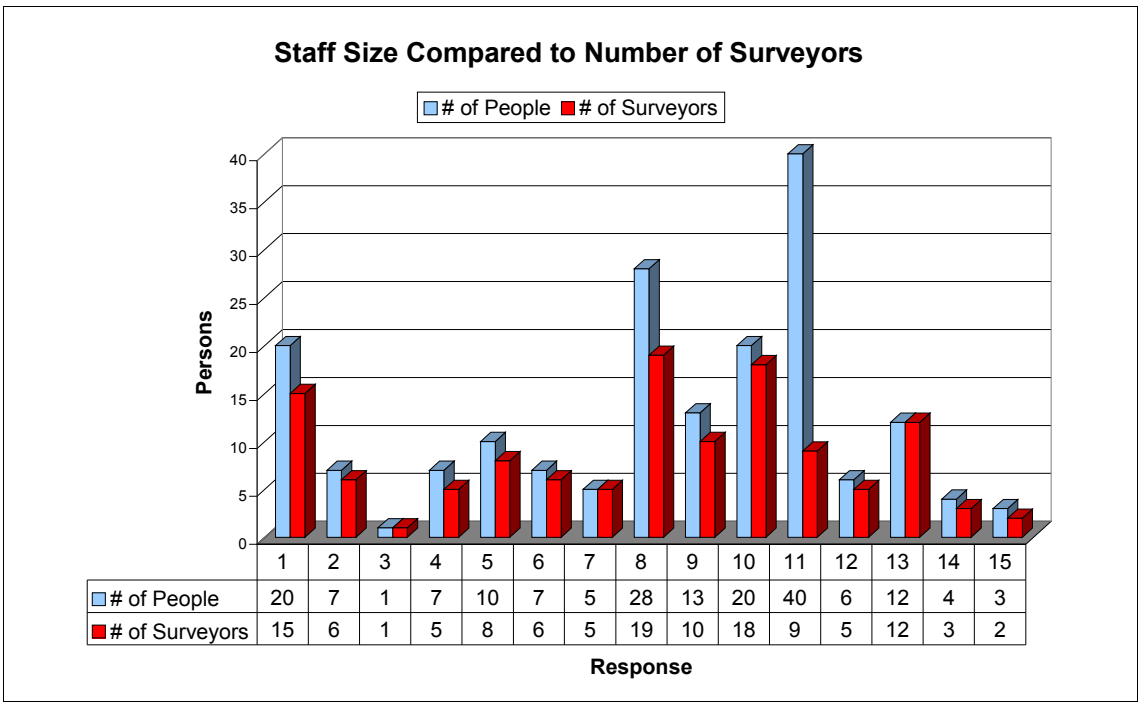
5.2 Common Results

While the importance ranking and number of licences for survey analysis and computer aided design software was gathered, this provided no obvious correlation with firm size or the use of GIS software. The ranking at a high level for both of these classes of software confirm the product dominant focus of most survey firms and the number of licences was always less than the number of surveyors, but not in any obvious pattern.

A majority of respondents said they value added to their work and since very few have GIS systems this value add can only be through their CAD systems. Since CAD systems are increasingly capable in the presentation of data from a diverse range of sources this is not an unreasonable result.

5.3 Firm Size and GIS Use

The respondents ranged in size from the single surveyor firm to local offices of large national groups. Comparison of practice size results indicated that as firm size increases so does the ratio of support staff to surveyors, generally in the range of one to three (1 support to 3 surveyors) and approaching one to two . This can be seen in Figure 5.3.1 (a repeat of Figure 4.2.1 from the questionnaire results) which compares the total number of staff to the number of surveyors.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
# of People	20	7	1	7	10	7	5	28	13	20	40	6	12	4	3
# of Surveyors	15	6	1	5	8	6	5	19	10	18	9	5	12	3	2

Response	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Staff / Surveyor Ratio	0.33	0.17	0	0.4	0.25	0.17	0	0.47
Response	**9**	**10**	**11**	**12**	**13**	**14**	**15**	
Staff / Surveyor Ratio	0.3	0.11	3.44	0.2	0	0.33	0.5	

Table 5.3.1 Staff to Surveyor Ratio

As can be seen from Figure 5.3.1 and Table 5.3.1 response eleven appears to indicate surveying is one of a number of core activities carried out by this firm, and discussions directly with them confirmed this was the case. Response eleven has therefore been removed from many of the following comparisons and calculations because their size and the multi-disciplinary nature of their business means they have access to corporate resources beyond the reach of many traditional surveying firms and to include them would overwhelm any fine detail in the comparisons.

The first question this research was looking to answer was whether the size of the firm correlates with the use of GIS software. The data collected had two measures for software, being the ranking of software importance and the number of licences held. In total only four firms out of fifteen respondents had GIS software. Achieving only this

number of positive responses means the sample size is far to small and it will be difficult to draw consistent conclusions. The following analysis must be reviewed in this context and further work needs to be conducted with a larger sample to verify the results presented.

When the rank of importance of GIS software is mapped to the size of the firm we see no obvious correlation, as shown in Figure 5.3.2, since there is a firm with less than five people who ranked GIS highly. Seven firms ranked the importance of GIS as zero. Similarly when we look at the actual firms with licences (Figure 5.3.3) we see no obvious correlation with the small firm that ranked GIS highly having a GIS licence.

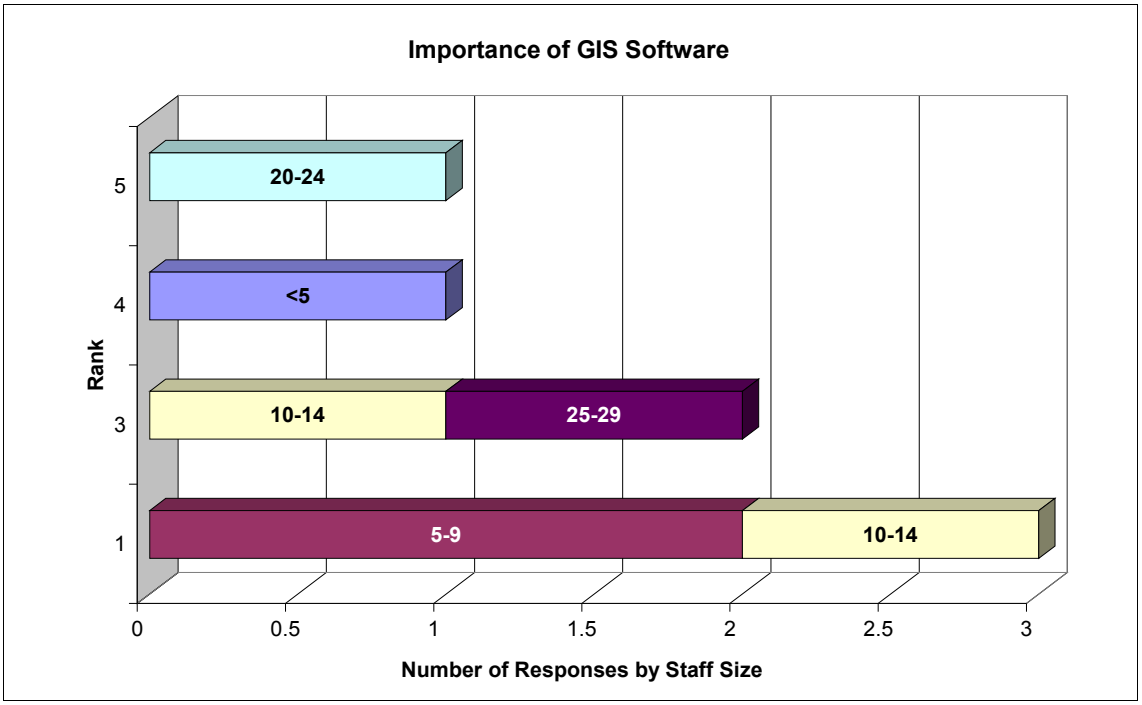


Figure 5.3.2 GIS Importance

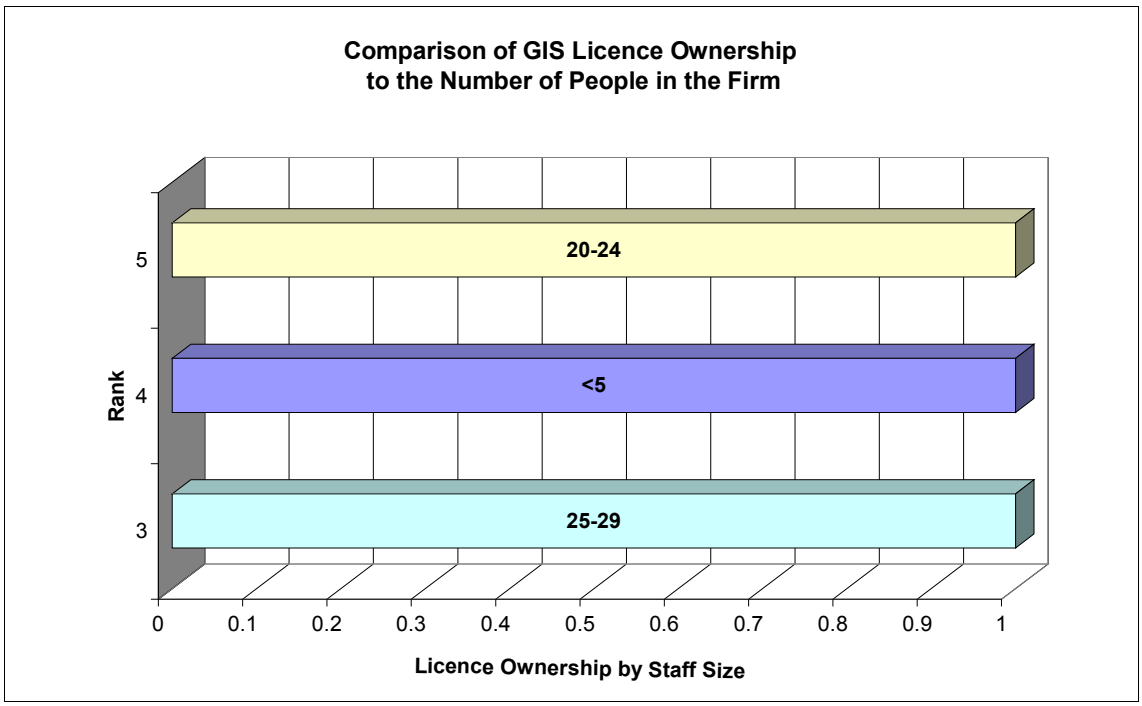


Figure 5.3.3 GIS Ownership to Number of People

However when the ratio of staff to surveyors is compared to the licences held and the rank of GIS importance (Figure 5.3.4) there appears to be a correlation.

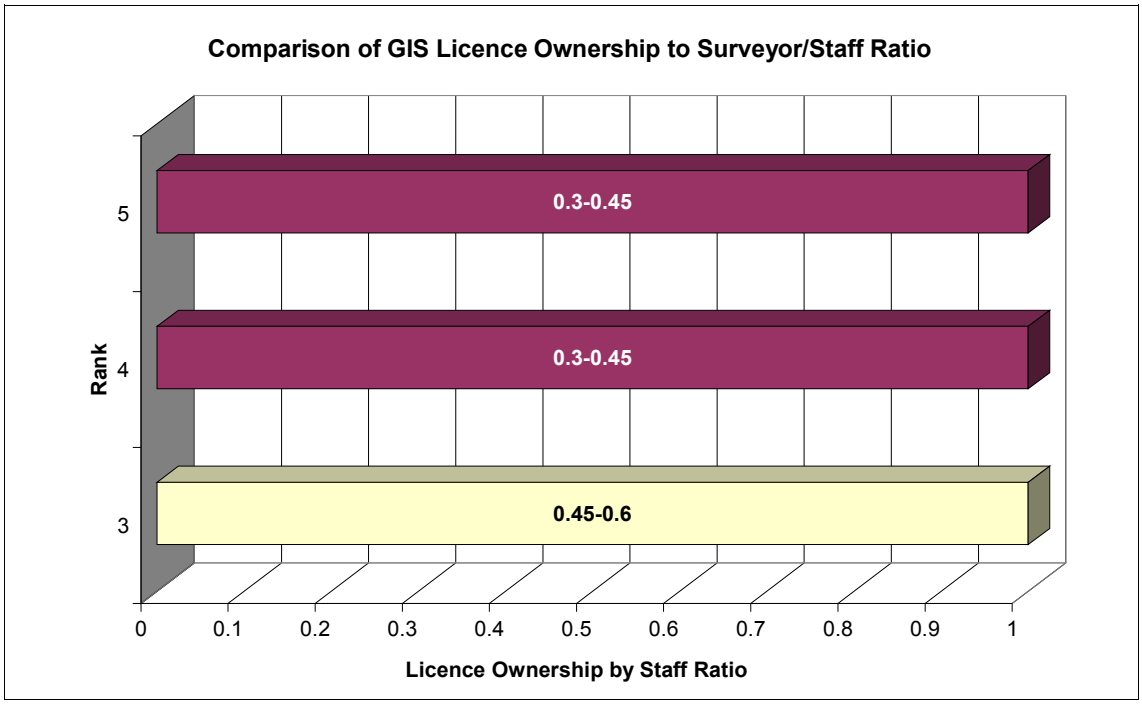


Figure 5.3.4 GIS Licences to Surveyor/Staff Ratio

The question then is does this result also have a correlation when we look at the firms GIS importance ranking (Figure 5.3.5).

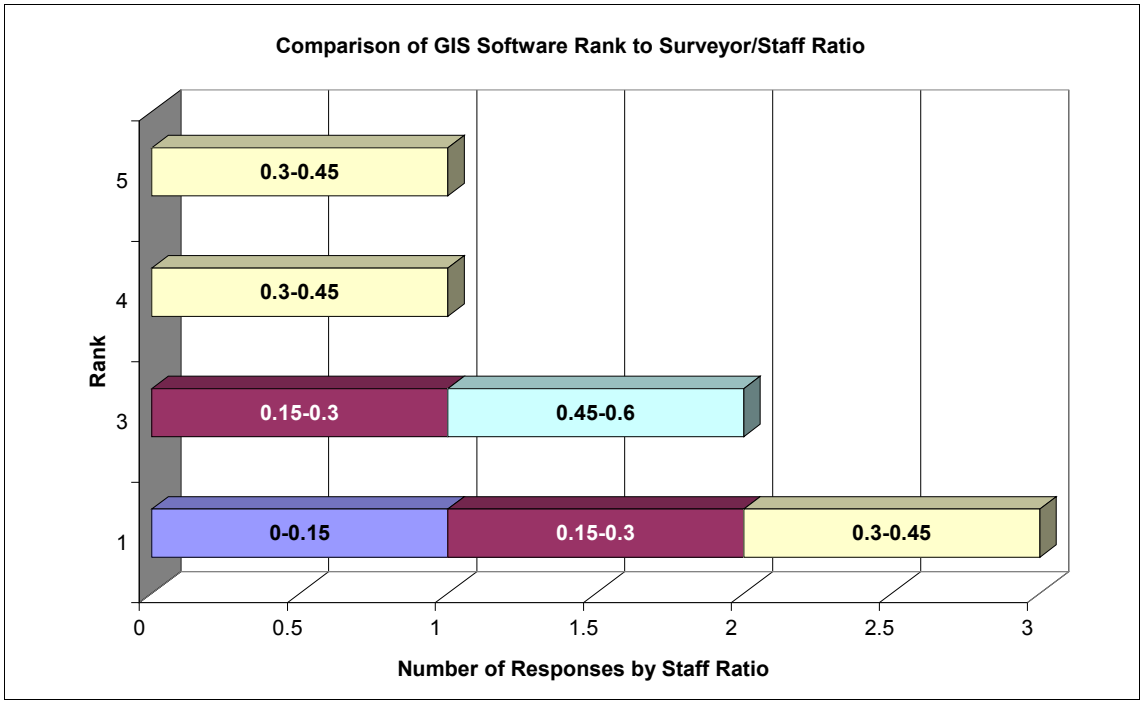


Figure 5.3.5 GIS Rank to Surveyor/Staff Ratio

The above two figures show a match between those firms who have GIS licences and rank its importance highly and those with a higher surveyor to staff ratio. One interesting result from this chart is the GIS importance ranking of three given by one firm in the 0.15 to 0.3 surveyor to staff ratio grouping that does not currently have any GIS licences. This would appear to indicate a firm that is on the cusp of implementing GIS software.

The questionnaire ranked a response of three as the boundary between importance and unimportance to the business. If we graph the product of the rank with the surveyor to staff ratio we get the result shown in Figure 5.3.6.

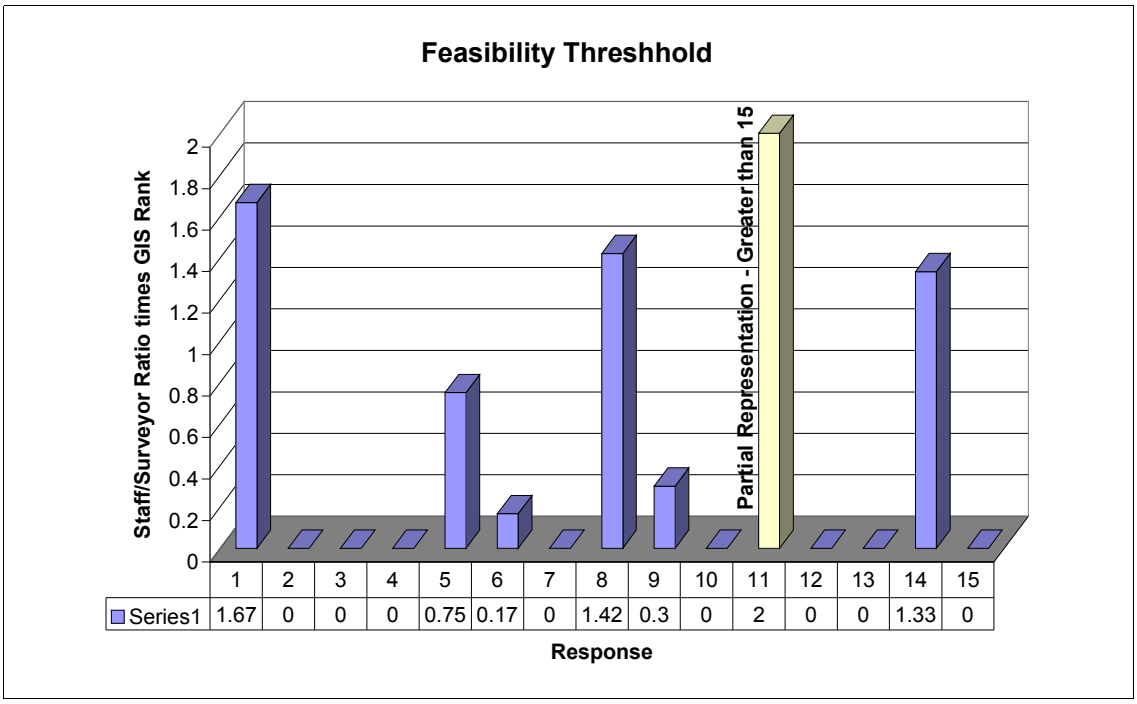


Figure 5.3.6 Feasibility Threshold

Those firms who ranked GIS at three and above and had a high ratio of non survey staff show up quite dramatically in comparison to the others. For those firms already using GIS, the average staff ratio is 0.38 (not including response eleven). Therefore the likely point of feasibility is approximately a value of one on this graph, when the staff ratio approaches one in three and the business is engaged in more spatial type work where the importance of GIS attains a rank of three. From the above graph we can see one response that is approaching that level, having ranked GIS at three and having a one in four staff ratio. This corresponds with the results in previous charts.

This appears to indicate that while the size of the firm is important to their ability to maintain a non survey staff, the mix of business may mean that GIS becomes more important to one firm over another irrespective of size. What does not seem to change is that a ratio of one to three or less provides the capability to support GIS as a component of the business. None of the large firms who had a low ratio ranked GIS at even the three level which seems to corroborate this hypothesis.

Looking further into the responses to the questionnaire, those firms who have GIS licences also responded that their surveying services were likely to grow in spatial data services and GIS. A number of other firms who did not rate GIS importance highly also

considered GIS and spatial data services as growth services for their business. The firm who rated GIS importance at a three but does not have any licences was also the only firm to specifically note GIS data sets as important to their business.

I would conclude from this analysis that a surveying firm has the potential to take on a GIS system when their staff to surveyor ratio approaches 0.3, which is approximately one non survey staff member per three surveyors.

5.4 Firm Size and Range of Surveying Services

The description of surveying services offered by each of the respondents provides no obvious identification of why GIS is more important to one business than another. In general however, those who ranked GIS at three and above in importance also expressed that GIS and spatial datasets are one of the potential growth areas for the firm, away from the more traditional cadastral services. From the fifteen responses received, seven firms are providing GIS related spatial services or see these services as part of their future business. One comment by a few of the respondents indicated that some firms are engaged in the management aspects of their clients projects and higher level consultative roles. There were a few services disclosed as land title consultant, project management and subdivision management that were different to the general responses. When these response are mapped against the surveyor to staff ratio we get Figure 5.4.1, a figure that looks similar to the Comparison of GIS Software Rank presented previously at Figure 5.3.5.

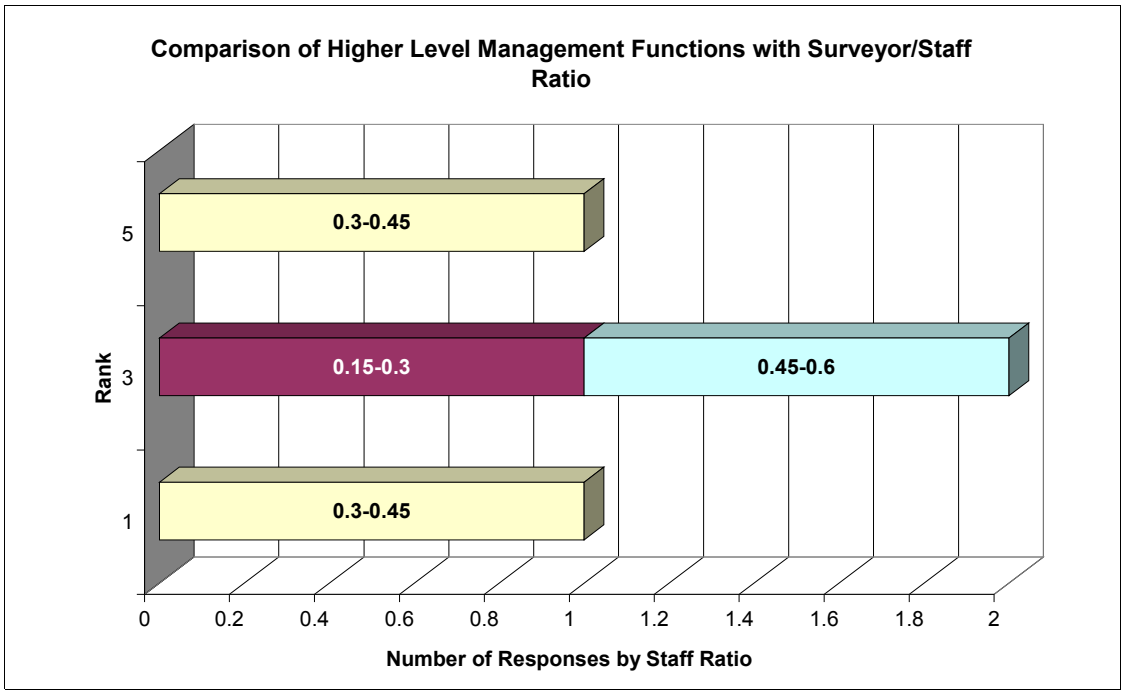


Figure 5.4.1 Higher Level Management Functions

These respondents appear to have the organisational capacity to deliver higher level services than just traditional field based surveying and it is again at the higher end of the surveyor to staff ratio. Two of these firms have GIS licences and one appears to be on the cusp of moving in that direction. All of these firms have at least ten staff.

Very few respondents indicated they had people with other professional qualifications in the firm. Interestingly, two of the firms who did have other professionals in the firm also ranked GIS highly as a software tool, indicating that their spread of work was probably greater for the extra specialisations.

In general the responses to the questionnaire show that some people are keen to stay within their traditional role, which is therefore increasingly competitive, and others are branching away into environmental and planning allied services. Comments from a number of surveyors involved with this questionnaire indicated their firm would do any survey work that a client requested. Therefore responses appear to have typically included all the possible services rather then just the most commonly delivered services.

When questioned about the likely change in services delivered by their firm, many respondents indicated that GIS and spatial information presentation are expected to grow. Most often this was in addition to maintaining or growing their existing lines of

service in the cadastral and engineering areas. The respondents who thought this way also indicated a changing role for the principal surveyor in the firm, being viewed as more of a spatial data manager with a greater focus on the marketing of new and different products through networking and promotion.

I would conclude from this analysis that a surveying firm with more than ten staff and a surveyor to staff ratio of more than 0.3 is capable of delivering an expanded range of management services to their clients. Since this appears to match with the previous analysis for staff size and GIS importance and use, it would appear that the expanded range of services includes GIS and spatial data services.

5.5 Digital Base Data

The questionnaire contained a series of questions about the importance of base data, whether they had used base data to value add and from which organisations they sourced this type of data. While base data was ranked at four and above by all respondents, and a majority said they used base data to value add to their products, very few obtained data from organisations other than those that provide the core cadastral / land title information. Only one respondent indicated the use of GIS data sets and another the use of aerial photography.

A question on Data Sharing culture in surveying provided an interesting range of comments related to sources of data. One respondent considered data was being locked away by State and Local Governments, with restricted public accessibility. Others saw a need for a centralised data facility covering the whole of Australia and freely available search access for surveyors. Intellectual property and royalties for providing this information to the central collection body also featured heavily in responses to this question. In general the responses indicated a lack of trust in both the bodies controlling the information and in the compatibility and reliability of the data. One response clearly encapsulated a position where there needs to be more discussion of the partnership in data and the flow of benefits or advantages to be gained by both the giver and the receiver.

Independently of the questionnaire I used the Internet to search for surveying data sources that would be available to the surveying industry. A brief search indicated that

all national and state government bodies who collect spatial data make this available to the public. Examples were found from Geoscience Australia, Queensland Department of Natural Resources, Mines and Energy, Public Sector Mapping Agency, New South Wales Land and Property Information and the ACT Land Information Centre. A sample of the digital data products available from these government bodies is included at Appendix C for information.

Geoscience Australia provides digital data for the whole of Australia in a range of themes, with licensing conditions that allow the creation of derivative products without further payment. The national map series from scales at 1:100,000 through to 1:10,000,000 are available along with digital elevation data. (GA. (1), 2004). Many of the Geoscience Australia digital map products are free if downloaded from the web and where a charge is made the cost is often little more than the cost of reproduction to the digital media. This is in accordance with the Australian Government fundamental spatial dataset pricing policy (OSDM, 2004), which promotes the efficient and effective use of spatial data collected by Commonwealth agencies through making it freely available. The policy recommends no restrictions be imposed on the creation of derivative products from fundamental spatial data.

The State Government spatial bodies similarly provide a range of digital data covering cadastral and topographic information and thematic variations. In all cases this information is licenced for single use at the published prices, but can be licenced for creation of derivative products upon application and agreement as to the royalties to be paid to the State. An example of this type of licensing is from the Queensland Department of Natural Resources, Mines and Energy who have four types of digital data licensing:

- User Licence – for use by the purchaser with no rights to develop upon or distribute the digital data.
- Defined Developer Licence – allowing development and sale of a defined product based on the digital data.
- Developer Licence – providing an ongoing licence to develop derivative products based on the digital data.

- Data Distributor Licence – allowing the sale of the original digital data to a third party without alteration. (NRM&E, 2004)

A limited search of the Australian Spatial Data Directory (ANZLIC, 2003) for digital data availability on local government development zoning provided a number of results in many States of Australia for property and other types of zoning. While this data was not available online, the directory contained the contact details for the relevant local government bodies.

What we therefore have through the questionnaire is a perception that good quality digital data is not readily available to surveyors from the various government collection bodies. Yet a search of the Internet found that most of these bodies make this information available on commercial terms and provide licensing for those firms who want to create derivative products. Perhaps this is why we have separate spatial firms who specialise in creating digital spatial products, using a range of data sources, and then engage surveyors to collect field information to enhance these products with timely spatial data. There appears to be no impediment to a surveying firm doing this themselves as opposed to being someone else's field staff.

This disconnect with data sourcing may also explain why when many of the respondents know of the Australian Spatial Data Infrastructure initiative none of them have any involvement with the SDI. I would propose that while surveyors are seen as a source of original field data they are not seen as a source of structured digital data by the first level of data aggregators in the SDI, who are the specialist spatial firms and government collection bodies.

5.6 Data Sharing

Data sharing was also seen in a fairly negative sense. Those who said they shared data generally only did so with other professionals to meet the requirements of the client's project. In general this means architects and engineers only. A wider data sharing culture was not in evidence from the responses to the specific question posed, with a general concern for intellectual property rights, reasonable payment for use and leadership at the government level.

Again these concerns could be tested by Internet research in the area of copyright. Copyright Agency Limited (CAL) have addressed the fact that 'survey maps and plans are protected by copyright as they constitute an artistic work, while bearings and distances are protected by copyright as they constitute a literary work' (Copyright Agency Limited, 2003). CAL are recognised by the Copyright Tribunal as the body authorised to act on behalf of surveyors for the receipt and distribution of royalties.

The area of contention is with survey products that are completed to meet government land registration and dealing requirements. Governments have relied upon the Copyright Act 1968 provisions that assigned copyright to the government for works created under the direction or control of government. In terms of products completed for a client but required for land registration and dealing, this reliance is being tested through the Copyright Tribunal by CAL. It is understood the Queensland Government agreed in 2001 to pay royalties to surveyors for the copying of maps and plans other than for the services of the State Government (ISA QLD, 2004). An action is currently in progress for a similar agreement with the NSW Government (Copyright Agency Limited, 2003).

The other possible area of concern is the ownership of copyright on client created products. This is an area where the surveyor is in full control, since they are presumed to own the copyright for every situation except the implied licence to use which is given to the client. The surveyor should therefore have an explicit agreement whenever they assign their copyright ownership to someone else.

The land surveyors practice has traditionally been concerned with surveys that would ultimately come into the possession of government bodies, and it is understandable that data sharing in an environment that compulsorily re-assigned a surveyors copyright to the government would not be a priority. For many surveyors this type of work is a less significant part of their business, but copyright issues may be overlooked in presenting products to clients and their other professional service providers.

5.7 Conclusion

The discussion in this chapter has drawn together the questionnaire results and other collected materials to draw comparisons between firm size, GIS use, surveying services, digital data and data sharing. This has answered the questions presented in the Research Method, even given the relatively small size of the sample. The next chapter takes these results and considers their impacts when the available research literature is taken into account.

CHAPTER 6 CRITICAL ANALYSIS

6.1 Introduction

In the previous chapter I discussed the results from the questionnaire and other materials sourced to assist with the analysis of these results. The purpose of this chapter is to put the analysis in context with the available literature prior to drawing conclusions. However, the small sample size effectively limits the level of confidence in these results without further study.

The literature review in chapter two discussed current views on the role of surveying, its organisation and infrastructure including digital data. In this critical analysis I extend on all of the available information to consider the lessons the surveying industry can take from other industries when pursuing GIS, the impacts on the surveying profession, the role being played by digital data in the wider community and any implementation issues to be considered. This will lead to the conclusions and recommendations from the research project.

6.2 Lessons for the Industry

The results of the questionnaire have shown that GIS is currently not a pervasive technology within the surveying industry, with a low percentage of firms having GIS capability and most firms not rating GIS as an important technology for their business. The industry appears to be in the early adoption stages of technology diffusion described by Onsrud & Pinto (1991), where the available literature concentrates on successful applications by forerunner firms and scientifically based research on the technology. A

demonstration that the industry is in this stage is the publication by Fenwick & Mayr (2002) which provides examples of the successful use of a single GIS product by some early adopter firms, and shows that they have embraced GIS for more than specific client products.

Given the private survey practice is today in the early stages of GIS adoption and diffusion, we can examine experiences from the introduction of GIS in State and Local government organisations, which is described by McDougall et al. (2002) as having a history of inconsistent development over 25 years but has now reached the point of being integral to operations of the organisation. Over this timeframe progress in local government was often driven by a small number of individuals, subject to changes in priority for financing and implemented initially to suit the needs of a single section or specific operation. Many local government bodies have finally reached the point where GIS is widely integrated with the other local government systems, since many transactions have a spatial component allowing GIS to be the portal to these business systems. Research has also identified two significant groupings of perceived utilisation success factors in local government, in the range of benefits provided to meet both internal and external user needs and the ability of GIS to improve the routine tasks of internal users (Chan & Williamson, 1996). Similar success factors would need to be identified by the survey firm when adopting GIS technology.

Local government has been through the GIS technology diffusion lifecycle and there is a growing body of research into the approaches used and the measures of success. The way it was initially approached for a section or specific operation is similar to the way most survey firms are approaching, or propose to approach, GIS through project specific implementation. The history of GIS implementation in local government can therefore provide a casebook of experiences for the private survey firm to fully consider the benefits of implementing a GIS and the most suitable approach for their organisational structures.

GIS technology is seen as revolutionary (Godschalk & McMahon, 1992, cited in Budic, 1994) and Sieber (2000) states that 'During the dynamic process of any innovation, an organisation adapts the technology to suit its needs; however, the organisation also is modified by the technology' (p 16). For a surveying organisation this means the firm must not only fit GIS to its current operations but look to change its business to

maximise the benefit of the technology. This is the revolutionary aspect of GIS, where the business will to some extent be destabilised during the process of adopting GIS as an operating paradigm in the business.

Chan & Williamson (1996) take this view further by defining the organisation wide GIS as containing 'data, information technology, standards, people with GIS paradigm and expertise, and the organisational setting' (pg 5). In the project toolbox use of GIS, practised by most of those firms with GIS in this research, there is only data and information technology with some expertise. The factors described by Sieber (2000) as necessary for a successful organisation wide implementation in local government, and by extrapolation to a surveying business, are:

'1) Evaluation of user needs;

2) long term upper-management commitment to the project;

3) sufficient allocation of resources;

4) adequate staffing;

5) timely and sufficient training;

6) someone, called a “GIS champion,” who will shepherd the project from acquisition to use; and

7) organisational communication or diffusion to smooth the transition to full utilisation' (pg 16).

The questionnaire results discussed in previous chapters noted only one firm, from those who had GIS licences, actually used it as a business knowledge management tool. Since this firm is multidisciplinary in operation, the use of GIS would be part of the production infrastructure described by Chan & Williamson (1996) to satisfy the objectives of the organisation through meeting the geographic information needs. This firm would be seen to fit into the corporate GIS / SDI model proposed by Chan & Williamson (1999) since it integrates data across the business such that all datasets can be shared.

A number of respondents to the questionnaire nominated GIS and spatial technologies as likely growth areas in their business, commonly as adjuncts to their current business.

This would indicate GIS use will be in a project specific model with these firms, following the path already pursued by local government, as referenced by McDougall et al. (2002). To move beyond this level of use will require a vision for GIS in the organisation that recognises the benefits of improved data, leading to operational effectiveness, as well as a desire to innovate with new products and approaches (Chan & Williamson, 1996; Sieber, 2000; Budic, 1994). Justification will need to consider both the tangible and intangible benefits and costs of GIS implementation, and business operations must be able to supply the necessary financial resources to take the implementation project through to the point of achieving the identified benefits.

6.3 Impact on the Surveying Profession

Numerous comments on the questionnaire indicated there is already an impact on the profession from the growth in a wide range of spatial services outside of traditional surveying. Many respondents noted an inability to attract suitably qualified and experienced people to their firm to undertake land surveying projects. Williamson (1997) appears to have accurately predicted this situation with the observation that the traditional cadastral surveying base, which is so often seen as an indicator of the health of the profession, has been in decline since the 1980's, with 30 percent or less of Australian surveying graduates going on to cadastral registration nationally in the 1990's. Over the same time period Williamson (1997) notes that surveying graduate numbers in Australia have steadily fallen from a peak of over two hundred per year to a predicted one hundred per year in the early part of the twenty first century.

Trinder and Li (1996, cited in Williamson, 1997) concluded, after examining employment trends for traditional cadastral surveying services, that:

- 'there will be little if any growth in demand and if current increases in productivity continue then there may be a reduction in demand.
- based on the current numbers of surveyors being produced by universities and seeking registration, and the current age profile, then there is the possibility of a shortage of surveyors in 5-10 years.
- accepting a possible short term increased demand for surveyors, the long term future is for a smaller profession with limited growth potential' (pg 2).

Williamson (1997) also discusses the changes that have taken place in surveying education and the fact that while the basic science component and the cadastre, land and environmental management and land development have remained at a constant level of curriculum content, the measurement sciences have been significantly reduced to allow for growth in information technology and GIS. This provides surveying graduates with a broader range of career options in the spatial sciences without the necessity for registration. Graduates in other spatial disciplines and engineering are also increasingly developing the basic skills in field surveying as the technology becomes easier to use.

It was considered by Williamson & Feeney (2001) that a driver of SDI evolution is the role that land administration plays in the economic, social and environmental priorities of society and that the measurement science and land management skills of professional surveyors are an area of strength. While cadastral information is seen as an integral part of any SDI, there is no evidence that the entire cadastral industry has been included in its ongoing maintenance through any shift away from the organisation specific constraints common with many government bodies. The questionnaire showed that private surveyors are not knowingly involved with any SDI initiative, yet this must occur in the future as those organisations currently collecting spatial information discover the need to keep this information updated in increasingly shorter timeframes and by necessity, partner with the industry to achieve this result.

We are now coming towards the end of the five to ten year window used by Trinder and Li, and the questionnaire responses are confirming a shortage of surveyors and surveying field staff. While there appears to be no shortage of work for land surveyors the demand may soon plateau at a level that matches the number of available surveyors simply because some projects cannot be undertaken. In this circumstance clients will look for alternative methods to achieve their outcomes, especially if the use of a surveyor is not required by government regulation. This is a dangerous outcome for the profession, for when clients find alternatives to using a surveyor they may decide to do all their non-regulated work that way. The developing SDI's in Australia may soon be an early indicator of this trend, since the cadastral base is only a small component of the necessary information and many other spatial professionals could provide the necessary update service.

6.4 The Role of Digital Data

Respondents to the questionnaire all valued access to digital data for their business. However digital spatial data is increasingly a commodity required by the general community for a range of functions in both business and personal lives. While much of this data is cartographic in nature it was originally sourced by surveyors and is prepared and, in many cases, presented using a GIS for the end user. However the questionnaire showed that surveyors are reluctant to share digital data outside of their direct clients project.

Again taking the related industry as an example, McDougall et al. (2002) said GIS systems in local and state government organisations were developed to service the day to day business needs of the organisation and were done in isolation of the larger spatial data community. It is only recently that the value of linking of disparate datasets to create state and national datasets has focussed attention on their wider use. Also, while there are both technological and institutional issues with data sharing between the various levels of government, it is the institutional issues that continue to present the greatest challenge since technical issues are regularly resolved by technology advancement. This leads to consideration of trust, which is defined by Harvey (2003) as 'an indicator of people's willingness to place faith in relationships and institutions in which they have limited influence' (pg 29). Trust provides the framework within which the institutional issues can be resolved.

Many responses to the questionnaire mentioned several of the institutional issues described by McDougall et al. (2002) and thereby indicated a lack of trust in the government bodies with whom they interact. If private surveyors are to be engaged in the growing arena of spatial data infrastructures this trust must be fostered by the surveying industry after fully considering the wider use of spatial data in the community, rather than following the exclusionary path initially taken by local government. Equally the general community sees digital data as a commodity that should be available to satisfy their needs. If surveyors are involved in the creation of these community products then the community will get quality spatial data, although the community has a need that will be satisfied irrespective of the surveying professions involvement. The general community has no way of measuring the quality of spatial data in the

commodity products it uses and it is up to the spatial professions to manage the delivery of appropriate quality for the known purpose.

6.5 Implementation Issues

While GIS is a technical tool, when used in its full organisational enabling form it will create many organisational and cultural issues. In its widest sense, bringing information products to the wider local community will now demand the use of the Internet as a delivery mechanism. As described by Coleman et al. (1997) any notion of control is largely irrelevant with the Internet and this can be very unsettling to an organisation already using traditional processes for spatial data distribution. This is also the case with the development and implementation of standards, which often take years under traditional structures yet can be completed often in less than a year within the Internet community. For the surveyor, the Internet will open up access to their products to many new users, including potentially to international scrutiny. Coleman et al. (1997) concludes that additional overheads will be incurred through requiring additional resources and 'While the new mix of system and human resource requirements will become clear over the longer term, the organisation must be able to withstand a period where the imbalance between these two will affect its ability to services customers effectively' (pg 7). This is the implementation effect of introducing a revolutionary technology.

Data is also an implementation issue when considering GIS. The ability to identity a specific type or theme of data and then establish from where it can be acquired is considered by Pienaar & van Brakel (1999) to be one of data acquisitions 'greatest operational problems and costs' (pg 365). As mentioned in chapter two, the surveyor who wants to use and distribute digital data they must consider the following three user criteria from the perspectives of being both a digital data user and a digital data supplier:

- 'consistent, quality digital data that can be relied on for long-term use.
- geographic files, standardised according to widely-accepted industry protocols and formats.
- an affordable price' (Wilson, 1997 as cited in Pienaar & van Brakel, 1999).

For the surveyor to engage in data sharing they must become spatial data managers, adhering to industry standards and providing consistent and complete metadata about the information they are contributing. To undertake this recognises the value and overheads of data custodianship. Many respondents to the questionnaire indicated their principal surveyors were already required to be data managers.

For any survey firm its people are its value and this will continue to be the case as technology evolves. There is a large demand for spatial professionals in many industries and the survey firm that has a vision of providing spatial data and value adding services will be competing in the wider employment marketplace for appropriately skilled individuals. To implement this move in business services will require an evaluation of the skills needed by the business and the development of strategies to achieve to results. Given the reduction in graduates previously discussed and the broad market for their skills, this may be the most difficult constraint to overcome. While in the short term training strategies and revised employment conditions may fill the gap, the long term solution is to have more people graduating into the profession. The implementation issue is therefore one for the spatial industry to demonstrate continuing relevance to society and foster the attractiveness of a spatial career.

6.6 Conclusion

This chapter has brought together all the research conducted for this project to discuss the issues for the private surveying industry when they undertake the implementation of GIS with a view to creating value added services. This discussion provides the basis for the following conclusions and recommendations.

CHAPTER 7 CONCLUSIONS

7.1 Introduction

The aim of this project was to investigate the feasibility of the private survey practice providing value adding spatial data services to their clients and the local community, thereby acting as a local spatial data custodian. This chapter takes all of the preceding analysis and discussion and presents the outcomes of my research and recommendations for further work which should be undertaken.

7.2 Research Outcomes

i. **Feasibility remains inconclusive for the private surveyor to be recognised as a local community spatial data custodian**.
Diffusion of GIS technologies is still in the early stages with surveying firms. GIS is one of a number of product toolboxes rather than part of the operation of the individual firm and in general the cadastral surveying sector of the spatial industry.

ii. **Feasibility of GIS as part of the surveyors product toolbox has been demonstrated by this research.**
Many surveying firms already have the technical infrastructure, including GIS software and people experienced with its use, and provide some value added services to their clients. There is a growing community demand for digital

data in GIS form and therefore a market that surveyors can satisfy. Feasibility therefore is already demonstrated in the surveying profession.

iii. **The income of a survey firm must be sufficient to cover the costs of non-surveying staff if GIS is to develop.**

For a firm to utilise GIS for value added products, this research has shown that they need to have a staff structure that contains at least one non surveyor for each three surveyors. This is most likely to be achievable as a firm approaches ten staff, since this appears to allow at least one person to be dedicated to product presentation and researching improvements in product presentation using GIS.

iv. **Digital Data is available to the surveyor to create value added products.**

Access to digital data was described by many respondents as a problem, but the research for this project demonstrated that a very wide range of data is available for use by the firm and can be licensed for creation of derivative products. The only constraints with digital data is the ability to find a source of appropriate data for the firm's needs and the provision of finance for the necessary licences.

v. **Surveyors will face many more organisational and cultural issues in adopting GIS than technical issues.**

The major software suits in use by the spatial industry provide for data interoperability between them without significant effort and the industry is increasingly consolidating on some accepted standards for data interchange that will facilitate this even further. However, GIS is revolutionary technology and will precipitate change in the organisation and the people who work in the organisation.

7.3 Achievement of Objectives

This project commenced with five objectives as documented in the Project Specification reproduced in Appendix A. In relation to these objectives the project has:

i. Reviewed the experience in other industry sectors, principally state and local government, extracting lessons that can be applied by the private surveyor when embarking on the implementation of GIS with a view to creating value added spatial data services.

ii. Investigated a number of constraints to the establishment of this type of service and found that many of the constraints were in the control of the surveyor.

iii. Determined some of the characteristics of a survey practice that would facilitate provision of value added spatial data services.

iv. Analysed the issues raised.

v. Presented conclusions about the feasibility of value added spatial data services.

While these objectives were achieved, it is recognised that the small sample size of the project means that the conclusions should be verified through a further research activity.

7.4 Further Work

The conclusions reached in this research have been based on a very limited set of information and for the benefit of the profession this information needs to be expanded and the conclusions re-evaluated. My recommendations for further research in this area are:

i. **Conduct a similar survey with a larger number of surveying firms across all states and territories of Australia.**
   A high response rate will require individual contact with each firm, particularly the larger firms who may provide the most interesting results.

ii. **Engage with the professional bodies and academic institutions to discover any statistical information available on the make-up of the profession.**

This will provide a broadly based context into which conclusions can be drawn with confidence.

iii. **Expand the research into the types of products that a local surveyor could successfully market.**

This will provide the benefit side of the cost / benefit equation.

iv. **Review in depth the emerging technologies that facilitate surveyors use of GIS technology.**

Such as surveying data capture tools, optimised data manipulation and analysis, and presentation particularly through the Internet.

APPENDIX A Project Specification

University of Southern Queensland

FACULTY OF ENGINEERING AND SURVEYING

ENG 4111 / 4112 Research Project

PROJECT SPECIFICATION

FOR: **Colin Wilcox**

TOPIC: The private surveyor as a spatial data custodian in the local community.

SUPERVISOR: Mr Kevin McDougall

PROJECT AIM: To investigate the feasibility of the private survey practice providing value adding spatial data services to their clients and the local community.

PROGRAMME: **Issue A, 22 March 2004**

1. Research the experience of other industry sectors in Australia and overseas, as it applies to this problem, where they have engaged in the provision of value added spatial data services.
2. Investigate the key constraints that exist to establishing such a service within the private survey practice, and whether these constraints can be relaxed or removed easily.
3. Ascertain the necessary characteristics of a survey practice that would make it possible to engage in the provision of value added spatial data services.
4. Analyse the issues raised and any methods proposed to address them.
5. Develop appropriate conclusions about the feasibility of value added spatial data services based on this research

AGREED:

Colin Wilcox
(Student)
(dated) 15/3/04

K McDougall
(Supervisor)
15/3/04

Figure A.1 Project Specification

APPENDIX B Questionnaire Form

Research Project Questionnaire

Outline

Who Am I

I am a final year Surveying Degree student with the University of Southern Queensland. During this year I am completing a research project that begins to address an issue in the field of surveying. In undertaking my research I wanted to conduct a survey with members of the profession using this questionnaire.

Project Background

In broad terms my research project is looking "*To investigate the feasibility of the private survey practice providing value adding spatial data services to their clients and the local community*". The surveyor is recognised in the spatial community as a significant source of up to date and accurate spatial information and many survey practices are involved in providing spatial products to their clients. But how much of the collected survey information could be leveraged to provide value adding services to other clients with similar needs and to the local community.

My review of academic literature indicates that for a survey firm to provide this type of service a geographic information system (GIS) would need to be the key business system. This raises a number of questions about practice size, services offered and data sources necessary to support this type of system.

In establishing feasibility I am only looking at the technical aspects as a first step upon which others can build. The much wider question of what products and services can be offered in the marketplace is a very individual problem that will need research over a much longer timeframe than was available for my project.

The Questionnaire

My questionnaire has been kept short so that it does not require a large amount of your time to complete. As a second step in the survey process I will be looking to conduct some in-depth discussions with representative survey firms to give a deeper understanding to the information collected from the questionnaire.

All responses to this questionnaire will be reported as statistical aggregates only so that the privacy of information for an individual business is maintained.

Project Questionnaire

Please complete all relevant questions and attach any further comments if there is other information you would like to contribute.

Practice Size

1. How many people work in the firm _ _ _ _ _

2. How many are carry out surveying duties _ _ _ _ _

3. Are there other professionals (Y/N) ☐

If Yes, please list their professional specialty.

Surveying Services

4. Please give a list of your surveying services.

Continued on Next Page

Colin G Wilcox (Student)

University of Southern Queensland

FACULTY OF ENGINEERING AND SURVEYING

ENG 4111 / 4112 – Research Project

Figure B.1 Questionnaire Page 1

Some of the following questions will ask you to rank the importance of the item to the practice. The ranking scale is:

0	1	2	3	4	5
Not used	Not very important	Not important	Neither	Important	Very important

Computer Technologies

5. Please rate the importance of survey reduction & analysis software to the firms' business. (0-5) ☐
Approx. how many licences are in use. _____

6. Please rate the importance of CAD software to the firms' business. (0-5) ☐
Approx. how many licences are in use. _____

7. Please rate the importance of GIS software to the firms' business. (0-5) ☐
Approx. how many licences are in use. _____

8. If you use a GIS, is it used:
(a) for analysis/presentation of products (Y/N) ☐

(b) for managing the firms corporate knowledge (Y/N) ☐

9. Do you think there will be a merging or consolidation of surveyors software toolsets in the near future (Y/N) ☐

If yes, which ones will likely dominate.

Sources of Basic Data

10. How important is access to electronic data, for use as base data, to your delivery of services.(0-5) ☐

11. Have you ever used base data to create a value added product for a client (Y/N) ☐

12. From which organisations do you acquire basic data such as searches, digital cadastral and topographic map bases, other digital map bases incl. photo and satellite.

13. What factors do you consider need to be addressed to facilitate a culture of data sharing by the surveying profession. In your opinion will this ever occur.

14. Do you share data with other organisations currently, either your data or theirs (Y/N) ☐

Spatial Data Infrastructure

15. Are you aware of the Australian spatial data infrastructure initiative (Y/N) ☐

16. If yes, do you have any business involvement with developing products under a spatial data infrastructure (Y/N) ☐

Business Futures

17. Describe briefly in which service areas you see the business growing and whether this will mean a growth in staff or a lessening of other services

18. Will any growth in your services require a change in your IT infrastructure (Y/N) ☐

19. What changing roles do you see the surveyor, as principal of a firm, undertaking as services change

Followup Information

20. Would you be interested in participating in a more in-depth interview at a later date (Y/N) ☐
If yes please provide your contact details.

Name _____

Address _____

_____

_____

Phone _____

Thank you for your input to this project

Colin G Wilcox

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Figure B.2 Questionnaire Page 2

APPENDIX C Digital Data Products

Geoscience Australia

A sample of the digital data products available from Geoscience Australia. While these are national coverage datasets at scales outside of the working range of a local surveyor, they may be useful digital bases for the local region (GA. (2), 2004).

Product	Notes	Price
1:100,000 Topographic Base	Price per tile, all themes. Bulk discount applies.	$108.00
Geodata Topographic 250K Series 2	All of Australia as 513 tiles and also as state/territory based CDROM packages	Free download $99 per CDROM package
Natmap Raster 250K	All of Australia	$99.00
Global Map Australia 1M	All of Australia	Free download $216 on CDROM
GEODATA 9 Second DEM	All of Australia	$99.00
3 and 18 Second DEM	Part of Australia	$99.00
National Public and Aboriginal Lands (NPAL) Pre-1998	All of Australia	Free Download $216 on CDROM
Australia's River Basins 1997	All of Australia	Free Download $216 on CDROM

Table C.1 Sample of Digital Data - Geoscience Australia

Land and Property Information (LPI) NSW

LPI NSW provides technical details on these digital data products through the Internet, with contact details for information on licensing and pricing policies (LPI NSW, 2000).

- Digital Cadastral Database
- Digital Topographic Database
- Scanned Aerial Photographs
- Satellite Imagery

ACT Land Information Centre

A sample of the digital data available for the ACT and the pricing structure for single use. Development of derivative products using this data is possible by commercial arrangement through a value added reseller agreement (ACTLIC, 2004).

- Cadastral Data – minimum charge of $231 with the total cadastre available for $2311.
- Additional datasets to the cadastral base covering a range of features such as road centrelines and casements, contours, building footprints etc. are available and calculated at a percentage additional cost to the cadastral base.
- Digital Orthophoto maps at a cost for the whole coverage of $28187.50 at 0.25 metre resolution and $14093.00 at 0.50 metre resolution. Prices for single tiles and bulk discounts are available.

PSMA Australia Limited

The Public Sector Mapping Agencies (PSMA) Australia Limited makes the following datasets available for value adding and distribution through value added resellers (PSMA, 2003).

- a National transport dataset
- a National cadastral database
- an Administrative boundaries dataset
- a Points of Interest dataset
- the G-NAF street address and associated geocode attribute database

Queensland Natural Resources, Mines and Energy (NRM&E)

A sample of the fees payable to develop derivative products using Queensland datasets (NRM&E, 2004).

Product	Developer Licence Fees
Digital cadastral data	Annual licence fee = $3000 Royalty fee = 20% of invoice to developer's customer Property boundaries 2004 on CD = $99 Comprehensive dataset = $2000 (once off supply)
Digital elevation (topographic)data	Annual licence fee = $3000 Royalty fee = 20% of invoice to developer's customer All available 1:25,000 map sheets = $2000 All available 1:10,000, 1:5000 and 1:2500 map sheets = $2000 All available DEMs = $2000
Digital property address data	Annual licence fee = $3000 Royalty fee = 20% of invoice to developer's customer Location 2004 on CD = $99 Comprehensive dataset = $1600 (once off supply)

Table C.2 Sample of Digital Data - QLD NRM&E

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