The Assessment of Information Systems Effectiveness in Private and Hospital Pathology

A thesis submitted in fulfilment of the requirements for the degree of

Doctor of Philosophy.

Markus Belkin

B.App.Sc.(MLS), RMIT

School of Business Information Technology

Portfolio of Business

RMIT University

January, 2009

Declaration

I certify that except where due acknowledgement has been made, the work is that of the author alone; the work has not been submitted previously, in whole or in part, to qualify for any other academic award; the content of this thesis is the result of work which has been carried out since the official commencement date of the approved research program, and there has been no editorial work, paid or unpaid, carried out by a third party on this thesis.

Markus Belkin

January, 2009.

Abstract

This research investigates the role of laboratory information systems on business outcomes in medical pathology in Australia. Medical pathology laboratory information systems are inherently large-scale systems handling large numbers of data daily to service not only the medical laboratory itself, but also the referring medical practitioners. Patient results are often required in a 'mission critical" time frame.

This research confirms, through a survey and three focus groups, that pathology laboratories are unable to undertake strategic information system planning (SISP). An organisation achieves the highest stage of strategic information system planning if it possesses an IT/IS strategic plan, fully aligned with business goals, which accurately references, at any point in time, current or target IT themes which provide data of high quality, accuracy, availability, and shareability for informed decisions that will give the organisation a competitive advantage.

This research has found that the factors that are critical to strategic planning in pathology laboratories in Australia are (a) laboratory information system capability (b) business-IT alignment (c) strategic spending (d) research and education (e) end-user involvement and (f) information system effectiveness.

In both a survey analysis and focus groups, the impact of the laboratory information systems on business outcomes in pathology in Australia was visible from the pre-planning phase. The key findings from the research are that the laboratory information system is regarded by multiple departments of the health industry as a commodity and therefore is regarded as having no strategic value. This long held view has created a situation whereby pathology as a whole is regarded with little or no priority for funding in hospitals in Australia. Spending in private laboratories is functional and not strategic. Financial considerations provide for internal functional enhancement of the private pathology business that rarely involves the laboratory information system. Any enhancements to the laboratory information system are restricted to being functional.

There is a clear distinction between the functionality and the capability of the laboratory information system. The laboratory information system lacks the capability for integration with, and the use of, modern technology. There is no possibility for the laboratory information system to complement and enhance the strategic components of such activities as international expansion of private pathology in Australia. There is a lack of pressure within the private pathology industry in particular to take steps to develop the capability of the laboratory information system that may be attributed to a three-way monopoly in private pathology in Australia. A lack of active research and lack of formal education into management and SISP in the medical and pathology industries is also a contributing factor to the acceptance of the existing status of laboratory information systems capability.

The lack of capability of the laboratory information system prevents the laboratory information system from fulfilling any strategic role. The ramifications of this are that contributors to successful SISP, such as business-IT alignment, are unable to occur. This then prevents effective SISP and hence the assessment of information system effectiveness to the detriment of business outcomes for pathology in Australia.

Abstract

This research provides a clear picture of a number of issues contributing to a lack of ability of medical pathology laboratories in Australia to undertake SISP. The research has also highlighted, through the concepts of a hypothesised relationship between SISP and information systems effectiveness measurement, a means and a mechanism for change. The adoption of the principles of this research would assist in the achievement of a more uniform approach to laboratory information systems in Australia that would be beneficial to patients and pathology business alike.

Acknowledgements

It is difficult to name all the people who have helped in this research over the last number of years. To all who have helped, directly and indirectly, I am forever grateful for your contributions.

First of all I would like to thank my wonderful, and very patient wife Jan, whose support for me, not only in this venture but throughout our married lives has been nothing short of incredible. Jan’s belief in me and her encouragement is most inspiring.

To my senior supervisor, Professor Brian Corbitt, I owe an enormous debt of gratitude. At a time of conflict and confusion pertaining to my studies, Brian quickly focused my research and clearly pointed the way forward. What I have achieved in a relatively short period of time is in the main due to Brian’s ability to inspire and lead.

A special thanks to Associate Professor Anne Rouse without whose statistics tutoring I could not have completed my work. Dr. Zijad Pita also assisted considerably in this area, and contributed time and input in the final readings of this thesis.

My second supervisor, Dr. Konrad Peszynski has made a significant contribution to my research planning and writing skills.

Dr. France Cheong and Dr. Alemayehu Molla in their roles as doctoral candidate coordinators, provided for all we doctoral candidates a fruitful, diverse and interactive learning environment through the research seminars and social gatherings they organised. Hendry Susilo has been a great help with IT support to me (and others in the school) – his quick responses were much appreciated. To all the other academics of the school, thank you for making me feel a part of the academic and research community of the school, and for your encouragement in my endeavours.

The assistance of my good friend, Dr. Adrian Freedman in helping to understand and work with the nuances of desktop publishing is much appreciated.

Last, but by no means least, I would like to thank all the laboratory staff who undertook to participate in the project by way of completing surveys and participating in the focus groups.

Table of Contents

Table of Contents

Table of Contents

Table of Contents

List of Figures

List of Tables

List of Tables

CHAPTER 1 - INTRODUCTION.

1.1 Background.

This thesis reports research concerned with the assessment of medical pathology laboratory information systems effectiveness, and in what way information system effectiveness impacts on the medical pathology business. The study focused on determining the level of Strategic Information Systems Planning (SISP) and by what means information system effectiveness is measured, in private and public hospital pathology laboratories in Australia.

Over the past 20 years medical professionals have increasingly become dependent on the expanding range of sophisticated diagnostic services provided by clinical laboratories (van Merode *et al.,* 1996; Boran *et al*., 1996; O'Moore *et al.,* 1994; Bossuyt *et al.,* 2007; Friedberg, 2008). Automated analytical instruments generate an ever-increasing variety and volume of test information at ever-increasing speeds. In terms of healthcare, this development has been a significant benefit – helping physicians to diagnose and treat illnesses accurately and quickly and to monitor recovery closely (Bender and McNair, 1996; Bossuyt *et al.,* 2007).

The modern pathology laboratory, whether private practice or hospital based, is a complex, heterogeneous environment, typically with a mix of autonomous and partially interworking applications running on a range of hardware platforms. A consequence is that bigger laboratories today are entirely dependent on their IT functionality and that the pathology laboratory IT solutions must be considered as 24 hour mission critical systems (Bender and McNair, 1996; Wells *et al.,* 1996). Most of the current laboratory information systems are mainframe systems, using older software languages and with little flexibility in terms of rapid programming, graphics display, integration with developing technologies and real-time analysis of management data (Boran *et al.*, 1996; Brender and McNair, 1996; Belkin *et al.,* 2008 [Appendix A]). The current systems were introduced at the end of the 1960s/early 1970s with the advent of the first auto analysers, which enabled a larger number of tests to be performed in a shorter time period. At this time, the main task that was required of the laboratory information systems was that of a database to store demographics and simple data. Over the next 20 years, the laboratories and the number of tests available expanded quickly and associated development of laboratory information systems in pathology did not eventuate (Bender & McNair, 1996).

Rapid evolution of pathology laboratory procedures, methodologies and equipment characterises the clinical laboratory. The development of pathology laboratory science is so rapid that a vendor organisation has difficulty in absorbing, digesting and practically incorporating new enabling technologies/techniques into their version of a global laboratory information system (Bender and McNair, 1996; Boran *et al.*, 1996). Major investment has been made in IT in pathology laboratories, which cannot be ignored. Hence, it is necessary that an IT solution is future viable and able to incorporate already installed IT functionalities (Wells *et al.,* 1996). Experience has shown that within the operation of a laboratory, the processes tend to bend, break or refine the work processes in order to cope with the individual ad hoc service needs (Brender and McNair, 1996). The current laboratory business model suffers from fragmentation, redundancy and excess capacity. Such a model has competitive disadvantages and is no longer adequate in the new reality of cost containment and competition (Bossuyt *et al.*, 2007). IT plays a role in overcoming fragmentation, excess capacity and redundancy through consolidation and integration, and contributes to improved cost efficiencies through enhanced diffusion of state-of-the-art-technologies and improved turn-around times (Bossuyt *et al.,* 2007; Porter, 2004; Zinn *et al.,* 2001).

The advent of "middleware" as a means to link otherwise incompatible functionalities has grown as an industry in pathology laboratories in Australia and internationally as a result of more stasis in laboratory information systems development in Australia. Middleware is a term used to describe the many different software packages that are available for a variety of information purposes, from a range of vendors including instrument manufacturers (Friedman, B., 2005; Torke *et al.,* 2005). This type of software generally sits between an analyser and the laboratory information system in an ad hoc manner and is required to provide functionality not possible from the laboratory information system alone by linking the analyser to the laboratory information system. The main direction in development of middleware has been auto-verification of patient results and process engineering in an attempt to reduce result turn around time. Middleware is rapidly expanding in use and functionality and some see it as a replacement for the limited functionality of laboratory information system in its current form (Friedman, B., 2005; Torke *et al.,* 2005).

It is interesting to note in the literature on middleware and its implications that there is no reference made to the design process of middleware and there are apparently no business-oriented components available. There is certainly no consultation between the vendors of the middleware and the potential laboratory users as to the design of the middleware and its supporting information system architecture – this is an example of misalignment in medical laboratories. Perhaps the benefits of middleware are superficial in the business context and are accepted by the medical profession because of the perception of a lack of understanding of SISP in medical laboratories. This perception will also be investigated in this thesis.

The establishment of open architecture systems implies that a market will develop for modular, scaleable, and cost-effective laboratory information system functionalities, able to be incorporated in a ‘plug-and-play’, fashion without the dependence on individual manufacturers and hardware/software platforms which characterise current systems. Bender and McNair (1996) and Boran *et al.* (1996) stressed as one of the main design requirements that the system must be highly flexible and maximally customisable – by the users themselves. More recently, this view has been expanded to indicate that pathology laboratory professionals can differentiate themselves not only by their technical skills but also by being involved in the creation, distribution, and application of knowledge related to laboratory aspects of patient care. Such extra service should be recognised and implemented in the business strategy (Bossuyt *et al.*, 2007; Friedberg, 2008).

There has emerged a growing recognition of the relationship between information system facilities and strategic development in medical laboratories. This was developed in the literature review in terms of the components of SISP, that is, business-IT alignment, cost benefit analysis (financial considerations) and end-user involvement in the planning process. The literature was examined to elucidate those factors influencing the effectiveness of information system in general, and for pathology laboratories in particular, to ascertain the issues relevant to the perceived sub-optimal performance of laboratory information systems and ineffective SISP in pathology laboratories in Australia.

1.2 Problem domain.

The current overall situation of pathology laboratory information systems and management led the researcher to the problem domain. The pathology laboratory community could benefit from a deeper understanding of what is involved in laboratory management, and more specifically, what enables successful SISP and information system effectiveness measurement. An improved understanding of SISP and information system effectiveness measurement may lead laboratory management to more efficiency, improved cost-effectiveness and improved competitive advantage, that is, more positive business outcomes. The focus of this study is both objective (quantitative) and subjective (qualitative). This research was interested to know how the medical pathology laboratory currently approached its management and information systems development, and what are the contras to positive outcomes. In particular, this research was interested to see if some of, or all of the recognised contras to SISP and information system effectiveness (end-user involvement, business-IT alignment, cost-benefit analysis, UIS) in other business verticals applied to the medical pathology laboratory. The researcher was interested to know what the medical pathology laboratory understands of SISP and information system effectiveness measurement – a lack of knowledge of these two processes may be identified as a contra to them in its own right.

In addition to these recognised contras to SISP, the research explored the role of the laboratory information system from the perspective of its functionality along the lines of "task-technology asynchrony", that is, the inability of the laboratory information system to accommodate new and/or enhanced functionality through a lack of technical capability. The role of research and education and its impact on SISP awareness was investigated as a possible significant, but largely overlooked contra to successful SISP and information system effectiveness. Research and education was investigated in the context that a lack of awareness and knowledge of systems technology and business principles by stakeholders precludes them from be able to contribute to SISP.

1.3 The research question.

The motivation behind this research is that very little, if any, investigation has been undertaken into information system effectiveness and SISP in pathology. This is thought to have a potentially negative impact on the pathology laboratory as a business. The identification of a source of inadequacy in the planning and assessment processes in SISP and information system effectiveness measurement could be advantageous to the profession, and would enable research and development into processes and procedures to ensure enhanced business outcomes.

There have been studies conducted in an attempt to improve the efficiency and cost effectiveness of pathology laboratories, but these studies do not embrace SISP and some take such approaches as accounting and workflow statistics. Goldschmidt *et al.* (1998) looked at the functional processes of workstations in the pathology laboratory with the view that staff should be assigned to a workstation when it was active. They proposed coordination of the workflow with the assessment of the state of activity of the workstation and developed planning rules to assign staff to achieve 100% efficiency. The rules are very complex and require an understanding of advanced mathematics – something well outside the scope of laboratory staff. Their study did not account for redundancy of time, that is, when the laboratory was not busy, and they did not consider the effect or control of peripheral services to the laboratory department, such as specimen delivery.

Revere and Roberts (2004) took more of an accountant's perspective in an attempt at improving cost efficiencies by combining the same services (pathology specimen delivery) of a group of hospitals. Through the use of a modelling process using commercial software, the hospitals were able to develop a seven-day rotating roster – this enabled shorter specimen delivery times to the hospital laboratory that in turn shortened turn around times for results. The exercise also saved 16.4% per annum in courier wages.

Mayer (1998) also took a financial approach to improving cost efficiencies in pathology laboratories with the use of commercially available cost analysis software. The software is a management tool that compares costs of procedures and activities. This information could then be used for evaluation of operations and decision making for the laboratory.

These studies, which consider only one aspect of the overall management of a laboratory (business), are time consuming and require outside skills to perform. They do not align with any SISP components and do not consider other aspects of the planning process. They may therefore be regarded as functional and not strategic studies. It is significant that with these three approaches, outside software and specialised people were required to develop and perform the processes, and that laboratory staff in general were not consulted or involved in the planning process. The OpenLabs project (Boran *et al.,* 1996), on the other hand, approached the problem of an information system change from the SISP process perspective. The consortium members included partners from industry, academia and laboratory services and they worked as a close-knit team to develop specifically identified and detailed change items. In the process used by the OpenLabs consortium, such SISP components as end-user involvement, business-IT alignment and pre-planning partnering were applied to ensure a successful outcome. The measure of success of the OpenLabs project was measured by the achievement of the original business objectives (Boran *et al.,* 1996; O'Moore *et al.,* 1994).

The researcher explored and reported on the reasons why there is not a broader approach to SISP and information system effectiveness measurement in pathology laboratories, paying particular attention to the role of the existing laboratory information system. This motivation led to researching the following question:

How does the effectiveness of laboratory information systems impact on business outcomes in medical pathology practice?

This also raises the following sub-questions: *Does SISP occur in pathology in Australia?* and *What are the determinants of information system effectiveness in pathology laboratories in Australia?*

This research identified the components of effective systems planning in pathology practice and gained a better understanding of the elements involved and their effect on business outcomes for pathology practices. It was of particular interest to the researcher to understand by what means a pathology laboratory information system is deemed effective in pathology laboratory practice, this interest having arisen from his criticism of current methods of assessing information system effectiveness as seen in the literature (Belkin *et al.*, 2008). This study provides the potential, through the gaining of these insights, to develop a more standardised approach to SISP and information system effectiveness measurement in pathology laboratories in Australia.

The objective of this study was to review the role, influence and importance of laboratory information system effectiveness and SISP in pathology laboratories in Australia. This research is unique in applying recognised models, ideas and philosophies to pathology practice, and demonstrated that a more cohesive approach to planning and outcome assessment will enhance the business gains and flexibility of the pathology industry. It is also envisaged that this study will stimulate further research in this important area of medicine. Chapter 2 introduces the background, evolution, role and significance of the models, ideas and philosophies to be applied to the business and planning processes in pathology laboratories in this research.

1.4 Research approach.

The work undertaken within this project has no models in pathology laboratory research on which to be based and compared. The researcher undertook the quantitative component to obtain from many laboratories in Australia (Melbourne, country Victoria, South Australia and Western Australia) a 'snap-shot" of the industry. From the analysis of this component, a series of questions was developed and put to three focus groups (the first with hospital laboratory staff, the second with private pathology staff and the third with academics and consultants familiar with SISP). The focus groups gave a more expansive insight into the research and added further comment to the findings of the survey.

1.5 Structure of the Thesis.

Chapter Two provides a review of the literature on SISP and information systems effectiveness, specifically the relationship between them, the process models, and previous and recent studies. A discussion on their weaknesses with regard to their uni-dimensional nature and the inappropriate use of indicators for information systems effectiveness measurement then follows. A SISP and information systems effectiveness design platform will then be discussed and presented as an alternative to current thinking on the basis that the new model suggests a more structured relationship between SISP and information systems effectiveness whereby information systems effectiveness is a measure of pre-determined SISP business goals. From this study, the findings will be applied to assess the degree of SISP and information systems effectiveness currently undertaken in pathology.

Chapter Three examines the literature on SISP and information systems effectiveness measurement with respect to their application and use in medical pathology practice. The research hypotheses will be determined at this stage. The proposals for the research instrument investigating the hypotheses will be extracted from the review of existing research in Chapters Two and Three.

Chapter Four will discuss the approach taken in this research. A combination of quantitative and qualitative research methodologies will be used to obtain a view of the current state of SISP and information systems effectiveness measurement processes in pathology practice, to design a set of questions for the focus groups and to ultimately provide a richer understanding of the phenomena under study. The qualitative element is also functional in triangulating this research back into the existing literature on SISP and information systems effectiveness measurement. Triangulation, in the context of this research, is taken to mean the relationship between the literature and the research methodology at different points in time in the overall research process. Initially, the literature provides a groundwork from which relevant information is sought to assist in framing the research methodology (survey questions in particular). The relationship between research methodology and the literature is reversed after the data analysis is completed and the results are referred back to the literature for cross examination and validation. The relevance of the research may also be assessed as to its contribution to the body knowledge by this method of triangulation.

Chapter Five presents and discusses the quantitative data and will ascertain whether research hypotheses derived from Chapters Two and Three are supported or rejected. By providing this detail, the researcher is able to ascertain the direction and extent of systems planning and effectiveness measurement in pathology practice. To enrich the elucidated information from the survey analysis, a series of questions is formulated to put to the participants of the three focus groups.

Chapter Six presents the structure, site and participant characteristics of the focus groups involving both hospital and private pathology laboratory workers. Each question will deal with a specific proposal that was derived from the literature review and that has had initial evaluation following analysis of the quantitative data from the survey.

An additional aim in conducting the focus groups is to illicit additional information and discussion complementary to the questions put to participants. The focus groups will also used as a method to ascertain if other factors are important. Chapter Six will then report on the content and contexts of the discussion that takes place in the laboratory workers focus group.

Chapter Seven details the structure, site and participant of a third focus group involving academics and practitioners with experience in researching, teaching and practical involvement with SISP and information systems effectiveness measurement. This focus group is used to triangulate the research back into the literature and help align the research with other schools of thought on SISP and information systems effectiveness.

Chapter Eight presents an overall assessment of the research and its implications. A discussion on the degree of SISP and information systems effectiveness measurement in pathology is discussed. The ramifications for the findings for pathology in a business and management context will be discussed, and an assessment for what the future position of pathology in the rapidly developing technical arena is examined. A comparison of the existing means of assessing information systems effectiveness as presented in the literature and compared to the means of assessment presented in the new model developed during this research is presented. The final part of Chapter Eight addresses topics for further and future research into matters and findings arising from this original and exploratory research into information systems effectiveness and SISP in pathology.

CHAPTER 2 – SISP AND INFORMATION SYSTEMS EFFECTIVENESS MEASUREMENT – THE BROAD CONTEXT. A REVIEW OF THE LITERATURE.

2.1 Introduction.

Reviewing SISP experience throughout years of practice provides the knowledge base upon which to define the research model and test hypotheses. The internal and external environments of SISP are analysed in this chapter to better understand the constructs relevant for the scope of this thesis.

Today's information rich and knowledge-based business society relies heavily on Information Technology (IT) (Wang and Tai, 2003) and Information Systems (Rondeau *et al.,* 2006). The IT and information systems are designed to enable the business to operate effectively and hopefully create a competitive advantage. Firms gain benefit from aligning their information systems design and performance with the core business competencies and business goals of the firm (Grover and Segars, 2005; Burn and Szeto, 2000; Chan *et. al.,* 1997; King, 1998). There are multiple paths towards this end and inefficiencies and conflicts may arise when the firm's information systems strategies diverge from the business goals (Rondeau *et al.,* 2006). This is no different in the health industry where conflicts exist between information systems infrastructure and development, and business goals – that is to say, there is business-IT misalignment. The existence of inflexible mainframe based file sharing information systems that are unable to support modern technology, such as the Internet, telemedicine, wireless technology and real-time management software, and which suffer poor performance under load has compromised the business goals and business development in the health vertical to the extent that it has now fallen behind other comparable knowledge industries (Wells *et al*. 1996; Kaplan, 1987; Bossuyt *et al.*, 2007).

There are a variety of approaches in the literature that try to overcome the problem of misalignment to improve the efficiency of the design process. Hackney *et.al*. (1999) suggest that misalignment in information systems strategies, goals, and objectives may be avoided by increasing end-user involvement. Gerwin and Kolodny (1992) regard the implementation of cross-functional decision processes as a means to the promotion of interdependent work. This is typically achieved through the creation of greater work system integration. Cross-functional decision practices are infrequently referred to in the literature (Gerwin and Kolodny, 1992) and this implies a degree of single vision on the part of researchers when they refer to the planning process.

Where reference is made to more cohesiveness between information systems capability, independence of the information systems department and the alignment of business goals, there is no mechanism or detail given on how this is achieved. Grover and Segars (2005) claim that while there have been studies that examine the “what” questions in SISP, particularly concerning the issue of business – information systems alignment, there has been little on the “how” questions, which include the process of planning and whether this yields effective outcomes. The presumption that businesses will change their planning processes over time in an attempt to improve their effectiveness and leverage their investment in SISP is also raised.

In this study, SISP is investigated through the concept of a system that is defined by its behaviour, structure and evolution. Special emphasis is placed on the evolution and structure of SISP to find relevant constructs for assessing SISP. Important SISP constructs such as SISP approaches, methods, techniques and tools are critically assessed. Several other SISP constructs like alignment of SISP and business, and key stakeholders are discussed with respect to the key reasons for SISP success/failure.

SISP behaviour, structure and evolution are described to provide the grounding material for defining the hypothesis and to demonstrate the gap in the existing knowledge to be addressed by this research. This will indicate how the research question *“How does the effectiveness of laboratory information systems impact on business outcomes in medical pathology practice”?* was developed.

2.2 Strategic Information Systems Planning (SISP).

Strategic Information System Planning (SISP) has evolved in method and style over the last decade on the basis that it emphasises the need to bring IT to align with and sometimes influence the strategic direction of the firm. In rich IT environments this has a recognised relevance to competitiveness (Grover and Segars, 2005). The degree, to which IT aligns with the strategic direction of medical pathology private and hospital practice and the resulting impact on competitiveness of medical pathology practices, will be evaluated in this research. An approach to the investigation of this relationship will be determined in Chapter 3 as a result of reviewing the literature relating to SISP in medical pathology practice.

With the more recent proliferation of Internet-based computing, outsourcing, personal computers and user applications the trend is to push developmental activities outside the exclusive domain of professional information systems groups thus creating challengers that did not exist when SISP was first conceived. This has evolved into a proactive search by many firms for competitive and value-adding opportunities co-existing with the development of broad policies and procedures for integrating, co-ordinating, controlling and implementing the IT resource (Grover and Segars, 2005).

However, although much has been studied with respect to business and IT alignment, little research has been undertaken into the mechanisms of SISP, including process planning. Grover and Segars (2005) examined the evolution and maturing of SISP from the early 1970s and made several important observations. The work conducted in the 1970s was later supported by other researchers such as Sullivan (1985), Earl (1993), and Sabherwal and King (1995). Grover and Segars (2005) found that many studies focussed on planning content with particular interest in methods and measurement of alignment between business and IS strategy (Burn and Szeto, 2000; Chan *et al*., 1997; King, 1988). Grover and Segars (2005) observed that these studies did little to illuminate the organisational aspects of planning. Early studies by Pyburn (1983), in an attempt to identify institutionalised planning dimensions, actions and behaviours, made field observations which noted the existence of both a rational/structured process and a personal/informal process.

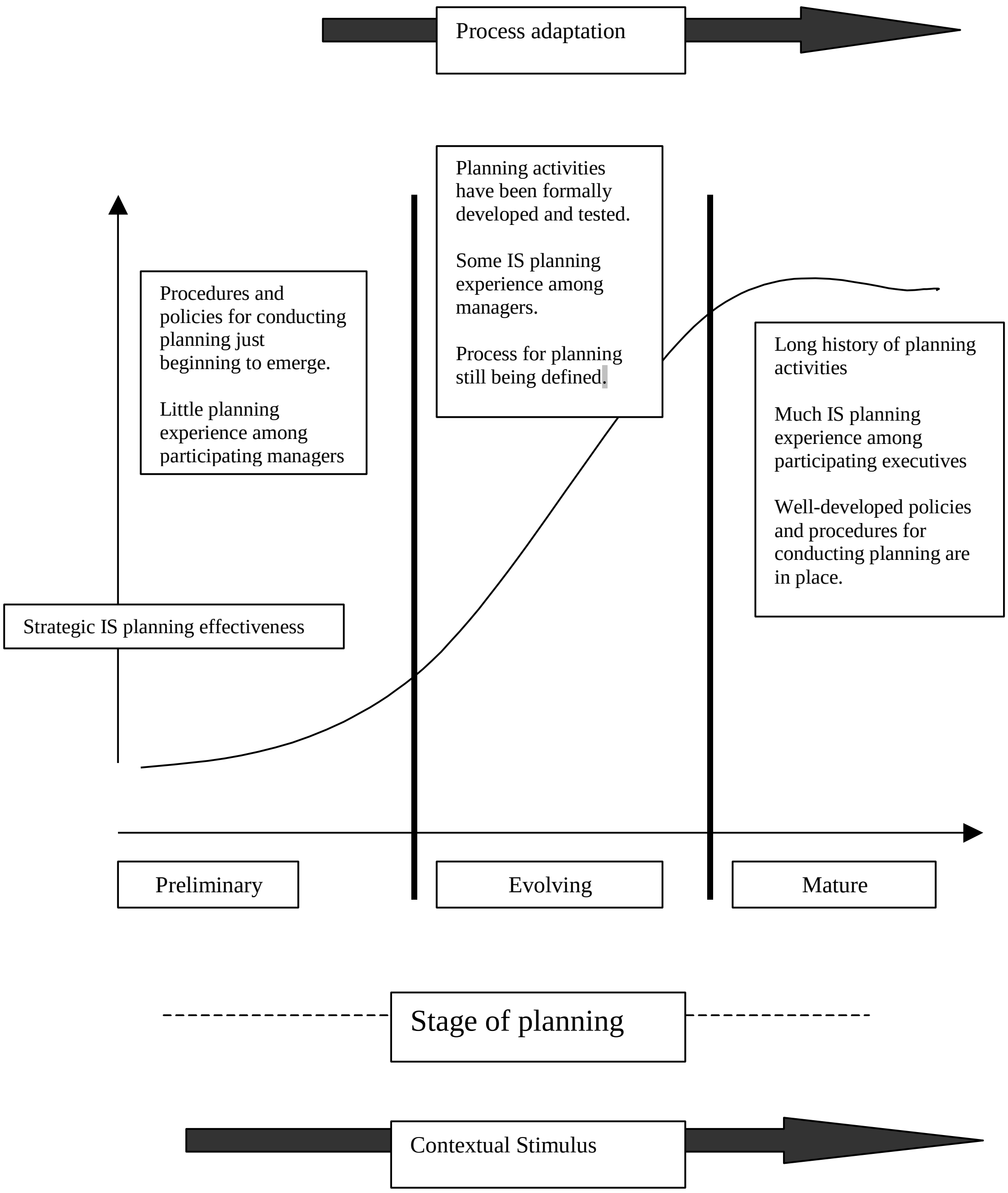

Figure 2.1 Strategic Information Systems Planning Model (Nolan, 1979).

Earl (1993) made similar observations when he distinguished SISP approaches based on the degree of rationality and adaptability built into the planning process. Earl (1993) however, noted a hybrid organisational system of planning which seemed to be more effective than the highly structured and less adaptable rational approaches. This observation was ratified by the work of Sullivan (1985) and Sabherwal and King (1995). Further research by several authors (Boynton and Zmud 1987, Zmud *et al.*, 1986 and Lederer and Sethi, 1998*)* has also implied that such systems may be necessary in order to manage increasingly diverse and dispersed technologies across the organisation.

2.2.1 SISP stages of growth models.

Evolution, or stages of growth models, is popular in organisational research and information systems planning. The best known of these being perhaps Nolan's stages of growth model (Nolan, 1979). In this model (Figure 2.1) Nolan proposed that the growth of computing follows an S-shaped curve through a preliminary phase in which planning procedures are beginning to be defined, an evolving stage in which planning activities are tested but still being defined and a mature stage in which procedures are in place. In terms of the experience of the operatives, the preliminary stage implies little or no planning experience, the evolving stage implies some experience and the mature stage implies a history of planning activities and much experience in the hands of participants. The suggestion that shifting the emphasis from "descriptive" to "prescriptive" can more effectively plan for and organise the computing recourse based on predictable stages is made by Nolan.

Nolan's (1979) hypothesis has been controversial and is perhaps dated for today's technological context (Grover and Segars, 2005). There is, however, a key implication that should be noted. Nolan (1979) suggested that his model could be viewed as a learning model where movement through the stages is influenced by the environment (changing technology) and the adaptation to that environment by internal adjustments – ultimately the stage of 'maturity' systems naturally mirror their context. Nolan's model has a degree of bi-directionality about it and has an in-built means for change management, placing it apart from the myriad of uni-directional models derived by other authors (Wang and Tai, 2003; Grover *et al.*, 1996).

Porter and Millar (1985) used the life cycle concept to illustrate how industries develop and how businesses adapt to pressure. Greiner (1972) described a model in which firms grew based on learning from crisis. Applegate *et al.* (1996) describe technology assimilation in firms that evolved through stages of "slack and control" to learn how to use new technologies more effectively. Magal *et al.* (1998) indicated that information centres evolved by adapting and learning from their client base, ultimately being treated as a major corporate resource. Henderson *et al.* (1987) also described their stages of end-user computing as a learning curve.

There is a common thread in the approaches of all of these authors in that their planning is based on undertaking a planning exercise with little prior experience, learning from crisis and mistakes, being influenced by external client factors and a 'change as we go' attitude. One would think that this approach is counter productive due to time lost in learning and sorting mistakes – any competitive advantage through information systems planning and technology could be lost. The planning process may be made more effective by way of more intense business analysis to define and align the information systems parameters. A means of evaluating the resultant information systems is also required (Irani and Love, 2001).

2.2.2 Information systems evaluation.

The difficulties in measuring benefits and costs of information systems are often the cause of uncertainty about the expected impact of information systems and thus, are major problems facing decision-makers. As a result, the information systems evaluation process is often ignored, or ineffectively or inefficiently carried out. The reason for this is that managers consider the evaluation process takes too long, costs a significant amount of money with little visible return, and involves too many people with departmental or individual political agendas (Irani and Love, 2001). Approaching any evaluative activity we need to consider the context of evaluation (who is evaluating and why), the process (how) and the content (what) (Symons, 1991). This is even more so in the field of health informatics where the traditions of medicine meet and interact with the information systems field (Klecun and Cornford, 2005).

As an example of evaluation difficulties in health informatics, we can consider the UK health sector. Policy has proposed over a number of years and formulations that information and communications technology can serve as a fundamental driver for reform and modernisation of the National Health Service (NHS) (DOH, 1997; 2002). The situation becomes yet more challenging when an organisation, like the NHS, is engaged in a range of complementary or interdependent change programs at the same time, and the consequences and outcomes of any particular project cannot be isolated from all the other changes taking place (Klecun and Cornford, 2005). Many contemporary health information systems are complex and aim to be both technologically and organisationally innovative, involving a large number of different stakeholders, spanning institutions and professions, and (potentially) changing both the way people and organisations work and the ways in which services are delivered and experienced (Klecun and Cornford, 2005).

Against this background it is not surprising that evaluation, although discussed extensively in both the information systems and health informatics literature, remains controversial and in practice often stumbles into trouble (Klecun and Cornford, 2005). Many accounts indicate how it can be incomplete, biased or just ‘touching the surface’ (Smithson and Hirschheim, 1998; Farbey *et.al.,* 1999). Traditionally, evaluation of information systems has become focused on technical aspects of a system, its performance, reliability, robustness and security, cost-benefit, and immediate questions of useability. As information systems have become more pervasive, ambitious, complex and interactive, evaluation emphasis has, to a degree, shifted to concerns with how and to what extent information system innovations serve ambitions of organisational change (Klecun and Cornford, 2005). This in turn leads to political, cultural and organisational aspects being seen as necessarily playing a major role in shaping the evaluation activity (Walsham, 1993). Thus, issues of alignment with business goals and institutional interests, understanding of existing work practices in formal and informal senses, and the diverse power bases and competing stakeholder groups and their information needs, have all been given attention in the information systems field (Symons, 1991; Smithson and Hirschheim, 1998).

The implementation and maintenance of information systems is invariably a costly exercise for organisations, so it is only natural for managers to assume that they should provide their organisation with a degree of economic value (Irani and Love, 2001). McKay and Marshall (2001) express concern that managers do not perceive that they are deriving value for money when it comes to information systems investments. Organisations continue to report that the deployment of information systems within their organisation has resulted in the substitution of old problems with new ones (techno-based) (Irani and Love, 2001). In addition, the introduction of information systems can be a huge disappointment, since unexpected difficulties and failures are regularly encountered, with expected business benefits often not realised (McKay and Marshall, 2001). Furthermore, the human cost of information systems failure (such as not realising stakeholder expectations) can be quite considerable, and prevent the take-up of future technology, thus impacting the long-term survival and growth of the business (Irani and Love, 2001).

According to McKay and Marshall (2001), there appears to be a dichotomy with respect to the question of investment in information systems. On the one hand, the notion of an information-based economy and the arrival of an e-business domain have led to considerable faith being placed in information technology to deliver performance improvements. On the other hand, there is concern that information systems are not delivering what was promised by vendors and project champions. Irani and Love (2001) attribute this lack of delivery to the difficulty in determining business value from information systems investments, and the considerable indirect costs associated with enterprise-wide systems. Klecun and Cornford (2005) raise the issue of information systems success meaning different things to different stakeholders, further complicating attempts at objective evaluation.

To add to the complication of information systems evaluation, there remains a host of tools and techniques available to managers for the purpose of information systems appraisal (*ex-ante* evaluation). Yet, there has been a lack of consensus in defining and measuring information systems investments (Renkema and Berghout, 1997; Irani and Love, 2002). Research studies report contradictory findings on the relationship between information systems investments and organisation productivity and performance (Grover *et al*, 1998; Bannister and Remenyi, 2000). Considering the growing needs for business to gain a competitive advantage in their respective marketplaces, the evaluation of technical innovations (E-Government, Enterprise Application Integration, E-commerce and Customer Relationship Management) will remain a necessity if the benefits of information systems are to be fully realised. Viewed in systems terms, evaluation provides the basic feedback function to managers as well as forming a fundamental component of the organisational learning process (Smithson and Hirschheim, 1998). Evaluation provides the benchmarks of what is to be achieved by the IT/ information systems investment. Whilst these benchmarks can later be used to provide a measure of the actual implementation success of information systems projects (Irani and Love, 2001), it is worthwhile at this stage of this literature review to consider the prior events to implementation, that is, the planning process. A cohesive and structured planning process lays the platform for development of information systems and, as will be argued in this literature review, successful project development is unlikely to succeed without it.

2.2.3 Planning Process dimensions and contexts of SISP.

More recent studies by Grover and Segars (1998; 2005) described and measured planning process dimensions and found hybrid systems tended to be more successful and seemed to apply generally to a variety of industries. Through their research Grover and Segars (2005) identified six important process dimensions of SISP: comprehensiveness; formalisation; focus; flow; participation; and consistency. These dimensions are robust in describing the SISP design and extend beyond the methodological-based and less generalisable descriptions of planning. The authors comment that as organisations become technologically and geographically complex, the importance of planning activities increases. As a result, they argue that a planning culture may emerge in the form of highly structured systems. Rationality may be built into strategic planning systems through higher levels of formalisation, a focus on control and top-down planning flow.

Adaptability refers to the capability of the planning system to learn. The planning system should contain characteristics that will alert managers to changing organisational and environmental conditions that may require a change in strategy. Adaptability may be designed into a system through wide participation profiles (Baets, 1992) and through higher levels of planning consistency (Eisenhardt, 1989). Such characteristics reflect the importance of gathering information from a number of sources and the importance of consistently reconciling strategic decisions with environmental conditions.

Wang and Tai (2003) add to the process dimensions for success in SISP with their work on organisational contexts, commenting that most process-oriented research has recommended using integration and implementation mechanisms while not considering the possible contingent effect of contextual factors. They suggest that this may lead to the planning system being less adaptable to different organisational contexts and therefore be overly deterministic. Wang and Tai's (2003) model is an attempt to integrate organisational contexts into SISP. This can be seen in Figure 2.2 below.

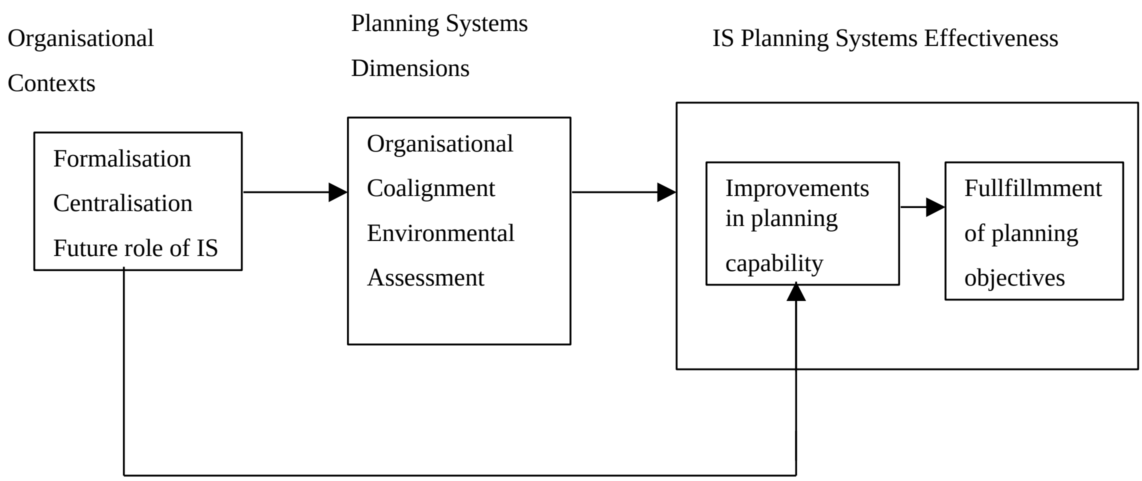

Figure 2.2 Conceptual model – contextual factors role in SISP Effectiveness (Wang and Tai, 2003)

This conceptual model of Wang and Tai (2003) has three domains:

- Organisational contexts – this domain deals with organisational factors such as formalisation, centralisation and the future role of information systems.
- Planning system dimensions – this domain consists of two categories: organisational co-alignment and environmental assessment. Organisational co-alignment reflects the internal alignment among the four organisational factors

(resources committed to planning, implementation mechanisms, acceptance of planning and integration mechanisms) having a strong influence on an organisation's information systems planning and effectiveness, whereas environmental assessment captures the orientation of the planning system

- Information systems planning system effectiveness - this domain has two parts – the improvements in planning capability and the extent to which the planning system objectives are fulfilled.

Overall, the study by Wang and Tai (2003) holds that organisational contexts can impact the effectiveness of information systems planning indirectly through mediating effects of the planning system's dimensions while these dimensions can influence the improvements in planning capability directly and the fulfilment of planning objectives indirectly. "Resources committed to planning" and "acceptance of planning" (Wang and Tai, 2003) together should reflect the organisational support to information systems planning activities, and are similar to the "favourable organisational context of planning" suggested by Steiner (1979). "Integration mechanisms" are the methods used to integrate business goals and plans into information systems strategies and possible mechanisms include the participation of information systems managers in strategic business planning and active interaction between information systems and business planners. "Implementation mechanisms" are the efforts to overcome problems, such as management control systems for review and feedback, resource mobilisation for implementing the plans and top management and user involvement in monitoring implementation (Doll, 1985). Consistent with a prior study (Venkatraman and Ramanujaman, 1987), the improvements in planning capability can affect the fulfilment of planning objectives.

Wang and Tai (2003) acknowledge that although their work is generally supported by empirical data, a theory of information systems planning is currently lacking. Their results did however support the contention that information systems planning is a rational-adaptive process, supporting the arguments of Pyburn (1983), Earl (1993), Sabherwal and King (1995), and Grover and Segars (2005). Having discussed the process dimension and contexts of SISP, it is now appropriate to consider by what means information systems effectiveness is measured.

2.2.4 Information systems effectiveness indicators.

The link between strategic performance and planning has been found to be inconsistent by several authors (Grover and Segars, 2005; Raghunathan and Raghunathan, 1988). Premkumar and King (1992) on the other hand found that firms in which information systems play a critical role have higher levels of planning resources and are more effective at planning. Medical pathology practices, both private and hospital based, require a mission critical status from their laboratory information systems for the provision of patients services. The literature pertaining to the level of planning resource deployment and planning effectiveness will be examined in Chapter 3, as a basis for further investigation by this research. Lederer and Sethi (1988) explain this relationship by identifying a variety of inhibitors from failure to consider business strategy to time span and resources. The measurement of effectiveness of information systems has been too uni-dimensional (such as financial ratios; Rubin, 2004), measured on a single item scale or focused on limited aspects of planning, such as alignment with business strategy only to be comprehensive in assessment of information systems effectiveness.

Other indicators suggested for assessment of information systems effectiveness have been information systems usage, user information satisfaction (UIS), quality of decision making, productivity from cost/benefit analysis and system quality (Ein-Dor and Segev, 1978). UIS is described by Petter *et al.* (2008) as the users' level of satisfaction with reports, web sites and support services. The most commonly favoured factors have been information systems use and UIS; because of a lack of a theoretical framework for placing UIS within the greater context of overall 'information systems effectiveness', its relevance as a performance measurement has been questioned (Grover *et al*., 1996). Gation (1994, p.119) elaborates on the context position of UIS as a surrogate measure of information systems effectiveness by saying "If an effective system is defined as one that adds value to the firm, then an effective system must have some positive influence on user behaviour (i.e. must improve productivity, decision making and so on). Advocates of UIS argue that there is some theoretical support for linking attitudes (i.e. satisfaction) and behaviour in the psychology literature".

The questionable relevance of UIS as a performance measurement has been demonstrated in one instance in the laboratory experiment conducted by Yuthas and Young (1998) on materials management information systems in which they investigated the relationship between management performance, user satisfaction and system usage. The study involved the development of a computerised inventory system which was used by fifty-nine undergraduate business students assuming the role of a materials manager for a small catering company dealing with highly perishable inventory. The task required of subjects was to prepare a purchase order for the companies anticipated inventory needs for one day. In order to assist the subjects in performing the task, written and system reports were provided. Four measures of effectiveness were used: decision-making performance; user satisfaction; system usage time and system usage volume report. In the course of executing their tasks, the would-be managers observed that information systems plays a vital role in the materials management function by providing timely and accurate information necessary for the accomplishment of decision-making goals (Yuthas and Young, 1998).

This information includes inventory control, purchasing, electronic data interchange, master production scheduling, capacity management, production activity control and materials requirements planning. Materials managers use systems to monitor their stock status, to alert themselves to critical shortages and to trigger purchase orders when reorder points are reached. The managers rely heavily on these reports, often consulting these information sources rather than touring the warehouse. Managers must be able to ascertain whether and to what extent information systems are assisting to achieve decision-making goals, such as reduction of inventory costs.

Yuthas and Young (1998) found that correlations among the three measures suggest that although satisfaction and usage are closely associated with performance, the relationships among the measures were not sufficiently strong to warrant their usage as interchangeable measures of effectiveness. That is, high levels of satisfaction and system use do not guarantee that the system actually increases management effectiveness. These authors hold the view that because information systems are generally designed to provide information to support decision making, decision performance is the most direct measure of effectiveness. Yuthas and Young (1998) suggest direct measures, such as turnover, fill-rates and inventory costs, as being appropriate measures of information systems effectiveness in materials management; this would suggest that the information system is better aligned with the business goals of the firm to maintain competitive advantage. Importantly, Yuthas and Young (1998) also comment on the role of management support and proper training of all users as an adjunct to effective use of information systems. This suggests a rather functional, hands-on view of the measurement of information systems effectiveness.

Grover and Segars (2005), by contrast, have a more strategic view with their development of a multidimensional conceptualisation of five key dimensions of SISP effectiveness, which recognise that there are outcomes that can be directly expected from a good planning system. The authors also recognise that SISP is a complex activity with a variety of benefits, and the contribution of SISP captured in terms of bottom line figures, such as return on investment (ROI) and return on equity (ROE), may be significantly confounded by many uncontrolled business, economic and environmental factors. Grover and Segars (2005) also argue that successful SISP should achieve alignment between information systems and business strategy; analyse and understand the business and associated technologies; foster cooperation and partnership between managers and user groups; anticipate relevant events/issues within the competitive environment and adapt to unexpected organisational and environmental change. Grover and Segars (2005) also argue a fundamental proposition that SISP will adapt over time through redesign of its process dimensions and that this redesign will result in more effective SISP. This multidimensional conceptualisation approach supports previous arguments by Weill and Olsen (1989) and Delone and McLean (1992). The author's approach also infers the capacity for the multidimensional model to be fluid and dynamic and on going. However, all authors cited acknowledge that further research is needed to define the construct space for effectiveness criteria, as discussed below.

2.2.5 Construct model for IS effectiveness.

Delone and McLean (1992; 2003) have focused on effectiveness with their information systems success model. The model consists of six interdependent constructs: system quality; information quality; use; user satisfaction; individual impact; and organisational impact. The basis for this model is product oriented. For example, system quality describes measures of the information processing system. Information quality represents measures of information systems output – typically measures in this area include accuracy, precision, currency, timeliness and reliability of information provided. An earlier study (Mason, 1978) labelled these two categories as production and product respectively. The model implies the measurement of overall success based on items arbitrarily selected from one construct is likely to be inaccurate. Instead, the measure of overall success should combine individual measures from these constructs to create a comprehensive scheme for performance.

Grover *et al*. (1996) have developed a theoretically based construct space for information systems effectiveness, which complements the information systems success model of Delone and McLean (1992). Grover *et al.'s* (1996) construct model provides a means of cross-validating the information systems success model and they attempt to synthesize the seemingly disparate array of effectiveness measures and research approaches through definitional dimensions of evaluative referent, unit of analysis and evaluation type. The evaluative referent describes the relative standard that is used as a basis for assessing performance. Combining these perspectives with the others found in studies (Hamilton and Chervany, 1981; Ives *et al.*, 1983) three potential evaluative judgements emerge: comparative, normative and improvement. The evaluative perspective of comparative judgement attempts to compare the effectiveness of a particular system with other ‘similar’ systems – typically those set up in similar organisations. A typical question in this mode is - How does our system’s performance compare with similar systems in comparable organisations? Although this perspective is intuitive, it may be difficult to actually implement. Gathering timely and accurate information regarding comparable systems is very difficult.

Within the perspective of normative judgement, a relevant assessment question is - How does our system’s performance compare against that of a theoretically ideal system? In fact, the system is compared to ‘systems of best practice’ rather than those of an organisation. This approach is amenable to research contexts providing the literature and experts readily identify the ‘standards’.

The third perspective of improvement judgement can be summarised by the following relevant question - How much have the capabilities of the system improved over time? The focus is therefore on assessing how information systems has evolved or improved (over time) in supporting organisational needs. Grover *et al.* (1996) are of the opinion that this third perspective is useful in cases where the system is in its initial stages and has yet to reach steady state. This opinion suggests conflict with the actual relevant question of improvement with time – steady state suggests an equilibrium with constant indices and raises the question of lack of capacity for change – an essential form of information systems effectiveness. To build a complete picture of information systems effectiveness, evaluation must be conducted from both a macro (organisational) and micro (individual) view. Such evaluation is necessary because information systems supports individual as well as organisational decision-making and can also provide competitive advantage (Grover *et al.*, 1996).

From the organisational effectiveness literature, Brewer (1983) argues that there are three types of evaluation: process; response; and impact. Process evaluation involves the assumption that organisational members work to ensure efficient use of resources when resources are limited. This assessment is based on user dependence on information systems, user perceptions of system ownership and the extent to which an information systems is disseminated throughout organisational administration and operating procedure (Trice and Treacy, 1986).

Response evaluation assesses the individual or the organisation to the information systems service or product. This assessment has significance in respect to user resistance to innovation and implementation. Any resistance or habitualisation must be identified to ensure successful implementation. This assessment also considers complex variables such as user's beliefs and attitudes toward information systems in general which are important for fulfilment of information system planning (Grover *et al*., 1996).

Impact evaluation represents the most comprehensive and most difficult to assess evaluation. It is associated with the direct effects of information systems implementation on the individual and/or the organisation. Grover *et al.* (1996) derived the following model (Figure 2.3) consisting of six classes of information systems effectiveness measurement, which define the overall construct space for information

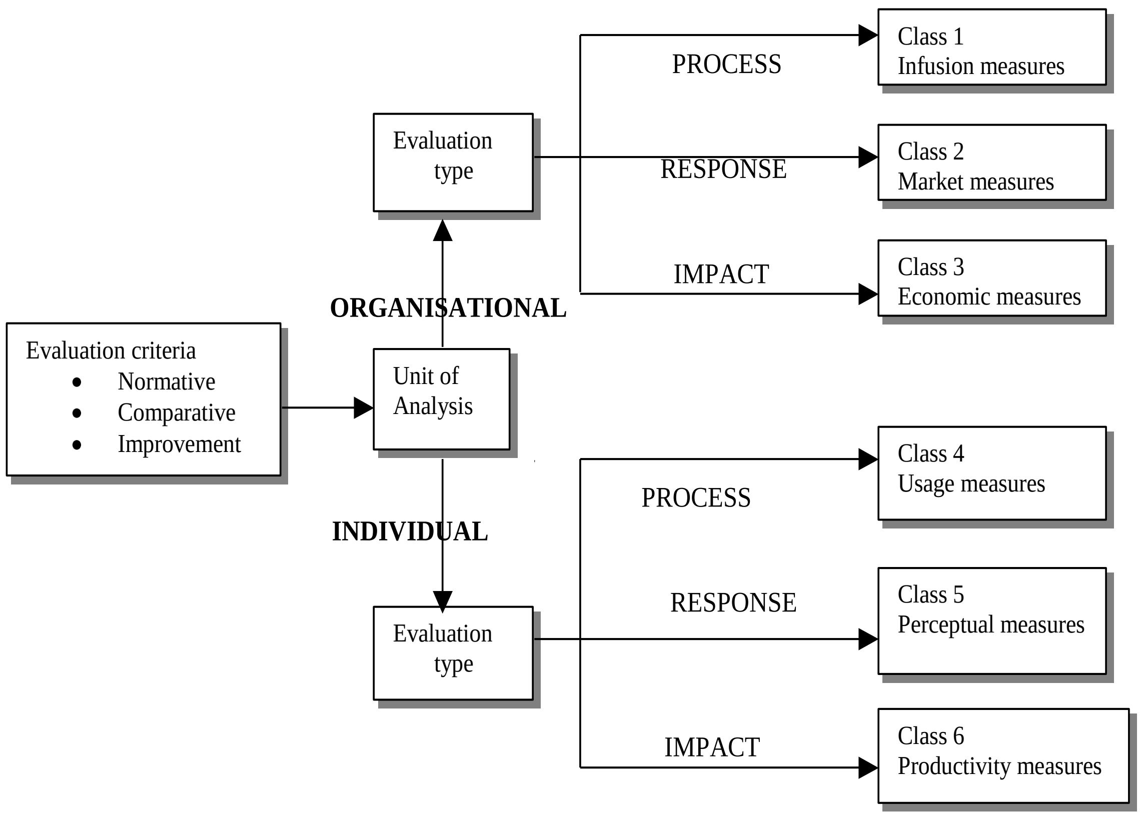

Figure 2.3 The construct space for information systems effectiveness

(based on Grover *et al.*, 1996)

systems effectiveness.

As shown in the Grover *et al.* (1996) model, the evaluation of information systems is initiated by choice of the relevant evaluative referent, which describes the relative standard that is used as a basis for assessing performance. The first three classes of effectiveness measures are associated with macro (organisational) evaluation. From their empirical work developing this model, Grover *et al*. (1996, p182) state "in general, it seems that both theoretical depictions strongly imply that information systems effectiveness is multidimensional in terms of types of measures and level of analysis." This statement supports their earlier stated contention, and supports the argument of other authors (Earl, 1993; Pyburn, 1983; Sullivan, 1985).

2.2.6 Information systems evaluation perspective.

The multidimensional dimensional approach of Grover and Segars (1996) may be regarded as an evolution of the Delone and McLean (1992) information systems success model, which considered six interdependent constructs (system quality, information quality, use, user satisfaction, individual impact and organisation impact) in a more uni-dimensional context. As stated earlier (Chapter 2, p. 19) measurement of overall success based on items arbitrarily selected from one construct is likely to be inaccurate.

Brewer (1983) has the view that process evaluation involves the assumption that organisational members work to ensure efficient use of resources, the assumption being based on user dependence on information technology and user perceptions of ownership. Saarinen (1996) raises the issues of correctness of interpretation of information systems effectiveness measures and personal bias in information systems product evaluation (Chapter 2, p. 30). These personal issues should be addressed in the context of full and proper evaluation of information systems products and developments. Further discourse by Grover *et al*. (1996) on evaluation perspective rightly raises questions asking from whose perspective the evaluation is being carried out. Though information systems may be viewed as effective from one standpoint, it may be viewed as ineffective from another. Cameron and Whetten (1983) suggest that one reason that no ‘best’ criterion exists is because there is no ‘best’ constituency. Hamilton and Chervany (1981) refer to four different viewpoints on information systems effectiveness: information systems personnel, users, management and internal audit. Members of all these groups have their parochial viewpoints. Grover *et al*. (1996) state that for the evaluation of information systems effectiveness, the specific views of all groups should be considered because they help to increase awareness of the value of the information systems and help the understanding of the multidimensionality of information systems effectiveness.

This view is ratified by the work of Rondeau *et al.* (2006) who undertook a study into information systems management effectiveness and end-user computing and its impact on information systems performance in manufacturing firms. The data for their study was collected from 256 senior manufacturing managers who were selected because of their perspective on information systems activities and performance within their respective organisations. The study framework relates to organisational involvement in information systems development, information systems management effectiveness, end-user self reliance in application development, end-user dependence on information systems expertise and information systems performance. Information systems management effectiveness is assessed by three elements: information systems strategic planning effectiveness, information systems responsiveness to organisational computing demands, and information systems effectiveness in end-user training.

The Rondeau *et al.* (2006) study showed that managers can create an environment that fosters cooperation and teamwork toward organisational rather than functional goals but in many firms, the relationship has been framed in an adversarial manner. They also comment that if the information systems unit asserts its authority to make the rules without the participation and cooperation of the other business units, end-users will continue to break them. Rondeau *et al.* (2006) also found that if organisations can create an atmosphere of mutual respect and cooperation among these units for the common good of the firm, information systems resources will be highly valued and effectively used and end-user perceptions of information systems performance will increase. Their study concluded that the significant improvements resulting from a better relationship between the information systems unit and end-users were increased information systems strategic planning effectiveness, more highly responsive and better designed computing solutions, and more useful end-user training programs.

The findings of the study by Rondeau *et al.* (2006) ratify Hackney *et al.'s* (1999) earlier views on the significance of end-user involvement in planning. Hackney *et al.* (1999) hold the view that the information-based society requires firms to develop information systems that are flexible, integrative, responsive, and information rich. Firms must align their information systems unit with core business procedures; multiple paths toward strategic alignment can exist and conflicts may arise when a firm's information systems technology strategies exceed its ability to align them with its business strategy. Misalignment of information systems strategies, goals and objectives may be avoided by increasing end-user involvement (Hackney and Kawalek, 1999). Increased end-user involvement together with better alignment of business and IT may create a greater holistic organisational approach to management, the ramifications of which are described in the following section.

2.2.7 Cross-functional decision process and information systems management practices.

Greater organisational involvement in information systems planning processes creates a better fit with the information systems requirements of a firm operating in an information rich-society. The implementation of cross-functional decision processes creates greater work system integration, collapses traditional organisational boundaries, and promotes independent work (Gerwin and Kolodny, 1992). With greater organisational involvement comes a revised set of information systems management practices that better fit the information systems requirements of a firm operating in an information-rich society. The result is improved information systems management effectiveness. Bhattacherjee (2001) makes the point that when information systems management is viewed as highly effective, users are more likely to report greater satisfaction with their systems and to exhibit high levels of information systems performance.

The study of Rondeau *et al.* (2006) explored the relationship between the information systems unit and the end-user in the context of organisational involvement in information systems related activities. Their study provided valid and reliable measures for end-user involvement related activities, cross-functional involvement in information systems related activities, information systems strategic planning effectiveness, information systems responsiveness to organisational computing demands, end-user self-reliance in application development, and end-user dependence on information systems expertise. The authors comment that managers can create an environment of greater organisational involvement that can only result in a better performing information systems unit that users will value and depend on to provide information services to the firm. A number of decision processes and management practices have been examined and the following section assesses methods of implementation of these processes and practices.

2.2.8 Means and methods of information systems effectiveness measurement.

Grover *et al.* (1996) found that a number of criteria are still used to assess information systems effectiveness. Of the criteria used, UIS was most used, followed by usage, cost/benefit analysis, firm performance, user attitudes and value perception. Gatian (1994) provides some insights into UIS in its role as a surrogate measure of information systems effectiveness. If an effective system is defined as one that adds value to the firm, then an effective system must have some positive influence on user behaviour (for instance – improve productivity, decision-making). Advocates of UIS argue that there is theoretical support for linking attitudes (i.e. satisfaction) and behaviour in the psychological literature. Many researchers and practitioners agree that emphasis in information systems research has shifted from efficiency measures towards effectiveness measures, including user perceived effectiveness measures such as user satisfaction (Srivivasan, 1985). Increasing use of UIS questionnaires in firms as a measure of system effectiveness is further evidence of this shift (Conrath and Mignen, 1990; Davis, 1989).

In the information systems literature two primary reasons for this shift towards UIS in particular are frequently mentioned. Firstly, many believe in the psychological expectancy theory that attitudes (i.e. satisfaction) are linked to behaviour (i.e. productivity) (Fishbein, 1967; Fishbein and Ajzen, 1975). More to the point, it is believed that satisfied users will be more productive. The second reason for moving away from efficiency measures is that it has traditionally been more difficult to measure white-collar efficiency or productivity directly. If an effective system is one that adds value to the firm, any measure of system effectiveness should reflect some positive change in user behaviour, that is, improved productivity, fewer errors or better decision-making. The use of UIS as a measure of information systems effectiveness, however, still attracts discussion by academics. The following section examines some of this discussion in more detail.

2.2.9 Shortcomings of evaluation criteria for information systems effectiveness measurement

The implicit assumption made by managers and researchers employing UIS questionnaires for system effectiveness evaluation is that satisfied users will perform better than users with poor or neutral attitudes (Bailey and Pearson, 1983). Gation (1994) points out the controversial nature of this view given that there is little information in the literature linking user satisfaction with any measures of user behaviour. There is one possible exception to this being research attempting to link satisfaction with system usage, system usage not necessarily translating to improved productivity or effectiveness, especially where usage is mandatory (Gation, 1994).

Gation (1994) also rightly raises the still pertinent question of proper and relevant question selection, and the possibility of careless interpretation of results leading to the drawing of poor conclusions. In her study to determine the validity of UIS as a measure of information systems effectiveness, Gation (1994) looked at the relationship between user satisfaction and user performance for a particular system. Within the limitations of the study, user satisfaction is correlated with two measures of performance - the system affected decision-making performance of users and the system affected user efficiency. The research focused on users of college and university information systems at thirty-nine different campuses. Two groups were studied - staff in the controller's office who were direct users and academic department heads who were indirect users. Both groups were asked to assess, via questionnaire, their own satisfaction and impact of the information system on their own decision-making performance.

The study overall supported the validity of UIS as a measure of information systems effectiveness. Specifically, the following relationships were revealed between both user groups. Firstly, a relationship between UIS and decision performance supported the psychological theory that availability of relevant information improves decision performance in a modern information systems setting. Secondly, a relationship between UIS and information systems efficiency provided support for the construct UIS as a measure of information systems effectiveness, suggesting that satisfied users may be more productive (Gation, 1994).

It is interesting to note that, in the selection of suitable criteria for measurement of information systems effectiveness, UIS is still regarded as a key criterion in this role. It would appear that one of the main objections to this is that UIS as a criteria of information systems effectiveness has little relationship with the primary business goals of the firm and hence questionable strategic significance (Grover *et al.,* 1996; Saarinen, 1996). Petter, DeLone and McLean (2008) have recently revisited the role of UIS instruments as a measure of information systems effectiveness in their extensive review of the literature pertaining to measuring information systems success. They compared the Doll *et al.* (1994) End-User Computing Support (EUCS) instrument and the Ives *et al.* (1983) User Information Satisfaction (UIS) instrument and found the EUCS instrument outperformed the UIS instrument in the context of accounting. They point out that both the EUCS and UIS instruments contain items relating to system quality, information quality and service quality, rather than only measuring overall user satisfaction with the system. Because of this, some researchers have chosen to parse out various quality dimensions from these instruments and either use a single item to measure overall satisfaction with an information system (Rai *et al.,* 2002) or use a semantic differential scale (Seddon and Yip, 1992).

The researcher believes that these alternative approaches highlights that UIS and EUCS are not consistent in their roles as measures of information systems effectiveness, as demonstrated by EUCS having outperformed UIS in the context of accounting information systems. How then do UIS and EUCS perform in other verticals in assessing information systems effectiveness, and, if an inappropriate instrument is used for analysis (for example, UIS for accounting system evaluation), how then does that affect the resulting analytical results? How would this then impact on business decisions? The researcher also believes that the items stated which make up both UIS and EUCS instruments (see above) constitute functional components of the instrument. Hence the information system it is measuring is viewed from a functional, not strategic view, thereby supporting the argument that UIS and EUCS have little relationship with the business goals of the firm.

Saarinen (1996) looks at this situation of evaluation of information systems effectiveness from a different perspective and introduces the consideration of cost/benefit analysis as a more comprehensive and direct assessment of information systems development projects. Cost-benefit analysis is essentially a comparison between two states. Proposed new system costs and benefits are usually compared with those of current systems whether they be manual, partly computerised or fully computerised (Lincoln, 1986). Post-audits of established systems however do not have such an obvious basis for comparison and it is essential to decide what the comparator will be before undertaking a study.

Saarinen (1996) extends the measure of success to include the development process (standing for the investment costs and efficient use of the resources) and the impact of the information systems on the organisation (standing for the benefits of the investment). Saarinen (1996) undertook a study to assess four dimensions of success – the development process, use process, information systems product quality, and impact of the information systems on the organisation, that he put forward as a means of measuring information systems success. These four dimensions were derived from his definition of a successful information systems development project, which is "The system development process leads to a high quality information systems product whose use has a positive impact on the organisation" (Saarinen, 1996, p.106).

The traditional investment analysis techniques and criteria, such as return on investment, net present value, or payback period are seldom used because of the unique nature of information systems investments (Saarinen, 1996). This has led to evaluation criteria being supplemented by subjective judgement and surrogate measures such as UIS. Furthermore, information systems investments share many features with research and development investments, often having corporate-wide, intangible and long lasting effects. Therefore, economic evaluation and quantitative measures tend to be difficult to obtain and easy to manipulate. These measures seldom suffice in practice, but should be supplemented with subjective judgement and multiple diversified criteria (Cerveny and Clark, 1985).

Subjective judgement and ease of manipulation of these measures cited by these authors raises the points of correctness and personal bias. For example, Saarinen (1996, p.104), by asking the following questions, puts some perspective of the existing inadequacies of approach to information systems effectiveness measurement. He asks "How is then the result or outcome, in a case of an information systems investment, be characterised? Is it the information systems product itself or the net benefit of using it, or both? Furthermore, for whom should that result be favourable or satisfactory - the developers, the users of the information systems, or_the managers?" Developers may aim at a high quality information systems product at minimum cost. User satisfaction may be determined by ease of use of the information systems and proper support for their own work. Managers, in turn, may prefer economic and quantitative values of both costs and benefits, giving an opportunity to compare the information systems investments with the alternative uses of these resources (Saarinen, 1996).

The investigation (Saarinen, 1996) was based on treating success as a four dimensional construct, consisting of the success of the development process, success of the use process, quality of the information systems product, and impact of the information systems on the organisation (Figure 2.4). The two extensions (inclusion of the development process and impact of the information systems on the organisation) align the subjective success evaluation better with the traditional cost-benefit paradigm, thereby increasing its content validity significantly (Saarinen, 1996).

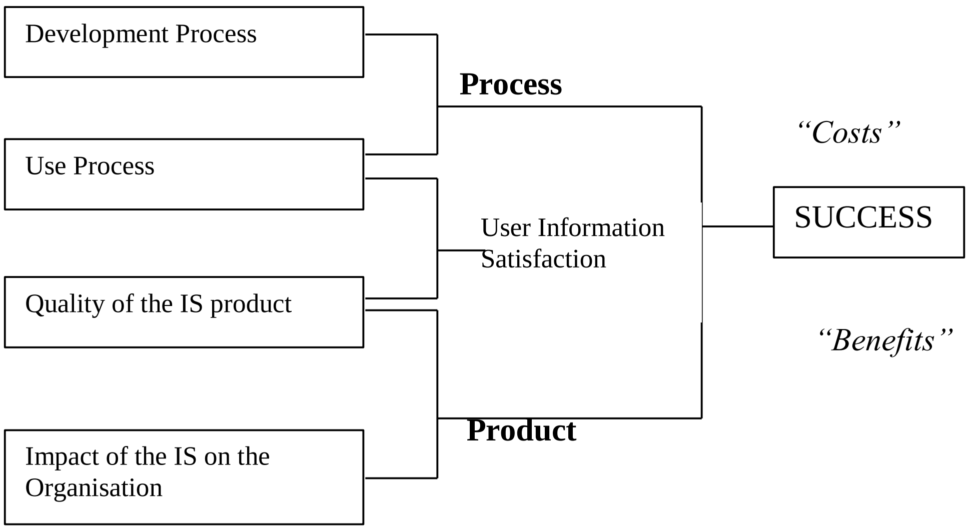

Figure 2.4 Main Dimensions of Information Systems Success (Saarinen, 1996).

Success of the development process: Successful development of an information system requires capable and motivated users and systems analysts, who can effectively communicate and specify requirements for the system. The systems analysts must be able to design a system meeting these requirements, and to implement it into a technically feasible solution. They must also be able to help the users with the implementation process. All this has to be done to budget and time constraints.

Measurement of the success of the development process can be based on an external view of the adherence to the given budget and time schedule (Lucas, 1981). The success of the development process may also be measured with an internal view of the project, evaluating the level of developer and user expertise for the development exercise (Bailey and Pearson, 1983).

Success of the use process: Evaluation of the use process can be done by the outcomes of the information systems services provided to the users; these should ensure that the information systems staff have those attributes and capabilities that would help them to communicate effectively and specify the users needs. The information systems staff should be able to respond to the users requests without undue delay (Saarinen, 1996).

Quality of information systems product: Measurement of the information systems product quality is often based on the user perceptions of different attributes of the system. High quality information systems products should have both high system quality and high information quality (DeLone and McLean, 1992). It should provide users with relevant and reliable information in the desired format. High system quality requires a good user interface and flexibility to allow for adaptation and expansion for the future.

Impact of the information systems on the organisation: The impact on the organisation of the information systems should be positive. The changes are measured in quantitative and monetary terms. Because these data are often difficult to obtain, surrogate measures, such as the managers perceptions of change pertaining to such changes that affect the profitability of the organisation may be used. Information systems can not only change the organisations structure, but also improve work processes, make decision-making processes more effective and intensify the controls of the organisation (Saarinen, 1996).

The methodology for Saarinen's (1996) study involved the development of a measuring instrument that was mailed to the participants – consisting of project managers and line managers. The project managers assessed the success of the development process and the user capabilities; the line managers assessed the information systems staff capabilities, controllability of the development process and results, that is, the quality of the information systems and its organisational impact. The project managers and line managers perceptions of success were used for the first three initial constructs in order to validate the measuring instrument (Saarinen, 1996).

Additionally, a modified version of the short-form UIS (Baroudi and Orlikowski, 1988, Ives *et al.*, 1983) was used in the study as a criterion for all four constructs. Seven point scales where only the extreme points of the scales were labelled were used to score the data. The data was taken from the two hundred largest companies and twenty-five of the largest banks in Finland. Altogether 272 information systems managers from these organisations were contacted. The response rate was approximately fifty per cent.

The results of the study showed that of the four factors used to assess the impact dimension, decision-making and control, efficiency and profitability, use and change, and communication and restructuring, profitability was found to be related to the impact on the work processes and consequent cost savings. Saarinen (1996) in his concluding remarks makes the point that there are no generally acceptable measures available to quantitatively and objectively assess information systems success. The reliability of measuring instruments has been increased by the use of multi-item questionnaires. Saarinen (1996) also states that further research in this area needs to be undertaken.

Saarinen's (1996) study has been an attempt to extend the scope of UIS, which includes only indirect measures of success – the use process and quality of the information systems product – whilst his instrument measures success directly by success of the development process (standing for the investment costs and efficient use of resources) and the impact of information systems on the organisation (standing for the benefits of the investment).

Saarinen's (1996) model may be a step forward in establishing a more realistic and standardised means of measuring information systems effectiveness in that he concluded profitability was found to be related to impact on the work processes with consequent cost savings. Perhaps here one could introduce the possibility that this model represents a closer relationship with the business goals of the firm because it considers improved work processes whilst reducing costs. This would be likely to improve the overall efficiency of the firm, and enhance its competitive position in the market, surely the primary business goal of any firm. That being said, Saarinen (1996) includes UIS as part of his model, in spite of the fact that it has widely recognised shortcomings as an indicator of information systems effectiveness. There also seems to be a lack of a mechanism for the absolute definition of business goals for SISP in this model as with most other models. The varying views and controversy surrounding methodologies for assessing the evaluation criteria for information systems effectiveness measurement, as discussed, warrant the establishment by researchers and practitioners alike of a standardised approach to the process of evaluation of potential criteria for information systems effectiveness, to find and agree on a standardised approach. One early attempt at this was the SESAME model, as described below.

2.3 Systems Effectiveness Study and Management Endorsement (SESAME).

A more standardised approach to cost-benefit analysis was discussed by Lincoln (1986). A large, consistent base of information was gathered using a standard methodology called Systems Effectiveness Study and Management Endorsement (SESAME) from a large number of applications across a range of industries. Previous analyses of barriers to IT use in the 70's (Lincoln, 1976; 1980) led to the establishment of a long-term program termed SESAME designed to explore computer investment appraisal issues. Using this base of information allowed senior executives to compare the financial performance of computer systems with other investments, to set reasonable financial targets for new systems development and to judge the 'return on investment' from their computer systems with that achieved by other companies.

Despite the wide use of cost-benefit forecasting to justify proposed system investments, executives remain sceptical about the level of benefits actually achieved. This is partly explained by the inherent uncertainties in the cost-benefit forecasting process. User reluctance to commit to future savings, previous large cost overruns, arbitrary estimates of system life, risk and inflation rates all erodes the credibility of any forecast. All too frequently there is a lack of financial disciplines applied to the system development process - it is often unclear who is accountable for the benefit achievement and it is rare to find a information systems plan integrated with the business plans, and the user benefits are frequently described as ‘intangible’ and rarely post-audited (Lincoln, 1986). Measurement of the business value of IT and factors that contribute to the success of information systems have been the subject of considerable research over the last two decades, and yet there is no single, widely accepted framework that could be employed in measuring impact of investments on IT (Davern and Kauffman, 2000).

A report sponsored by the UK Department of Trade and Industry (Dept. of Trade & Industry, 1984) reviewing the barriers and opportunities associated with information technology concluded that the main barriers to further use of information technology are the lack of appropriate cost-benefit techniques and the need to consolidate previous investments. This conclusion is a further example of the lack of a suitable framework for measuring the impact of investments on IT. Nothing much has changed over twenty years. For many organisations, measuring the outcomes of technology investments is a frustrating exercise because of the confusion over what should be measured and how to define the value of IT (Seddon *et al.*, 2002; Tallon *et al.*, 2000). The impact of information systems investment on performance also depends on contextual variables, such as the external environment, the organisational context and information systems maturity (Choe, 2003). Kivijarvi and Saarinen (1995), Ragowsky *et al.* (1996) and Li and Ye (1999) have empirically shown the moderating effect of environmental uncertainty and the moderating effect of information systems maturity on the relationship between information systems investment and improved financial performance.

Business investments are judged to have value only if their contribution to the output of the business could be distinctly quantified (Sugumaran and Arogyaswamy, 2004). The ability to assign value to IT business outputs is far more difficult than a simple cost/benefit analysis. Most IT investment decisions based on standard return on investment (ROI) and net present value (NPV) assumes a static scenario. These traditional measures of value often lead to inadequate or outdated IT systems. The debate is still continuing regarding what are appropriate independent and dependent variables to consider while assessing the effectiveness of IT with respect to productivity and performance (Sugumaran and Arogyaswamy, 2004). This view has prompted Sugumaran and Arogyaswamy (2004) to propose a three-stage model linking environment/organisation to the value centre and to performance measures to provide conceptual guidance to select the most appropriate measure(s) of IT performance. They have recognised the fact that IT performance measures need to be tailored to fit with the purpose of the IT in question, and that the purpose itself is determined by external/internal variables.

An alternative means of evaluation of the impact of an information system change is a comparison of the same organisation before and after the system was introduced. The question being asked is then “Has the system brought an improvement in overall financial performance?” In many of the cases in the UK Trade and Industry study this approach was found to be unsatisfactory due to changing environmental factors

(Lincoln, 1986). External environmental factors remain an issue in more recent time (Choe, 2003). Other means of evaluation involve comparison against an alternative system. There are two fundamental questions to be answered with this approach the first involves the basis for comparison and the options include the previous computer system, alternative technology or manual systems. The second concerns the level of service that will be assumed and the options range from the same level of service provided by the current system to not undertaking the activity at all (Lincoln, 1986).

Not all computer systems lend themselves to this type of analysis. Strategic systems are usually so interlinked with business decisions that to dissociate the two becomes virtually impossible. Lincoln's (1986) experience has shown that after reviewing the options and thinking through the implications, most senior executives require an initial analysis against an essentially manual alternative system with a level of service that could be expected from a manual system. This raises the possibility that many executives still query whether the use of computer technology is beneficial even after many years of computer usage. As IT expenditures increase as a proportion of total expenditures, management is under constant pressure to justify the investment in IT and produce tangible evidence of this return on investment (Sugumaran and Arogyaswamy, 2004; Petter *et al.,* 2008; Miller and Doyle, 2001). This also relates to another barrier or resistance to change pertaining to information systems effectiveness and integration discussed by Gation (1994) when she talks about personal agendas, bias and manipulation or misinterpretation of data. This facet of the planning and effectiveness measurement process is something that cannot be modelled out and will always be an unknown quantity. The recognition of multi-stakeholder perspectives adds further complications, raising issues such as power asymmetry, politically-driven changes, technology-led changes and conflict objectives (Connell and Young, 2007).

The SESAME project, by way of its design approach, laid the groundwork for a standardised means of assessing the value of information systems investment. It is timely at this point to examine the practical performance of SESAME in business and to ascertain the full impact it has had on IT project valuation.

2.3.1 Application of SESAME.

Clearly, a consistent approach was required by Lincoln (1976; 1980) to alleviate the shortcomings of existing methodologies. The use of a consistent approach across a large number of applications also provides the capability of developing a statistical base. The SESAME approach has now evolved into a co-ordinated attempt to build a database of proven financial returns gained from the use of information technology. A SESAME study focuses on systems that have been implemented for at least twelve months and identifies in considerable detail the full costs and benefits experienced to date (Lincoln, 1980). Once these are established, projections are made over the expected system life to a maximum of five years. The approach adopted by an individual study is tailored to specific requirements. When a before and after comparison is valid, it will be undertaken. In most cases of SESAME analysis however, the approach has been a comparison against an alternative system.

SESAME is essentially a bottom-up approach, based on individual case studies, in contrast to top-down studies of the business impact of information technology (Cron and Sobal, 1983; Strassman, 1984; Yap and Walsham, 1986). SESAME does not attempt to evaluate the full implications of a computer system. There may well be social and organisational implications for example, which a full and detailed evaluation would wish to consider. These social, environmental and organisational issues have been studied by Choe (2003), Kivijarvi and Saarinen (1995), Ragowsky *et al.*, 1996, Li and Ye (1999) and Sugumaran and Arogyaswamy (2004) in recognition of the growing importance of these issues in consideration of planning and evaluative processes. SESAME set out to explore one dimension of the evaluative process in the hope that the results themselves would be of interest and would add to a fuller appreciation of the impact of computing on organisations.

The SESAME approach made three significant points in trying to understand the evaluative process for information systems development, implementation and impact. The first is the bottom-up approach based on case studies, which concurs with other authors, for instance Grover and Segars' (2005) work on rational - informal process in planning, creativity focus and wide participation profiles. The second is the recognition that the cost-benefit component of information systems effectiveness measurement is only one component of the evaluation of the full implications of the information systems. SESAME recognised that there are other influencing factors that exist and pose significant difficulties in assessing implications (Hirscheim and Smithson, 1986). The third is that the SESAME program is tailored to the specific requirements of each individual study. This important feature illustrates that the SESAME program has the ability to recognise and allow for the nuisances of individual businesses. This facility is explored in more detail by Sugumaran and Arogyaswamy (2004, p.85), who state "our primary intent has been to alert the user to the need to tailor IT performance measures to fit with the purpose of the IT in question”.

Lincoln (1986) made the point that analyses of this type (SESAME) have proved valuable for senior management. The analyses enabled management to feel confident about financial returns available from technology and thereby allow a more rational investment policy to be developed. Equally, such analyses enabled senior management to remove the applications that are not financially viable and thereby enhance the overall return on investment made from technology. Another advantage of a standardised methodology such as SESAME is to use the results obtained to enable targets to be set for new developments.

Now the opportunity arises to establish a standard for effectiveness of applications in terms of return on investment, and the facility to undertake post-audits of the financial returns of the computer systems exists. Lincoln (1986) also suggested that all major computer applications should have clear cost-benefit targets established as part of the planning process and should be automatically post-audited. As information systems developed and expanded in general use, other issues and potential means of assessment of effectiveness have arisen, and these will be discussed in the following section.

2.4 Other approaches to information systems effectiveness measurement.

There are other approaches to the measurement of information systems effectiveness. Singh (1993), in his paper on using IT effectively, comments on IT and computer-based information systems (CBIS) being major concerns to the firm. This relates to firm performance, which is used as a measure of information systems effectiveness. In spite of the enormous potential of IT and CBIS, actual experiences of organisations have been less than satisfactory. Lyytinen (1987, p.5) summarises these concerns as follows: "The information systems community faces a paradox: despite impressive advances in technology, problems are more abundant than solutions; organisations experience rising costs instead of cost reduction, information systems misuse and rejection are more frequent than acceptance and use." Organisations vary in their capacity to absorb IT and identify two important determinants being motivation and the ability to exploit IT.

Motivation is a function of the perceived value of IT to the firm in furthering organisational goals and objectives (Singh, 1993). The survival and growth of both the firm and key individuals in the firm depends on results, which are measurable and quantifiable. Positive results motivate key individuals to experiment with new approaches and technologies. Ability creation has structural, procedural and behavioral dimensions. The relevant socio-technical skills have to be imparted to the concerned personnel; appropriate structural mechanisms must be put in place and a climate supportive of the use of IT must be created (Singh, 1993; Klecun and Cornford, 2005; Rondeau *et al.,* 2006).

Furthermore, it is reasonable to presume that organisations will be motivated to change their planning processes over time in an attempt to improve their effectiveness as well as leverage their investment in information systems (SISP) (Grover and Segars, 2005). Firms are aggressively searching for new ways to leverage information, knowledge and IT in supporting strategic goals and competitiveness. Hence, SISP in many firms refers to both a proactive search for competitive and value-adding opportunities, as well as development of broad policies and procedures for integrating, coordinating, controlling and implementing the IT resource (Grover and Segars, 2005).

A major concern to management practitioners and academics is to help organisations realize, in practice, the growing potential of IT/information systems. This is compounded and confused by the lack of a universal cohesive approach to SISP and information systems effectiveness measurement. Existing models may be characterized as growth stage, planning, project management or composite depending on their primary concern (Grover *et al.,* 1996; Wang and Tai, 2003; Henderson *et al.,* 1987). The growth stage model is based on the premise that the process of the organization's adaptation and use of IT/information systems is an evolutionary one involving organisational learning and should therefore proceed through identifiable stages (Nolan, 1979).

Planning models are directed towards producing an action blueprint to help an organization harness IT for enhancing its information/knowledge management capability and are functional at two levels - strategic and operational. After analyzing major planning models, Boynton and Zmud (1987) concluded that IT planning must be viewed as a continual series of incremental efforts to first surface and then resolve or exploit business problems and opportunities. These authors also hold the view that future projects in which the aim is to better understand the planning process are likely to be more significant than projects focusing on identifying additional issues to be addressed in the planning process. As planning evolves, companies are expected to realize that formal structures can make planning processes more efficient. Experience in dealing with uncertain technological options can yield more comprehensive decision processes (Grover and Segars, 2005).

Operational level planning models tend to be much closer to information systems project management whilst strategic planning models vary considerably in their focus, scope and use (Singh, 1993; Grover and Segars, 2005). Project management models are used for developing tactical and operational level plans and schedules to facilitate effective implementation of IT/information system projects. These are based on traditional network methodologies, taking into account the peculiarities of information systems related activities, such as the level of risk associated with the project, project size, the degree of structure of the tasks to be automated and the level of technology of the project relative to the organization (Davis and Olson, 1984). An integration of these planning model components makes a composite planning model possible.

2.4.1 Composite planning models.

Composite planning models exist at strategic, tactical and operational levels in an integrated fashion. Evidence of increasing recognition of these models and their use is increasing in the literature (Singh, 1993; Grover and Segars, 2005; Petter *et al.*, 2008). Historically firms' performances have been deemed sub-optimal due to shortcomings in the planning processes mentioned, being the highly fragmented nature of, and the narrowly focused approach to, the information systems planning and management effort.

While the limited domain of application of growth stage, strategic planning and project planning models is self-evident, prevalent composite planning models tend to provide a cursory treatment to implementation aspects. Many models are not context-independent as may be assumed, they have grown in a specific organization and invariably many changes have to be undertaken before they can be adopted for other organisations (Singh, 1993). Lack of pragmatic orientation is evident in most models. Organisations have to make information systems related decisions in the "here and now" situation characterized by their history, the present context and the rapidly changing internal as well as external environments. Most models by themselves are of little help in deciding how to get started, how to adjust the plans to incorporate the latest technological advances, what organisational changes to make, when to abandon a system and a host of other questions (Singh, 1993).

However, several useful trends were emerging. The scope of planning models was being continuously broadened, as was evidenced by an increasing number of comprehensive information systems planning models that incorporate strategic, tactical and operational levels. Importantly, integration and service quality was also being made an integral part of most comprehensive models (Petter *et al.,* 2008). Most models also made provision for an external feedback loop (technology, competition, manpower) to help review and keep the plans current (Singh, 1993). As organisations become technologically and geographically complex, the importance of planning activities increases. Accordingly, a planning culture often emerges in the form of highly structured systems. Rationality may be built into strategic planning systems through comprehensiveness (Fredrickson, 1984; Sambamurthy *et al.*, 1993), higher levels of formalization (Lederer and Sethi, 1988), a focus on control (Boynton and Zmud, 1987) and top down flow.

In spite of this continued research into planning, the literature seems to highlight a common fault in the planning process – something that one would think elementary, the identification of the core business competencies and business goals, and their alignment with IT planning. Ensuring then that alignment between business and information systems departments is paramount and rigorously enforced, the planning, development and implementation processes can take place. Singh’s (1993) mention of an external feedback loop is essential for the continued success of the SISP and IT development, and is essential in helping to maintain the competitive advantage obtained by the information systems implementation by furthering the organisational goals and objectives of the firm. The feedback loop enables rescheduling of activities and redeployment of resources and facilitates monitoring and controlling tasks (Singh, 1993). The planning system then should contain design characteristics that will alert managers to changing organisational and environmental conditions that may require a change in strategy (Grover and Segars, 2005).

Another useful development in the early 1990's was increasing automation in the planning process that helped reduce the replanning effort and render feasible planning on a continuous basis. The increasing involvement of managers and top management in the planning and management of information systems functions was another adjunct to success in information systems use for the firm. The use of the firms performance as an indicator of information systems effectiveness, in view of the lack of a comprehensive and cohesive approach to information systems planning and a recognition in the literature that IT/information systems use and investment have been largely sub-optimal, is self-defeating. If the firm cannot plan for an outcome, how can that outcome be used as an indicator of success? Evaluation and analysis of planning models and what they should include continues today.

In their recent review of models, dimensions, measures and interrelationships pertaining to measuring information systems success, Petter *et al.* (2008) acknowledge that there have been substantial strides forward towards understanding the nature of information systems success. They give the example of the widely cited DeLone and McLean model of information systems success (1992) was updated a decade later based on a review of the empirical and conceptual literature on information systems success that was published during this period (DeLone and McLean, 2003). Some researchers have synthesized the literature by examining one or more of the relationships in the DeLone and McLean information systems success model using the quantitative method of meta-analysis (Mahmood *et al.*, 2001; Bokhari, 2005; Sabherwal *et al.*, 2006) to develop a better understanding of success. Others have started to develop standardized measures that can be used to evaluate the various dimensions of information systems success as specified by DeLone and McLean (for instance, Sedera *et al.,* 2004).

While research has provided strong support for many of the proposed interrelationships among success dimensions in the DeLone and McLean model, more research is needed to explore the relationships that have not been adequately studied. Empirical research is also needed to establish the strength of interrelationships across different contextual boundaries (Petter *et al.,* 2008). The Petter *et al.* (2008) qualitative literature review, in which 180 academic papers between 1992 and 2007 with some aspect of information systems success were reviewed, takes the first step by parsing out the results based on individual *vs.* organisational units of analysis. The study found that there is insufficient empirical evidence to evaluate most of the relationships at the organisational level. However, there could be other, more complex effects that could explain the relationship between these success constructs at either the individual or organisational levels of analysis. Petter *et al.* (2008) suggest that researchers may want to consider complex functions, such as curvilinear effects, that affect the relationships among information systems success constructs.

Researchers have also suggested that service quality be added to the DeLone and McLean model. An instrument from the marketing literature, SERVQUAL, has become salient within the information systems success literature within the past decade. SERVQUAL measures the service quality of IT departments as opposed to IT applications, by measuring and comparing user expectations and their perceptions of the IT department, and is discussed in the following section.

2.5 SERVQUAL as an investigative tool.

Research by Parasuraman *et al.* (1985) concluded that service quality is founded on a comparison between what the customer feels should be offered and what is provided. Subsequent work by Parasuraman (1988) saw the evolution of the SERVQUAL scale for the measurement of customer perceptions of service quality. Parasuraman has reassessed and improved the scale during the following decade (Parasuraman, 1991; 1993; 1994). There is support for this argument in the information systems literature. Conrath and Mignen (1990) report that the second most important factor of user satisfaction, after general quality of service, is the match between the users' expectations and actual information systems service. Rushinek and Rushinek (1986) conclude that fulfilled user expectations have a strong effect on overall satisfaction. The prime determinants of expected service quality, as suggested by Zeithaml *et al.* (1993), are word-of-mouth communications, personal needs, past experiences and communications by the service provider to the user.

A frequent contributor to the finished system's inability to meet the user expectations is the misinterpretation of user needs by the information systems department. A study by Laudon and Laudon (1991) reveals the failure rate to be between thirty-five and seventy-five percent. The information systems department's communications influence expectations, in particular, the information systems can be a very powerful shaper of expectations during system development. Users are reliant on the information systems staff to convert their needs into a system. In the process, the information systems staff creates an expectation as to what the finished system will do and how it will appear. Laudon and Laudon (1991) found that all too frequently the information systems staff misinterprets user requirements or give users the wrong impression of the outcome because many systems fail to meet user expectations.

The notion that information systems departments are service providers is not well established in the information systems literature. As stated earlier in this review, six measures of information systems success have been identified (Delone and McLean, 1992); Pitt *et al.* (2001) have augmented this list to include service quality. They used the instrument SERVQUAL to assess service quality as a measure of information systems effectiveness. Since system quality and information quality precede other measures of information systems success, existing measures are strongly product focused. This is not surprising given that many studies providing the empirical basis for this categorization are based on data from the early 1980s, when information systems was still in the mainframe era. The quality of the information systems department's service, as perceived by users, is a key indicator of information systems success (Moad, 1989). User satisfaction is used by information systems departments to improve their quality of service provided (Conrath and Mignen, 1990). The product supplied by the information systems department, a computer with software, is tangible. The intangible attributes associated with this product need to be considered in the context of information systems effectiveness measurement. That is to say, users/clients do not want just the machine, they want and possibly expect installation assistance, product knowledge, software training and support and online help. Current information systems success measures, product and system quality, focus on the tangible.

Pitt *et al.* (2001) argue that service quality, which is intangible, needs to be considered as an additional measure of information systems success. The results of their study led

Pitt *et al.* (2001) to conclude that information systems service quality is an antecedent of use and user satisfaction. SERVQUAL has been validated as a suitable instrument to measure information systems service quality after examination of content validity, reliability, convergent validity, nomological validity and discriminant validity. Instruments such as SERVQUAL may be used as a diagnostic tool to measure information systems service quality (measurement of service quality prior to and after IS service quality change).

Pitt *et al.* (1995) evaluated the instrument from an information systems perspective and suggested that the construct of service quality be added to the DeLone and McLean model. The Pitt *et al.* (2001) study also assessed information systems effectiveness in different types of organisations using an investigative instrument. The study focused on service quality as a measure of information systems effectiveness. The role of the information systems department within the organization has broadened considerably over the last decade. Once primarily a developer and operator of information systems, the information systems department now has a much broader role. They have expanded their roles from product developers to become service providers (Pitt *et al., 2001).*

The introduction of personal computers results in more users of IT interacting with the information systems department more often. Users expect the information systems department to assist them with a myriad of tasks, such as hardware and software selection, installation, problem resolution, connection to local area networks, system development and software education (Pitt *et al.*, 2001; Moad, 1989). Facilities such as the information centre and the help desk reflect this enhanced responsibility. Information systems departments now provide a wide range of services to their users and have expanded their roles from product producers and operations managers to become service providers. The information systems department has always had some service component to its role, but service rarely appears in the vocabulary of the traditional systems development life cycle.

DeLone and McLean (2003) added service quality to their updated model, acknowledging that ‘the changes in the role of information systems over the last decade argue for a separate variable – the “service quality” dimension’ (p.18). In recognition of other developments in information systems and related topics, other researchers have modified the DeLone and McLean model to evaluate specific applications such as knowledge management (Jennex and Olfman, 2002; Kulkarni *et al.,* 2006; Wu and Wang, 2006) and e-commerce (Molla and Licker, 2001; DeLone and McLean, 2004; Zhu and Kraemer, 2005). When applying the DeLone and McLean model to different practical applications, Petter *et al.* (2008) make the point that the DeLone and McLean model is naturally dependent on the organisational context, and that the researcher wanting to apply the DeLone and McLean model must have an understanding of the information system and organization under study. This will determine the types of measures used for each success dimension. The selection of success dimensions and specific metrics depend on the nature and purpose of the system(s) being evaluated. For example, an e-commerce application would have some similar success measures and some different success measures compared to an enterprise application. Both systems would measure information accuracy, while only the e-commerce system would measure personalization of information (Petter *et al.*, 2008).

In their conclusion, Petter *et al.* (2008) recognize that measuring information success or performance in empirical studies has seen little improvement over the last decade. Researchers and practitioners still tend to focus on single dimensions of information systems success and therefore do not get a clear picture of the impacts of their systems and methods. They add that progress in measuring the individual success dimensions has also been slow. The work of Sedera *et al.* (2004) in developing measures for success is encouraging and this type of work should be continued in future research. Valid and reliable measures have yet to be developed and consistently applied for system quality, information quality, use and net benefits (Petter *et al.,* 2008).

In a similar manner to the research and development of planning models, methods of information systems effectiveness measurement are the subject of continued research. Many researchers up to the early 1990's (DeLone and McLean, 1992; Ein-Dor and Segev, 1978; Weill and Olson, 1989) have noted the multifaceted nature of information systems effectiveness rendering the use of a single overall indicator of information systems effectiveness unlikely. UIS is still popular as a single measure of information systems effectiveness but it is difficult to justify this as a comprehensive or adequate measure.

In their closing comments on this part of their review, Grover *et al.* (1996) make the observation that there are other studies that have utilised multiple criteria for information systems evaluation, these studies tend to be more comprehensive and able to alleviate the problem of limiting the amount of variance. These studies hypothesise how the variables related to one another and show promise. This approach however may be limited if the multi-criteria are in conflict. More recent work suggests that the use of UIS as a measure of information systems effectiveness is still being questioned. Gation’s (1994) study looked at the relationship between user satisfaction and user performance for a particular system. Although her study overall supported the validity of UIS as a measure of information systems effectiveness, Gation raises the question of focused and relevant question selection for survey instrument in studies of this nature, and the possibility of careless or biased interpretation of results. DeLone and McLean (2008) revisited user satisfaction measurement. They considered the most widely used measures, those being the Doll *et al.* (1994) End-User Computing Support instrument and the Ives *et al.* (1983) UIS. They report a study by Seddon and Yip (1992) which found that the EUCS instrument outperformed the UIS instrument in the context of accounting information systems. The Seddon and Yip (1992) study also found that both the EUCS and the UIS contain items related to system quality, information quality and service quality, rather than only measuring overall user satisfaction with the system. Because of this, some researchers have chosen to parse out the various quality dimensions from these two instruments and either use a single time to measure overall satisfaction with an information system (Rai *et al.*, 2002), or use a semantic differential scale (Seddon and Yip, 1992). Others have used scales for attitude that are comparable with the concept of user satisfaction (Coombs *et al.*, 2001).

Hackney and Kawalek (1999) believe that end-user involvement and business-IT alignment are important means to ensure information systems effectiveness – this view was ratified by Rondeau *et al.* (2006) in their study into information systems management effectiveness and end-user computing and its impact on manufacturing firms. Gerwin and Kolodny (1999) considered the role of an organisational approach to information systems planning on the basis that cross-functional decision process creates greater work system integration and hence more information systems effectiveness.

Composite planning models, then, are continuously being evaluated and expanded as a result of extensive research in information systems planning and as a result of the expansion of information systems into other functionalities as technology advances. Areas such as knowledge management and e-commerce involving internet systems are now included in the information systems planning literature and in practical business. The discussion resulting from the volume of research being undertaken in information systems planning models is an indication of the complexity of the issue and the differing views on what is required for improved efficiency of planning models in the future. A consistent major inadequacy though, is what measure of information systems effectiveness should be used to assess the success of the planning process. This matter is also undergoing continuous and vigorous research in an effort to facilitate a standard approach to information systems effectiveness measurement, which would surely be a considerable positive advancement for the assessment of information systems planning. An evaluation of other methods of information systems effectiveness measurement follows in the next section.

2.5.1 Evaluation perspective of other approaches to information systems effectiveness measurement.

Individual level of analysis has been the dominant evaluative perspective, consistent with the popularity of perceived criteria and usage measures. Few studies deal with the perspective of external entities perhaps because researchers have examined effectiveness from within the organisational context, which is relevant, when information systems research focuses on data, information, or a decision. When information systems research focuses on information systems strategic impact this approach is not appropriate. Hamilton and Chervany (1981) hold the view that multiple viewpoints should be incorporated into the assessment of system effectiveness. This may facilitate increased awareness of the value of information systems and to understand the multidimensionality of information systems effectiveness. This view was later explored from differing approaches by Hackney and Kawalek (1999), Gerwin and Kolodny (1999) and Rondeau *et al.* (2006). Hackney and Kawalek (1999) make the point that misalignments in information systems strategies, goals, and objectives may be avoided by increasing end-user involvement in planning. Gerwin and Kolodny (1999) comment on the dimension of cross-functional decision process and their implementation, which creates greater work integration and collapses traditional organisational boundaries. Rondeau *et al.* (2006) look at greater organisational involvement and the resultant revision of information systems management practices that better fit the information systems requirements.

Grover *et al.* (1996) make the point that improving information systems effectiveness is generally the goal of information systems research, that application of the results should lead to information systems effectiveness or success. The application of a myriad of IT in business process change and electronic commerce makes evaluation of investments even more important and complex. The construct model developed by Grover *et al.* (1996) is an attempt to provide a common set of dimensions for the evaluation of information systems effectiveness and there use in future studies will enable the acceptance of a common paradigm. Rondeau *et al.* (2006) developed a framework for assessing information systems performance which related organisational involvement in information systems development, information systems management effectiveness, end-user self-reliance in application development, end-user dependence on information systems expertise, and information systems performance and tested the framework in a survey of manufacturing managers. Their study concluded that increased information systems strategic planning effectiveness, more responsive and better designed computing solutions and more useful end-user training programs were significant improvements resulting from organisational cooperation and respect. The degree to which medical pathology practices, both private and hospital based, are able to coordinate such frameworks for information systems development and assessment will need to be investigated in the context of a contributing factor to information systems development success. The knowledge of such frameworks will also be determined. These issues will be further examined in Chapter 3, in which the literature pertaining to medical pathology practice is examined.

Grover *et al.'s* (1996) study also importantly recognizes the significance of more focus on impact evaluation and the organisational level of analysis due to the changing orientation of the field. Their study does so without distracting from the relevance of process or response evaluation. Rather the study calls for more attention to matching the appropriate type of evaluation with the unit of analysis, evaluative perspective domain of study, frame of reference and purpose of evaluation. This approach is also recommended by Petter *et al.* (2008).

Jiang *et al.* (2002) take a different approach and look at the process of information systems planning and information systems effectiveness in terms of the project team structure and relationship of its members as an adjunct to success. Projects are a major process structure for accomplishing many tasks in organisations (Peters, 1999). A project is a non-routine, complex, one-time effort limited by budget, resources, time and performance specifications designed to meet customer needs (Gray and Larson, 2000). In spite of obvious challenges this form of organization is used widely because historically it has been successful in the development of new software and hardware projects whilst satisfying customer requirements. The project team and the project manager are the two crucial components to implementing projects (Campbell, 2005). Each component must be effective to promote the chances of project success (Schwalbe, 2000). However, a variety of views in the project team may lead to conflict in tasks and personalities. The project manager may be powerless to remove any conflicts due to lack of authority over team members. Thus, building a cohesive, motivated project team is a key to ultimate accomplishment of project goals and the project manager has the primary responsibility for providing leadership to meet these goals (Peters and Homer, 1996, Chan and Reich, 2007).

It is obvious that effectiveness of both project managers and the project team is essential for the success of the project. Unfortunately, this effectiveness is hard to achieve and is even harder to define because of the different perceptions of system success between information systems staff team members and owner/user team members (Linberg, 1999, Chan and Reich, 2007). For example, the information systems staff team members may declare a project outcome successful if the system abides by information systems standards and policies for data security, accuracy, documentation and hardware and software compatibility (Jiang and Klein, 1999).

By the same token, information systems users may consider the project outcome in terms of content and currency of information, the extent of the changes to their workloads and impacts on their jobs (Delone and McLean, 1992). These differing viewpoints can lead to conflict. This conflict, if present in medical pathology practice, may represent a barrier to information systems planning success, and is a significant issue that requires evaluation by this research. Pre-project partnering, a collection of practices aimed at controlling conflict and system quality, have been proposed as a method for avoiding problems associated with multiple interests within a project (Larson, 1997).

Pre-planning partnering involves a considerable up-front investment in time and resources to establish a foundation for teamwork during the project's duration. This involves institutionalizing procedures and provisions for continued commitment to teamwork, resolving disputes, attaining top management support and agreed upon approaches for collaborative problem solving. The purpose of pre-planning partnering is to lay the groundwork for a successful partnering process (Jiang *et al.,* 2002). Under ideal conditions, pre-project partners should be selected from those who have established a successful track record of partnering on previous projects. When this is not possible, other strategies should be used. For example, Larson (1997) reports that pre-project activities normally focus on getting top management's commitment to the partnering process. This should involve an initial top management conference that sets the tone for the partnership process and establishes the dialog to control conflicting tasks and issues among those involved with the project.

Building a collaborative relationship between the major players is imperative. The project manager for each partner has a major role in this by facilitating the breakdown of barriers to collaboration and establishing trust and respect amongst team members (Larson *et al.*, 1992; Jiang *et al.*, 2002). The team members bond through the development of a common set of goals and objectives, a process that reduces potential conflicts. Pre-planning partnering also expands the commitment to other key individual members who will be working on the project, and may involve outside consultants, well-versed in team-building skills facilitating a workshop on ice-breaking activities, principles of teamwork, synergy and approaches to continuous improvement.

A study was undertaken by Jiang *et al.* (2002) to investigate pre-project partnering with two research questions in mind. The research questions were - Do pre-project partnering activities influence information systems project manager performance? and Do pre-project partnering activities influence effective project team characteristics? The research methodology involved questionnaires being sent to randomly selected members of the Project Management Institute (PMI). The membership is widely used in other project management research, yielding comparability across studies (Larson, 1997). The items concerning pre-planning partnering investigated were - before the project began people met to build a collaborative relationship; before the project began key people met to identify potential conflict areas; before the project began documented processes were in place for joint resolution of problems; before the project began a formal charter stating shared objectives was drawn up; the project included provisions for continuous improvement. Analysis of their data supported the following hypotheses - pre-project partnering activities lead to improved project manager performance; pre-planning partnering activities lead to more effective team characteristics; strong project manager performance improves effective project team characteristics; strong project manager performance improves project outcomes and strong project team effectiveness improves project outcomes.

In their conclusion, Jiang *et al.* (2002) make the point that the implications of their study are clear. Pre-planning partnering should be implemented to promote a collaborative framework for conflict avoidance and resolution, and continual quality improvement. The impact of this on the successful outcome of information systems projects can only be positive and contribute towards more effectiveness in information systems planning and development. The work of Jiang *et al.* (2002) is significant with respect to business-IT alignment in SISP generally and could be adopted as a set process for this undertaking. It would seem that the principle of conflict resolution in their work is critical in improving the communication, co-operation and collaboration between business and information systems staff in view of this widely recognised misalignment, which is discussed further in the following section.

2.6 Business-IT alignment.

Alignment between business and IT is inherently of value and contributes to organisational success (Chan and Reich, 2007). The Society for Information Management conducts an annual survey to gauge the importance of various IT issues. In 2005, the number one management concern of all groups of respondents was alignment. Alignment was also ranked as the top management concern in 2004 and 2003. For two decades, IT alignment has consistently appeared as a top concern for IT practitioners and company executives (Luftman *et al.,* 2005). For many years researchers have been drawn to the importance of business-IT alignment (McLean and Soden, 1977; Henderson and Sifonis, 1988). Chen and Reich (2007) have undertaken a review of the literature on this important topic with the view to ascertain where and how the research and business communities regard alignment. This research seeks to examine the literature on business-IT alignment relative to medical pathology practice, both hospital based and private practice, to ascertain how SISP is regarded by the medical pathology industry. Chapter 3 contains this examination, and from the content of the literature the researcher will formulate an approach for further investigation of this important contributor to SISP as applied to medical pathology practice.

Early research showed a number of approaches to achieving alignment - linking the business plan with the IT plan; ensuring congruence between business strategy and IT strategy; and examination of the fit between business needs and information systems priorities. Motivation for this early research on alignment emerged from a focus on strategic business planning and long-range IT planning in the early 1980s (e.g. IBM, 1981). From a business perspective, planning was characterized as a top-down and a bottom-up process, and departmental (e.g. IT) plans were created in support of corporate strategies. From an IT perspective, decisions on hardware and software had such long-term implications that tying them to current and future plans of the organisational unit was a practical necessity (Chan and Reich, 2007).

The business and IT performance implications of the alignment have been demonstrated empirically and through case studies during the last decade (Chan *et al.*, 1997; de Leede *et al.*, 2002; Irani, 2002; Kearns and Lederer, 2003). These authors' findings support the hypothesis that those organisations that successfully align their business strategy with their IT strategy will outperform those that do not. Alignment leads to more focused and strategic use of IT which in turn leads to increased performance (Chan *et al.*, 2006).

There are a number of issues that require acknowledgement with respect to alignment mechanisms or models. The literature (Choe, 2003; Wang and Tai, 2003; Chan and Reich, 2007; Rondeau *et al.*, 2006) implies that there should be a priority between business and IT. That is to say that, whilst effective alignment of the IT plan with the business plan can provide competitive advantage, the opposite – aligning the business plan with the IT strategy – can result in potential losses. For this reason, researchers and practitioners should be cautious about putting IT in the lead (Kearns and Lederer, 2000). Levy (2000) raises the issue that IT – even aligned IT – in and of itself is not strategic. In order for IT to be strategic, it must be valuable, unique and difficult for competitors to imitate. These two issues may in part explain why the outcomes of the implementation of enterprise systems in business are very often sub-optimal.

Chan and Reich (2007) discuss a number of challenges in attaining alignment, the first being those related to knowledge. These knowledge challenges refer to the central problem that IT executives are not always privy to corporate strategy, and that organisational leaders are not always knowledgeable about IT. Also, managers are not always knowledgeable about key business and industry drivers. One would perhaps then ask how did these managers attain their positions? It would be pertinent to suggest that if Jiang *et al.'s* (2002) ideas on pre-planning partnering and project team structure were in place, then the knowledge issue would not exist and alignment outcomes would be more favorable. It is also an interesting observation that in today's technology dependent and rich business environment there is now more corporate requirement for managers to have a basic IT qualification in addition to business qualifications.

The second challenge to alignment according to previous alignment research is the recurring issue that often corporate strategy is unknown (Reich and Benbasat, 2000), or if known, is unclear and/or difficult to adapt. This poses a significant challenge because most alignment models presuppose an existing business strategy to which an IT organization can align itself. This would also make SISP difficult at best, impossible at worst, because there could be no business goals on which to plan SISP.

The third challenge to alignment is a lack of awareness or belief in the importance of alignment. Henderson and Venkatraman (1993) found that managers were more comfortable with business positioning choices than with IT positioning choices. This situation as with the knowledge challenge above, could be alleviated by an approach to co-operative planning based on Jiang *et al.'*s (2002) research. Careful selection of people with the knowledge and attitude for team building and ensuring co-operation makes a positive impact on alignment and planning outcomes. Baets' (1996) research in the banking industry supports this approach. Baets (1996) found that IT alignment was hindered by a lack of knowledge of the banking industry amongst banking managers. Chan and Reich (2007) comment in the implications for alignment research that a number of issues need to be addressed. These issues – shared responsibility for alignment; shared knowledge; building the right culture and informal structures; educating and equipping; embracing change; and focusing on essentials; are not only necessary to ensure improved business IT alignment but are equally necessary to ensure successful SISP and information systems effectiveness measurement. The incorporation of established and significant research such as Jiang *et al.* (2002) should be incorporated into any effort to make alignment and SISP more standardized and successful. Relating to some of these issues is information systems service quality, and this was recognised as an important consideration for the assessed success of information systems projects (DeLone and McLean, 2003).

The preceding sections have examined information systems planning approaches, principally business-IT alignment and pre-planning partnering, and information systems effectiveness measurement, which now includes service quality. In spite of a large body of research into these practices, there remain a number of issues that are dealt with in the following section.

2.7 Comments on information systems planning approach and information systems effectiveness measurement.

The research on the approach to measurement of information systems effectiveness shows a great variation in the measurement techniques and the possibility of inefficiencies in the deployment of effectiveness measures through personal agendas or bias in the management team. Several authors, such as Pyburn (1983), Earl (1993), Sullivan (1985) and Sabhewal and King (1995) on SISP, agree that the planning process is most successful when rational and adaptive pathways are used in the design process. However, there is no mechanism suggested for possible pathways for this to happen, or overall consensus that this is the case.

There are several other shortcomings in the planning models presented in business – lack of business-IT alignment; lack of consideration for team member selection in either top- down or bottom-up situations; lack of consideration as to how people communicate to make plans, that is knowledge management/extraction and organisational learning; lack of a clear definition of business goals by thorough business analysis involving stakeholders from management to end-users; and ensuring that the current information systems hardware/software has the capability to handle the planned information systems changes. The relativity of these cited issues to medical pathology practice, in particular laboratory information system capability, will be examined in the course of this research, and the structure of the planning process will be investigated through the emerging hypotheses.

2.8 Summary of literature review – the broad context.

An extensive review of the literature pertaining to SISP and information systems effectiveness measurement has been undertaken. The literature review has revealed a number of components of the strategic planning and effectiveness measurement processes that are deemed by the authors cited as having high significance with respect to successful outcomes for the strategic planning and effectiveness measurement processes. These components were found to be end-user involvement in the planning process, business-IT alignment, pre-planning partnering and the recognition that the setting of an achievable business goal for SISP is a important strategic measure of information systems effectiveness.

The more recent literature is drawing the attention of researchers and practitioners alike to emerging socio-technical and environmental changes that are taking place. Petter *et al.* (2008) state that DeLone and McLean (2003) have modified their model to accommodate service quality as a result of a changing social emphasis. Information systems service is also recognised as a component of the function of an IT department. Petter *et al.* (2008) revisit the contention that practical application of the DeLone and McLean model (rightly) depends on the organisational context, but now that context has been broadened to include knowledge management and e-commerce. They also allude to the fact that as more research into information systems planning and success measuring is undertaken other, more complex effects need to be considered when investigating items such as individual and organisational levels of analysis. Choe's (2003) work introduces a view that contextual variables, such as external environmental factors, have a moderating effect on information systems investment and improved financial performance. Chan and Reich (2007), in their review of IT alignment, found that challenges remain for IT alignment; they suggest more research be undertaken to investigate the process of alignment, contingency perspectives of alignment, measuring alignment and sharing knowledge.

There were other possible components of the strategic planning process, cost-benefit analysis, and information systems effectiveness measurement using UIS, that attracted considerable debate as to their true value in their respective roles, and are generally not seen as adequate measures of information systems effectiveness or information systems success by researchers. Cost benefit analysis is seen as functional and not strategic and takes no role in business-IT alignment (Choe, 2003). The researcher takes the view that UIS is not a sound basis for the evaluation of information systems effectiveness. The researcher's view is that UIS should be part of the system design and subject to alpha and beta testing for approval by end-users before incorporating into the system that is to be implemented.

The discussion in the first part of the literature review has provided a well-documented basis on which the researcher can more forward into the area of research focus, that is, the medical pathology laboratory. The key argument of this literature review is that for SISP to occur, a number of components need to be in place, these being business-IT alignment, pre-planning partnering, and end-user involvement in the planning process, as stated above. There needs to be an objective and pre-planned means of assessing the success and effectiveness of SISP, and it is the researcher's view that this is the business goal(s) that is (are) driving SISP. That is to say, the measure of information systems effectiveness is the objectively measurable achievement of the pre-determined business goal for which the SISP was undertaken.

In Chapter 3 the literature is used to develop a research model and a set of hypotheses to test effectiveness of information systems in pathology laboratories.

CHAPTER 3 - SISP AND IS EFFECTIVENESS MEASUREMENT – MEDICAL PATHOLOGY PRACTICE: DEVELOPING A RESEARCH MODEL

3.1 Introduction.

The extensive search of the literature into SISP and information systems effectiveness measurement reported in Chapter 2 revealed little work in medical pathology. What is recognised is that there is a task/technology asynchrony that is compromising laboratory information system performance in medical pathology (Brender and McNair, 1996; Wells *et al*, 1996). It is this gap that is the focus of this research. The modern pathology laboratory is a complex, heterogeneous environment, typically with a mix of autonomous and partially inter-working applications running on a range of hardware platforms. A consequence is that bigger pathology laboratories today (all main private pathology companies in Australia, for instance) are entirely dependent on their laboratory information systems functionality, and that the pathology laboratory information systems must be considered as 24 – hour mission critical systems (Brender and McNair, 1996). Rapid evolution of laboratory procedures, methodologies and equipment characterises the pathology laboratory.

At present, the development of pathology laboratory science is so rapid that a vendor organisation has difficulty in absorbing, digesting and practically incorporating new enabling technologies/techniques into their version of a global laboratory information system. At one hospital site studied by Wells *et al.* (1996), an in-house pathology laboratory information systems using object-orientated software tools based on a conventional file-sharing platform was found to give poor performance under load.

Major investments have been made in IT in pathology laboratories, which cannot be ignored. Hence, it is necessary that a laboratory information system solution is future viable and able to incorporate already installed laboratory information systems functionalities. Therefore, an obvious laboratory information systems solution for the pathology laboratory domain is a solution based on a concept of open interconnected systems, interoperating on a functional level (Brender and McNair, 1996). An example of an open systems architecture and design philosophy is given in the following section.

3.2 The establishment of the OpenLabs project.

The establishment of an open architecture implies that a market will develop for modular, scalable, and cost-effective laboratory information systems features without the dependence on individual manufacturers and hardware/software platforms which characterises current systems (Brender and McNair, 1996). With this in mind, a consortium was formed in 1991 as part of the European Community's Advanced Informatics in Medicine Programme and included partners from industry, academic institutions and hospital laboratory services.

In 1992, the OpenLabs project began work with several major objectives: to improve the efficiency and effectiveness of laboratory information systems by integrating knowledge-based systems with laboratory information systems and equipment; to provide and implement standard solutions for electronic data interchange between laboratories and other medical systems; to specify an open architecture for an integrated laboratory information systems; and to demonstrate the integration of various knowledge-based system modules on the open architecture platform and with existing laboratory information systems (Boran *et al.,* 1996).

The OpenLabs project is an ideal example to cite as an objectively planned and implemented SISP because the project involved all the concept factors suggested in the literature in Chapter 2 – empowerment, motivation, innovation, pre-planning partnering, co-operative planning, information systems use, UIS and working towards a business goal. The OpenLabs project has taken as its core problem the definition of a computing infrastructure in which existing laboratory information systems are accommodated and in which new functions or modules can be easily added. The main elements of the OpenLabs solution comprise a set of advanced laboratory services, a communication architecture including a coding system, generic interfaces to exiting legacy systems, and a service manager to co-ordinate the overall computing environment (Boran *et al.,* 1996).

The OpenLabs project services, in principle, any number of services providing support to the different aspects of a clinical laboratory which could be incorporated into the OpenLabs computing environment. The prototype service modules of the OpenLabs solution include: support for requesting laboratory investigations; automatic re-scheduling of additional investigations; performing laboratory investigations (advanced laboratory workstations); interpreting laboratory results; telematics for remote requesting and reporting; and managing the laboratory's use of resources by simulation (O'Moore *et al.,* 1994).

In a trial at a major hospital in the United Kingdom, the ordering of laboratory services by clinicians was aided by the use of knowledge-based systems. The ordering system automatically recommends laboratory investigations appropriate to each patient's clinical condition and recent pathology. The doctors review the recommended tests and add to, delete from or simply accept the tests proposed for the patient. Routine use has resulted in a significant reduction in the number of tests ordered, a significant saving in medical staff time and improved appropriateness and continuity of management (Boran *et al.*, 1996).

Another OpenLabs service is the advanced instrument workstation service, which was designed and developed on the basis of user requirements assembled from thirteen partners with a range of complementary laboratory expertise within the OpenLabs project. The gathered information was the result of discussions, local questionnaires, interviews, experiences and market analysis by industry partners (O'Moore *et al.*, 1994; Boran *et al.*, 1996).

The OpenLabs business process represents an intensive, objective and thorough SISP, but it is not referred to as such by the consortium – perhaps this is an industry nuance. It is in stark contrast to most other literature and studies cited in this review, and it is argued that the OpenLabs project represents a better approach to SISP. The OpenLabs project embraced several of the cited contributors to successful SISP (for example, end-user involvement, business-IT alignment and pre-planning partnering) cohesively in the same project. Many of the measures used by other authors (Doll *et al.* (1994); Ives *et al.* (1983)) and recognised as a means of measuring information systems effectiveness, such as information systems use, user information satisfaction (UIS), decision-making and system quality are used by the OpenLabs team as requirements of the design process. The sole criteria for measurement of the effectiveness of the OpenLabs project is its ability to meet the design brief, which was stated as the definition of a computing infrastructure in which existing laboratory information systems are accommodated and in which new functions and modules can easily be added. The UK project met this goal and therefore can be considered to be successful and effective.

3.3 Achievements of the OpenLabs project.

The OpenLabs communications architecture had to achieve two important goals, firstly the provision of an environment for facilitating the integration of modules implementing the advanced OpenLabs services, and secondly, the provision of an open solution by which these modules could be developed with a vendor-independent approach, that is, provide portability and interoperability in a heterogeneous distributed computing environment. Furthermore, there was a need for the system to be configurable so that some or all of the advanced OpenLab services could be integrated whilst having the facility to customise their use to suit a particular laboratory.

Existing legacy systems to be integrated within the OpenLabs computing environment include clinical analysers and pathology laboratory information systems generic interfaces capable of being configured to a wide range of existing instruments. The OpenLabs service manager controls the information flow between different modules connected to the OpenLIS (the OpenLabs laboratory information system), thereby supporting the workflow in the clinical laboratory and enabling the management of laboratory production in a highly computerised domain. The use of the generic interface and of system editors enables a high degree of flexibility in the configuration of the system for individual user requirements – a key function for information systems effectiveness.

The OpenLabs system has been designed to assume an interactive role in the interpretation of some key clinical results. Through a structured evaluation methodology, the system can provide interpretive comments of routine results and is programmed to provide alarms if interpreting abnormal results in the acute and high dependency hospital environment. This facility has been found to considerably improve the efficiency and turn-around time of the laboratory (Boran *et al.,* 1996).

The project team has introduced an important component in the design and planning process with the realisation that any information system requires continual assessment and ‘fine-tuning’ to maintain maximum impact on the firm. The OpenLabs open architecture approach is a major step forward for clinical laboratories in being able to break free of the restrictions of commonly used mainframe systems. The ability to embrace modern technology and improve efficiency and effectiveness within the laboratory environment sets the agenda for improved business outcomes and the ability for the pathology laboratory information systems to grow with the business and with the rapidly increasing developments in modern technology.

The OpenLabs project and its impact on laboratory computing is significant for this research as it has documented (Boran *et al.,* (1996); O’Moore *et al.,* 1994) what amounts to a successful SISP undertaking in a pathology laboratory environment. The OpenLabs project also makes the association of a planning exercise with business outcomes as a measure of information system effectiveness. The OpenLabs project has provided a link between SISP in general business and SISP in medical pathology practice for this research. The OpenLabs project has also provided some insight into what is achievable technically in medical laboratory computing, and this will be expanded in the following section.

3.4 Future directions for pathology laboratory information systems.

Brender and McNair (1996) have proposed user requirements and future directions of pathology laboratory information systems in their paper on user requirements on future laboratory information systems. They put forward the following as the main user needs and requirements for future IT solutions in clinical laboratories: IT solutions must be highly flexible and maximally customisable – by the users themselves; IT solutions are based on the concept of open systems, both technically and functionally, which enables modular functionalities from different vendors to co-operate forming a global laboratory information systems functionality; IT solutions are future viable and able to incorporate already installed IT functionalities; IT solutions support management of failure prevention, of repair, of success and of change. The authors conclude that the establishment of an open architecture implies that a market will develop for modular, scalable and cost-effective laboratory information systems features without today's dependence on individual manufacturers and hardware/software platforms (Brender and McNair, 1996).

The popularity of open architecture systems developed considerably with the advent and increasing use of client-server technology (Anandarajan and Arinze, 1998). The two major contributing factors to the increasing use of client-server technology at that time were technical factors and economic factors (Anandarajan and Arinze, 1998;

Wells *et al.*, 1996). The technical advancements in IT have converged to make client-server computing possible through faster and minimised hardware components, and open standards that have created portable, scaleable and inter-operable systems. Software trends such as graphical user interfaces (GUI), forth generation programming language and the advent of component-ware has also helped in the evolution of client-server information systems (Anandarajan and Arinze, 1998). The ability to perform processing on desktop workstations instead of mainframes has considerably lowered the cost of computing for many industries (Anandarajjan and Arinze, 1998). The limiting factor to development and enhancement of laboratory information systems with open architecture and client server technologies is the presence and reliance of a current mainframe information systems (Anandarajan and Arinze, 1998; Wells *et al.*, 1996). The laboratories studied in this research currently use mainframe systems, and their ability and desire to change to these more modern technologies will be assessed in the course of this research.

3.5 Other areas of information systems development in pathology laboratories.

Other areas of information systems/software involvement in pathology laboratories found in the literature include a study by Mayer (1998), in which he describes the use of a commercially available financial management package to perform a cost-benefit analysis in a hospital pathology laboratory. The results obtained by the cost-benefit analysis were a major factor in the decision-making process for the management and development of the laboratory. This research (Mayer, 1998) demonstrates the all too common piecemeal approach to laboratory management and the decision-making process in laboratories, unsupported by effective information systems management tools and perhaps full and proper business analysis.

Economic constraints within the healthcare system advocate the introduction of tighter control of costs in pathology laboratories. Detailed cost information forms the basis for cost control and financial management. Based on cost information, proper decisions regarding priorities, procedure choices, personnel policies and investments can be made (Mayer, 1998). The package studied by Mayer (LabCost) serves as a general management tool for resource handling, accounting, inventory management and billing. The study involved cost-benefit analysis to aid the decision-making process concerning the purchase of a new analyser. The increasing need of pathology laboratories to implement cost control is a direct consequence of the unprecedented pressure to improve the financial efficiency of the laboratories and to reduce their operational costs. Whilst cost analysis is being increasingly used in the laboratory to support management decisions concerning financial alternatives, most laboratory directors find it increasingly more difficult to deal with the complex financial issues of the laboratory services (Kreig *et al.*, 1978).

Mayer (1998) recognises that there are several shortcomings to the process of cost-benefit analysis: costs vary with laboratory size, spectrum of services, volume of work and types of equipment. Therefore it is not possible to compare costs occurring in different laboratories; different levels of cost analysis are required for different levels of management; cost evaluation is expensive; cost analysis is usually based on historical data – the validity therefore of past cost evaluation for prediction of future trends has to be regarded cautiously; and most importantly, the inability of cost analysis to evaluate the clinical usefulness of the tests in terms of financial benefits that result from the test performance.

In his concluding remarks, Mayer (1998, p.61) argues that "Due to cost containment, laboratory analysers can no longer be selected only on the basis of their quality and capacity". The fact that cost is seen as the sole determinant in equipment selection, usually by upper/senior management, is important. The laboratory then may be forced into a position where it cannot take advantage of any technological advancement that a new analyser may have because it is deemed to cost too much to run.

Mayer's (1998) work on cost-benefit analysis as a means of improving cost efficiency in pathology laboratories is significant in that it points out that consideration of costs as the sole determinant of efficiency improvement can negatively impact on laboratory quality that may compromise patient well-being. The cost-benefit approach may also be viewed as a functional means of efficiency planning, and as such it is not strategic. There are several views on what contributes to strategy and the means by which they may be included in a planning exercise and these are examined in the following section.

3.6 Development of a framework for SISP.

In spite of suggested pathways for SISP (Pyburn, 1983; Earl, 1993; Sullivan, 1985), no mechanism (model) has been proposed to demonstrate how SISP should be approached for application to laboratory information systems. Grover and Segars (2005), in their evaluation of the evolution and maturing of SISP, found that many studies had focussed on planning content with particular interest in methods and measurement of alignment between business and information systems strategy. Grover and Segars (2005) also found that these studies did little to illuminate the organisational aspects of planning. Earl (1993) made the observation that SISP approaches based on a degree of rationality and adaptability built into the planning process seemed to be more effective. This was thought to lead to a more effective basis for managing increasingly diverse and dispersed technologies across the organisation (Boynton and Zmud, 1987; Zmud *et al.*, 1986; Lederer and Sethi, 1998). It would seem from their research that an effective mechanism for SISP has yet to be determined. An extensive search of the literature into SISP and information systems effectiveness measurement in medical pathology practice revealed little work in this specific area.

To hypothesise an effective mechanism for SISP, we can consider the approach adopted by the OpenLabs team. The approach used by the OpenLabs team was to utilise the components of SISP and the setting of a clearly defined business goal to be used as a measure of information systems effectiveness, in a cohesive and cooperative manner.

Through the formation of a consortium to discuss, plan and implement the system, the following concept factors were embraced – empowerment, motivation, innovation, pre-planning partnering, co-operative planning and team building, information systems use and UIS (end-user involvement) and most importantly working towards a business goal. A model for the OpenLabs project is represented in Figure3.1.

The most dramatic difference in the OpenLabs approach as opposed to other approaches cited is that the OpenLabs team had a clearly defined goal for SISP, that is – the establishment of a modular, scalable and cost-effective open architecture laboratory information system without the dependence on individual manufacturers or vendors. The achievement of this goal is the sole measure of the effectiveness of SISP

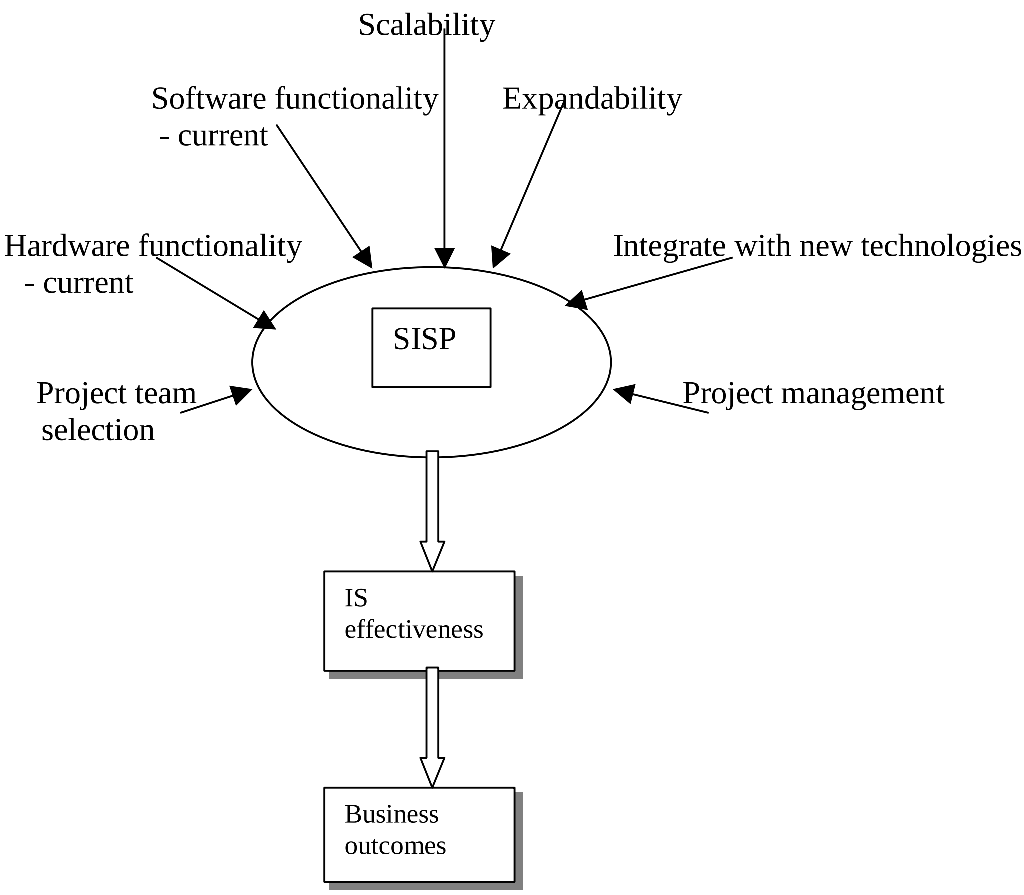

Figure 3.1 OpenLabs SISP/information systems effectiveness model.

and the information system. The approach used in the OpenLabs project with a clearly defined business goal as the measure of SISP success and information systems effectiveness could set a direction or standard for SISP projects. This is because the OpenLabs project team recognised that such previously and inappropriately used measures of information systems effectiveness (information systems use and UIS) were regarded as part of the system design is another important step in the rationalisation of an effective mechanism for SISP.

Figure 3.1 represents the project structure from the pre-planning partnering stage through to completion and shows the components of SISP in the OpenLabs project. The planning stage has integrated team selection and building with a clear definition of technical requirements of the new system. The model also shows that the new system has to be scalable for the future and have a platform that will facilitate integration with future technologies. The model also shows the relationship between the single measure of information systems effectiveness and SISP success – that being the achievement of the previously defined business outcome.

There are however shortcomings with this model. There is no allowance for future change (business and economic as well as technical) and no allowance for maintenance of competitive advantage. The model is also static and uni-directional – it has a start and a finish. For any future changes to the information systems another SISP has to be undertaken. A further question remains: 'What facility does this model have for monitoring the effect of internal and external influencing factors on the present and future degree of effectiveness of the information systems?'

The literature reviewed in Chapter 3 has shown that there is a lack of knowledge of SISP in pathology laboratory settings. The measurement of information system effectiveness can be shown to link to business outcomes as in Boran *et al.'s* (1996) and O'Moore *et al.'s* (1994) work on the OpenLabs project. In the researcher's opinion, these authors' approach to information effectiveness measurement represents a more accurate assessment of effectiveness than other methods discussed. The OpenLabs project represents the only major strategically driven planning exercise in medical laboratory computing that was found in the literature and it may be regarded as an important benchmark reference for this research. As well as investigating the components for successful SISP, such as business-IT alignment, end-user involvement and pre-planning partnering that are generally discussed on an individual basis when considering their impact on SISP, this research seeks to investigate the effects on SISP in medical laboratory information systems when the components are considered to be acting together. This research will also investigate the role of the existing laboratory information systems capability in the particular context of it being able to support strategic and technological change. The hypotheses stated here will, if accepted, help to demonstrate the shortcomings of the current laboratory information systems capability, a lack of business-IT alignment and an inability for modern pathology laboratories to progress their businesses in parallel with other knowledge-based companies.

In the following section of this chapter, the issues raised above and the conclusions reached in Chapter 2 are brought together to frame a research model to begin an initial investigation of SISP practice in pathology laboratories.

3.7 Research Hypotheses.

Stasis in technological development in pathology laboratories has existed for many years because of the persistence of mainframe laboratory information systems. The systems use older, inflexible software not compatible with modern technologies (Brender and McNair, 1996; Boran *et al.*, 1996; Wells *et al.*, 1996). There is little, or no, facility for the pathology laboratory to embrace web technology and all its ramifications. A web-based system would allow the pathology laboratory to utilise such facilities as wireless communications, web-based voice recognition software, telemedicine, and centralised supply chain management and human resource management (Brender and McNair, 1996; Boran *et al.*, 1996; Bossuyt *et al.*, 2007). The ability to eliminate workplace boundaries, introduce a completely paperless laboratory, real-time communication between all interstate and overseas branch laboratories and introduce real-time standardised management facilities is non-existent (Bossuyt *et al.*, 2007). The ability for a pathology practice to implement these technical and management facilities would represent a considerable strategic development, and should bring strategic pressure to bear on the practice(s) to undertake such change. The change would require SISP to be successful, but as noted above, the stasis of the existing mainframe information systems precludes SISP from occurring. The efficiency, effectiveness and profitability of the laboratory are compromised considerably by this and the business outcomes are negatively impacted. With the international expansion of some of Australia's laboratories this lack of modern technology integration ability must be detrimental to effective globalisation of the organisation and negatively impact SISP. Therefore the first hypothesis is that:

H 1: *Lack of functionality of current laboratory information systems negatively impacts SISP effectiveness in medical pathology information systems.*

It is common for senior management of pathology laboratories to use financial considerations in an attempt to increase profits (Friedberg, 2008). The frequently used avenues available to senior managers are take-overs and mergers to attempt to take advantage of perceived benefits of economies of scale; negotiating with reagent/instrument suppliers for absolute minimum costs; and to keep reducing the labour cost component (Bossuyt *et al.*, 2007; Mayer, 1998). None of these financial measures used to reduce costs involve technology and full business analysis, and they are self-limiting (Choe, 2003; Sugumaran and Arogyaswamy, 2004). In the pathology laboratory this financial considerations approach provides information that forms the basis for evaluation of operations and decisions concerning the introduction or elimination of tests and services, choices of procedures, modification of methods and introduction or replacement of equipment (Mayer, 1998; Klecun and Cornford, 2005). These alternate measures are difficult to fit into a strategic plan both for the present and the future, and have little capacity to consider outside business and economic changes that may impact on the firm. Accordingly, the second hypothesis is that:

H 2*:* *Decisions based on financial considerations negatively impact on effective SISP in medical pathology information systems.*

The literature refers to the bottom-up approach and the rational component in SISP (Petter *et al.* 2008; Earl, 1993; Sabherwal and King, 1995; Grover and Segars, 2005). It also details a step-by-step method that this may be facilitated – empowerment→ motivation → innovation → information system effectiveness. Involvement or empowerment of end-users in the design process leads to motivation and a feeling of ownership of the project – the end-users are enthusiastic to use the system and this assists with innovations to further enhance the project (Jaing *et al.*, 2002; Hackney *et al.,* 1999; Klecun and Cornford, 2005). There is a lack of this involvement of end-users in the SISP in pathology and as a result a perception that the laboratory information system is ineffective. The generalised negative attitude by end-users in medical pathology is attributable to the fact that end-users involve all staff from department heads and pathologists to junior scientists. The end-users involved in initial laboratory planning, both in information systems and workflow, are department heads and senior scientists. These staff members interact with senior management and the IT staff. The more junior scientists are engaged for their input that may have a more functional view as junior scientists attend to the physical testing of specimens and hence have greater use for the core functional processes of the laboratory information system. Accordingly, the third hypothesis is that:

H 3*:* *Lack of involvement of end-users in SISP (specifically in pathology in Australia) negatively impacts on information systems effectiveness.*

In pathology laboratories in Australia, there is a varying degree of business/IT alignment. Often the scientists are not involved in the planning or development processes of the laboratory information systems at all (Brender and McNair, 1996; Bossuyt *et al.* 2007). IT service is lacking with respect to dissemination of information regarding changes or developments to the current system, and in-house training for end-users. The shortcomings of the current in-house systems frequently compromise changes and developments end-users may suggest because of inadequate technology to support these desired changes or developments (Boran *et al.*, 1996; O'Moore *et al.*, 1994; Connell and Young, 2007; Friedberg, 2008). The business/IT misalignment present in medical laboratories, which contributes to the lack of empowerment and pre-planning partnering with end-users in the development process and the lack of facility of current systems to support many of the wants of the end-users (Friedberg, 2008; Brender and McNair, 1996, Boran *et al.,* 1996; O'Moore *et al.,* 1994) leads to decreased motivation and innovation (Jaing *et al.,* 2002). This negatively impacts the role that the current laboratory information systems has in assisting the business to grow and increase its competitiveness in the market. Therefore it is proposed that:

H 4: *The greater the degree of business – IT alignment the more effective SISP is in medical pathology information systems.*

There is little research undertaken pertaining to SISP and information systems effectiveness measurement in medical pathology throughout the world. The OpenLabs project (O'Moore *et al.,* 1994; Boran *et al.,* 1996; p.75) represents a SISP exercise in laboratory medicine, but is not referred to as such by the participants in the project. There appears to an ignorance of SISP and information systems effectiveness terminology in medicine. Little other research in strategic development of information systems in medical laboratories is reported (Wells *et al.,* 1996; Connell and Young, 2007; Bossuyt *et al.* 2007; Friedberg, 2008). The research relating to implementation and integration issues has resulted largely from a recognition by workers in medical laboratories throughout the world that there are major problems with laboratory IS in laboratories and there needs to be considerable changes made to rectify these problems (Friedberg, 2008; Bossuyt *et al.,* 2007; Brender and McNair, 1996). Defining the problems facing medical laboratories strategically is difficult without knowledge and experience in the components of SISP and a means of effectively measuring the outcome of a SISP exercise. In common with all things in life, knowledge is obtained from eduction and research. Therefore, an approach to change using standardised investigative tools and models is not suited to medical laboratories at this stage because of the lack of research and education, and hence knowledge of SISP of the potential participants. This also negatively impacts on medical pathology in terms of not having a standardised means to objectively investigate current problems and find an ordered solution to move forward. The fifth hypothesis is therefore that:

H 5: *Lack of laboratory information systems research and education negatively impacts on SISP effectiveness in medical pathology information systems.*

The relationships of the hypotheses are represented in Figure 3.2

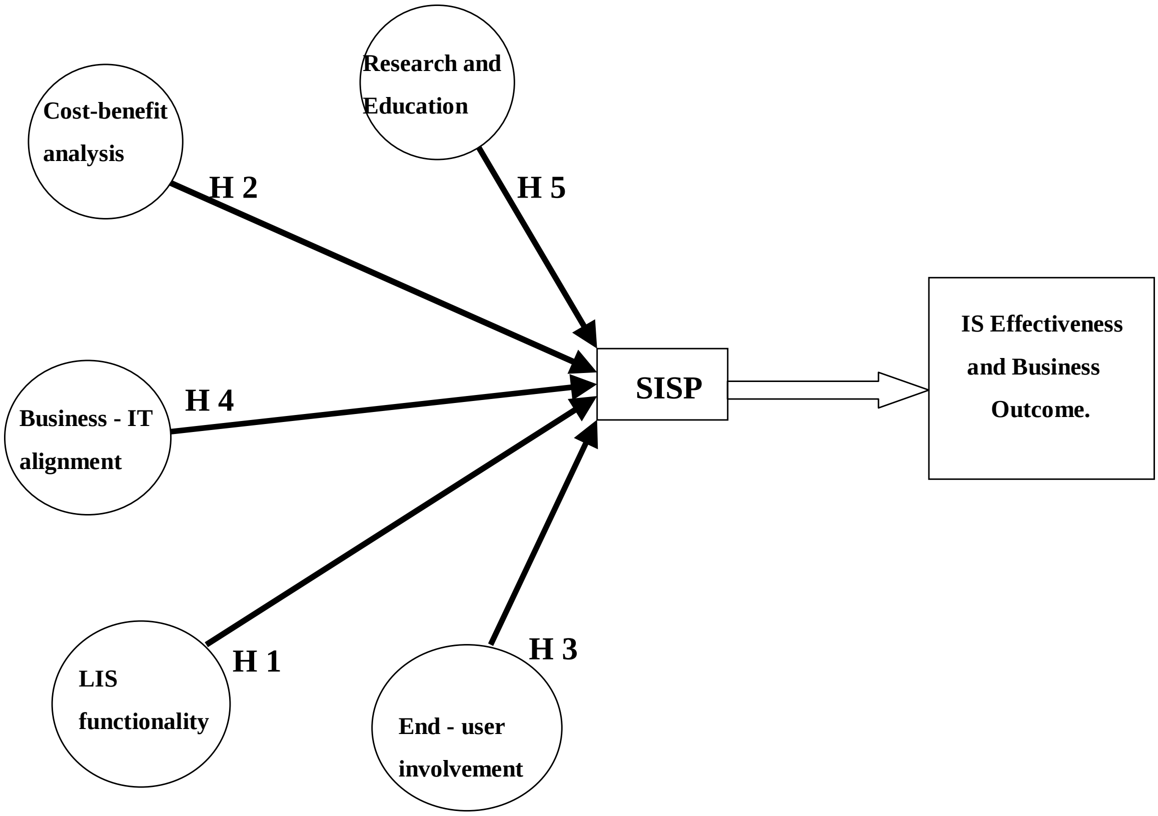

Figure 3.2 The Research model.

The structural model shown in Figure 3.2 is a representation of hypotheses developed from the literature review relating to successful SISP (end-user involvement in planning, business-IT alignment and cost-benefit analysis) and two additional items (laboratory information systems functionality and research and education) investigated in this study with particular reference to medical pathology practice. Each individual item is initially assessed by a survey and quantitative analysis to investigate the relationships between each of the items in SISP in medical laboratories. The structure of the model proposes that each item contributes to SISP. The model also proposes that any information system effectiveness measure embraces the achievement of a pre-determined business goal. The structure of the model also implies that all five items act in harmony, in a positive manner for SISP to be successful. Contributing factors to some items, such as pre-planning partnering (Jaing *et al.* 2002) are assessed in the context of end-user involvement to give added depth to the investigation. Assessment of a possible task-technology gap (or a reality gap, as Connell and Young, (2007) refer to it) is undertaken in the investigation of laboratory information systems functionality. The research model in Figure 3.2 represents a cohesive approach to SISP, incorporating all the components derived from the literature review and the two additional components relating specifically to pathology practice. The research also relates SISP to assessing information systems effectiveness by evaluation of the achievement of a pre-determined business goal.

3.8 Conclusion

The literature review has established three well recognised and researched impacts on successful SISP, –

- Lack of end-user involvement
- Business-IT misalignment
- Financial considerations in planning

This research considers that two other issues are important to the effectiveness of SISP that are specifically relevant to the medical pathology environment:

- Task-technology gap (lack of laboratory information systems functionality)
- Lack of research and education in laboratory information systems and laboratory management.

This research extends the conclusions of many of the authors cited in this and the previous chapter about what contributes to both successful SISP and what are suitable measures of information systems effectiveness. The research model proposes a dependant relationship between them.

The literature review in Chapters 2 and 3 lays the basis for the investigation of the effectiveness of the laboratory information systems and its impact on business outcomes in medical pathology practice. A series of questions formulated to gather data from participants in a survey (Appendix B) distributed to medical laboratories within Australia is formulated from the hypotheses reported in this chapter. The answers obtained by the survey are analysed statistically and subject to further analysis by three focus groups. The details of the research methodology used follows in Chapter 4.

CHAPTER 4 - RESEARCH METHODOLOGY

4.1 Introduction.

This chapter deals with the issues relating to the research methodology and research design of the study and argues their justification. Research is about answering questions in a systematic and organised way (Blaikie, 2003). The “essence” of research lies in the scientific method, which helps the researcher to know and understand the research topic, and to confirm or disprove prior conceptions (Zikmund, 1997). A research methodology depends on the research domain and philosophical position of the researcher.

The researcher has thirty years experience in pathology laboratories in Australia in senior technical and scientific roles. He has undertaken much mentoring of more junior scientists and has a want to develop systems to improve efficiency. Because of this interest, he has developed and in-depth interest in computing and workflow modelling – which led to him designing a suite of laboratory management software. The researcher’s philosophical viewpoint is a combination of pragmatism and transformative. He does not believe in boundaries to the intellect: what is possible to achieve is a function of one’s imagination.

Pragmatism is singular and multiple realities, practical, has multiple stances (biased and unbiased) combining pluralistic approaches; it uses what works and may be formal or informal. Pragmatism is real world orientated. A transformative viewpoint acknowledges that inequality and injustice shape a power and privilege reality, embraces culturally competent mixed methods and power and privilege determinants of reality for community engaged in this work. Qualitative method component unveils processes and quantitative component describes outcomes.

The research domain of this study is defined by the question '*How does the effectiveness of laboratory information systems impact on business outcomes in medical pathology in Australia'?* At the beginning of this chapter the research approach and methodology is discussed. There is a distinct absence of research and research methodologies pertaining to information systems effectiveness in pathology laboratories and as a consequence there is no established methodological pathway(s) for researchers to follow. The methodology used in this research is therefore exploratory. Firstly, a quantitative study was undertaken to help develop a framework for investigating the effectiveness of information systems in medical pathology in Australia (that is – Melbourne, South Australia, Western Australia and country Victoria). Then, a qualitative study was conducted to both attempt to validate and then investigate further the statistical findings of the quantitative survey.

Dooley (2002) states that qualitative data can promote the development of an understanding of theory underlying relationships that surface from quantitative procedures. Sarantakos (2005) further indicates that quantitative research is objective and seeks explanatory law while qualitative research is subjective and aims at in-depth description. Explanatory law in this thesis is taken to mean that quantitative research measures what it assumes to be a static reality in the hope of developing universal laws – quantitative analysis analyses and relates current observations to existing theories which have been developed from past observations to explain the physical world (reality). The strengths of the multi-method approach are that different perspectives at different levels on the same issue are collected, allowing for greater interpretation of the results and a more comprehensive understanding of the research problem (Tashakkori and Teddlie, 2003). Multi-methods research intends to confirm and cross validate research results using the two methods to minimize the weaknesses with each individual method (Tashakkori and Teddlie, 2003). Qualitative methods could achieve a greater quality of data to make up the limitation in quantitative methods. This research employed both methodologies to triangulate and yield more comprehensive and meaningful data in answering the research questions and achieving the following research objectives:

1. To measure the relationships among the contributors to success SISP as applied to medical pathology, namely end-user involvement, business-IT alignment and cost-benefit analysis.
2. To measure the contribution of two new/specific contributors to successful SISP in medical pathology, namely laboratory information systems functionality and research/education in laboratory information systems.
3. To test the hypotheses that information systems effectiveness can be measured by the achievement of a specific business goal and that information systems effectiveness relies on successful SISP.

Firstly, the quantitative section of the research used a questionnaire survey of laboratory staff in Australia to test the five propositions relating to information systems effectiveness and its impact on business outcomes in medical pathology in Australia established from the literature reviews in Chapters 2 and 3. These hypotheses are:

H1: Lack of functionality of the current laboratory information systems negatively impacts SISP effectiveness in medical pathology information systems.

H2: Decisions based on financial considerations negatively impacts on effective SISP in medical information systems.

H3: Lack of involvement of end-users in SISP (specifically in pathology in Australia) negatively impacts on information systems effectiveness.

H4: The greater the degree of business – IT alignment the more effective SISP is in medical pathology information systems.

H5: Lack of laboratory information systems research negatively impacts on SISP effectiveness in medical pathology information systems.

The qualitative component of the research, in the form of three focus groups, was conducted to evaluate the results of the analysis on the hypotheses and to triangulate the overall findings back to the literature. The researcher had planned to conduct four focus groups but one of the four laboratories approached to participate declined. The reasons cited, when given, were concerned with issues of commercial confidentiality and imposing on the staff that was felt by the management to be too disruptive to the workflow of the laboratory concerned. The issues surrounding a considerable lack of willingness to participate in this research project by completion of the survey or participating in a focus group is discussed in greater detail later in this Chapter (p.117).

4.2 Background and context to the exemplar organisations in medical pathology practice in Australia used in the research.

Laboratory A is the oldest laboratory in Melbourne with its origins in the 1920s. Laboratory A’s growth path is one that is shared by all pathology companies in Australia. Growth occurred as a result of an increasing population, an increasing appreciation of the value of pathology testing by the medical practitioners and an increasing diversity of pathology tests available to medical practice. Practicing pathologists managed all three majors’ players in pathology in Melbourne during this time, with some small input from senior scientists.

In the late 1980s and early 1990s more business players became involved in the management and ownership of pathology practices. This led to a change of attitude with respect to business growth and enhancement. The way forward was a strategy to grow and increased revenue and profit through acquisitions and mergers. As a result of this process, Laboratory A became part of a large, publicly listed international company.

Laboratory A started as a hospital-based practice, but now serves all areas of medical practice. Laboratory A has both an extremely large central laboratory, which performs a wide range of routine and specialised tests, and a number of satellite laboratories, which cater for the more routine tests requested by local practitioners. The satellite laboratories also cater for urgent tests at hospitals in their proximity. Laboratory A services over one million patient episodes annually with revenue in excess of $AUD200 million derived from the pathology business.

Laboratory B was started in 1936 and followed the development history common to all three existing major pathology companies in Australia. Laboratory B was a practice which principally serviced general practitioners until it was taken over by a publicly listed group that has a hospital component to its business portfolio. The group has other diverse interests in the health vertical, including veterinary pathology, medical radiology and pharmaceuticals. Laboratory B has 43 accredited laboratories and 225 licensed collection centres throughout Australia, and laboratories in New Zealand, Singapore and Malaysia. The health services group of which Laboratory B is a part, has annual earnings of $AU1.8 billion, $AU263.7 being from the pathology business.

Laboratory C, whilst retaining the name of the pathologist who started the business in the late 1960's, is part of a publicly listed, diversified health services company and consists of many merged and acquired pathology practices. Laboratory C performs over one million patient episodes per annum, and employs more that 150 pathologists and 6000 scientists and ancillary staff at 80 laboratories and 660 collection centres Australia-wide. The parent group of Laboratory C has an annual turnover of $AU3.8 billion of which $AU648 million is attributed to the pathology business.

4.3 Common issues in medical pathology practice.

There are a number of issues common to all three laboratories. They all have a common business background. All three laboratories started in the same era approximately thirty years ago and all three were private companies owned by pathologists. Over the years to the present, listed public companies have become involved in ownership of private pathology practices by acquiring the private practices from the individual pathologists. The way management of private pathology practice has been undertaken and the planned forward growth shown by all three public companies has been through a policy of acquisitions and mergers with competitor pathology practices to achieve a larger pathology practice and hopefully enjoy the benefits of economies of scale; health vertical diversification, such as private hospital ownership; and international expansion by acquiring pathology practices in Europe and America. The management philosophy of all three private pathology companies also embraces instituting management processes to ensure maximum cost effectiveness within the laboratory structure that will enable maximum shareholder returns. All three companies have limited IT facilities, such as browser or dial-up results access and electronic test ordering and results delivery to the referring practitioner’s practice management software packages, between the laboratory and the referring practitioners as a result of the use of mainframe, dumb terminal laboratory information systems.

Public hospital pathology laboratories in Australia have undergone significant management change in parallel with the mergers and acquisitions of private practice. Public hospital laboratories have become privatised and have had to develop business models to enable them to be competitive with private practice laboratories. In some cases the pathology services were put out to tender and in some instances the private practices won the tenders. The pressure for continuously improving cost effectiveness and profitability is now spread across the pathology vertical as a whole, and the privatised hospital pathology laboratories are under pressure to perform effectively as a business as much as the private laboratories. Having now understood the context of the pathology industry, the chapter will now develop an understanding of the context and background of management practice study.

4.4 Differing notions of "rigour" when studying management practices

The goal of studying management practices is ultimately to provide advice that leads to improved outcomes (Avison and Fitzgerald, 1995). However, the researcher recognises that the notion of "improve" is a value-laden concept. It presupposes that there are certain goals to be achieved, although the nature of these goals and the idea of "whose goals?" may not be agreed. Avison and Fitzgerald (1995) have shown that the practices and methodologies taught in the discipline of information systems often have very different assumptions about the nature of organisations and information systems, the stakeholders whose goals are to be considered, and the extent to which there is agreement on both means and ends. Hence there may be many goals for practice. Despite this, practitioners want to adopt practices that have a high probability of achieving their own goals (whatever they may be) and thus they are seeking reassurance that theory and prescriptions will "work" within their own context or setting.

The issue is complicated by the nature of human decision processes. Human beings are not "rational", nor are they unemotional (March & Simon, 1963). In a number of research settings it has been established that human beings respond more to, and are more likely to remember, stories and instances that are vividly portrayed, and with which they can identify personally. This characteristic is sometimes labelled the vividness cognitive bias (Kahneman *et al.,* 1982). Another known cognitive bias is that human beings will tend to pay attention to information that supports their existing models and understandings, while paying little attention to disconfirming information. This has been labelled the disconfirmation bias (Kahneman *et. al.,* 1982).

Because of these biases people may not be interested in research and development on the basis that it is not practical and relevant to their situation. They may not identify with the research or change. The research undertaken in this thesis is based on problems that arose in the researcher's own experience in a medical laboratory. The problems encountered by the researcher included an unwillingness of the most senior management staff to engage in developing the laboratory information systems to allow for more efficient use of technology and improve efficiencies. The objection to development plans was based solely on cost considerations with the blatant statement by the CEO at the time that "*I am not interested in technology; I am only interested in the money*." Some of the developments suggested by the researcher, technologies such as telemedicine, real-time management software and the creation of a paperless laboratory, required a more up- to- date IT platform to enable their integration.

This research is based on participant's existing workflow models and an understanding of their environment. The approach to the propositions, and the wording of the questions seeking opinion on them, is of a familiar same level context as the working members of the laboratory staff. Participants can identify personally with the 'stories and instances' of Kahneman *et al*. (1982). It is thought that this familiarity in the research instrument elicits a feeling of association between researcher and participant, which helps quiesce cognitive and disconfiguration bias. According to Kahneman *et al.* (1982), if this were the case the participants would be more responsive to the research instrument. This context framed the nature of the survey instrument and its design. The next section will discuss the research approach adopted.

4.5 The research design adopted – a mixed method approach.

The data collection and data analysis for this thesis comprises two parts – the first being a quantitative study by way of a survey; the second being a qualitative study by way of three focus groups. The merit of using a multiple research method is well known. Cresswell (2003) indicates that qualitative research helps explain and roots into distinct paradigms, which corresponds to the findings from quantitative studies. Teddlie and Tashakkori (2006) further state that the qualitative method brings more in-depth understandings from reality. Kitzinger (1995) adds that questionnaires are more appropriate for obtaining quantitative information and explaining how many people hold a certain (pre-defined) opinion; focus groups are better for exploring how these opinions are constructed. She adds that whilst surveys repeatedly identify gaps between knowledge and behaviour, only qualitative methods, such as focus groups, can actually fill these gaps and explain why these occur. The mixed method approach is, however not without some limitations. Johnson and Onwuegbuzie (2004) suggest that much work is still to be done on mixed methodology with respect to clarifying its philosophical positions, designs, data analysis and validity strategies. The mixed method approach has other functional limitations, such as a single researcher having to carry out two tasks, it is more expensive and time consuming, and the researcher has to learn multiple tasks. There is also resistance from the purist researchers that the mixed method approach is a valid research method (Johnson and Onwuegbuzie, 2004).

Rather than advocating a single paradigm, be it interpretive or positivist, or even a plurality of paradigms within the discipline as a whole, it is suggested that research results will be richer and more reliable if different research methods, preferably from different (existing) paradigms are routinely combined together (Mingers, 2001).

Following on from Mingers (2001), a multiple method is adapted in this study. In the first part of the research, a research model (Figure 3.2 p.104) depicting some hypothesised relationships between constructs and dependant variables was developed. This theoretical framework could not be based on any prior research in pathology laboratory information systems, as there has not been any previous research in this specific area (information systems effectiveness) pertaining to medical pathology. The hypothesised relationships therefore have been extrapolated from other relevant and related research in other areas of business and industry (Broad, 1997; Teubner, 2007) and expanded with two propositions more specific for medical pathology, namely laboratory information systems functionality and laboratory information systems research and education.

4.5.1 Quantitative method – the survey

A quantitative survey was chosen as the initial stage of data collection for its many advantages (Kitzinger, 1995), in particular, enabling the researcher to facilitate distribution around Australia. The advantages (and disadvantages) are detailed as follows and are cited from the work of students and staff at the Colorado State University (Barribeau *et al.*, 2005). The strengths of surveys are that they are relatively inexpensive (particularly self-administered surveys); surveys are useful in describing the characteristics of a large population. No other method of observation can provide this capability. Surveys can be administered from remote locations using mail, e-mail or the telephone. Surveys provide a facility for very large samples to participate, making the results statistically significant when analysing multiple variables. Surveys provide for many questions to be asked about a given topic giving considerable flexibility to the analysis. Standardised questions in a survey make measurement more precise by enforcing uniform definitions upon the participants, and standardisation ensures that similar data can be collected from groups and then interpreted comparatively (Kitzinger, 1995; Barribeau *et al.*, 2005). Usually, high reliability is easy to obtain using surveys - by presenting all subjects with standardised stimuli, and observer subjectivity is greatly eliminated.

The disadvantages of the survey method (Barribeau, *et al.*, 2005) include firstly, that the researcher must ensure that a large number of the selected sample will respond. Secondly, surveys are inflexible in that they require the initial study design to remain unchanged throughout the data collection. Thirdly, surveys, as a standardised data collection method, force the researcher to develop questions general enough to be minimally appropriate for all respondents, possibly missing what is most appropriate to many respondents. As opposed to direct observation, survey research can seldom deal with “context”.

The use of the survey enhanced quick access to as many laboratories in Australia as possible, and hence broadened the scope of the research in terms of potentially more diverse attitudes and opinions. Statistical analysis of a survey is achievable in a short time frame providing validity to both the research project and the survey instrument. Data analysis of the survey instrument also quickly provides meaningful results on which to base the questions for the focus group.

The initial means of data collection for the quantitative component in this research commenced with the design of a research instrument based on the three hypotheses derived from the literature review and the two medical laboratory specific propositions.

The data was then subjected to statistical analysis. The purpose of this exercise was to identify correlations within the data that would allow the extraction of factors to ascertain the underlying relationships amongst the research instrument questions, leading ultimately to an assessment of information systems effectiveness in medical pathology in Australia. The value of these factors in explaining the observed phenomena was measured in the percentage variance explained, which was determined in a factor analysis.

When undertaking quantitative research there are a number of implications to be considered –

- That the respondents hold the same view of an item to give the item the same score;
- That the respondents will give the same scores to the items a week later; and
- That the average scores from all respondents has real meaning. (Remenyi, 1998).

Consideration of these implications was reflected in the design of the research instrument by way of the number of items for each proposition (cross referencing the items – Kline, 1994; p.127), the spread of respondents from different levels and areas of the laboratory (Kline, 1994; p.73) and the level of significance attached to the statistical analysis ($p < .005$)(Coakes, 2005).

4.5.2 Qualitative method – the focus groups

Since assessment of the research propositions cannot be based solely on facts as the research itself involves values such as SISP success, a means to consider the subjective feelings of participants was undertaken by way of a focus group. The focus groups were expected to provide information that the quantitative analysis was unable to, (reflected in the percentage variance explained being < 100%), by elucidation, analysis and understanding of respondents' feelings. An appropriate definition of qualitative research used here is – "*By the term qualitative research we mean any type of research that produces findings not arrived at by statistical procedures or other means of quantification*" Strauss and Corbin (1998, p.11). Morse (1991, p.120) claims that qualitative research is appropriate if "(a) the concept is "immature" due to a conspicuous lack of theory and previous research; (b) a notion that the available theory may be inaccurate, inappropriate, incorrect or biased; (c) a need exists to explore and describe the phenomenon and to develop theory; or (d) the nature of the phenomenon may not be suited to quantitative measure." The focus group will elucidate people's feelings about the newly developed theories and enable discussion about the conclusions drawn from the quantitative analysis.

The focus group questions were framed around the five propositions derived from the literature review that were tested in context by the findings of the quantitative analysis of the data from the research instrument. The focus groups serve to triangulate the findings of the quantitative analysis back into the literature; to use the data from the focus groups to cross examine the data collected from the quantitative analysis and that cited from the literature that contributed to the overall research model. Triangulation also assists in laying the groundwork for future research to explore the evolved theories in this research. The role played by the researcher during the focus group discussion was one of observer – the focus group was conducted and recorded by two academics. The research process used is illustrated in Figure 4.1.

4.6 Data collection procedures.

4.6.1 Ethical consideration

This study has followed the Ethics Guidelines Procedures outlined by RMIT University in the Ethics Review Process in December 2005. Ethical approval and ethics consideration were presented to the participants before they filled in the questionnaires. The researcher explained the research's objectives in the Plain Language Statement accompanying the survey (Appendix C). Therefore, all participants understood their rights and their participation in the survey was entirely voluntary.

4.6.2 The survey instrument (questionnaire).

The literature review elucidated a number of well documented factors which contribute to successful SISP and successful outcomes of SISP implementation. These factors include a lack of end-user involvement, (Fishbein, 1967; Fishbein and Ajzen, 1975; Rondeau *et al*, 2006; Boynton and Zmud, 1987; Pyburn, 1983; and Earl, 1993), business – IT misalignment (Hackney, 1999; Gerwin and Kolodny, 1992; Grover and Segars, 2005) and a cost-benefit approach to information systems planning (Lederer and Sethi, 1998; Ein-Dor and Segev, 1978). The business and industry verticals to which these authors' studies apply are wide and varied. The purpose and the context of the survey instrument used in this research is to apply these findings to the little researched domain of medical pathology information systems. The investigation then introduced the SISP – information systems effectiveness model, developed in

Chapters 2 and 3, and explored the hypothesised relationship between SISP and information systems effectiveness in terms that information systems effectiveness should be measured by the attainment of a specific business goal(s).

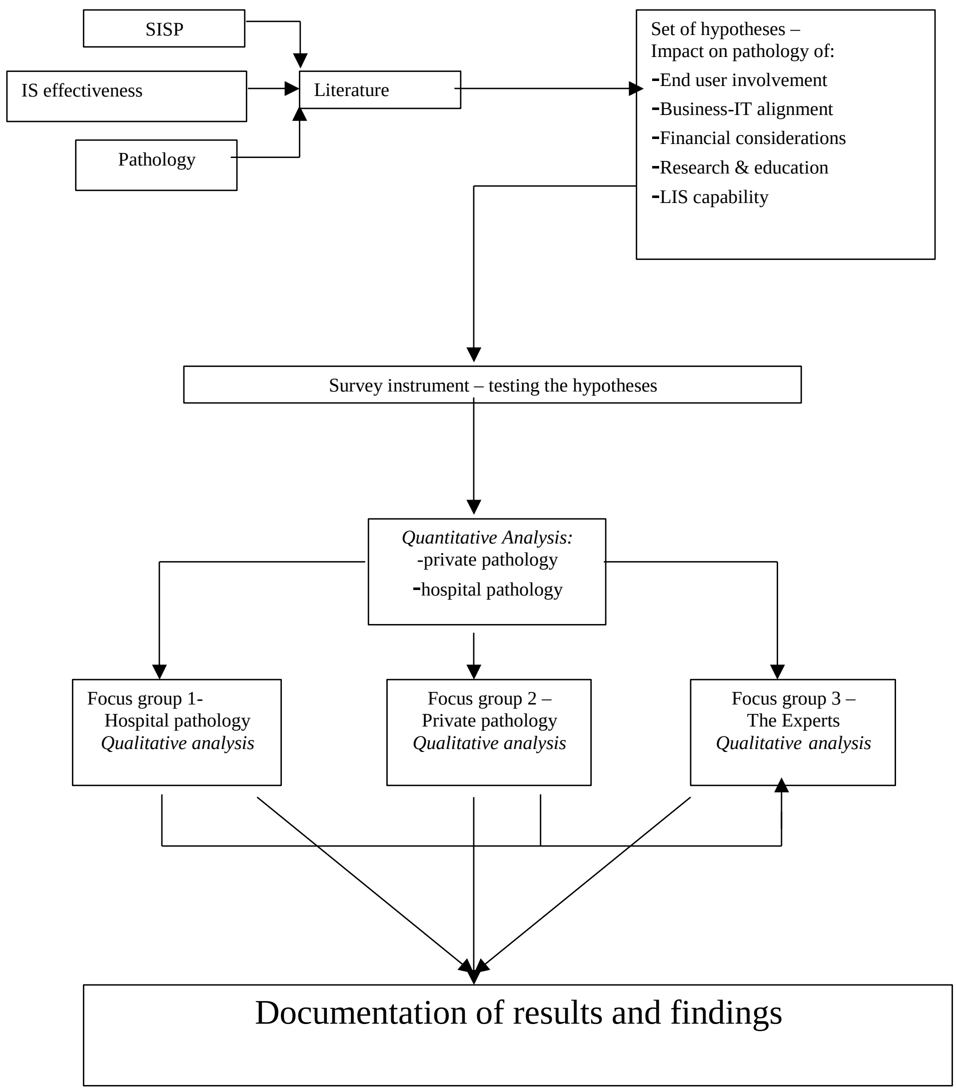

Figure 4.1 Research methodology summary.

In the course of research in these areas, authors such as Jiang *et al.* (2002), Wang and Tai (2003) and Yuthas and Young (1998) used a similar approach as the researcher in collecting data to investigate effectiveness in SISP. The instruments used by these researchers are of a similar format to that used by the researcher and have been shown to be valid and reliable in the execution of their purpose of data collection. Hence, a Lickert scale was used for the survey instrument, there being six terms or points of assessment for each question. The terms of assessment ranged from “strongly disagree” (1) to “strongly agree” (6). The advantages of the Lickert scale are that it is easy to construct and respondents readily understand how to use the scale (Jiang *et al.*, 2002). A six point (even number) scale was used as it was thought that this might lessen the “sit-on-the-fence” answers by respondents.

From the literature review five hypotheses were determined as being relevant to this research and it is from these five hypotheses that the three propositions for investigation were used to form the research instrument (see Appendix B). Each proposition had a number of questions designed in simple terms to elucidate the participants’ opinion. The number of questions per proposition met the criteria for regression, that is, ideally there should be twenty times more cases than predictors, the minimum requirement being at least five times more cases than independent variables. The number of cases was 96, the number of predictors was five and the number of independent variables was eleven (SPSS 12.0 for Windows, Coakes, 2005). The number of respondents to the survey was low in terms of the numbers required for more elaborate statistical analysis methods, such as Structural Equation Modeling (SEM). Chi (2005) suggest that 385 should be the most appropriate sample size for SEM for a sample with 95% accuracy and a 95% confidence level. As is documented later in this Chapter (p.117), there was considerable resistance from laboratories throughout Australia to participate in this research, based mainly on fear of loss of commercially sensitive data and time constraints of staff. The result of the low number of respondents was that the researcher had to change his approach to path analysis and model determination from SEM to multiple regression.

The propositions being researched are:

- *Do management decisions based on cost-benefit (financial considerations) analysis impact on laboratory planning?* - Investigating Hypothesis 1 that decisions based on financial considerations negatively impact on effective SISP in medical pathology information systems. There were twelve items investigating this proposition (see Appendix B). The researcher developed the items for each proposition. The items were designed to determine the participants' opinions by examining different aspects of each proposition and used language and terms familiar to the participants. The item content was designed to elicit information that contributed to investigating components of SISP.
- *Does the lack of functionality of the laboratory information systems impact on laboratory planning*? – Investigating Hypothesis 2 that lack of functionality of current laboratory information systems negatively impacts on SISP effectiveness in medical pathology information systems. There were seven items investigating this proposition (see Appendix B).
- *Does lack of end-user involvement in the laboratory information systems planning process impact on system effectiveness?* – Investigating Hypothesis 3 that lack of involvement of end-users in SISP (specifically in pathology in Australia) negatively impacts on information systems effectiveness. There were six items investigating this proposition (see Appendix B).

- *Does a high level of business – IT alignment produce effective laboratory* information systems *planning?* – Investigating Hypothesis 4 that the greater the degree of business - IT alignment the more effective SISP is in medical pathology information systems. There were eight items investigating this proposition (see Appendix B).
- *Does the lack of laboratory information systems research impact on system planning?* – Investigating Hypothesis 5 that lack of laboratory information systems knowledge negatively impacts on SISP effectiveness in medical pathology information systems. There were eighteen items investigating this proposition (see Appendix B).

A pilot study was undertaken to test the items using the same survey instrument as was to be distributed to the participants (see p. 115). Following the pilot, the number of items for each question was trimmed and reduced as a result of exploratory factor analysis by which the identification of items with similar factor loadings suggesting the items may be asking the same question. For example, from the items in the survey instrument investigating the proposition "does the lack of functionality of the laboratory information system impact on laboratory planning", the following EFA results were obtained (Table 4.1) after the first extraction –

Table 4.1 Factor loadings for combined items – an example.

ITEM	**Factor loading**
Reagent stock control	0.879
Reagent waste calculation	0.848
Reagent ordering	0.840
Labour cost per shift	0.834
Staff efficiency analysis	0.646
Rosters	0.642

These items were combined together to make the independent variable ‘management tasks’ thereby trimming the data and associating items investigating similar issues.

The introductory paragraph of the research instrument (Appendix B) explained that the exercise related to attributes of the respondent’s practices laboratory information systems and asked that from their own experience they answer the questions being put to them. The questions themselves were worded in simple language to make interpretation straightforward and to not complicate issues with terms that may be foreign to medical laboratory workers (see Appendix B). This approach was also thought to minimise any imagined or implied bias in interpreting the questions.

4.6.3 Pilot study

The survey procedure was initiated with a primary review and validation of the survey instrument by a small expert group of academics, four medical scientists and a pathologist. This preliminary exercise was undertaken to examine the relevance of the questions being asked of the participants by the survey to the propositions (hypotheses) framing the research question. The participants in the pilot study were asked to complete the survey and assess its clarity and user friendliness.

Based on their feedback, some minor changes to wording of some of the questions were made to ensure that the questionnaire was easy to understand. Words pertaining to SISP, such as SISP itself, business-IT alignment and pre-planning partnering were changed to system planning, planning groups and team building respectively – for example ‘the end-users are involved in planning groups for laboratory information systems change and enhancement/development (see Appendix B). After the changes were made, there was agreement amongst this group that the instrument was a competent tool that would assist the researcher in collecting data that would enable proper and thorough investigation of the propositions and hence the hypotheses. The instrument was said to be easy to read, the questions clear and concise in their meaning and relevant to the proposition they were seeking information on.

4.6.4 Distribution targets.

The instrument was to be placed amongst staff employed in private practice and public hospital medical pathology laboratories in Melbourne, Gippsland, Frankston, Sydney, Brisbane and Perth. The personnel targeted in the survey were deemed by the researcher to operate in core functional and developmental positions within each organisation. The personnel were pathologists, IT staff, middle and senior management staff and medical scientists, comprising department heads and senior scientists. There was a demographic survey sheet accompanying the research instrument that collected data for participants pertaining to their age, gender, and qualifications (including “cross-over” qualifications such as laboratory medicine and business, for instance). The summary of the demographics is detailed in Chapter 5. The number of staff who possessed “cross-over” qualifications was less than 5%, being mainly scientists with either a management or business degree. There was one scientist who possessed a second degree in IT and had [1]in fact worked in IT. Scientists, pathologists, IT staff and management staff were targeted because they all require different components and functionality of the laboratory information systems and are thought to look at the laboratory information systems from different perspectives. Some of the more senior

[1] It would be appropriate here to make the point, after a review of the major Australian University web sites referring to course content, that no laboratory medicine or pathology degree in Australia offers any business or IT training – there are no major or elective subjects in these fields offered. Likewise, there are few business degrees, including Master of Business Administration, which offer IT and laboratory medicine subjects.

members of staff could also be involved in the planning and development of the laboratory information systems.

The laboratory information systems in each organisation have some functional similarities in that they are mainframe-based and use either in-house developed software or in-house modified commercial software (Personal communication and experience). The laboratory information systems have been in service for between 15 and 30 years.

4.6.5 Participation resistance.

Once validity of the survey instrument had been ascertained, the researcher contacted fifteen medical directors and laboratory managers in the private pathology and public hospital sectors throughout Australia. In conversation with these people it was explained that the researcher wanted to undertake the survey as part of data collection for a doctoral thesis and that the exercise had ethics committee approval from the university. It was stressed that confidentiality and anonymity was paramount in this exercise. This was set out in writing in the Plain Language Statement (see Appendix C) that was to accompany each survey that was to be posted or hand delivered to the target laboratory.

Unfortunately twelve of upper management declined to participate – some citing concerns regarding commercial confidentiality, others just not responding at all to messages. One laboratory manager asked was the researcher prepared to pay his staff to participate on the basis that they would be “unproductive” for the time it took to complete the survey. The researcher was also accused of being a “spy” for a rival software vendor.

Comments passed by two very senior staff within the same organisation, one of the three major publicly owned practices, were of great interest and in their own right have a bearing on the study with respect to management attitude and end-user involvement. The Chief Information Officer of the organisation (a pathologist with no formal IT training or qualifications and who is based in another state), when told by the researcher that the Melbourne laboratory was participating, commented that there would be no point in his laboratory participating as both laboratories used the same system therefore opinions would be the same. The laboratory manager of the same organisation, when asked to ensure that some junior scientists completed the survey, commented she thought that would be counter productive as junior scientists “would not know what a laboratory information system was”. The junior scientists are of course the end-users who require of the laboratory information system sufficient functionality and effectiveness to efficiently carry out their scientific duties.

A second round of survey distribution was required to obtain a reasonable number of completed surveys due to non-compliance of a number of target laboratories. The most common reason given by way of an explanation for non-compliance by the laboratories was that of being overworked and not having the time to complete the survey. A policy of staff trimming and non-replacement seemed to be prevalent in some laboratories as a way of improving cost-effectiveness through reduction in labour costs (In-situ experience, personal communications). The staff at one private practice laboratory was also preparing for a merger with another practice and this further compromised the staff’s time. The overall completion/return rate was 30% - 320 surveys sent out and 96 returned.

When permission to survey a laboratory was given, the researcher either delivered or posted the survey documents to a contact person at the laboratory, this person being a laboratory manager or department head, who distributed the survey document to participating staff. The confidentiality and anonymity was again stressed either verbally or by e-mail, as were the definitions of the target groups required to undertake completion of the instrument. A period of two weeks was agreed upon for completion and return of the surveys. The researcher attended local laboratories to collect completed surveys; interstate and country completed surveys were posted to the researchers home address.

Since there are only three major medical pathology businesses in Australia, when one of these major practices declined to participate, it reduced the potential respondents by 33%. The pathology vertical in Australia is, by comparison with other international knowledge-based industries, quite narrow and limited in its core function – that is, supplying analysis of pathology specimens for diagnosis and treatment guide. There is little room and facility for diversification. The refusal therefore of one of the three key players had a considerable negative impact on the research plan with respect to the number of completed surveys anticipated (greater than 250) and hence the statistical methodology used to analyse the data. It was originally intended that Structured Equation Modelling (SEM) would be used after exploratory factor analysis to determine the research model. This was changed to multiple regression due to the number of completed surveys returned (96) being insufficient for SEM and investigation of alternative methods, such as Partial Least Squares (PLS). Loehlin (1992) and Hoyle (1995) suggest that a minimum of 100 samples be used for SEM and recommend that a sample size of approximately 200 is required for meaningful and accurate SEM. Because of the controversy surrounding PLS and the claims that the technique can produce reliable pathway analysis with small sample numbers (Marcoulides and Saunders, 2006), the researcher undertook an extensive review of the literature on PLS and multiple regression to assist in ascertaining the best, reliable and accepted method of analysis of the sample number obtained in the survey in this research.

4.6.6 Selecting an appropriate analytical tool for path analysis.

PLS regression is a recent technique that generalises and combines features from principal components analysis and multiple regression. It is particularly useful when one needs to predict a set of dependent variables from a large set of independent variables, that is, predictors (Abdi, 2003). PLS regression is becoming a tool of choice in the social sciences as a multivariate technique for non-experimental and experimental data alike, for example in neuroimaging (see McIntosh *et al.,* 1996). PLS was first presented as an algorithm akin to the power method (used for computing eigenvalues) but was rapidly interpreted in a statistical framework (Frank and Friedman, 1993; Helland, 1990; Hoskuldsson, 1988; Tenenhaus, 1998).

It was on the basis of the Goodhue *et al.* (2006) study and the strongly worded critique article published in MIS Quarterly by Marcoulides and Saunders (2006) that the researcher made the decision to undertake linear multiple regression as the pathway analytical technique because PLS was deemed not to meet its claims in small sample analysis. The study by Goodhue *et al.* (2006) has presented a reference point for the researcher's quantitative analysis by demonstrating that, for a strong effect size, the 95% C.I for linear multiple regression for sample sizes of 90, 150 and 200 were (.98, 1.0), (.98, 1.0) and (.98, 1.0) respectively. This clearly shows that for a strong effect size and very reliable indicators, a sample size of 90 is adequate for meaningful multiple regression analysis. Linear multiple regression, with a relatively small sample size, has also been used in information systems research by Gorla (1989), Le Blanc (1991), Menachemi *et al.* (2007,) and Byrd *et al.* (2006).

4.7 Data analysis – quantitative method.

SPSS for Windows v15 (Coakes, 2005) was used as the quantitative tool for the quantitative analysis. The survey data was entered directly into SPSS. The format of the data entry has the survey questions as variables in the vertical columns and the respondents or cases in horizontal rows. Each column was labelled with a code to identify the relevant question in the survey (see Table 4.2).

Table 4.2 Example of SPSS v 15 data layout.

realtimeinfo	sameformat	useformat	soledriver	enhancemanage	meetbudget	supportchange
3.00	4.00	3.00	4.00	5.00	4.00	4.00
4.00	4.00	4.00	4.00	5.00	6.00	6.00
3.00	2.00	3.00	3.00	4.00	4.00	4.00
3.00	5.00	3.00	2.00	4.00	5.00	4.00
4.00	4.00	4.00	2.00	4.00	4.00	3.00
4.00	3.00	4.00	4.00	5.00	6.00	5.00
4.00	4.00	3.00	5.00	4.00	3.00	4.00
5.00	5.00	4.00	4.00	4.00	4.00	4.00
4.00	4.00	4.00	4.00	4.00	5.00	4.00
2.00	4.00	3.00	5.00	3.00	4.00	9.00
9.00	9.00	9.00	5.00	9.00	9.00	9.00
3.00	3.00	9.00	9.00	9.00	9.00	9.00
5.00	5.00	4.00	5.00	9.00	9.00	4.00

All standard statistical tests were conducted using SPSS version 15 in order to elucidate and qualify the identified research question and hypotheses. Descriptive statistics (mean, SD, median) were used to assess the normality of the data in order to conform with the assumptions of other statistical methods used, PCA and multiple regression in particular, that the data is normally distributed. Although factor analysis is robust to assumptions of normality, the solution (from PCA in this research) is enhanced if the variables are normally distributed (Coakes, 2005). Normal distribution is also assumed by multiple regression, for the differences between the obtained and predicted dependent variable scores and that the residuals have a linear relationship with the dependent variable score (Coakes, 2005). Missing data was initially coded in keeping with the recommendations in the SPSS V15 manual – it was coded as a' 9.' This gave excellent performance and results in all the statistical analytical techniques except for the multiple regression, where the regression gave erroneous results. The missing values were scored as '0' (zero) and the multiple regressions worked. (Pitar, Z., 2008). The following statistical procedures were then applied to the data. The results are presented in Chapter 5.

4.7.1 Descriptive statistics

Descriptive statistics was applied to the data as a means of checking for errors in data entry, which would be detected as out-of-range data. This technique is also used to test for normality of the data via normal probability plots (Coakes, 2005). Tests for central tendency and variability, being mode, mean, median, standard deviation and variance were also performed. The descriptive statistics also describes the distributions of the respondents in terms of socio-demographic attitudinal and behavioural characteristics towards the medical laboratory and the use and planning of the laboratory information systems (Coakes, 2005).

4.7.2 Correlation

Correlation was then performed on the data. Correlation looks at the relationship between two variables in a linear fashion – it is a numerical measure of the degree of agreement between two sets of scores. A Pearson/ product/ moment correlation coefficient '*r*' is a measure of the degree of linear relationship between two variables (Stockburger, 2007). This analysis process represents simple bi-variate correlation, also referred to as zero-order correlation, and refers to the correlation between two continuous variables and is the most common measure of linear relationships. The correlation has a range of possible values from –1 to +1. The value indicates the strength of the relationship, while the sign (-/+) indicates the direction. The closer the score gets to 1 (regardless of sign) the higher the degree of agreement between the scores and thus the better the possible prediction. If correlations are squared the percentage agreement of the sets of scores is indicated - a correlation of 0.8 represents 64% agreement whilst a correlation of 0.2 represents 4% agreement (Kline, 1994). The Pearson's correlation coefficient describes this relationship. In this study, Pearson's correlation values equal to or greater than 0.7 were considered to represent a strong correlation (Coakes, 2005). The associated significance level is also calculated for each correlation, the significance value of this study being $p < .05$ (Coakes, 2005). A p value of <.05 is a commonly used arbitrary value for statistical significance, the other commonly used arbitrary value being <.01. A p value of <.05 avoids reasonably well the error of giving meaningful interpretation to a statistical error (Kline, 1994). A linear correlation is normally performed as a prelude to factor analysis and identifies the variables that are loading on the underlying factor (Pearson's 'r' greater than 0.7; Hair *et al.*, 2006).

4.7.3 Reliability

Reliability is defined as the consistency of observations or measures (Nunnally, 1978, Nunnally and Bernstein, 1994). Reliability implies that the index of an instrument is stable. It is determined by the Cronbach's Alpha coefficient, which is based on the internal consistency of the scale (Hair *et al.*, 2006) and on the average correlation of items within a test if the items are standardised. If the items are not standardised, it is based on the average covariance between them (Coakes, 2005). The higher the value of the Cronbach's Alpha coefficient, the higher the internal consistency of the item measurement of each construct suggesting a high reliability of the survey instrument (Wu, 2005). Hair *et al.* (2006) claim that a Cronbach's Alpha coefficient of at least 0.7 can be considered acceptable for internal consistency across items. Because Cronbach's Alpha can be interpreted as a correlation coefficient, it ranges in value for –1 to +1. SPSS provides a standardised item alpha that is the value that would be obtained if all the items were standardised. Items usually possess comparable variances so there is little difference between these two alphas (Coakes, 2005).

4.7.4 Exploratory factor analysis

Exploratory factor analysis (EFA) is a data reduction technique used to reduce a large number of variables to a smaller set of underlying factors that summarize the essential information contained in the variables (Kline, 1994). Factor analysis is primarily used to analyse the structure of interrelationships (correlations) among a large number of variables by defining a set of common underlying dimensions, referred to as factors (Hair *et al.,* 1998). Its purpose is to enable the researcher to arrive at a simple factorial structure (that is, a factor solution characterised by high loadings for non-overlapping subsets of indicator variables and low loadings otherwise) that facilitates meaningful interpretation (Thurstone, 1935; 1947). For testing a theory about a structure of a particular domain, confirmatory factor analysis is appropriate.

Exploratory factor analysis was used in this research. There are several different factor analysis methods – Principal Components Analysis (PCA), Principal Axis Factoring (PAF) and Alpha Factor Analysis (aFA) being the more commonly used techniques (Coakes, 2005; Garson, 1998, 2007). The researcher used PCA in deference to its common use in information systems research as seen in the information systems literature (Rondeau *et al.,* 2006; Wang and Tai, 2003). The decision was confirmed after a brief study was conducted by the researcher whereby all three factor extraction methods, PCA, PAF and aFA, were applied to the data in this study to investigate the relative sensitivities of each technique with respect to factor loadings and percentage variance explained. All three techniques gave results which, when they did vary, did so only in the third decimal place. Since the primary concern of this analysis is to predict the minimum number of factors (components) needed to account for the maximum portion of the variance represented in the set of variables, PCA is appropriate (Hair *et al.*, 1998).

Exploratory factor analysis enables the identification of new factors (variables or constructs) underlying the linear correlation (Kline, 2005, page 7). The factor loadings (component loadings in PCA) are the correlation coefficients between the variables (rows) and factors (columns). Analogous to Pearson's r, the squared factor loading is the percent of variance in that variable explained by the factor. The communality, h^2, is the squared multiple correlation for the variable as dependent using the factors as predictors. The communality measures the percent of variance in a given variable explained by all the factors jointly and may be interpreted as the reliability of the indicator (Garson, 1998, 2007). Communalities must be interpreted in relation to the interpretability of the factors. A high communality (for example .75) is meaningless unless the factor on which the variable is loaded is interpretable, though it usually will be (Garson, 1998, 2007).

Eigenvalues, also called characteristic roots for a given factor, measures the variance in all the variables that is accounted for by that factor (Garson, 1998, 2007; Kline, 2005, page 29-30). The ratio of eigenvalues is the ratio of explanatory importance of the factors with respect to the variables. If a factor has a low eigenvalue, then it is contributing little to the explanation of the variance in the variables and may be ignored as redundant with more important factors (Garson, 1998, 2007). In keeping with the SPSS methodology recommendation, factors with eigenvalues less than one were considered as redundant and not included in any further analysis (Coakes, 2005, page 157, 160).

To ensure the suitability and appropriateness of EFA, there are several assumptions which have to be met (Hair *et al.*, 2006);

1. The data correlation matrix has to be greater than 0.50 to justify the application of factor analysis;
2. The Bartlett's test of sphericity which provides the statistical probability of significant correlations among variables in the entire correlation matrix, and the Kaiser-Meyer-Olkin measure of sample adequacy (MSA) which measures the appropriateness of factor analysis should be significant (p <0.05). Furthermore, a value greater than 0.6 should be expected for factor analysis.
3. Factor extraction, which refers to determining the smallest number of factors that can be used to best represent the inter-relations among the set of variables, should be greater than one and together explain 60% of the total variance to be classified as satisfactory. In this study, Principal Components Analysis was used to determine the number of factors that should be retained.

4.7.5 Linear multiple regression

Multiple regression was the next and final statistical analytical method applied to the data. Multiple regression is an extension of bivariate correlation. The result of multiple regression is an equation that represents the prediction of a dependent variable from several independent variables (Coakes, 2005). For example, if there are n independent variables, referred to as $x1$, $x2$, $x3$ and so on up to xn. Multiple regression then finds the values for a,$b1$,$b2$,$b3$ and so on up to bn which give the best fitting equation of the form

$$y = a + b1x1 + b2x2 + b3x3 + \ldots\ldots\ldots.. + bnxn$$

*b*1 is called the coefficient of *x*1, *b*2 is the coefficient of *x*2 and so on. The coefficient of each independent variable indicates the relationship that variable has with *y*, the dependent variable, with all the other variables held constant. So, if *b*1 is high and positive, that means that if *x*2, *x*3 and so on up to *x*n do not change, then increases in *x*1 will correspond to large increases in *y* (Lea, 2005).

The goodness of fit in multiple regression is measured by the R^2_{adj} value. An adjusted R^2 value is used in multiple regression to account for the increase in R^2 that occurs when additional independent variables are added to the regression. The R^2_{adj} is calculated from the expression

$$R^2_{adj} = 1 - (1 - R^2)(N - n - 1)/(N - 1)$$

where N is the number of observations in the data set and n the number of independent variables or regressors.

Linear multiple regression analysis is used when independent variables are correlated with one another and with a dependent variable. There are a number of values computed during regression that are applied to the data in this research. The first is the beta weight, which are weightings for each variable that maximise the multiple correlation, that is, beta weights maximise the correlation between one variable and a set of other variables. The beta weights allow decisions to made about path diagrams and the impact of variables on other variables, and is a measure of the variance explained by each independent variable (Kline, 2005, page 26, 85). To assess the degree of association of the independent variables with the dependent variable, the F statistic is assessed in the “Analysis of Variance” or ANOVA part of the regression output. The *F* value tests the overall significance of the model. Specifically, it tests the null hypothesis that all of the regression coefficients are equal to zero. This tests the full model against a model with no variables and with the estimate of the dependent variable being the mean of the values of the dependent variable (www.nlreg.com/results.html). The *t* value that is generated by the multiple regression technique is a measure of the statistical significance of each regressor with the dependent variable, with all other regressors taken into account (Lea, 2005).

There are three major multiple regression models – standard regression, hierarchical regression and stepwise regression. Standard multiple regression was used in the analysis of the data in this work because the aim was to investigate the relationship between the whole set of predictors and the dependent variable (Coakes, 2005).

The relationships between the variables and the research propositions obtained from the quantitative analysis will form the basis for a series of questions to be put to the participants of the three focus groups. The purpose of the focus groups is to gather further interpretative information as to the relevance and impact of the quantitative and qualitative research findings. The quantitative section of the research only determined relationships and highlighted key factors influencing SISP effectiveness in medical pathology information systems. There is also a need to evaluate the findings of that research and to do this, focus group methodology was also adopted.

4.8 The focus groups.

The historical development of the focus group technique is attributed to two social scientists, Robert Merton and Paul Lazarsfeld, who developed the technique to assess war related communications conducted by radio (Merton, 1987). Focus groups involve open, in-depth discussions with small groups (typically six to ten participants) of purposely selected individuals, led by a trained facilitator, to explore a predefined topic of shared interest in a non-threatening, semi-structured setting. Such groups are said to be “focused” (Bagozzi, 1994 p.51) because the participants are similar in some way, and the goal of the encounter is to obtain data about a single topic or a limited range of topics (Kitzinger, 1995; Gibbs, 1997). Focus groups are basically group interviews, the goals of which are to examine, in detail, people’s perceptions about products, services, situations, political candidates and so forth, in order to evaluate how their thoughts and beliefs shape behaviour. Focus groups involve an entire group that answers questions together, rather than an interviewer who asks questions of a single individual (Walden, 2006; Hines, 2000).

Of the two primary approaches to the acquisition of knowledge, qualitative and quantitative, the focus group technique is representative of the former, with the statistically based sample survey an example of the quantitative genre (Remenyi, 1998). Likewise, focus groups can be used effectively by themselves or as an ancillary method to complement other research tools (Walden, 2006; Kitzinger, 1995). They are especially appropriate in assisting with hypothesis formation, research design, questionnaire development and data analysis (Walden, 2006; Hines, 2000; Kitzinger, 1995).

There are fundamental differences between focus groups and other data collection methodologies. Kitzinger (1994), Morgan (1997) and Bryman (2004) emphasize that it is the interaction within the group that distinguishes the method from the traditional form of group interviewing, that is, interviewing a number of people at the same time. Focus groups generally emphasize a specific subject that is explored in depth. The researcher examines how the individuals react in a group setting. Unlike sample surveys, which are based on a one-way flow of information in a one-to-one interview environment with a series of closed-ended questions, focus groups generate qualitative insights into peoples' feelings, values and opinions. Focus groups produce a range of perspectives, rather than data on actual behaviour (Gibbs, 1997; Hines, 2000).

Some empirical studies deal with how to interrelate the qualitative findings from the focus group approach with the quantitative results produced by surveys and other formats. Focus group discussion is useful in explaining or exploring survey results (Kitzinger, 1994; O'Brien, 1993). Focus groups can provide valuable insights into understanding the rationale for the responses people give in larger sample surveys (Walden, 2006), and as a complement to other methods, especially for triangulation (Morgan, 1988) and validity checking (Gibbs, 1997).

Other researchers (Glynn *et al.,* 2004, p.312) offer a different view concerning similarities and differences between focus groups and other data gathering approaches. They write that focus groups "greatest utility lies in what they have in common with other methods than what is unique about them," noting that "focus groups can illuminate aspects of public opinion that are less accessible through traditional methods. In particular, focus groups are valuable in revealing the process of opinion formation, in providing glimpses of usually latent aspects of this process, and in demonstrating the social motive of public opinion."

Proponents of the Focus Group method (Walden, 2006;Hines, 2000; Kitzinger, 1995; Gibbs, 1997) attribute its popularity to the fact that data can be provided quickly, costs are low compared to face-to-face interviewing, qualitative data is produced on beliefs and attitudes, and more detail can be obtained than in surveys. In addition, the group setting provides an opportunity to probe answers, clarify responses and ask follow-up questions (Gibbs, 1997; Hines, 1998). There is also the advantage of stimulating ideas of participants through interaction itself. Disadvantages include the non-production of quantitative data, the non-generalisation of the results, the small number of interviewees, the lack of privacy and the difficulties in recording and analysing open-ended responses (Walden, 2006).

There are four fundamental steps involved in the focus group research process which were adopted in this research –

1. Planning – Several elements need to be considered in the planning stage. Initially the number of focus groups required must be established – this is usually between two and fourteen as a general rule (Waldon, 2006; Kitzinger, 1995). An appropriate facility should be selected and enticements such as refreshments, lunch and/or a small honorarium have been shown to encourage participation. Gummesson (1991, p.21) describes access to participants as the researcher's biggest problem. The scheduling of the session(s) is crucial for optimal attendance – work related issues are best discussed during or immediately after normal business hours (Walden, 2006).

2. Recruiting the participants – Typically, a focus group includes between four and ten participants (Kitzinger, 1995). Participants must be willing and able to contribute to the topic at hand and be comfortable when discussing the issue with other people. In addition, they should have some knowledge of, or experience with, the topic, and it is generally beneficial if they also have a personal interest in the issue under review. The target individuals are selected on the basis of their ability to provide the data required for the research (Walden, 2006; Hines, 2000; Gibbs, 1997).
3. Conducting the discussion sessions – The facilitator should explain that the aim of the focus group is to encourage people to talk to each other rather than to address themselves to the researcher. The researcher may take a back seat at first, allowing for a type of “structured eavesdropping” (Powney, 1988). Later on in the session, however, the researcher may adopt a more interventionist style; urging debate to continue beyond the stage it might otherwise have ended and encouraging the group to discuss inconsistencies both between participants and within their own thinking (Kitzinger, 1995).

The questions used for the sessions are structured and must be designed to elicit the requisite information. The script is prepared in advance and is based on the goals of the research. Focus group protocol requires the open-ended question format (as opposed to those that can be answered with a “yes” or “no” response). Therefore, questions should be written that lend themselves to thoughtful exploration on the part of the participants (Walden, 2006).

4. Analysing and reporting – Data generated by focus groups are derived by audio – or video recordings and then transcribed. Additional note taking may be undertaken during the focus group session. The findings and conclusions from the focus group are incorporated into the final analysis of the research and contribute to findings and implications of the research project as a whole (Walden, 2006). The researcher draws together and compares discussions of similar themes and examines how these relate to the variables within the sample population; consideration must be given to deviant cases, that is to say, attention must be given to minority opinions and examples that do not fit the researchers overall theory (Kitzinger, 1995).

The questions for discussion in the focus groups were derived from analysis of the data from the survey instrument – which is objective and the data analysed is empirical. Three focus groups were conducted – one for a hospital pathology laboratory, one for a private practice laboratory and one for an academic group of SISP experts. It was the intention of the researcher to conduct multiple focus groups in both the hospital and private pathology sectors, but the degree of resistance to participation by many laboratories dictated that only two laboratory focus groups could be conducted. The reasons given by the laboratories that refused to participate related to disruption of their workforce, a fear of a breech of confidentiality (laboratory identification) and concerns regarding sensitive corporate information.

A description of each focus groups participant's position and qualifications follows in Tables 4.2, 4.3, and 4.4 below. The laboratory participants were selected on the basis of their seniority and involvement in laboratory departmental management, either as a shift supervisor, department head or member of the middle management team. The participants' level of seniority ensures that all participants have more than fifteen years experience in medical laboratories in Australia and, as all participants had worked in more than one laboratory in that time, ensures that all participants had used more than one laboratory information system. The participant identification method used in this thesis uses a two-digit number, for example – Participant 11. The first digit signifies which focus group the participant belongs to, and the second digit identifies the individual participant. This method was adapted to alleviate confusion of participant between focus groups.

Table 4.2 Hospital laboratory participant details.

Participant	**Description and qualifications**
Participant 11	Principle scientist in microbiology and involved in middle management - *B.App.Sc*
Participant 12	Supervisor scientist in biochemistry - *B.App.Sc, PhD*
Participant 13	Supervisor scientist in biochemistry - *B.App.Sc.*
Participant 14	Supervisor scientist in haematology - *B.App.SC.*
Participant 15	Senior scientist in haematology - *B.App.Sc.*

Table 4.3 – Private pathology laboratory participant details

Participant	**Description and qualifications**
Participant 21	Principal scientist in biochemistry and involved in middle management - *B.App.Sc*
Participant 22	Peripheral branch laboratory manager - *B.App.Sc.*
Participant 23	Senior general scientist - *B.App.Sc.*
Participant 24	Principal scientist in haematology - *B.App.SC.*

The participants for the academic focus group were selected on the basis of past or current research and/or teaching in SISP. Participant 1 is an internationally experienced scholar with extensive publications and experience in the area of management information systems (MIS) and their integration. He has industry experience in the implementation of MIS in the university and hospital environments in Asia. His extensive all round experience was sought to comment on the findings of this research with respect to financial considerations, business-IT alignment and end-user involvement in SISP. Participant 2 was asked to join the discussion within the group because of his role as a consultant in information systems and information systems strategy. His contribution in the dual roles of academic and a practitioner in the Health industry was thought to be invaluable to the discussion. Participant 3 has many years of experience and publications in the areas of SISP and business-IT alignment. Participant 4 was included for his recently completed doctoral studies in SISP and his expertise in statistical methods. Participant 5 recently completed his doctorate in SISP evaluation in industry in Australia and his input into the mechanisms of SISP was sought. Participant 6 is currently pursuing doctoral studies in business-IT alignment. Participants 3 and 6 were included in FG3 for their knowledge and expertise in business-IT alignment.

Table 4.4 – Academic group participant details

Participant	Description and qualifications
Participant 31	Professor of Management Information Systems, Head of School, Dean of Research & Innovation.
Participant 32	Post doctoral strategy consultant
Participant 33	Post doctoral - senior lecturer alignment
Participant 34	Post doctoral - researcher SISP and statistical methods
Participant 35	Post doctoral - thesis on SISP in Australia
Participant 36	Doctoral candidate - researching alignment.

4.9 The notion of Validity.

The term validity has different meanings within the quantitative and qualitative arenas (Janesick, 2000). Janesick has argued that in the quantitative arena validity "has a set of technical microdefinitions" (p.393) related to Cook and Campbell's (positivist) definitions, which are discussed below. In the non-positivist, qualitative arena, validity has to do with "whether or not the explanation fits the description…is the explanation credible?" Janesick emphasises that there is no one "correct" interpretation.

However, within the positivist tradition, Cook and Campbell (1978) articulate the notion of validity in field settings. They describe four kinds of validity: statistical conclusion validity, internal validity, construct validity, and external validity. This latter validity refers to generalisability, or the extent to which "causal relationships can be generalised across persons, settings or times" (p.223), and so is particularly important to a practitioner discipline.

Lincoln and Guba (2000) have argued that the paradigmatic differences can, at some level, be reconciled. They suggest that while concepts such as objectivity are not viewed the same within different epistemological paradigms, the notion of validity is. Lincoln and Guba argue (2000, p.178) that both positivist and non-positivists are interested in validating whether -

> *Findings [are] sufficiently authentic (isomorphic to some reality, trustworthy, related to the way others construct their social worlds) that I may trust myself in acting on their implications [and] sufficiently secure about these findings to construct social policy or legislation based on them.*

Baskerville and Lee, (1999) and Lee and Baskerville, (2000) have attempted to reframe Cook and Campbell's notion of validity from the point of view of generalisability. Findings can be generalised to theory (theory building) or to different groups (populations, settings) to those in which the findings originated. This parallels the distinction made in research-methods literature between research conducted in the exploratory, or theory generation phase, and that conducted in theory validation phase.

4.9.1 Validity and reliability of the questionnaire.

This study used four steps to test the validity and the reliability in the measurement items that were derived from the literature. Validity is the extent to which a scale or set of measures accurately represents the concept of interest (Hair *et al*., 2006). This study employed two validity checks for the measurement items, namely content validity and construct validity.

Content validity represents the comprehensive and reliable measurement of all the dimensions of a construct by an instrument (Kidder and Judd, 1986). Nunnally (1978) claims that the standard of content validity is based on a representation of set items of instrument and employment of sensible methods of scale in constructs. In this study, forty-two indicators representing five dimensions (or factors) were used to measure the impacts on IS effectiveness on business outcomes. All of the measurement items of each construct were adapted from the literature (see Chapter 2). Expert examination within a pilot study (section 4.6.3, p. 112) was employed to ensure the suitability of the item. This helped justify the content validity of the instrument.

Construct validity is generally used to test if a variable is genuinely a construct (Kline, 1994). It is used to check if a variable correlates with others in the study and to make sure the conceptual model is internally consistent, statistically speaking (Chi, 2005). Usually, “researchers establish construct validity by correlating a measure of a construct with a number of other measures that should, theoretically, be associated with it (convergent validity) or vary independently of it (discriminate validity)” (Chi, 2005, p.102).

Convergent validity refers to the extent to which multiple attempts to measure the same concept with different methods are in agreement, whereas discriminate validity is the degree to which a concept differs from other concepts (Hair *et al*., 2006). To establish convergent and discriminate validity, correlations between the latent constructs in factor analyses were checked. In this study, multi-factor analyses, such as Exploratory Factor Analysis (EFA) which “concerns relationships among variables is in the explication of constructs” (Nunally, 1978, p.329), were employed to test the convergent validity of measurement scales. After a validity check of the measurement scale via EFA, the convergent validity of the scale was measured by the composite reliability (CR) and the average variance extracted (AVE). Higher CR and AVE values imply higher convergent reliability of measurement. A discriminate validity is established to measures of constructs that theoretically should not be related to each other (Hair *et al*., 2006). To estimate the degree, to which any two measures are related to each other, the correlation coefficient is commonly used to observe intercorrelations among measures. Typically, AVE values should exceed the square of the correlations between each pair of latent constructs (Fornell and Larcker, 1981).

Reliability is defined as the consistency of observations or measures (Nunnally, 1978, Nunnally and Bernstein, 1994). Reliability implies that the index of an instrument is stable. It is determined by the Cronbach's Alpha coefficient, which is based on the internal consistency of the scale (Hair *et al*., 2006). The higher the value of Cronbach's Alpha coefficient, the higher the internal consistency of the item measurement of each construct suggesting a high reliability of the survey instruments. Hair *et al*. (2006) claim that at least a Cronbach's Alpha coefficient of 0.7 can be considered acceptable for internal consistency across items. This study follows this guideline using a cut-off point of $\alpha = 0.70$ as a reasonable indicator of fit for each construct. Further elaboration of the above methods for validity and reliability checks is described in section 5.4 of the statistical procedure (Chapter 5). This section has determined the context for the determination of the validity and reliability of the research instrument. The impact of a small sample size, as achieved in this research (see p. 108), needs to be considered to evaluate any implications that may arise for the data analysis and this is investigated in the following section.

4.10 Small '*n*' qualitative studies

The implications and relevance of small '*n*' studies to this research relate to the relatively small number of respondents to the surveys sent to hospital and private pathology laboratories throughout Australia. One potential criticism of intensive, small *n*, qualitative studies is that they cannot generalise to other settings, and so can only be used in the exploratory phase of research. However, Baskerville and Lee (1999) point out that more cases do not necessarily mean greater theoretical generalisability and that whilst large numbers can reduce statistical error (that is, increase confidence limits) they do not necessarily increase the generality of a theory (that is, the range of situations in which the theory has been demonstrated to hold). These authors go on to point out that small *n* studies can both generate theory (inductive generalising) and test theory (deductive generalising). They illustrate that deductive generality depends not on large numbers, but on the capacity to disconfirm or contradict the theory. Baskerville and Lee (1999) argue that intensive research (such as case studies) can lay claim to generalise to other situations which share similar attributes of that case, in the same way that a single experiment can be expected to generalise to similar empirical circumstances. This should not be confused with the capacity of an experiment (or quantitative survey) to provide statistical generalisation. That is, provided subjects or respondents are selected randomly, and sufficient numbers are involved, a quantitative study can use statistics to determine how likely the results are to represent those for the population from which subjects were drawn (statistical generalising). This is not possible for a small *n* study, or for a single case study. Baskerville and Lee's argument about deductive generality is important because it disentangles intensive small *n* research from exploratory research.

Earlier researchers had argued that in disciplines such as information systems that were not yet mature, an exploratory approach, involving generating ideas, theories and hypotheses, rather than "simply" testing them was most appropriate (Mumford et. al., 1985). Because of the general lack of research in the area of SISP/ information systems effectiveness in medical pathology the research in this thesis may be regarded as ground breaking in that context. As such, research in this area should be regarded as exploratory. Extra due diligence to ensure validity of the instrument and the derivation of the instrument from the literature in this exploratory research was essential to maintain its grounding and relationship to pertinent literature.

4.11 Summary.

The quantitative analysis results of the survey data are expected to illuminate the relationship between the independent and dependent variables in this research. The beta weights and *t* values obtained by multiple regression will give some insight into the relative importance of the independent variables to the dependent variables, which in turn will elicit an order of priority for the research propositions relating to SISP in medical pathology practice. Questions framed from these results and initial interpretation of the quantitative data analysis will then be put to the participants of the three focus groups for discussion and elaboration. It is expected that the combination of the results from the quantitative data analysis and the focus group discussion will then present the researcher with a detailed view of the role of the research propositions in the application and measurement of SISP in medical laboratories, and the prospects that may arise from these possibilities for medical laboratories to enhance their strategic position. Chapter 4 has detailed the best approach to undertake in examining the data that will be obtained to investigate the research question. Chapter 5 will now outline the actual analysis of the quantitative data, not only to ascertain an initial impression of the effects of the propositions on medical pathology practice, but to lay the groundwork for the evolution of items for further investigation by way of the three focus groups.

CHAPTER 5 - QUANTITATIVE DATA ANALYSIS.

5.1 Introduction.

To investigate the hypotheses developed in Chapters 2 and 3 and assess their impact on the business of medical pathology, a survey was designed and distributed amongst the target audience (Chapter 4, p116). This chapter presents the results of analysis of the data contained in the 96 returned surveys.

The data analysis summary outlined in Figure 5.1 gives a diagrammatic overview of the research methodology. The initial stage was the literature review from which the five propositions to be researched in medical pathology practice were determined. The next step involved the design and testing of the research instrument (questionnaire) with a pilot study. The final questionnaire was then distributed to medical laboratories throughout Australia. Conclusions derived from an analysis of the returned data will serve to provide information for further discussion through the three focus groups.

This chapter begins with descriptive statistics that are used to describe the socio-demographic, attitudinal and behavioural characteristics of the respondents towards the functionality of the laboratory information systems they use, and the impact that may have on medical pathology as an industry. It should be noted that 5 of the surveys were found to be incomplete at the data entry and data screening stage and were consequently excluded from further statistical analysis. Next, a reliability test of each individual variable is performed to test individual measurement scales to make sure that they achieved an acceptable level of reliability for subsequent steps in the analysis. Each multi-indicator measurement scale will then be subjected to exploratory factor analysis (EFA) and then multiple regression for data reduction and to identify the underlying dimensions and statistically tests for goodness of fit in the model. Determination of the beta weights from the multiple regression will then assist in determining the relationships amongst constructs. These findings will then be used as the basis for the discussion items for the focus groups, the findings of which will be discussed in Chapters 6 and 7.

5.1.1 The research question:

The data analysis will help answer the question: '*How does the effectiveness of laboratory information systems impact on business outcomes in medical pathology practice'?*

RESEARCH QUESTION: How does LIS effectiveness impact on business in medical pathology practice?

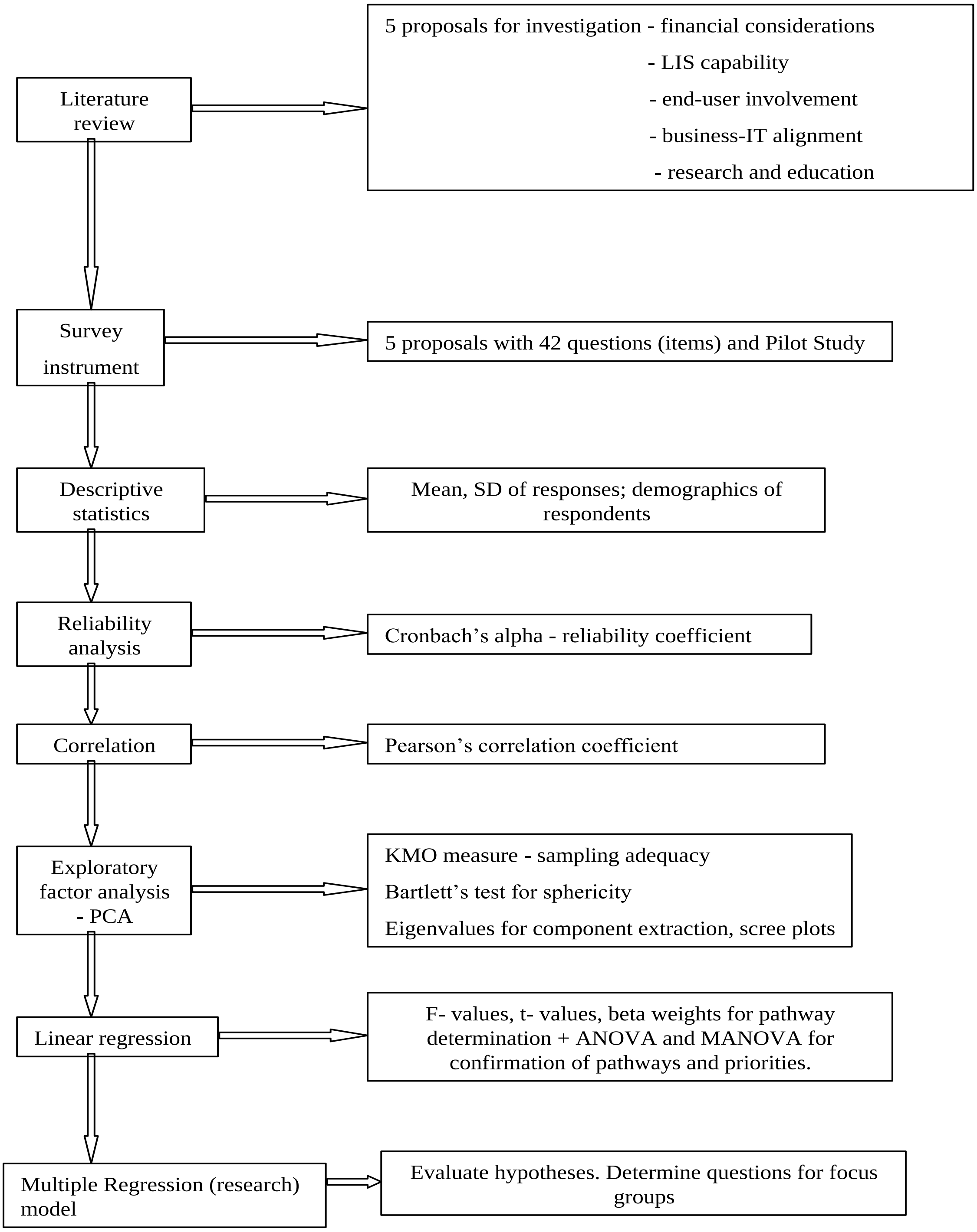

Figure 5.1 Data analysis summary.

5.2 Data screening

The questions in the research instrument were designed to seek information from respondents in both private and hospital based medical laboratories in Australia to investigate the five propositions derived from the literature in Chapters 2 and 3.

The research instrument was distributed to private and hospital laboratories in Melbourne, Western Australia, country Victoria and South Australia. The researcher requested that representatives from each area of the laboratory structure that used the laboratory information system complete the survey. These target staff were medical scientists (senior and junior), IT staff, management staff and pathologists. Three hundred and twenty surveys were distributed by post and by hand delivery and ninety-six were returned completed. This is a 30% completion rate. As stated in Chapter Four, page 14, one private practice declined to participate, effectively eliminating a third of possible respondents from the survey. This then precipitated a change in analytical methodology as there were not enough completed surveys to undertake structured equation modeling as originally planned. Data was screened for out-of-range values by using the ‘Descriptives’ command in SPSS v15 (Coakes, 2005; p. 29) and any out of range data was re-entered.

5.3 Demographic and Sample Profile.

The respondents’ demographical data is presented in Table 5.1. Of the 91 respondents of laboratory staff who completed the demographics component of the survey, 50% were females and 50% were males indicating an equal representation. The largest age group category was the 31 – 55 year olds with 62% of total respondents. It is interesting to note that only 10% of respondents were 30 or younger, and that 16% of respondents were older than 55 years.

Table 5.1 Demographic information of respondents – age and gender.

Demographic variable	Category	Frequency n = 91	Percent
Age	Under 21		
	21 - 25	1	1%
	25 - 30	9	9%
	30 - 40	21	23%
	40 - 45	13	14%
	45 - 55	23	25%
	Over 55	15	16%
Gender	Male	45	49%
	Female	46	50%

The academic qualifications of the respondents are shown in Table 5.2 and followed expectation according to the respondents respective roles in the laboratory – 77% of the respondents were medical scientists and had completed a Bachelor of Applied Science degree in Laboratory Medicine, 14% were pathologists with medical and pathology degrees, and 4% were management with appropriate management and/or business degrees. Three respondents (3%) had dual academic qualifications in business/management and medical science/hospital management, and no respondent was dual qualified in medical science and IT.

Table 5.2 Demographic information of respondents – qualifications.

Demographic variable	Category	Frequency n = 91	Percent
Qualifications - science/medicine	B.App.Sc(MLS)	67	74%
	B.Sc.(Comput Sc)	3	3%
	MB. BS. FRACPath	13	14%
	Other	4	4%
Qualifications - business/management	B.Bus	3	3%
	B.Comm/Eco		
	B.Acc/CPA	1	1%
	MBA	3	3%
	B.Bus(Info.tech)	2	2%
	Dip. Management	4	4%

Table 5.3 shows the length of work experience of the respondents. The majority of the respondents, 62%, had more than 15 years laboratory experience and only 4% had less than 5 years experience. 49% of the respondents were employed in a senior laboratory role as either a scientist or pathologist, and 20% were in management positions. Membership of a laboratory IT interest group was 6%. IT interest groups are groups and societies who meet and hold conferences to foster interest and discussion in laboratory informatics. Such groups include the Health Informatics Society of Australia, Pathology Informatics Society (USA) and forums assisted by the Medical Scientists Institute of Australia and the Australian Association of Clinical Biochemists.

Table 5.3 Demographic information of respondents – work experience

Demographic variable	Category	Frequency n = 91	Percent
No. of years laboratory experience	Less than 5	4	4%
	5 to 10	12	13%
	10 to 15	9	10%
	More than 15	62	68%
Position held - classification	Grade 1	8	9%
	Grade 2	14	15%
	Grade 3	14	15%
	Grade 4	4	4%
	Department Head	14	15%
	Management	18	20%
	General Pathologist	1	1%
	Specialist Pathologist	11	12%
	IT Department	5	5%
Interest groups - associations	Management	14	15%
	Business	4	4%
	Information Tech	6	6%

5.4 Descriptive Analysis of Questions.

There has been very little research done on information systems effectiveness in medical laboratories and consequently the literature is bereft of methodologies to set a pathway for following researchers. The methodology used in this work is therefore exploratory. This research follows some components of other research in other fields of information systems work (OpenLabs and others) and will apply these techniques to this project. Examination of the descriptive statistics gives an initial impression of the proposals under investigation.

For the dimension of cost-benefit analysis (financial considerations) impacting on laboratory planning, the respondents rated the items “info enhances management skills, info enables meeting budgets, info supports implementation of change and financial reasons responsible for change” relatively highly with scores from 3.83 to 4.39 (Table 5.4). The items pertaining more directly to more functional laboratory information systems input –“info available in real time, info in same format and format easy to use” scored lower with scores ranging from 3.51 to 3.80, indicating the respondents’ dissatisfaction with the laboratory information systems performance with these functions. The dimension “financial info sole driver for change” scored the lowest figures indicating that this dimension was not a driver for change.

Table 5.4 Descriptive statistics for Proposal 1 (Financial considerations).

	N	Mean	Std. Deviation
Info available in real time	84	3.73	1.37
Info in same format	82	3.80	1.37
Format easy to use	81	3.51	1.38
Financial info sole driver for change	91	3.23	1.41
Info enhances management skills	81	4.04	1.36
Info enables meeting budgets	80	4.38	1.29
Info supports implementation of change	81	4.04	1.18
Financial reasons responsible for change	88	3.82	1.27

Table 5.5 shows the descriptive statistics for the dimension of laboratory information systems functionality. The results show that for management (roster generation, labour costing, reagent stock control, reagent ordering, staff efficiency and reagent waste calculation) most respondents disagreed that the laboratory information systems are adequate for these functions. Scores ranged from 1.97 to 2.63. The implications for the laboratory are that there is no ready access to this laboratory management data in an information systems sense, and that manual methods of data gathering therefore still apply in the laboratory. This situation, it can be argued, reduces efficiency and increases labour costs (Mayer, 1998). The scores for attributes pertaining the integration capability of the laboratory information systems were likewise low being 2.23 and 2.64. This shows that the respondents disagreed that the laboratory information systems are efficient in this area also. The lack of integration capability would handicap the laboratory with respect to importation of modern technologies and management support software, such as telemedicine and MYOB[2] respectively. Support for other factors in the dimension of laboratory information systems functionality, such as capability for international and domestic expansion was judged neutrally by the respondents with scores ranging from 3.00 to 3.50. This suggest some support for the laboratory being able to expand both domestically and internationally, but only in the context of the support of a static laboratory information systems. The ability for the laboratory to implement technologies better suited to a global business, such as the internet and intranets, telemedicine and real time management facilities is compromised by a lack of capacity of current laboratory mainframe information systems to embrace these technologies.

[2] MYOB – Mind Your Own Business is a commercially available financial software package.

Table 5.5 Descriptive statistics for Proposal 2 (Laboratory information systems capability).

	N	Mean	Std. Deviation
Roster generation	89	1.95	1.45
Labour costing per shift	86	2.31	1.52
Reagent stock control	84	2.19	1.44
reagent ordering	87	2.31	1.45
Staff efficiency analysis	87	2.60	1.70
Reagent waste calculation	84	1.97	1.27
LIS can integrate with comm financial s/ware	67	2.26	1.27
LIS can support graphics from analysers	83	2.63	1.63
LIS has a common interface	86	3.03	1.76
LIS is expandable for future IT developments	84	3.32	1.44
LIS suitable for expansion in Australia	86	3.51	1.49
LIS suitable for expansion internationally	81	3.13	1.46
LIS is able to support mobile technology	82	3.08	1.64

Analysis of the descriptive statistics pertaining to the involvement of end-users in the planning process and end users involved in planning groups (Table 5.6) showed general disagreement by the respondents relating to these items with scores ranging from 2.68 to 2.95. The respondents were not in agreement that end-users are involved in the planning process and development of the laboratory information systems. There was more agreement amongst respondents that IT staff is familiar with end-user operations, the score being 3.71. The respondents' answers relating to the end user involvement proposal also showed that documentation is inadequate and that the IT staff do not respond quickly to requests for change, evidenced with item scores of 2.75 and 2.67 respectively. The combination of lack of end- user involvement in planning and lack of information systems documentation, in particular, will be further investigated in focus groups 1 and 2 as possible key elements contributing to lack of information systems effectiveness in laboratories.

Table 5.6 Descriptive statistics for Proposal 3 (End – user involvement).

	N	Mean	Std. Deviation
Adequate documentation on LIS is provided	95	2.75	1.37
IT staff respond quickly to requests for change	95	2.67	1.39
IT staff are very familiar with end user operations	92	3.71	1.46
End users involved in operation and development	93	2.68	1.31
End users involved in planning groups.	93	2.95	1.45

The analysis of the descriptive statistics for the dimension of business – IT alignment (Table 5.7) showed no clear agreement with scores in the range 3.27 to 3.66. This result is important in that it implies that there is little co-operation between the scientific staff and the IT department in the planning process (scores 3.23 and 3.42), that there is little adequate alignment of the IT development direction with that of the laboratory (scores 3.33 and 3.66), and that there is no strategic plan evolved for development (score 3.34). These findings may have a significant negative impact on the outcomes of information systems planning in the laboratory as it well recognized in the literature as being an imperative for successful planning (Hackney *et al.,* 1999; Wang and Tai, 2003; Rondeau *et al.,* 2006 and Wells *et al.,* 1996).

Table 5.7 Descriptive statistics for Proposal 4 (Business-IT alignment).

	N	Mean	Std. Deviation
Dep heads and IT work together to build LIS	90	3.65	1.50
There is a strategic plan for LIS development	83	3.37	1.49
LIS is compatible with business objectives of firm	80	3.66	1.35
Planning involves extensive group discussions	83	3.27	1.54
Lab staff are involved in implementation of change	92	3.42	1.42
Lab staff and IT staff have aligned objectives for LIS	91	3.32	1.34

The descriptive statistics for the dimension of research and education (Table 5.8) showed that the respondents were inconclusive regarding the proposition that a lack of research and education negatively impacts on laboratory information systems planning, – scores were in the range 3.16 to 3.95. There was, however, a clear disagreement that laboratory staff are actively involved in research into both laboratory information systems and management with scores of 2.42 (laboratory staff actively research laboratory information systems) and 2.72 (laboratory staff actively research management) respectively. This is a meaningful finding in the light of the respondents view that post graduate studies would enhance the management of the firm (score 4.1). The scores for staff, both laboratory and IT, belonging to discussion forums or groups

(3.36 and 3.58) reflects the low figure of 6% of forum/group membership recorded in the respondent demographics (Table 5.3, page 149).

Table 5.8 Descriptive statistics for Proposal 5 (Research and Education).

	N	Mean	Std. Deviation
Journals would enhance development of LIS	87	3.35	1.32
Journals would enhance management of firm	88	3.70	1.27
Post grad quals would enhance development of LIS	88	3.65	1.29
Post grad quals would enhance management of firm	89	4.06	1.23
Lab staff belong to management groups or forums	91	3.58	1.28
Lab staff belong to LIS groups or forums	89	3.35	1.34
IT staff belong to LIS groups or forums	79	3.94	1.25
IT staff actively research LIS	76	3.31	1.47
Lab staff actively research LIS	85	2.45	1.17
Lab staff actively research management	88	2.72	1.33

5.5 Reliability.

Nunnally (1978) and Nunnally and Bernstein (1994) define reliability as the internal consistency of observations or measures, and reliability implies that an index of an instrument is stable. Reliability is determined by the Cronbach's Alpha coefficient, which is based on the internal consistency of the scale (Hair *et al*., 2006). The higher value of the Cronbach's Alpha coefficient, the higher the internal consistency of the item measurement of each construct, indicating the instrument's high reliability (Hair, *et al.,* 2006).

Scholars (Nunnaly, 1978; Hair *et al.,* 2006) claim that Cronbach's Alpha coefficient value of at least 0.70 is acceptable for internal consistency across items. This study used SPSS 15.0 for data entry accuracy, missing data, and for violations of multivariate statistical assumptions. Table 5.9 shows the Cronbach's Alpha coefficients for each of constructs of this study.

Table 5.9 Reliability test of indicators and proposals.

Dimension	**Cronbach' Alpha**	**Number of items**	**Items deleted Cronbach's alpha**
Cost benefit analysis	0.80	8	nil
Laboratory functionality	0.91	13	nil
End-user involvement	0.92	5	nil
Business-IT alignment	0.91	6	nil
Lack of research	0.91	10	nil

The results show that the reliability scores (Cronbach's Alpha coefficients) range from 0.80 to 0.92 in each dimension. All variables within the construct presented a high internal consistency of higher than 0.70, therefore the results demonstrate generally good reliability. All measurement items were kept at this stage, and underwent further testing. The next stage in the data analysis was Exploratory Factor Analysis. A description of the technique used and the results of the analysis are presented in the following section.

5.6 Exploratory Factor Analysis (EFA).

Exploratory factor analysis was then undertaken using Principal Components Analysis (PCA). Factor analysis is a data reduction technique used to reduce a large number of variables to a smaller set of underlying components that summarize the essential information contained within the variables. Chapter 4 of this thesis contains a full and detailed description of the principles of EFA techniques (p.123,124). PCA with Varimax rotation was undertaken to reduce the forty-two items to a smaller number in order to obtain a more defined data set for multiple regression and model path investigation. The assumption of multicollinearity and singularity is not relevant to PCA. The anti-image correlation matrix is used to assess the sampling adequacy of each variable. Variables with a measure of sampling adequacy less that 0.5 were excluded from the analysis. Component loadings of 0.7 (Coakes, 2005) or greater were taken as indicating a significant underlying factor and the independent variables indicating these loadings were used either singularly or as composite factors in the overall hypothesis model. These same factors were used in the final analysis step – the regression. Communality, h^2 is the squared multiple correlation for the variable using the factors as predictors (Garson, 2007). The communality measures the percent of variance in a given variable explained by all the factors jointly and may be interpreted as the reliability of the indicator (Garson, 2007).

5.6.1 Cost-benefit analysis (financial considerations) approach and impact on SISP.

A sample of 96 observations was tested in order to identifying the underlying dimensions of cost-benefit/financial considerations on management decisions relative to IS planning. The data was subjected to Bartlett's Test for Sphericity and the Kaiser-Meyer-Olkin (KMO) measure prior to EFA to test the data for suitability for factorisation. Bartlett's Test for Sphericity is used to test the null hypothesis that the variables in the population correlation matrix are uncorrelated. The KMO measure of sampling adequacy is an index for comparing the magnitudes of the observed correlation to the magnitudes of the partial correlation coefficients. If the Bartlett's Test for Sphericity is large and significant, and the KMO measure is greater than 0.6, then factorability is assumed.

As the Table 5.10 indicates the Barlett test is significant at .001 level (Bartlett's test of sphericity = 326.901, $p<0.001$), and Kaiser-Meyer-Olkin Measure of sampling Adequacy (KMO-MSA) overall value approaches 0.80, indicating that the collected data is suitable for factor analysis. This dimension's measure of sampling adequacy (MSA) value is 0.76, well exceeding the requirement of the MSA to be over 0.6 (Hair *et al.,* 2006). Thus, factors within the dimension of cost-benefit/financial management approach could be further examined in deriving factors and assessing the overall test fit by adopting the EFA.

Table 5.10 KMO and Bartlett's test results for cost-benefit analysis (fin cons).

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.758
Bartlett's Test of Sphericity	Approx. Chi-Square	326.904
	df	28
	Sig.	.000

There were three components (information for change, valuable information and information format) extracted from eight indicators (Table 5.11). The factor loadings are similar for all three components extracted, the average factor loadings being 0.88, 0.86 and 0.90 respectively. Component 1, namely information format, has the highest eigenvalue and hence explains the majority of the variance (47.7%). Information format therefore is regarded as the most significant variable. The average score for this component from the descriptive statistics is 3.69, indicating that the survey respondents neither strongly agreed nor disagreed with the context of component 1 – information format.

Table 5.11 Underlying dimensions for financial considerations (c/b analysis).

Component	**Indicators**	**Communality**	**Factor loading**	**Eigen value & variance explained**
Information format	Info available in real time	0.83	0.88	3.81
	Info available in same format	0.81	0.88	47.70%
	Info easy to read	0.82	0.86	
Valuable information	Info enhances management	0.85	0.90	1.25
	Info enables meetings	0.84	0.89	15.60%
	Info supports process change	0.84	0.78	
Information for change	Info sole driver for change	0.84	0.91	1.66
	Info influences development	0.85	0.89	20.70%

The screen test (Figure 5.2) for this dimension also suggests a three component solution. All three components have eigenvalues greater than 1.0, and together explain 85.04% of the variance. The communalities range from 0.81 to 0.85 suggesting that the variance in each original indicator is reasonably explained by the three components taken together. The high communality values for the three indicators may also be interpreted as an indicator of the reliability of each indicator.

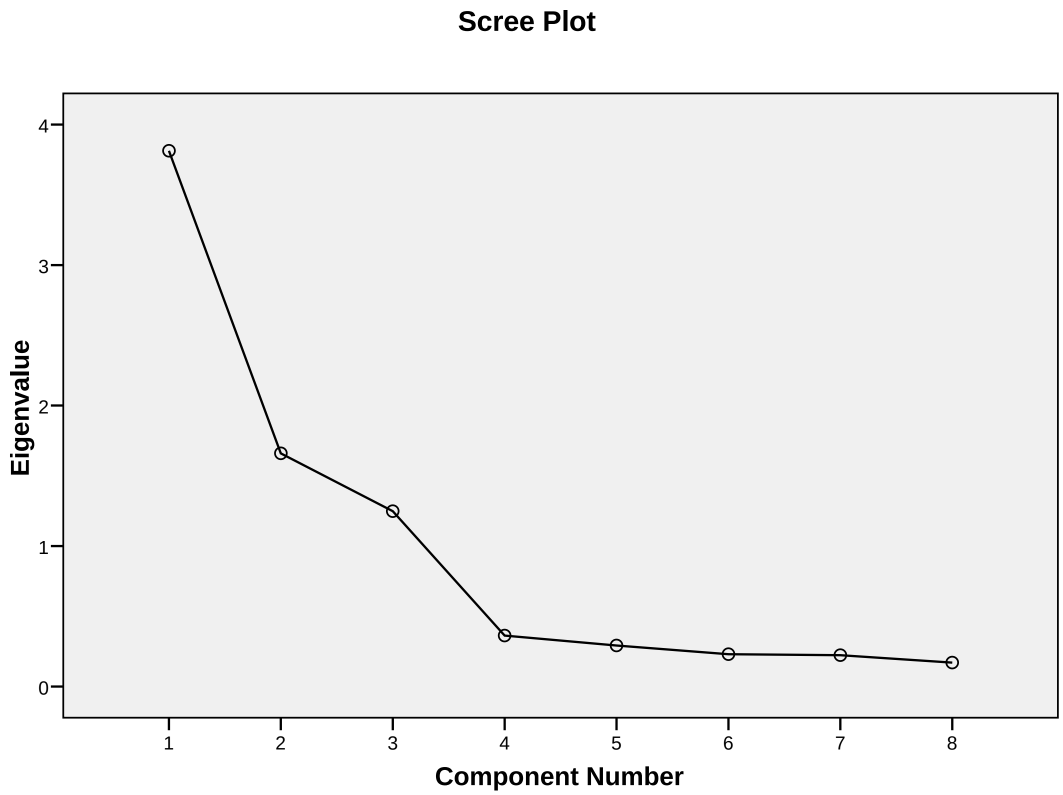

Figure 5.2 Scree plot for dimensions of financial considerations (cost-benefit analysis).

5.6.2 End-user involvement in information systems planning process.

The Barlett's Test for Sphericity for the factor end-user involvement is significant at .000 level (Bartlett's test of sphericity = 247.172, $p < 0.000$), and KMO-MSA overall value was above 0.80, indicating that data was suitable for factor analysis (Table 5.12). The MSA value was 0.814, which was appropriate as the value exceeds the requirement of the MSA being over 0.6 (Hair *et al.*, 2006). Thus, the factors within the dimension of end-user involvement in information systems planning could be further examined in deriving factors and assessing the overall fit using the EFA.

Table 5.12 KMO and Bartlett's test results for end-user involvement.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.814
Bartlett's Test of Sphericity	Approx. Chi-Square	247.172
	df	10
	Sig.	.000

As seen in Table 5.13 there was only one component (end-user/IT alignment) extracted from eight indicators.

Table 5.13 Underlying dimensions for end-user involvement in information systems planning.

Component	Indicators	Communality	Factor loading	Eigen value & variance explained
End-user/IT alignment	Adequate documentation	0.62	0.79	3.4
	IT staff respond quickly	0.80	0.90	68.01%
	IT staff familiar with user ops	0.57	0.75	
	End-users develop LIS	0.76	0.87	
	End-users involved in planning	0.63	0.81	
Only one component extracted therefore cannot be rotated.				

The screen test (Figure 5.3) for this dimension also suggests a one-component solution. The component has an eigenvalue greater than 1.0, and explains 68.01% of the variance. The communalities range from 0.57 to 0.80 consistent with the variance in each original indicator being reasonably explained by the component extracted, and that the indicators are reliable. Examination of the descriptive statistics for the questions framing this variable and pertaining directly to end-user involvement (end-users develop information systems and end-users involved in planning) show that the respondents disagreed that end-users were involved in planning (average score = 2.7). The data indicates that respondents disagreed that there is adequate documentation on the laboratory information systems provided, and that the IT department responds quickly to requests for change and service (average score = 2.8). There was, however, some support by the respondents for the IT staff being familiar with end-user operations (score = 3.72).

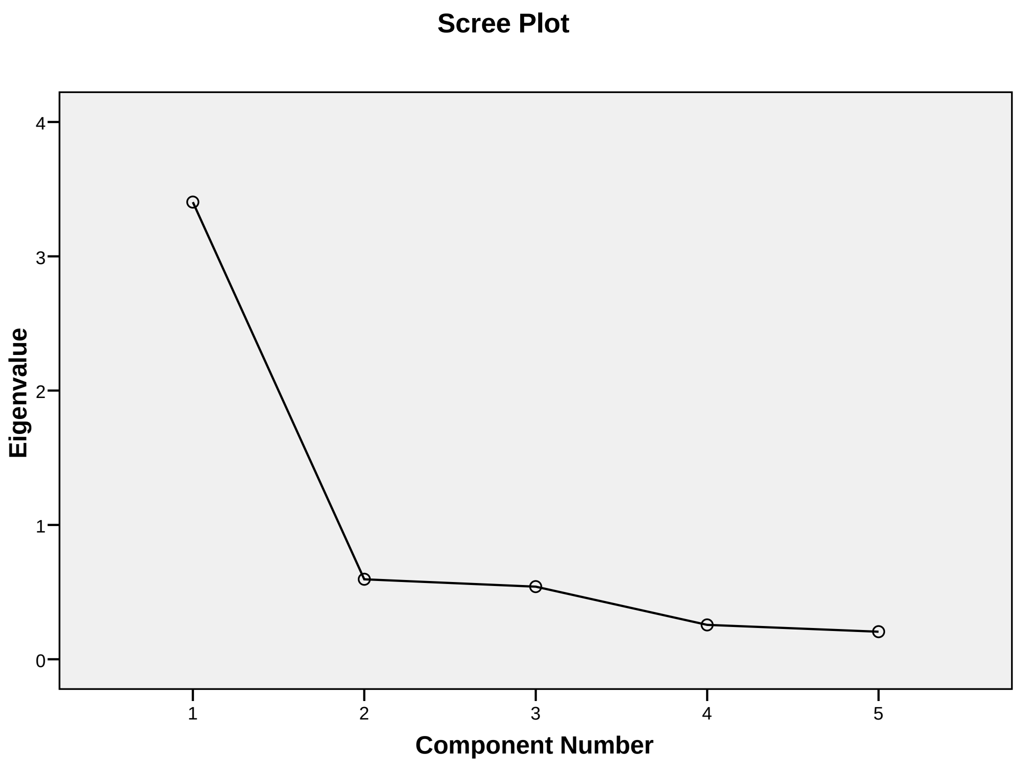

Figure 5.3 Scree plot for the dimensions of end-user involvement in information systems planning.

5.6.3. Business/IT alignment in IS planning.

As Table 5.14 shows, the Barlett test is significant at .000 level (Bartlett's test of sphericity = 276.188, p<0.000), and KMO-MSA overall value was above 0.80, indicating that data was suitable for factor analysis. The MSA value was 0.872, which was appropriate as the value exceeds the requirement of the MSA being over 0.6 (Hair *et al.*, 2006). Thus, the factors within the dimension of business/IT alignment in information systems planning could be further examined in deriving factors and assessing the overall fit using the EFA.

Table 5.14 KMO and Bartlett's test for business/IT alignment.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.872
Bartlett's Test of Sphericity	Approx. Chi-Square	276.188
	df	15
	Sig.	.000

There was only one component (laboratory information systems development planning) extracted from six indicators (Table 5.15).

Table 5.15 Underlying dimensions of business/IT alignment in IS planning.

Component	**Indicators**	**Communality**	**Factor loading**	**Eigen value & variance explained**
IT development planning	Lab/IT staff common objectives	0.56	0.75	3.98 66.38%
	There is a strategic plan	0.72	0.85	
	There is group planning	0.47	0.84	
	Lab staff are involved in change	0.72	0.81	
	Lab/IT staff develop together	0.65	0.92	
	LIS helps bus objectives	0.84	0.81	
Only one component extracted therefore cannot be rotated.				

The screen test (Figure 5.4) for this dimension also suggests a one component solution. The component has an eigenvalue greater than 1.0, and explains 66.38% of the variance. The variance in each original item is reasonably explained by the component extracted (communalities range from 0.56 to 0.84). The high communality value is also an indicator of the reliability of the indicators. Referring back to the descriptive statistics for business-IT alignment responses shows an average score for all questions of 3.45 indicating that the survey participants agree that there is some alignment in their laboratory.

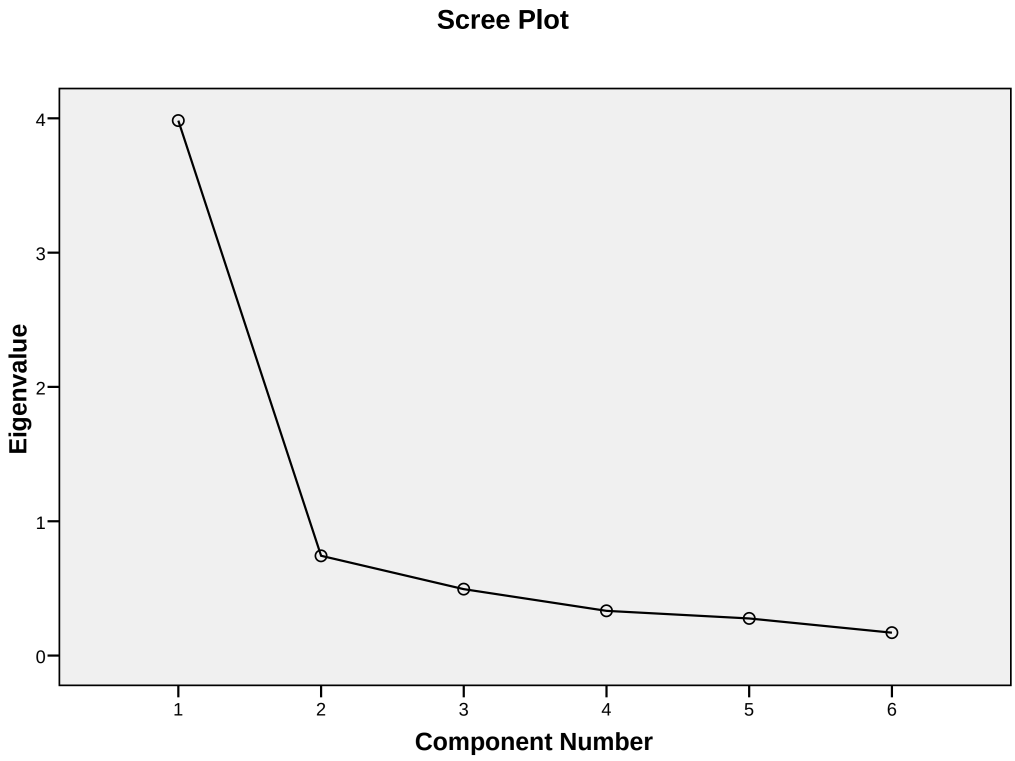

Figure 5.4 Scree plot for business-IT alignment dimension.

5.6.4 Laboratory information systems functionality and impact on planning.

Table 5.16 shows that the Barlett test is significant at the .000 level (Bartlett's test of sphericity = 667.395, p< 0.000), and KMO-MSA overall value was 0.80, indicating that data was suitable for factor analysis. The MSA value was 0.800 which was appropriate as the value exceeds the requirement of the MSA being over 0.6 (Hair *et al*., 2006). Thus, the factors within the dimension of laboratory information systems functionality in information systems planning could be further examined in deriving factors and assessing the overall fit using the EFA.

Table 5.16 KMO and Bartlett's test for laboratory information systems functionality.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.800
Bartlett's Test of Sphericity	Approx. Chi-Square	667.395
	df	78
	Sig.	.000

As seen in Table 5.17, there were three components (management tasks, expansion and new IT, and integration) extracted from thirteen items. The eigenvalue for the component management tasks is the dominant value and since the ratio of eigenvalues is the ratio of exploratory importance of the component with respect to the variables, management tasks carries the most significance relating to the dimension "laboratory information systems capability". Likewise, the component expansion and adaptability (Eigenvalue 2.52) has more exploratory significance than the component integration capability (Eigenvalue 1.18). Examination of the descriptive statistics for the questions from the survey pertaining to laboratory information systems capability show that the respondents disagree that the laboratory information systems is able to support management tasks (average score = 2.22) or that the laboratory information systems has an integration capability (average score = 2.64). There was also little support from the respondents that the laboratory information systems is able to support and expand into new technology (average score = 3.28).

Table 5.17 Underlying dimensions of laboratory information systems functionality.

Component	Indicators	Communality	Factor loading	Eigen value & variance explained
Management tasks	Roster generation	0.55	0.70	5.89
	Labour cost per test	0.73	0.85	45.32%
	Reagent stock control	0.85	0.90	
	Reagent ordering	0.82	0.87	
	Staff efficiency analysis	0.60	0.70	
	Reagent waste calculation	0.82	0.86	
Expansion and new technologies	LIS expandable in Australia	0.84	0.84	2.52
	LIS expandable internationaly	0.82	0.81	19.40%
	LIS able to support mobile tech	0.72	0.75	
	LIS able to support future devel	0.83	0.84	
Integration	LIS can integrate financial prog	0.680	0.770	1.18
	LIS can supprt graphics	0.740	0.720	9.12%
	LIS has common interface	0.550	0.680	

The screen test (Figure 5.5) for this dimension also suggests a three component solution. All three components have eigenvalues greater than 1.0, and together explain 73.84% of the variance. The communalities range from 0.55 to 0.85, supporting the reliability of the indicators and suggesting that the variance in each original indicator is reasonably explained by the three components taken together.

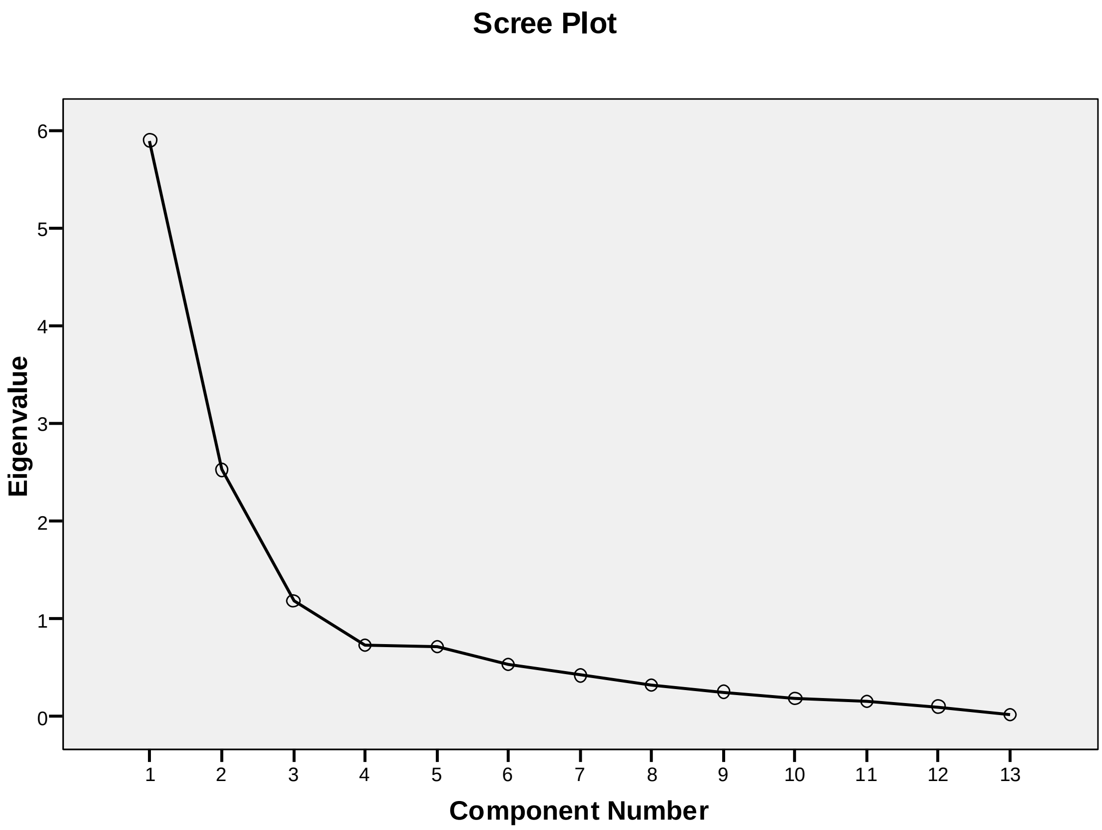

Figure5.5 Scree plot for laboratory information systems functionality.

5.6.5. Research and education.

As Table 5.18 shows, the Barlett test for this dimension is significant at .000 level (Bartlett's test of sphericity = 667.395, p< 0.000), and KMO-MSA overall value was 0.80, indicating that data was suitable for factor analysis. The MSA value was 0.800 which was appropriate as the value exceeds the requirement of the MSA being over 0.6 (Hair *et al.*, 2006). Thus, the factors within the dimension of laboratory information systems functionality in information systems planning could be further examined in deriving factors and assessing the overall fit using the EFA.

Table 5.18 KMO and Bartlett's test for research and education.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.786
Bartlett's Test of Sphericity	Approx. Chi-Square	450.467
	df	45
	Sig.	.000

There were three components (academic development, group membership and laboratory information systems/management research) extracted from ten indicators for the dimension research and education (Table 5.19). The average score from the descriptive statistics for the items in the survey relating to research and education revealed that the respondents had agreement for the most significant component being academic development (eigenvalue 5.06) with an average score of 3.8. Likewise there was also support for the next most significant component, group membership (eigenvalue 1.55). The average score for the component relating to research into laboratory information systems and management (average score = 2.8), however, indicates that, in spite of the respondents acknowledge of potential importance of research and education into laboratory information systems and management, there is little research taking place in these areas.

Table 5.19 Underlying dimensions of research and education

Component	**Indicators**	**Communality**	**Factor loading**	**Eigen value & variance explained**
Academic development	Journals enhance LIS develop	0.83	0.87	5.06
	Journals enhance lab manage	0.76	0.81	50.69%
	Post grad qual enhance LIS	0.81	0.84	
	Post grad qual enhance manage	0.67	0.69	
Group mambership	Lab staff belong manage group	0.82	0.86	1.554
	Lab staff belong LIS group	0.78	0.81	15.54%
	IT staff belong LIS group	0.78	0.77	
LIS/management research	IT staff research LIS	0.68	0.68	1.100
	Lab staff resaerch LIS	0.85	0.86	11.00%
	Lab staff research management	0.70	0.81	

The screen test (Figure 5.6) for this dimension also suggests a three component solution. All three components have eigenvalues greater than 1.0, and together explain 77.23% of the variance. The communalities range from 0.67 to 0.85 suggesting that the variance in each original indicator is reasonably explained by the three components taken together.

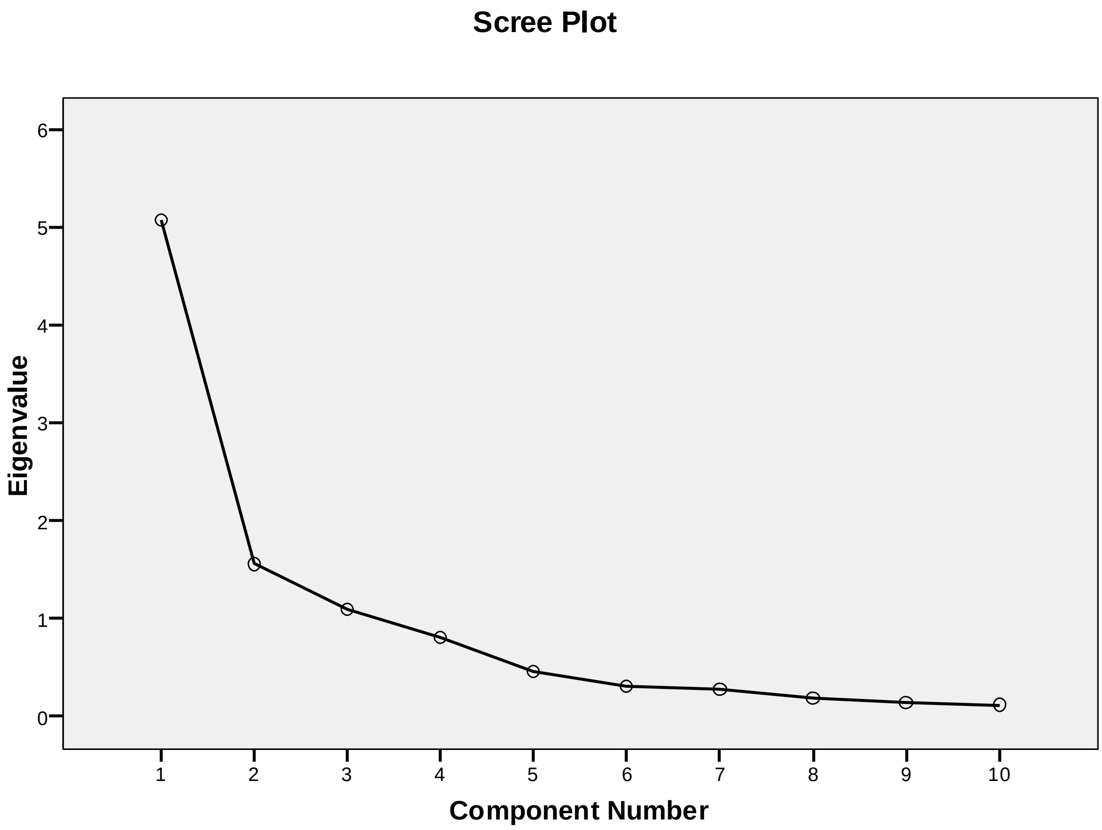

Figure5.6 Scree plot for research and education

5.6.6 Summary of EFA.

Factor analysis is used to uncover the latent structure (dimensions) of a set of variables. It reduces attribute space from a larger number of variables to a smaller number of factors (or components in PCA) and as such is a "non-dependent" procedure (that is, it does not assume a dependent variable is specified Garson, 1998, 2007). Factor analysis is a data reduction technique used to reduce a large number of variables to a smaller set of underlying factors (components) that summarizes the essential information contained in the variables (Coakes, 2005). Factors will henceforth be referred to as components as the EFA method used in this research was Principal Components Analysis.

The EFA in this research successfully identified new components underlying the linear correlation, the component loadings being the correlation coefficients between the variables (rows) and the components (columns) in the correlation matrix (Kline, 2005). The new components for the financial considerations proposal were ‘information format’, ‘valuable information’ and ‘ information for change’. The component extracted for end-user involvement in planning was ‘end-user/IT alignment; for business-IT alignment was ‘IT development planning’; for information system capability ‘management tasks’, ‘expansion and new technologies’ and ‘ integration’. There were three new components extracted for the proposal research and education, those being ‘academic development’, group membership’ and ‘laboratory information systems/management research’. High values for communalities, h^2 along with high component loadings indicates a sound result set on which to progress to pathway relationship analysis. In this research, the technique used for pathway relationship analysis was linear regression. The communality value, together with the component loading, reliably determines the percentage variance explained (Garson, 1998; 2007). The EFA results in this research had high values for communality (h^2) and high component loadings (Table 5.20) and hence were regarded as suitable for multiple regression.

The EFA of the five dimensions has been tested in the first construct validity stage. No cross-loading components were identified; hence the necessity for data removal did not occur (Coakes, 2005). EFA has been used in order to identify whether indicators fit within the constructs. The next stage in the data analysis and model determination was to undertake multiple regression, as dictated by the small sample size (Chapter 4, page 117).

Table 5.20 Summary EFA figures for new components.

New Component	Average Communality	Average Component loading	Eigenvalue and % variance explained
Information format	0.82	0.88	3.81 47.70%
Valuable information	0.84	0.86	1.25 15.60%
Information for change	0.85	0.9	1.66 20.70%
End-user/IT alignment	0.68	0.82	3.4 68.01%
IT development planning	0.67	0.83	3.98 66.38%
Management tasks	0.73	0.81	5.89 45.32%
Expansion & new technologies	0.8	0.81	2.52 19.40%
Integration	0.66	0.72	1.18 9.12%
Academic development	0.77	0.8	5.06 50.69%
Group membership	0.79	0.81	1.55 15.54%
LIS/management research	0.74	0.78	1.1 11.00%

5.7 Multiple regression – first stage.

Multiple linear regression is an extension of bivariate correlation (Kline, 2005). It was assumed that the differences between the obtained and the predicted dependant variable scores are normally distributed, and it is also assumed that the residuals have a linear relationship with the predicted dependent variable scores and that the variance of the residuals is the same for all predicted scores. These assumptions are tested by examination of the residual scatterplots (Coakes, 2005).

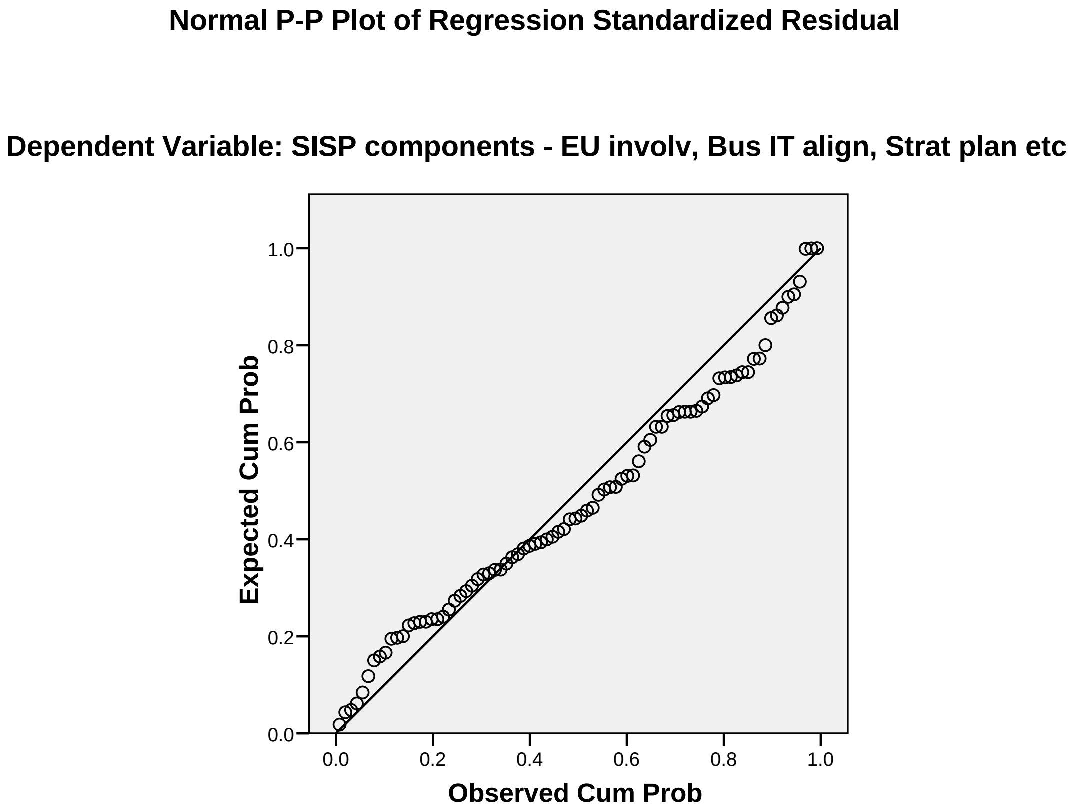

Figure 5.7   Example of regression standardized residual.

Figure 5.7 is an example of the scatterplot of residuals against predicted values. As can be seen from the scatterplot there is no clear relationship between the residuals and the predicted values, consistent with the assumption of linearity (Coakes, 2005).

Figure 5.8 represents a normal plot of regression standardized residuals for the dependent variable and it also indicates a normal distribution.

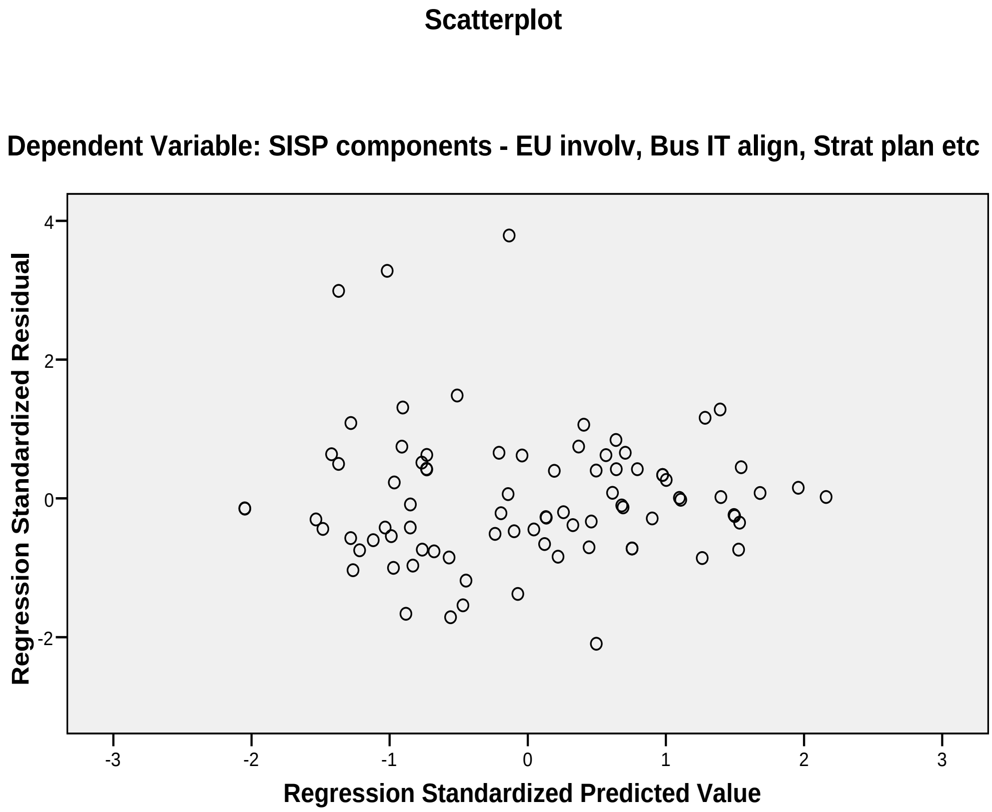

Figure 5.8 Example of a standardized residuals scatterplot.

For standard multiple regression ideally the number of cases should be twenty times the number of predictors and should be at least five times the number of independent variables. The researcher considers that this assumption is met for this study – there are 96 cases for 5 dependent variables and 96 cases for the 11 independent variables.

The multiple regression evaluates the variance explained through the R^2 value and the significance through the F-value from the ANOVA process (Coakes, 2005; Lea, 1997). High values for both values indicate a significant explanation of the majority of the variance. The coefficients of each of the variables indicate the amount of change one could expect in the dependent variable given a one unit change in the value of that predictor and given that all other predictors are held constant. The beta coefficients are used in this analysis to compare the relative strength of the various predictors within the model (Figure 5.6). Because the beta coefficients are all measured in standard deviations, instead of units, they are directly comparable.

The multiple regression procedure also calculates the Mahalanobis distance to assess the presence of multivariate outliers and a significance level of $p < .05$ is also used for this process (Coakes, 2005; Simnis-Knight, 2007). The Mahalanobis distance utilizes group means and variances in each variable, and the correlations and covariance between measures to check for multivariate outliers. The Mahalanobis distance was calculated in all multiple regressions and will only be reported in the following tables if any abnormal cases are found.

The format used in reporting the multiple regression results in this section of this thesis follows the American Psychological Association's guide "Reporting Statistics in APA Style" (Washington, 2001).

5.7.1 . Business-IT alignment

There was only one component extracted for the business-IT alignment, that being 'IT development planning' and consequently there is a single multiple regression result. The dependent variable in this case, business-IT alignment, was defined by the item 'there is alignment between the objectives of the laboratory staff requirements and the IT department staff requirements for the laboratory information system' in the survey instrument. The multiple regression expression for the result is: $F(1,89) = 445.578$, $p < .000$; beta = .913, $p < .000$.

Table 5.21 Multiple regression indices for Business-IT alignment.

Regression indices

Adjusted R squared	**Variance explained**	**F value**	**Sig.**	**Beta value**	**t test**	**Sig**
0.834	83%	445.578	0.000	0.913	21.109	0.000

Assessment of this result shows that the variable, laboratory information systems development planning, explains 83% of the variation, which is significant (F-value of 445.578). Given that the beta weight sign is positive, the relationship between the dependent variable and the predictor is likewise positive and direct, that is, the more laboratory information systems development planning occurs, the more business and IT are aligned in medical pathology in Australia.

5.7.2 Cost-benefit (financial considerations) analysis.

The multiple regression expressions for the three components of cost benefit analysis are as follows - financial info valuable for running the firm; $F(3,87) = 217.931$ $p<.000$, beta –0.092 p =.045, information format is intuitive; $F(3,87) = 217.931$ $p<.000$, beta .068 p = .068 and information contributes to change in firm; $F(3,87) = 217.931$ $p<.000$, beta .934 p = .000. The dependent variable was defined by the item ‘financial considerations are the sole driver for change’ in the survey instrument.

Table 5.22 Multiple regression indices for cost-benefit (financial considerations) analysis.

Regression indices

Adjusted R squared	**Variance explained**	**F value**	**Sig.**	**Beta value**	**t test**	**Sig**
0.883	88%	217.931	0.000	1 = -.092 2 = .068 3 = .934	-2.038 1.514 25.387	0.045 0.134 0.000

The multiple regression shows that the three variables explain 88% of the variance, which is highly significant (F-value of 217.931). Component 3, information underlies change, has the highest beta weight which is positive and direct. Information underlies change therefore is the strongest predictor for the variable financial information. The low beta weight and *p* value of 0.134 for component 2 suggests an insignificant bearing on the dependent variable. Component 1 has a negative beta weight value, meaning that this predictors relationship with the dependent variable is inverse; the *p* value of 0.045 suggests that component is not significant. Components 1 and 2 were therefore not included in the second stage multiple regressions.

5.7.3 End-user involvement in planning.

The multiple regression results for end-user involvement in planning has a formula $F(1,91) = 159.191$ $p <.000$; beta = .798 $p <.000$. The result of this multiple regression shows that the variable end user/IT planning alignment explains 64% of the variation, significance is high as indicated by the F-value of 159.191. The relationship between ‘end user/IT planning alignment’ and the dependent variable ‘end-user involvement’ is positive and direct as indicated by a positive beta weight sign. The dependent variable 'end-user involvement' was defined by the item 'end-users are involved in planning groups' in the survey instrument.

Table 5.23 Multiple regression indices for end-user involvement in planning.

Regression indices

Adjusted R squared	**Variance explained**	**F value**	**Sig.**	**Beta value**	**t test**	**Sig**
0.636	64%	159.191	0.000	0.798	12.617	0.000

5.7.4 Laboratory information systems functionality

The three predictors explain 83% of the variation in the dependent variable, which was defined by the item 'the laboratory information system is expandable for future IT developments' in the survey instrument. The significance as indicated by the F-value is 127.613. Components 2 (expandable and adaptable) and 3 (integration capability) have beta weights that are positive and direct. The beta weight of component 2 (expandable and adaptable) is far greater than other two components meaning that component 2 has the most effect on the variable, laboratory information systems capability. The low beta weight (-.108, *p*.033) for predictor 1 (automatable management tasks) suggests an insignificant impact on the dependent variable, as does the low beta weight of component 3, and therefore these two components were not included in the second stage multiple regressions.

Table 5.24 Multiple regression indices for laboratory IS functionality.

Regression indices

Adjusted R squared	Variance explained	F value	Sig.	Beta value	t test	Sig
0.827	83%	127.613	0.000	1 = -0.108	-2.169	0.033
				2 = 0.882	16.922	0.000
				3 = 0.119	2.279	0.025

The multiple regression results formula for potentially automatable tasks is $F(3,80) = 127.613$ $p<.000$; beta = -.108 $p = .033$; for expansion and adaptability for future is $F(3,80) = 127.613$ $p<.000$; beta = .119 $p = .025$, and for integration capacity with new technology $F(3,80) = 127.613$ $p<.000$; beta = .882 $p< .000$.

5.7.5 Research and education.

The multiple regression of the three components together against the dependent variable, which was defined by the item ‘laboratory staff actively research laboratory information systems’ in the survey instrument, explains 75% of the variation. The F-value is 80.35, indicating the high significance of the results. Components 1 and 3 have positive beta weights and hence a positive and direct relationship with the variable, research and education. Component 2 has a negative beta weight meaning an inverse relationship with the variable. The high beta score of component 3 (.851 p .000) indicates that it has the most impact on the variable and will be included in the second stage multiple regressions. Components 1 and 2 will be excluded from the second stage of regressions on the basis of their insignificance (beta .135 $p = .036$ and beta -.079 $p = .276$ respectively) and hence lack of impact on the variable research and education.

Table 5.25 Multiple regression indices for research and education.

Regression indices

Adjusted R squared	**Variance explained**	**F value**	**Sig.**	**Beta value**	**t test**	**Sig**
0.748	75%	80.350	0.000	1 = 0.135 2 = -0.079 3 = 0.851	2.127 -1.097 12.18	0.036 0.276 0.000

The multiple regression formula for the research and education variable are as follows: new technologies F(3,81) = 80.35 p < .000 beta = .135 p = .036;

knowledge from networking F(3,81) = 80.35 p < .000 beta -.079 p = .276 and research and development to build own laboratory information system F(3,81) = 80.35 p < .000 beta .851 p <.000.

5.8 Multiple regression – second stage.

The principal components from the first stage multiple regression for each variable were then used in the second stage multiple regression against a composite variable representing SISP. The components used were financial considerations sole driver for change, laboratory information systems expandable for future IT developments, laboratory staff and IT staff have aligned objectives for SISP, end-users are involved in planning groups and laboratory staff actively research laboratory information systems. The composite score for the variable for SISP was determined from the following questions in the survey- the laboratory information systems is scalable for expansion in Australia, the laboratory information systems is scalable for expansion internationally, the laboratory information systems is scalable for future IT developments, the laboratory information systems is compatible with the business objectives of the firm, a strategic plan is prepared for the development of the laboratory information systems and end-users are involved in planning groups. These questions were selected as representatives of the components of SISP from the survey instrument in this research and, apart from descriptive statistics to evaluate data entry accuracy, were not included in any other statistical analysis.

5.8.1 Reliability of indicators.

Figure 5.25 shows the reliability and internal consistency for the composite SISP variable. The variable has a Cronbach's alpha of greater than 0.7, which is acceptable for internal consistency across items (Nunnaly, 1978; Hair *et al.*, 2006). The results also demonstrate good reliability.

Table 5.26 Reliability test for indicators for SISP.

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.906	.906	5

Table 5.27 shows the composite results of the second stage multiple regression of the five mediator variables against the composite SISP variable. The adjusted R^2 is a measure of the variance explained, showing that the five propositions together explain ninety percent of the total observation. The high F value also contributes to a significant explanation of the majority of the total variance. The beta values (co-

efficients) are used to indicate and compare the relative strengths of the various predictors within the model. The higher the beta value between variables, the stronger the effect they exert on each other. In Table 5.27, the mediator variable 'laboratory information systems capability' has the highest beta value and hence has the greatest influence on the dependent variable SISP. The *t* value is a measure of the statistical significance of each mediator variable in the multiple regression with the SISP variable, and as with the beta value, the mediator variable 'laboratory information systems capability' has the highest score, meaning it has more significance than the other four mediator variables.

Table 5.27 Multiple regression indices for SISP mediator variables.

Regression indices

Adjusted R squared	Variance explained	F value	Sig.	Beta value	t test	Sig
0.903	90%	141.114	0.000	1 = -0.021	-0.568	0.572
				2 = 0.610	13.578	0.000
				3 = 0.285	5.977	0.000
				4 = 0.227	4.318	0.000
				5 = 0.037	0.998	0.322

The format of regression expressions is suggested by the American Psychological Association, and incorporates the F ratio, the numerator and denominator degrees of freedom [written as F(5,70) for an F value of 141.114] and the significance [written as a *p value*]. The beta weight is also included [written as beta value]. In summary, the regression expressions for the five mediator variables in the research model are:

financial information F(5,70) = 141.114 *p* <.000 beta -.021 *p* =.572;

laboratory IS capability F(5,70) = 141.114 *p* <.000 beta .610 *p* <.000;

end-user involvement F(5,70) = 141.114 *p* <.000 beta .285 *p* <.000;

business-IT alignment $F(5,70) = 141.114$ $p < .000$ beta .227 $p < .000$

research and education $F(5,70) = 141.114$ $p < .000$ beta = .037 $p = .322$.

The three significant mediator variables explain 90% ($R^2 = .903$) of the variation and are highly significant, $F(5,70) = 141.114$, $p < .000$. Laboratory information systems capability (beta = .610, p<.000), end-user involvement (beta = .285, $p < .000$) and business-IT alignment (beta = .227, $p < .000$) demonstrated significant effects on SISP. The beta and *p* values for financial information and research and education are low, indicating that these two mediator variables have no impact on the dimension SISP. A model, derived using the first stage and second stage multiple regression beta weights is presented in Figure 5.9 below.

The key observations from the final multiple regression model are firstly the emergence of the strongest independent variables in the first stage of the multiple regression. This shows which independent variable(s) influences the propositions most and it also shows the marked decrease in all the beta weights in the second stage multiple regression against the dependent variable SISP. The marked decrease in beta weights is most obvious for the mediator variables ‘financial information’ and ‘research and education’. The beta weights for all the mediator variables decreased in the second stage multiple regression, with the beta weight for the mediator variable ‘laboratory information system capability’ remaining dominant in both regression stages. The results and implications of the observations will be discussed in detail in the following section.

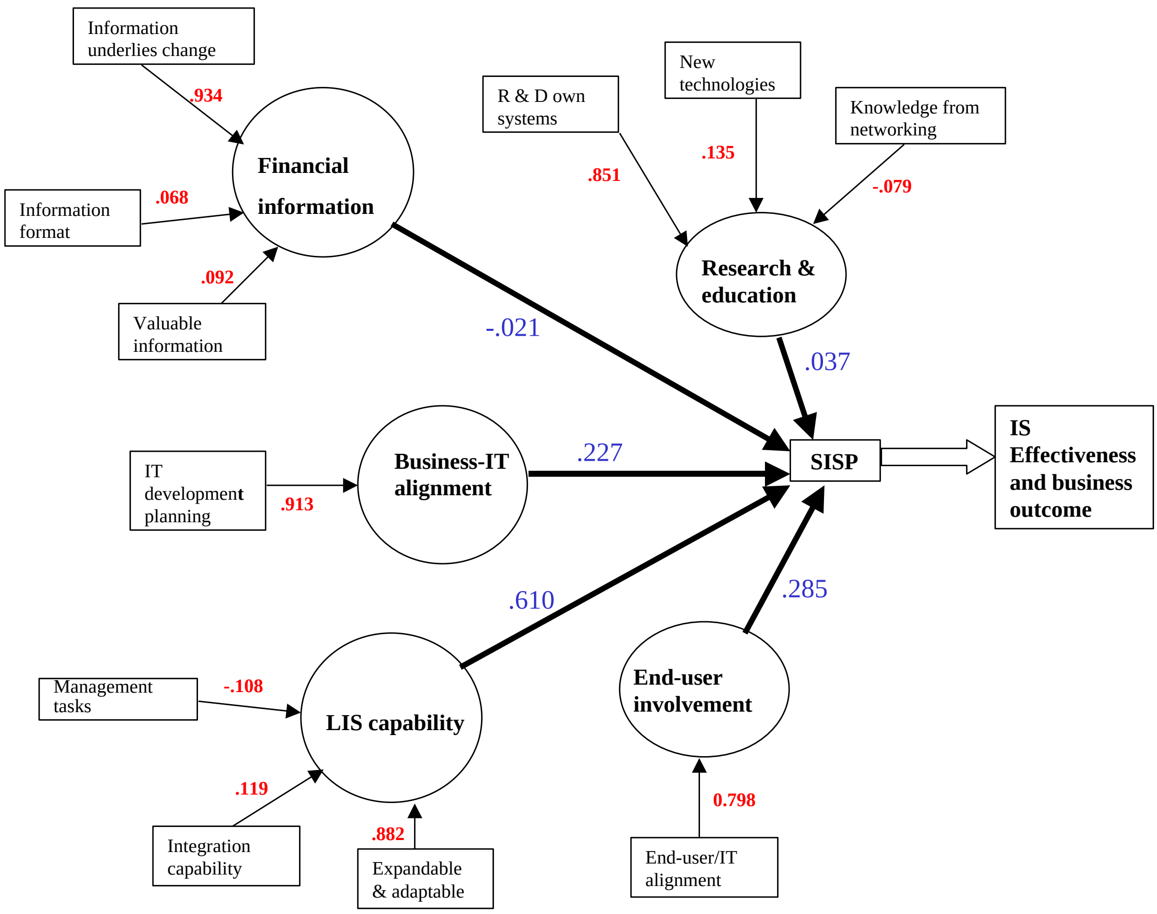

Figure 5.9 Final multiple regression model.

5.9 Summary and findings of data analysis.

This Chapter has presented the results a series of statistical data analysis procedures with the results aimed at providing objective information to enable the researcher to either support or reject the propositions derived from the literature review in Chapters 2 and 3 as reiterated here. Firstly, the research question "*How does the effectiveness of laboratory information systems impact on the business outcomes in medical pathology practice"?* The five propositions derived from the literature and forming the basis of the research instrument (AppendixB) to gather data to assist with answering the research question are –

- Does a lack of functionality of the laboratory information systems impact on laboratory planning?
- Do management decisions based on financial analysis impact on laboratory planning?
- Does a lack of end-user involvement in the laboratory information systems planning process impact on system effectiveness?
- Does a high level of business-IT alignment produce effective laboratory information systems planning?
- Does a lack of laboratory information systems research impact on system planning?

The multiple regression results show that the mediator variable ‘laboratory information system capability’ is the dominant predictor in both multiple regression stages, and consequently has the most influence on SISP. The beta weights for the mediator variables ‘business-IT alignment’ and ‘end-user involvement in planning’, although reduced in the second stage multiple regression, are still significant in their impact on SISP. This research has found that the mediator variables ‘research and education’ and ‘financial considerations’ have no impact on SISP in medical pathology practice.

The results of the second stage multiple regression provided some unexpected findings that will require further investigation before their significance is fully understood and the ramifications can be explored. The major unexpected finding was a reduction in the significance of the independent variable "information underlies change" from the first multiple regression against the mediator variable "financial information" (beta .934 p <.000) to insignificance when regressed against the composite variable SISP (beta -.021

p .572). The independent variable “information underlies change” is the only significant independent variable relating to the mediator variable “financial information”, (Table 5.21) and because of the magnitude of the beta weight (.934) is the sole determinant of “financial information”. These findings suggest that the independent variable “information underlies change” has a strong relationship with the dimension of “financial information”, but is irrelevant to SISP and hence information systems effectiveness. . Hypothesis 1, that decisions based on financial considerations negatively impacts on effective SISP in medical pathology information systems, is rejected on the basis of the data analysis (beta = -0.021, p = 0.572, t = -0.568).

The literature review identifies a reluctance for industry to spend on information systems projects, citing large cost overruns, arbitrary estimates of system life, risk and inflation from an information systems plan that is rarely integrated with business plans, and from which user benefit is frequently intangible (Lincoln, 1986). Irani and Love (2001) point out that many managers in business consider that IT/ information systems evaluation takes too long, costs a significant amount of money with little visible return and involves too many people with departmental or individual political agendas. The difficulties in measuring the benefits of IT/ information systems investment are therefore considerable. This is perhaps even more so in the field of health informatics where the traditions of medicine meet and mingle with the information systems field (Klecun and Cornford, 2005). The results of this research have shown that there is a connection between financial information and change, but that financial considerations have no impact on SISP in medical pathology practice - Is it that the pathology does not want to entertain spending on laboratory information systems development because of difficulties in the evaluation of potential benefits, or does the lack of a cohesive approach to SISP have an impact on strategic spending for the development of laboratory information systems?

Another possible extenuating circumstance pertaining to the strategic development of medical pathology and laboratory information systems in Australia is the small number of large players in the private pathology market (three large players only in Australia) and the possibility that there is a monopoly in the industry. The possible ramifications of this will be explored through the three focus groups to ascertain the likelihood of a monopoly view affecting the role of strategic development in medical pathology practice. The context of a monopoly view is that of the monopoly producing an equal playing field where change may be viewed as unnecessary, given a healthy balance sheet for all three players in private pathology in Australia. The reason(s) for this finding is unclear, and will be further explored in the three focus groups.

The variables 'business-IT alignment, end-user involvement in planning' and 'laboratory information systems capability' were shown by the data analysis to be significant influencing variables for SISP in medical pathology practice. The three hypotheses pertaining to each variable (lack of functionality of current laboratory information systems negatively impacts on SISP in medical pathology information systems, lack of involvement of end-users in SISP negatively impacts on information systems effectiveness, and the greater the degree of business-IT alignment the more effective SISP is in medical pathology information systems) were accepted (Table 5.27, p.193).

A similar pattern of a marked decrease of beta weights has evolved between regressions. For the mediator variable “business-IT alignment” there was only one independent variable (IT development planning) and the beta values between regressions fell from .913 to .227, p remaining unchanged at <.000. Likewise for the mediator variable “end-user involvement – there was only one independent variable (end-user/IT alignment) and the beta values fell from .798 to .285, $p<.000$. The mediator variable “laboratory information systems capability” had three independent variables (expandable and adaptable, integration capability, and management tasks) with the independent variable “expandable and adaptable” being the dominant independent variable (beta = .882, $p<.000$). The independent variables “integration capability” and “ management tasks” were regarded as insignificant because of their low beta weights and comparatively high p values (Table 5.27). Clearly then, from the two stage regression results, the dominating mediator variable is “laboratory information systems capability”, and this mediator variable has the most impact on SISP. This is illustrated in the final regression model in Figure 5.9 (p.193).

Table 5.27 Hypothesis assessment table.

Hypothesis assessment table - second stage regression
F= 141.144 p <.000, R^2= 0.91.

Hypothesis	beta weight	p level	t-value	Outcome
Cost benefit analysis negatively impacts on effective SISP	-0.021	0.572	-0.568	Rejected
Lack of functionality of current LIS negatively impacts SISP effectiveness.	0.61	0.000	13.578	Accepted
Lack of involvement of end-users negatively impacts on IS effectiveness	0.285	0.000	5.977	Accepted
The greater the degree of business-IT alignment the more effective SISP is	0.227	0.000	4.318	Accepted
Lack of LIS research negatively impacts on SISP effectiveness	0.037	0.332	0.998	Rejected

The role of business-IT alignment and end-user involvement in SISP is well documented in the literature (Hackney *et.al.*, 1999; Rondeau *et.al.*, 2006; Gation, 1994; Chan and Reich, 2007). The results from the first stage and second stage regressions have shown a decrease in beta weights when all three components (including laboratory information systems capability) were regressed against the composite variable SISP – which is unexpected because of the important role these components play in the processes of SISP. The fact that the laboratory information systems capability is the dominant predictor variable in the second stage regression against SISP provides the basis for new thought and investigation as this predictor variable has not been investigated in this context before. This finding could be significant, given that the descriptive statistics reported earlier in this Chapter, suggest that most end-users disagree that the laboratory information systems has capability for future national and international expansion and the provision of real time management data. Real time management data is currently unavailable to laboratories in Australia, as shown by the results of the survey instrument, and this could be a major contra to medical pathology laboratory's ability to re-engineer their business practices to improve efficiencies and effectiveness, flexibility and the bottom line for investors.

The data analysis in this research suggest that business-IT alignment and end-user involvement are part of the process for laboratory information systems planning in pathology in Australia, but to what extent and with what input remains unclear. To investigate these unexpected findings further and to determine their impact on an answer to the research question, three focus groups will be undertaken.

Focus group 1 and 2 (Chapter 4, p.7) will involve laboratory end-users and the aim of this focus group will be to elicit a practitioner's perspective on the findings of the data analysis with particular reference to the anomalies seen in financial considerations and laboratory IS capability in the regressions. A report and analysis of focus group 1 and 2 will follow in Chapter 6.

Focus group three will involve academics working with, teaching or researching SISP and its principles. The aim of this focus group is to consolidate the findings of the data analysis, and to add an academic view of the components of SISP as determined by the quantitative analysis, as to their relevance and functionality. The final regression model (Figure 5.7) will be analyzed with a view of interpreting the model in terms of the anomalies found in the regressions and to ascertain any nuances that may be peculiar to the pathology industry in Australia. A report and analysis of focus group three will follow in Chapter 7. The research question and the hypotheses will then be re-assessed.

CHAPTER 6 – FOCUS GROUPS 1 AND 2 – THE LABORATORY.

6.1 Introduction.

This Chapter outlines the first qualitative component of this research. It involves two focus groups (FG1 and FG2) conducted within the medical pathology industry. The aim of the focus groups is to evaluate the initial findings from the data analysis of the survey and assess their impact on the research question "*How does the effectiveness of laboratory information systems impact on business outcomes in medical pathology practice?"* A third qualitative component follows in Chapter 7; it involves a third focus group (FG3). Its aim is to discuss secondary findings from the quantitative data analysis and outcomes from FG 1 and FG2 in a more theoretical sense. The outcomes of FG3 are then applied to the research question to elicit an overall picture of the research domain and its proposed implications for SISP in general, and pathology laboratories in particular. These outcomes are detailed in Chapter 8: Research findings – discussion and conclusions.

Since assessment of the research propositions cannot be based solely on facts as it involves *values* such as SISP success, a means to consider the subjective feelings of participants was undertaken by way of focus group research. The focus group were expected to provide information that the quantitative analysis was unable to, (reflected in the percentage variance explained being < 100%), by elucidation, analysis and understanding of respondent's feelings. "By the term qualitative research we mean any type of research that produces findings not arrived at by statistical procedures or other means of quantification" Strauss and Corbin (1998, p. 11). Morse (1991, p.120) claims that qualitative research is appropriate if "(a) the concept is "immature" due to a conspicuous lack of theory and previous research; (b) a notion that the available theory may be inaccurate, inappropriate, incorrect or biased; (c) a need exists to explore and describe the phenomenon and to develop theory; or (d) the nature of the phenomenon may not be suited to quantitative measure." A focus group would elucidate people's feelings about newly developed theories and variables from a quantitative analysis. This was covered in detail in Chapter 4, p 105.

The FG1 and FG2 questions were framed around the five propositions derived from the literature review that were supported or not supported in context by the findings of the quantitative analysis of the data from the research instrument. The five propositions are that lack of functionality of current laboratory information systems negatively impacts SISP effectiveness; cost-benefit (financial considerations) negatively impacts on effective SISP; lack of involvement of end-users in SISP negatively impacts on information systems effectiveness; the greater the degree of business-IT alignment the more effective SISP is and lack of laboratory information systems research negatively impacts on SISP effectiveness in medical laboratories. Information from the participants of FG1 and FG2 was sought to expand on, and to seek explanation for the findings of the survey analysis, namely that financial considerations has no impact on SISP; that laboratory information systems functionality is the dominant proposition over business-IT alignment; and end-user involvement in SISP in pathology practice. The ramifications of laboratory information systems functionality being dominant in influencing SISP were particularly sought out as laboratory information systems functionality could be the major hindrance to SISP and hence information systems effectiveness in pathology practice. These propositions would be the basis for the original theories derived from this research and pertaining to SISP and information systems effectiveness in medical pathology. FG1 and FG2 served to triangulate the findings of the quantitative analysis back into the general literature, thus validating the application of quantitative analysis to this project, and by laying the groundwork for future research to explore the theories evolved from this research. FG1 and FG2 would also validate the research instrument questions themselves used in the quantitative component.

As stated in Chapter 4, four laboratories were approached regarding conducting the focus group at their respective laboratories. Two declined to participate citing reasons of restricted time and staff shortages. The usual practice within research is to conduct focus groups and to have the participants off site from their working environment to eliminate distractions. In sympathy for the workload and staff constraints, the researcher decided there would be more chance of participation by laboratory staff under these circumstances if the focus group were conducted at the prospective participants' laboratories. The offer of a supplied lunch was made to help entice participation and to provide a more relaxed atmosphere in which to conduct the focus group. This occurred with FG1. FG2 was conducted after hours and off site at the request of the participants to allow for an uninterrupted discussion session.

6.2 Focus group 1 – the hospital laboratory.

The focus group was conducted at a major public hospital laboratory. The focus group was conducted in the middle of the day, in a private room where the participants would not be disturbed or the focus group interrupted, and was attended by five participants.

Table 6.1 Focus group 1 participant details.

Participant	Description and qualifications
Participant 11	Principal scientist in microbiology and involved in middle management - *B.App.Sc*
Participant 12	Supervisor scientist in biochemistry - *B.App.Sc, PhD*
Participant 13	Supervisor scientist in biochemistry - *B.App.Sc.*
Participant 14	Supervisor scientist in haematology - *B.App.SC.*
Participant 15	Senior scientist in haematology - *B.App.Sc.*

The researcher made sure, when negotiating with the laboratory manager, that the participants of the focus group were not the same staff who had completed the survey. This would then ensure that the focus group responses were spontaneous and unbiased.

The role played by the researcher during the focus group discussion was one of observer. Additional notes to the focus group questions and responses were made by the researcher to promote further discussion and to help with the interpretation of the discussions and passed onto the facilitator to gain further understanding from the participants. The focus group was conducted by the researcher's senior supervisor, who acted as facilitator, and was assisted by the researcher's second supervisor. The focus group was recorded on two digital recording devices, one being a back up in case of a recorder failure. Before the commencement of the focus group, each participant was asked to complete an RMIT human research ethics form, which detailed that the project had ethics committee approval, and that the project was to be recorded and that the material could/would be published in this thesis and other academic journals and articles. The RMIT Human Ethics research form also explained that each participant was free to withdraw from the focus group at any time, should they wish to do so. It was stressed to the participants by the facilitator that anonymity and confidentiality were assured.

In the introduction to the FG1 participants, it was explained that the benefit of conducting a focus group was in investigating the relevance of the survey to the participants as laboratory practitioners. Surveys are answered not necessarily in the way we think because of the limited number of alternatives presented in the survey. The focus group can help investigate other possible alternatives to those presented in the survey. FG1 proceeded well with all participants actively contributing to the discussion. There was little prompting required by the moderator as the discussion, once a topic was determined, flowed freely.

The main issues to emerge from the first focus group discussion were –

1. there is a very low priority for funding for pathology, in particular for laboratory information systems development;
2. pathology is held in poor regard by many other services in the hospital, especially the hospital management and some specialist departments;
3. there is no involvement of laboratory staff in development planning within the laboratory – especially with respect to the State Government's Healthsmart project;
4. there is no research and formal education provided for laboratory information systems development, laboratory informatics and laboratory management; and
5. there is no co-operation between scientists, IT staff and hospital management in the development of laboratory services, which depend on the laboratory information systems.

Each of these issues is discussed in detail below.

6.3 Low priority of laboratory information systems.

6.3.1 Management considerations

The participants reported that there is very little consideration given by the hospital management as to the needs/wants of pathology and therefore their allocation of funds is minimal. The pathology department holds a low priority level in the eyes of hospital management, and other ancillary hospital/medical services. This situation then leaves the laboratory short of staff and with no funds for basic development of the laboratory information systems. The efficiency of the pathology department is therefore further compromised, as the department is unable to update equipment, principally the laboratory information systems, that would enable more efficient and cost-effective workflow processes. This was illustrated by Participant 13 who commented – “*we would love to have a paperless laboratory, and be able to get more management information but the current system cannot accommodate these functions”.*

The lack of cohesion between hospital management and the pathology department is further illustrated with respect to discussion by the respondents about the hospital steering committee concerned with the Healthsmart [3] system (a generic hospital whole of hospital information systems and initiated by the state government), and further highlighted the laboratory’s plight with comments suggesting that the hospital would embrace this system without any consultation with laboratory staff. Laboratory staff feelings were negative to this as the staff has no idea what the system does and how it would impact pathology, Participant 11 stating – “*we have been told we are getting Healthsmart; we don’t know what it does, we will just have to use it”.* The laboratory staff had not been involved in much discussion with the Healthsmart steering committee. This was an issue of laboratory staff as end-users (as a component of successful SISP), considering that they have no input into the planning process.

6.3.2 Financial considerations

The participants in FG1 noted that lack of finance is the sole factor limiting the development of the laboratory, which requires a capable laboratory information system. Participant 11 commented - “*because they could get away with basic equipment if they can and turn around times are not seen as a high priority, pathology has a low priority.*

[3] Healthsmart is the Victorian Governments whole-of-health information and communications strategy for the public health sector. Healthsmart aims to improve patient care and reduce the administrative burden and associated costs by adopting a more standardised approach to information systems.

There is a shortage of money in the whole network – a freeze on staff. There have been no new ideas for the last 4 years."

The inability of the pathology department to improve the efficiency of the laboratory information systems is due principally to financial constraints that have led to a situation promoting over-ordering of tests. The participants also noted that some doctors, having not received the results on patients ordered the previous day, simply order the test again. This results in senior pathology staff members having to cross check daily requests from hospital doctors to eliminate double ordering of tests. This issue was illustrated by Participant 12 - *"this can take one hour, it can take two hours of your day as a senior person. The computer should be able to do this."* The problem then results in a cost escalation at the hospital that is two fold –

- Multiple duplicate test ordering, and
- Senior staff time cross checking test requests.

The participants agreed that the allocation of funds for the public sector is a different process than that for private pathology and has different pressures/considerations for outcomes. Participant 11 elaborated – "*The amount of funding varies with which political party is in power at the time. Private pathology gets money from income and investment"*. The identity and hence priority held by pathology is also a consideration when the hospital was allocating funds. The participants believe that the image of pathology and scientists is poor and as a result, pathology has a low priority in the hierarchy of the hospital; for example, Participant 13 noted – *"I don't think there has ever been a high priority for pathology work in any public hospital over the years. It is not seen as a high incentive or priority for them to do anything. I have worked in a few* *public hospitals and it is always the same – pathology is always on the lower end of the scale with money and equipment – never seems a high priority."*

Participant 12 also remarked that – "*this image of low priority has meant little consideration is given to pathology when considering who gets what out of the overall hospital budget*". The participants agreed that this scenario has been compounded in the past by a hospital CEO who was also insensitive to pathology department's needs. The fact that the clinical importance of pathology in the hospital is out of balance with the priority for provision of funding required to enable the turn-around times that would be commensurate with in-house critical medical situations was agreed by all participants. There is an enigma here – the laboratory has little priority for funding as it is not regarded as being an important or significant part of the medical/diagnostic team, and so is neglected financially - and yet its services are frequently required in a mission critical scenario to provide test results for critically ill patients.

6.3 Lack of capability of laboratory information systems.

6.3.1 Communications – impact on in-house and peripheral business.

The participants agreed that there is a lack of capability in the laboratory information system at the hospital. The laboratory information system's lack of capability, they said, to facilitate commonly used communications technology, such as e-mail and broadband, is a severe strategic restriction as their laboratory is unable to compete in the market for local general practice referrals. Participant 13 stated the results of this situation – *"we have lost GP work simply because the laboratory information system cannot e-mail results"*. The participants stressed that the lack of communications ability of the laboratory information systems also creates a significant and potentially compromising situation for in-patients in the hospitals critical wards (Intensive Care Unit, Cardiac Care Unit). The participants gave an example where the laboratory receives specimens from patients in these critical wards and can perform the tests requested and have the results available before the patient's details can be entered on the laboratory information system. The current laboratory information system, the participants noted, does not allow for patient details to be entered in the ward. Participant 12 alluded to an impact of this shortcoming - " *the doctors are on the wards all day – being able to do electronic requests would help in the laboratory – something we are looking at and the State is looking at with Healthsmart."* The outcome of this scenario, the participants said, is that the results therefore cannot be entered on the laboratory information systems and delivered to the ward. Participant 12 continued – "*This creates an unacceptable time delay for patients as there are complaints about this from the doctors and specialists in these wards. This delay may potentially compromise the patient"*. The use of wireless technology has been trialled in some emergency departments in Melbourne and the idea to import this technology had been raised within the laboratory and, according to the participants, was impossible to pursue due to lack of capability and adaptability of the laboratory information systems. As has been noted by the participants, this situation would be difficult to change due to financial constraints on hardware purchases and the required software changes.

6.3.2 IT support

The IT support to the pathology laboratory was acknowledged by the participants as consisting of two IT staff members, who assist scientific staff with basic computer maintenance but who cannot assist with any software development. Participant 13 described the situation by stating - *"IT is run by 2 people – that is grossly under resourced – they do PCs, cabling, software and look after the hardware – they do the whole works, and they know nothing about pathology."* The Pathology Department is under resourced, the participants noted, with respect to simple hardware requirements such as replacement hard-drives and screens in the event of their failure – further evidence of poor funding.

A lack of disaster recovery/redundancy in the current laboratory information system was also highlighted by the participants, not only in the context of laboratory information system lack of capability, but also in the context of more operational and basic functional issues, such as redundancy planning, back-ups and programmed obsolescence of hardware.

The participants agreed that as a consequence of the lack of IT support by staff who are knowledgeable of the laboratory information systems functionality, senior staff are at times involved in simple changes to the system such as test set layout. When this occurs it puts a strain on the other staff to cover the seniors in their absence. This negatively impacts the laboratory's turn around time. Participant 11 added – "*There are no meetings between laboratory staff and IT staff to co-ordinate any laboratory information system changes and enhancements, or functional management changes - Melbourne Medical Centre pathology has never had a computer group to look after the laboratory information system or anything like that – like meetings on what we want to do and what we would like to have on the system – it is all ad-hoc really."*

6.3.3 Laboratory management tasks

The participants pointed out that the scientists are unable to perform simple management analysis processes like workflow analysis, design of workflow systems and simple budget analysis. They noted that senior scientists have little access to any financial figures, and it takes a considerable time to find/ extract any financial data from the laboratory information system. The main thrust of “management” data provided by several laboratory information systems refers to patient numbers referred by each doctor and the number of different test performed each day, the participants acknowledged. Participant 14 remarked – “*we can get patient number data but it is always weeks in the past – it takes so long to get any information from our system”.*

The participants agreed that the ability of the laboratory to perform tasks, or provide information for the performance of tasks such as workstation analysis, workflow analysis and associated roster building and costing, benchmarking and reagent tracking in real time is non existent.

6.3.4 Paperless laboratory.

The participants raised the issue of a “paperless” laboratory as another example of how workflow and time are compromised by lack of capability and lack of changeability of the laboratory information system. Discussion with respect to an example ensued - the haematology analyser (an instrument that tests blood to provide data to help provide diagnoses) produces numerical and graphical data (22 parameters) on each patient sample analysed. The laboratory handles approximately 1,300 patients per day. The number of individual test results, as opposed to test set results (A full blood examination [FBE] = 1 test set and has 22 individual test results) for the department of haematology alone would be 1,300 x 22 = 28,600 individual results. These results are passed from the analyser to the laboratory information system to report stations in strings of the 22 result characters plus a unique patient identifying number and an episode number. The total number of characters for each patient having an FBE may be as high as 38. Time is lost in the finding, matching and stapling of request forms and data print outs. The participants pointed out that this also increases the risk of transcription errors, and has cost components for labour, paper and staples. The participants noted that most, if not all, haematology analysers today have a powerful PC to control the analyser – it would be possible to network these together through the mainframe, they suggested, to provide a paperless laboratory. Participant 14 elaborated – "*in haematology at the moment, we still actually staple the request to the analyser print out and look at every one of those FBEs and validate it. There are no validation rules in the computer – we have got rules in our heads.*"

The participants noted that validation rules could be used from the abnormal flags the analyser produces, thus providing the paperless laboratory which all participants agreed would be a major development in laboratory efficiency. As the participants had mentioned earlier, any development effort to accomplish this is not possible due to the geographical barrier having the software writer in Bangkok, (see p.219 for fuller detail) the laboratory information system's lack of capability and hospital cost constraints.

Examples of other technical problems with the laboratory information system were given by the participants, a significant one being that when individual test results from other departments are added to a patient file (the most common scenario is for multiple test sets to be ordered) then the amount of data packets that the laboratory information system has to deal with is quite considerable. Participant 13 made the point that "*when there is a lot of data going through the system, it just about stops. The file sharing mainframe has a real problem with lots of data".* The laboratory information system cannot accept the graphical information, they said, which is important for the scientist in interpreting haematology results, and so it has to be printed and attached to the doctor's request form. The participants noted that the doctor's request form is able to be digitally scanned into the laboratory information system but they pointed out that integration between the scanning software and the laboratory information system is sub-optimal involving several key strokes to change from one screen to another (it is not possible to visualise the image and the results at the same time on the system).

6.3.5 Laboratory information systems research.

The comments made by participants and the mood of FG1 portrayed a lack of co-operation and synergy between the management and the laboratory staff. The participants noted that there appears to be no cooperative group for providing direction in technological and service development in laboratory capability and strategy. It should be noted, despite the participants addressing issues surrounding the enhancement their competitive position in the local pathology market, did they use the terms "strategy, business development, business-IT alignment and laboratory information system effectiveness". The participants noted that the main thrust of research in laboratory information systems centred on auto-validation of results and middleware[4]. Without middleware, they went on to explain, laboratories would not be

[4] Middleware is intermediate software between a more technically advanced analyser and the current "old" generation of laboratory information systems that enables the analyser and the laboratory information system to integrate, (Friedman, 2005).

able to use modern analysers and have them interfaced to the laboratory information system.

Middleware is a growing field of IT development, the participants added, presumably because laboratory scientists and IT staff consider the prospect of developing an laboratory information system that embraces “new” IT technology too difficult – particularly in terms of implementation in place of the existing laboratory information system, and too costly. The participants pointed out that there is, however, no customisation in middleware design - the middleware dictates how the laboratory must use it. As Participant 12 noted – “*the two main topics of investigation in medical scientist journals are auto-validation and middleware. Autovalidation is software that is specifically written to automatically validate test results, and it must consider matters such as multiple diseases, multiple drug regimes and their possible interactions, and multi-department test results*”. The hospital laboratory information system cannot integrate fully with the middleware, the participants added, and this compromises the middleware installation and functionality, as Participant 12 explained – “*middleware is a compromise anyway because it comes as a standard package and never suit individual requirements. Even with middleware the laboratory still has its work practices dictated by the software.”*

6.4 Hurdles to hospital laboratory information systems development.

6.4.1 Software development.

The participants in FG1 noted that the lack of capability of the laboratory information system at the hospital is significantly further complicated by there being only one person who can develop and change the software and "*he lives in Bangkok*". Participant 11 gave some background to the situation - "*it was written by this programmer guy – he was the team leader who wrote it. Gradually all the other users have stopped using it – he has taken the licence now.*" A lack of awareness and understanding of the SISP planning process by scientists, IT staff and management in this hospital is also a very considerable barrier to any attempts to develop the laboratory information system with a cohesive, planned and integrated method. The measurement of information system effectiveness is therefore also compromised in the hospital.

6.4.2 Vendor laboratory information systems

It was noted by the participants that the prospect of working with the vendors to modify and customise a system for their laboratory was not attractive because it was expensive and very time consuming in terms of trying to get the vendors to make the changes. Participant 15 detailed some of his experiences with vendor software – "*the commercial systems are off the shelf software and do not exactly meet the demands of the laboratory. The use of this off the shelf software meant that the laboratory has to work around the software; that the vendor software does not fit the workflow processes of the laboratory thereby limiting the laboratory's functionality".* Vendors often do not keep adequate records, the participants also noted, of which laboratory information system contains customized changes. The ramifications of this are that vendors would therefore not necessarily be familiar with any particular system. The alternative of building an in-house system was, to the participants, equally unattractive due to time and financial constraints. Again, it would seem from the participants' comments, that there is little or no chance that this laboratory could obtain a laboratory information system that entirely suits their needs – this fact is severely compromising the effectiveness of this hospital laboratory in providing adequate services to inpatients and outpatients alike, the participants added. It can be seen from analysis of the discussion in FG1 thus far that the hospital environment places the laboratory under pressure to perform from two perspectives –

1. A fast turn-around capability that must be viewed as "mission critical" for desperately ill patients in emergency, ICU and CCU.
2. The facility to compete in the market locally to attract referrals from local general practitioners; this facility must provide integration with the general practitioners wants with respect to turn-around time, report format and report medium.

6.4.3 Workflow analysis as a development tool.

With respect to "management" information and its application to the laboratory information system developmental process, the participants noted that the senior staff receive only quarterly cost centre and laboratory financial reports. The participants believe that it is complicated to retrieve any financial data from the laboratory information system. They went on to add that there is virtually no management data, such as test numbers per day, readily available with their current laboratory information systems; Participant 14 stating – "*with the current laboratory information systems, if people ask if the workload has increased or decreased, I would not have a clue – I can't get any stats.*" The fact that this seriously compromises attempts at management/business planning by laboratory senior staff was made abundantly clear by the participants, Participant 14 adding – "*how can we plan when we don't have real time test numbers to plot and compare with last year so we can calculate growth"?*

They went on to illustrate the situation by example – if the laboratory information system is unable to supply data relating to workflow analysis and hence staff requirements/time (rosters), goal setting (meeting performance targets as an adjunct to rapid turn around times), reagent tracking and supply chain management, best practice and benchmarking are not achievable.

6.5 Laboratory information systems wish list

There was consensus amongst the participants that with enough people and money, they could make their existing systems satisfactorily functional. In the view of the participants, people and money resources would be better applied to building a totally new system that would allow the scientists to re-engineer the whole laboratory and review and improve every facet of its operation. The participants' arguments against a vendor supplied system was based on their view that a vendor system lacks customisation, and the implementation time and expense in achieving such changes are excessive. These customisation changes would be necessary to tailor the system to the work practices of the laboratory, the participants stressed. In the opinion of the participants, a web-based laboratory information system was thought not to be beneficial and was thought to have doubtful advantage over the infrastructure of the system presently in-situ. This was an interesting attitude given the lack of education and research into information systems and business/management development; the lack of such knowledge as strategic information systems planning (SISP) and information system effectiveness measurement. It is also interesting given the discussion on technology such as wireless portables that was supported by the participants earlier in FG1.

6.5.1 Summary

The key findings of FG1 which focused on pathology practice in a public hospital were:

1. The pathology department is regarded within the hospital structure with low priority, and therefore does not attract funds for laboratory development, which includes development of the laboratory information system. Political reasons contribute to the low priority with which pathology is regarded, both internal hospital politics (i.e. the CEO's view of pathology in the hierarchy) and federal politics (i.e. the incumbent political party's policy on health spending).
2. End-users, from department heads to junior scientists, are not involved in planning processes.
3. There is a task-technology gap that has had a negative impact on business outcomes for the hospital laboratory.
4. There is no IT department support for basic routine processes such as back-ups, and disaster/redundancy planning. There is no IT department support for laboratory information system development.
5. There is no management data available to assist with the management and potential planning of the pathology department.
6. There are no special interest groups or forums for laboratory management or laboratory information systems.

In the next section, a focus group conducted in a private pathology context is described and analysed.

6.6 Focus group 2 – the private pathology laboratory.

Focus group 2 was held after hours and off site from the participants' workplaces at the request of the participants so that the meeting could be conducted without interruption. All four participants have at least twenty years experience in private pathology laboratories and all participants have worked in more than one private pathology laboratory. The details of the participants' qualifications and current positions are detailed in the table below.

Table 6.2 Focus group 2 participants' details.

Participant	Description and qualifications
Participant 21	Principal scientist in biochemistry and involved in middle management - *B.App.Sc*
Participant 22	Peripheral branch laboratory manager - *B.App.Sc.*
Participant 23	Senior general scientist - *B.App.Sc.*
Participant 24	Principal scientist in haematology - *B.App.SC.*

The participants were selected for their length of experience in private pathology in Melbourne, which for all participants, involved working at more than one practice. This gave the researcher access to the participants' views on several laboratory information systems. The researcher ensured that none of the participants had participated in the survey (Chapter 5). As with FG1, each participant was asked to sign a consent to participate form, in keeping with the protocols set down by the RMIT University Ethics Committee. The participants were informed that the focus group was being recorded and that the material would be used in this thesis and for possible academic publications. The participants were also informed that they were able to withdraw from the discussion at any time if they wished to do so. The researcher introduced the focus group with a short dissertation on the benefits of conducting a focus group (see p.3 Chapter 6), and the background to the research.

The focus group proceeded readily with active discussion from all participants. The main issues to emerge from the discussion of FG2 were similar to those main points that came from FG1. The main points from FG2, the private pathology laboratory were

1. co-operation between scientists, upper management and IT staff is virtually non-existent for the development of the laboratory information system;
2. funding for laboratory development is based on minimal cost expenditure, and does not involve the laboratory information system;
3. there is no laboratory informatics or laboratory management courses available;
4. conferences and the few papers that are published in medical science journals are concerned with middleware and not overt redevelopment of laboratory information system; and
5. the laboratory information system is not regarded as an important part of the laboratory business by the upper management in private pathology.

Each of these issues is discussed in detail below.

6.6.1 Management considerations

The participants of FG2 agreed that the relationship between scientists and management with respect to laboratory information system planning is functionally non-existent. Management relates to the IT department staff, the participants noted, and works to develop additional functionality in the laboratory information system, but this functionality is directed towards report delivery and the accounts department. The participants pointed out that there is a void between management, scientists and the IT staff with respect to development – as Participant 22 noted "*management makes decisions without any consultation with us".* The result of this has been seen by all four participants within the laboratories in which they have worked, Participant 23 commenting "*I remember several occasions where the IT guy would let us know about a change they had made – we had no formal training with the change (or the whole system for that matter) and we were expected to use it".* Participant 21 added – "*often the change did not help us, some were a disadvantage. I remember in one laboratory where they told us we had to use a bar code scanner to get up a patient's file, but it would not read the bar code labels they had printed. When I said buy some proper labels, the reply was we were told by management to try and print them, as it is cheaper. The end result was we could not use the bar code reader".*

Scientists' ideas and their input into the development of the laboratory information system, in the experience of the participants, has not been in the past and is currently not welcomed by management or the IT staff. The participants added that scientists in general therefore feel that in the current climate of non-cooperation that it is futile to try and become involved in any development of the laboratory information system. The participants expressed a view that the laboratory information system was not regarded by staff generally as having any importance, other than to generate results. As Participant 24 said – “*everyone thinks that it is there to send out reports. We can’t do much else with the system and because of years of frustration, we don’t try now”.*

6.6.2 Financial considerations

The participants noted that laboratory spending in private pathology laboratories in Melbourne concentrates on the purchase of analysers for which the best reagent deals can be struck. This situation further illustrates the lack of acknowledgement that scientists receive from management, the participants added, and it may ultimately compromise cost effectiveness for the practice. Participant 24 gave an example of this – *“for years we had used brand A for our haematology analyser. The laboratory manager, as instructed by the CEO of the practice, informed me that we were to change to brand B, which I knew from my colleagues who were using it, had technical inadequacies. I had a meeting with the CEO to inform him of the problems we would have if he went ahead with brand B. He stated that he had signed a contract because the reagents were cheaper, and that was the sole driver for his decision, and that his decision was final. Within two years we had changed back to brand A because the inadequacies of brand B were costing us so much in checking results”.*

The researcher raised the question of why this attitude to spending within private practice exists. The management and IT staff do not have an informed view of the benefits of a properly integrated analyser – IT relationship, and the efficiency of the laboratory is suffering as a result. Participant 21 raised an interesting perspective that may explain many negative attitudes towards the laboratory information system by suggesting – “*we are talking around the system as if nobody wants to know about it, as* *if it isn't there – like a commodity".* Being regarded in this manner by the laboratory staff generally, and the upper management staff in particular, would have a considerable bearing on the allocation of funds, the participants agreed. Participant 24 expressed – "*to change to a totally different platform, say a web-based system, would cost a fortune – and for what benefit*?" Spending, as has been observed by the participants, is therefore functional and not developmental. The researcher acknowledges that the view of commoditisation of the laboratory information systems and the type of spending acknowledged by the focus group warrants further discussion and investigation and will be put to the participants of FG3 (Chapter 7) for that purpose.

6.6.3 Lack of capability of the laboratory Information Systems

The participants acknowledged that the laboratory information system in private pathology is regarded as a closed system and lacks both adaptability and scalability. All four participants have been through mergers between private practice laboratories and have seen large increases in workloads. The participants noted that the inadequacy of the laboratory information system in providing laboratory management details such as workstation analysis and test versus time graphics compromised the smooth transition between the participating laboratories of the mergers. As a result, they said, the merged entity lost a considerable amount of work because of the difficulties that arose in servicing referring doctors test requests. Participant 21 illustrated the problem – "*we merged with practice A, which was using a very old in-house system written in Cobol and running on a mainframe. It could only store results for three weeks, then they had to be microfiched. Within two weeks of the merger, because it took forever for us to find results for the doctors, we had lost twenty percent of the doctors referrals".*

The participants reported that there are some serious shortcomings in the private laboratory information system with respect to adaptability and integration. Participant 22 commented – "*the systems can't adapt to the workflow, they are static. They are resistant to change – I think everyone thinks it is too hard to change them now".* This raised some discussion by the participants on middleware, as was the case in FG1 in the hospital laboratory (Chapter 6, p. 201). The participants of FG2 pointed out that in the private laboratory also, analyser vendors are more frequently implementing middleware solutions to help cover the inadequacies of the current laboratory information system, in an effort to enable laboratories some access to the more modern technology and clinical advantages of their analysers. One of the major hindrances to integration of new technology analysers is the lack of a common interface, the participants added; each analyser has to have a specifically written interface to the current mainframe systems in use in private pathology. Participant 24 elaborated on this scenario –"*if we want a new high tech. analyser these days, more often than not we need an intermediate system because we can't interface the analyser to the mainframe – so we have PCs all over the place in the lab. and barely enough bench space to do the work".*

The participants went on to add that the only area of laboratory information system development in private practice pathology is the area of auto-validation, where a series of rules are written into the laboratory information system to facilitate validation of results without scientist or pathologist intervention. They said that this applies to biochemistry and haematology primarily. The question of cost effectiveness for this approach was raised, as the time, complexity and cost of developing such a system against the time and cost of maintaining validation with experienced scientist and pathologists could potentially be much greater.

6.6.4 End user involvement in planning

In the experience of the participants of FG2 within the various laboratories in which they have worked, there is no evidence of a cohesive, group approach to laboratory information system planning. Changes are made to the laboratory information system at the behest of the IT staff, senior management or laboratory manager, as is the case with the auto-validation programs and they said the general staff remain uninformed and untrained on the changes. As participant 22 commented – "*we put ideas forward but no-one listens. We have always had to learn the systems as we go – there is no formal training*". The participants also reported that as a result of the lack of formal training on the laboratory information system, the scientists are compromised in their knowledge of the full functionality of the system, to the detriment of efficiency.

The participants added that there is therefore a lack of ownership, which is known to create a negative attitude towards an information system amongst the users, further compromising laboratory efficiency (Singh, 1993). Participant 24 mentioned "*years ago there used to be user group meeting, supported by vendors, to foster discussion on laboratory equipment and information system – that does not happen now unfortunately*". Participant 23 mentioned that he had seen a few employment advertisements for scientists with an interest in laboratory information system to work with the vendors as "Application specialists" to assist with training and implementation of new technology and to foster co-operative development of laboratory information system. Participant 23 added – "*maybe the vendors are waking up to the fact that it is all terribly ad hoc and that someone should do something to change that*". Having a scientist as a vendor employee could give a totally different perspective to the whole sales and support process and may lead to a change of attitude towards the laboratory information system. Participant 21 added. "*The more that we (scientists) are involved, the more chance we have of making a system that does what we want – and that can bring about efficiencies like a paperless laboratory for instance".*

6.6.5 Laboratory information systems research in private pathology

The feelings of FG2 toward a lack of co-operation and synergy between the management, IT staff and scientists were the same as the researcher experienced with FG1 – the public hospital laboratory. The participants' comments reflect the same lack of a cohesive approach to direction and planning in technical and IT services as seen in FG1. There is also a lack of awareness of such terms as "strategy, business-IT alignment and laboratory information system effectiveness". The question of research and education was raised by the researcher in the context that research and education in SISP would alleviate problems of lack of cohesion and foster worthwhile information system development. Participant 24 agreed that it would make a positive impact – "*research and education must be critically important to the development of medical science, and yet we have none in our course. And no-one researches laboratory information system that I know of".* Lack of research and education in the area of medical informatics and SISP applied to the laboratory environment had led to stasis within the laboratory environment, as demonstrated by Participant 23 – "*there is no information available to or passed on to we end-users and we have stagnated technically".*

The participants of FG2 raised the issue of laboratory management in the context of a lack of formal courses for scientists who are to be promoted to middle management positions. As Participant 23 pointed out – "*being a good scientist does not make you a good manager. Management skills historically have been acquired by observation, not by education, and everyone does it differently".* All participants strongly agreed that there should be formal management training for scientists who are being promoted to middle management and Participant 22 told the group that in his practice now there is an internal management course that is compulsory prior to promotion. He elaborated – "*we do some internal training now in budgets, cash flow and how to use spreadsheets to support this".* Research and education in laboratory information system and technological IT advancements, and business processes such as SISP are non existent at this current point in time. The consensus (FG1 and FG2) is that there is a very considerable impediment to change in medical pathology information system in Australia.

6.6.6 Laboratory information system wish list – private pathology

The approach taken by the participants with respect to a laboratory information system wish list was to request small changes to their existing systems, such as alleviation of the problems associated with data entry by having the ability to digitise request slips. Participant 24 suggested – "*an automatic stock control system would be good – sort of a supply chain management system – so that we don't keep running out of reagents".* More intelligence in the system was suggested by Participant 24 in the context of standardised, real time data and semi-intelligent system to help interpret results –"*these things would save a lot of time for us"* he added.

It is interesting to note that responses of the participants of FG2, similar to those of FG1, did not include a consideration for a total change in the information system. For example, they did not consider a change to the adoption of a web-based information system. This similarity between the two groups is perhaps a reflection of a lack of knowledge of modern IT or the lack of the ability to laterally think to apply existing technologies to a different environment. The researcher initiated some discussion on web-based systems and what other technologies that are possible with a web-based system, for instance telemedicine, voice recognition software and voice over IP telephony. The participants reacted enthusiastically to the possibility of having these facilities and could appreciate their benefits. As Participant 24 noted – "*with the telemedicine, I could look at abnormal films from the country laboratories with the other scientists at the same time, in real time – instead of waiting two or three days for the films to get to me in Melbourne".* The participants understood little of SISP, business-IT alignment and information system effectiveness measurement, which is understandable given the lack of education in these areas available to pathology staff. The impact of this lack of knowledge is evident from the discussion, as at no time during the focus group did any of the participants use terms such as "strategy, information system planning, information system effectiveness and business-IT alignment".

6.6.7 Summary

The key issues to emerge from the discussion of FG2 were similar to those main points that came from FG1. The main points from FG2, the private pathology laboratory were:

1. co-operation between scientists, upper management and IT staff is virtually non-existent for the development of the laboratory information system;
2. funding for laboratory development is based on minimal cost expenditure, and does not involve the laboratory information system;
3. there are no laboratory informatics or laboratory management courses available;
4. conferences and the few papers that are published in medical science journals are concerned with middleware and not with the overt redevelopment of laboratory information system; and
5. the laboratory information system is not regarded in this case as an important part of the laboratory business by the upper management in private pathology.

6.8 Discussion and conclusion.

The participants of FG1 and FG2 hold similar views on the proposals put to them in the focus group sessions. It is clear from the results of the analysis of both of the focus group data that the lack of financial support for laboratory information system development, along with a lack of laboratory information system capability, are the two main barriers to information system development in medical laboratories. It is interesting to note that, although the end results are similar between hospital and private pathology with respect to lack of spending, the mechanisms are quite different. The hospital laboratories are subject to internal (within the hospital) and external (government) politics and this determines the amount of financial support the laboratory receives. The private company wanting to maximise both profitability and shareholder returns, on the other hand, dictates spending in private pathology.

The FG1 and FG2 responses to the question of laboratory information system lack of capability suggest support for the conclusions that emerged from the survey. For example, the lack of capability of the laboratory information systems was reported by the participants to negatively impact on business outcomes because of an inability to integrate with modern communications technology, such as broadband e-mail and electronic ordering of pathology tests. End-users were not involved in the planning process with the result that workflow processes were compromised because of unsuitable or inadequate software development. The availability of finance for laboratory information system development was lacking in hospital pathology, as a result of the low priority with which the pathology is held within the hospital, and was lacking in private pathology because of the emphasis on maximising shareholder returns. Research and knowledge of formal business processes and current information systems technology compromised the pathology staff from both hospital and private laboratories in terms of creating development plans and to ascertain a future direction for the laboratory, should funding become available. There was no alignment between the business objectives of the practices and the direction of IT development, which negatively impacted on the laboratories abilities to service their respective referring practitioners.

The findings of this research have shown that the lack of laboratory information system capability results from an unwillingness of both the hospital and the private companies to invest in integration and monitoring of the information systems. In addition there appear to be some political and policy issues affecting this situation. In the case of the public hospital pathology laboratory, both the attitude of the government towards health, and the attitude of the hospital CEO towards the pathology department reflect disinterest in laboratory development. The findings of FG1 showed that both of these forces were negative for the pathology department and that this compromised funding for the department. But an awareness of what is possible to have in a laboratory information system is also lacking in scientists in both the hospital and private pathology through lack of IT awareness of modern information systems technology and a closed view of current laboratory information systems. This was demonstrated by rejection of the idea of a web based system and all that entails (for example - telemedicine, web-based voice recognition, paperless laboratory) in FG 1 and also by the participants of FG2 not including it on their IT wish list.

FG1 and FG2 participants had a closed view to the introduction of new IT. This was further demonstrated when all participants were asked about obtaining a new system – both groups as a whole started discussing the existing vendor systems and there was no mention of importing new technologies such as the web into their laboratory environments. The existing vendor systems are the same basic age as the technology that the hospital system currently uses. This outcome reflects a general lack of knowledge of research into new technologies within the pathology vertical in both hospital and private laboratories, and their possible application to medical laboratory IS. The current thrust of development in industry journals, the Clinical Biochemist Reviews for instance, is the implementation of auto-validation, a set of rules developed by pathology IT staff or IT vendor staff to validate test results automatically, to save the senior scientists and pathologists looking at results manually and validating these results.

Lack of cooperation between senior scientists in management positions (department heads) and IT staff has been shown by this research to play a significant role in ineffective laboratory information systems resulting in negative business outcomes for pathology, both private and hospital based. Examples of negative business outcomes for the hospital laboratory are a lack of ability to provide hospital doctors with electronic ordering of tests that has led to duplicate orders for tests due to slow turn around time for results. There is also the loss of income from referring general practitioners because of the inability of the laboratory information system to accommodate broadband communications technology, precluding the laboratory from e-mailing results to the referring doctors. Examples of negative business outcomes for private pathology as a result of lack of capability of the laboratory information systems are the inability to create a paperless laboratory that would improve efficiencies and cost effectiveness, and the lack of a web-based laboratory information system that would enable a better match between the laboratory information system and the private practice's global development.

The analysis of the focus group data has also highlighted another misalignment – that of scientist/management/IT. FG2 confirmed that this is more prevalent in the private practices surveyed where laboratory information system changes may be initiated by the IT staff alone, or with management – the scientists are rarely involved in discussion and planning of any changes. These changes are functional and not strategic and are frequently based on cost considerations. The researcher's experience that there is an attitude by IT staff that scientists know nothing about IT has been confirmed in FG1 (p.197). This attitude exists in spite of the fact that scientists are the main end-users and determine the workflow and what is required to support the work flow processes. The suggestion that IT staff thinks poorly of scientists IT knowledge was also supported by the views expressed by the participants of FG2 (p.207). This situation may result from a lack of knowledge and education on the part of all parties, and is further exacerbated by a lack of alignment between management, scientists and IT staff. To use the terminology seen in the SISP literature, there is a significant lack of business-IT alignment, compounded by non-existent end-user involvement in the planning process Grover and Segars, 2005; Chan *et al.,* 2007; Rondeau *et al.*, 2006; Jiang *et al*, *2002*).

FG1 showed that because of the lack of funds, bought about by the low priority and lack of strategic capacity with which the hospital laboratory information system is held, there is an inability to change the laboratory information system to be more capable. Added to a lack of significant management data from the laboratory information system renders the hospital laboratory static. There are three major issues resulting from this –

1. Inability to provide a turn around time for results commensurate with the acuteness of patients in ICU and CCU illnesses;
2. Inability to integrate developing technologies (communications) requested by referring practitioners which has lead to a loss of work and income; and
3. Generation of excess work (over servicing) by doctors due to lack of availability of results in a timeframe similar to opposition practices – the doctors re-order the tests. This contradicts government efforts to cut health expenditure in the Australian context.

An unexpected consequence of the pressure of reduced staff numbers and the inadequate laboratory information system was raised by one participant - that of frustration and perhaps anger as the scientists have been aggressive when answering inquiries about result availability. The social aspects of this project are considerable and warrant further investigation, but do not apply to the research question of this current project. The researcher has mentioned this consequence to make the point that there are other manifestations of the lack of laboratory information system capability, the lack of finance and inadequate staffing levels. The scientists' attitudes can have a direct impact on the business, negative in this case –

- too aggressive and rude may lead to loss of referrals and hence income; and
- may have an indirect negative financial impact through days lost with sick leave and the possible need for counselling (anger management).

The focus groups (FG1 and FG2) data suggests that the lack of laboratory information systems capability and effectiveness is having a negative impact on business outcomes for pathology in the Australian context. There is a demonstrable inability to undertake SISP. The key issues that emerged from the FGs affecting medical pathology information systems effectiveness are the lack of capability of the laboratory information systems, lack of business-IT alignment and poor end-user involvement and a low priority by the practice owners to finance developments in pathology information systems. There are three possible alternatives that laboratories could chose from to update their laboratory information system –

1. A commercial venture to build and implement the new system;
2. To form a consortium, as did the OpenLabs project. This could have additional benefits such as shared resources, central hosting of resources, better management of redundancy & disaster recovery and provision of a test environment (server compartment); and

3. The government could be involved through its Healthsmart project and in consultation with private and public pathology provide a standardised laboratory information system. This would be best configured as an application service provider (ASP) model where each laboratory could draw down modules to structure a unique system that best suited their own particular needs.

The data analysis of the two focus groups presented in this Chapter has supported the major findings of the quantitative data analysis (Chapter 5). The quantitative data analysis showed that laboratory information systems capability was the dominant mediator variable for SISP and that the survey participants viewed the laboratory information system as not capable of scalability and integration with modern technology. The focus group participants from both the hospital and private pathology sectors agreed that this lack of capability of the laboratory information system has had a negative impact on business outcomes for their respective laboratories. The participants' comments also confirmed that the laboratory information systems in both private and hospital laboratories were given little priority for development funding, due possibly to the supposition that the laboratory information systems are regarded as commodities.

The analysis of the survey data for the mediator variables - business-IT alignment and end-user involvement in planning - identified some recognition for these variables as a part of the process of laboratory information systems planning. The extent of the role played by business-IT alignment and end-user involvement was clarified by the participants of both focus groups who expressed a strong view that these two variables are important in the planning process. The participants went on to express strong disagreement that business-IT alignment and end-user involvement in planning took place in either hospital or private laboratories and that this negatively impacts of the effectiveness of the laboratory information systems.

The participants of FG1 and FG2 acknowledged that there is no funding for the strategic development of laboratory information systems in their respective laboratories, as was shown in the quantitative analysis results. The participants' suggestion for this observation was that funding is functional and not strategic. This would explain the marked change in the multiple regression beta weights between the first and second regressions (Figure 5.9).

The focus groups discussed in this Chapter have provided rich data to complement the findings of the survey analysis presented in Chapter 5. There are, however, some findings that are yet to be fully explained – in particular the concept of functional and not strategic funding and what underlies this concept, and the possibility and extent to which the laboratory information system is regarded as a commodity. These incomplete findings form the basis for the more specialised discussion and interpretation that follows in Chapter 7 where another focus group was established to deepen the researcher's understanding of these issues.

CHAPTER 7 FOCUS GROUP 3 – THE EXPERTS

7.1 Introduction.

This Chapter reports an analysis of a third focus group of academics and practitioners experienced in SISP who discussed both the outcomes of the data analysis reported in Chapter 5 that showed some unexpected findings, and the outcomes of the focus groups in the two practitioner sites, reported in Chapter 6.

The expected linear multiple regression results supported the original contentions of this research that financial considerations (cost-benefit analysis – Saarinen, 1996; Lincoln, 1986; Mayer, 1998), end-user involvement in planning (Rondeau *et al.,* 2006; Hackney and Kawalek, 1999) and business-IT alignment (Chan and Reich, 2007; Delone and McLean, 1992, 2003; Segars and Grover, 2005) are the major issues affecting the outcome of SISP. The unexpected findings were a marked decrease in beta weights from the first regression (independent variables of financial considerations, business-IT alignment and end-user involvement against the mediator variables) to the second regression (mediator variables against the dependent variable SISP). The beta score for laboratory information systems capability was consistently the highest beta value, and therefore, it can be argued, has the greatest influence on the dependent variable SISP. The ability for pathology laboratories to undertake SISP, it was argued in Chapters 2 and 3, is a pre-requisite for information systems effectiveness measurement and hence the measurement of business outcomes.

The participants of FG1 and FG2 had also raised the possibility that the changes observed in the quantitative data analysis for financial considerations may be because spending is functional; the strategic ramifications of this view will be explored in this

Chapter with particular reference to impact of decisions about functional spending on SISP and business outcomes for the pathology industry. The participants in both FG1 and FG2 also observed that the laboratory information systems are viewed as a commodity in both hospital and private pathology, but could not fully explain why. They did, however, acknowledge that the current management perspectives towards the pathology laboratories has a negative impact on strategic planning and business outcomes. Although the extent to which end-users are involved in planning and the degree of business-IT alignment was not fully explained by the data obtained from FG1 and FG2, the participants supported the contention that these were essential for effective planning to occur.

A focus group of SISP experts was seen as an efficient way to stimulate discussion on the quantitative data analysis and FG1 and FG2 findings to try and elicit an explanation for these anomalies and assess their impact on understanding an answer to the research question "*How does the effectiveness of laboratory information systems impact on business outcomes in medical pathology in Australia*?"

7.2 Focus group of experts

The participants invited to attend the focus group were six in number (seven including the researcher). Six of the participants are academics (one professor and five post doctoral) within a research school at RMIT University, Australia, and the seventh is a doctorally qualified consultant in the health vertical for a multinational consulting firm (Table 7.1). All members of the panel have practical experience with SISP applications in industries. Only two have actual experience in the health vertical.

Table 7.1 Academic focus group participant details.

Participant	Description and qualifications
Participant 31	Professor of management information systems, Head of School, Dean of research & innovation.
Participant 32	Post doctoral strategy consultant
Participant 33	Post doctoral - senior lecturer alignment
Participant 34	Post doctoral - researcher SISP and statistical methods
Participant 35	Post doctoral - thesis on SISP in Australia
Participant 36	Doctoral candidate - researching alignment.

As a prelude to the commencement of discussion on the anomalies seen in the multiple regressions, the researcher gave the experts participating in FG3 an overview of pathology laboratories, in both the business and IT contexts. As a result of this overview a discussion developed which focused on a set of key issues and explanations that emerged which the panel considered were significant in the context of this research.

The key issues arising from the research process as a result of the survey and the two focus groups of pathology practitioners are that:

- there is a lack of funding for pathology laboratory development, including laboratory information systems development;
- there is a lack of end-user involvement in the planning process in pathology laboratories;
- there is a lack of business-IT alignment in the planning process in pathology laboratories;

- laboratory information system capability is the major influencing mediator variable on SISP in pathology;
- research and education into pathology laboratory management and information systems does not occur; and
- there is no awareness of the principles of SISP in the pathology industry.

Each of these issues was put to the panel of experts and the results of their analysis are discussed in detail below.

7.3 Strategic impact, alignment and commoditisation.

The researcher explained to the participants of FG3 that this research is interested in determining the role that the recognised contributors to successful strategic planning (business-IT alignment, end-user involvement and financial considerations) play in pathology. Successful SISP is seen as a cohesive approach to strategic planning and each component plays a pivotal role without which SISP is compromised. He acknowledged that analysis of FG1 and FG2 has shown some of the components to be lacking, notably business-IT alignment and end-user involvement, but the full understanding of the research findings and their impact on SISP needed to be elicited by the SISP experts of FG3.

The researcher initiated discussion in FG3 with the statement and question – "*we found a high beta value for laboratory information systems capability against SISP compared to business-IT alignment and end user involvement that is in the classical literature – what are your comments and feed back on that – what do you think that might mean?"* To inform the participants of FG3 of the views held by the members of the two previous FGs with respect to an assessment of the strategic value of the laboratory information system, the researcher explained - *"Focus group 1 (FG1) showed that there is apparently no strategy in pathology test request and no priority given to strategic development of pathology in hospital funding, yet the pathology test results in many cases (intensive care, cardiac unit and emergency) are required quickly and accurately for treatment and diagnosis of desperately ill patients"* (Chapter 6, p.196). Participant 31 reiterated the scientists' view - "*scientists don't care about strategy. They are not involved in any planning; there is no end-user involvement so over the years they have lost interest. The hospital doctors don't understand about SISP – the words are not known to them and neither are the principles. There is a misalignment of the knowledge domains".*

The participants then sought an explanation for this observation, Participant 31 commenting that - *"the survey involved educated people, many with PhDs – pathologists and medical scientists, yet you got an incredibly low* r^2 *value for research and education for SISP – it is almost as though none of that matters at all".* Participant 33 asked the question -*"is the low beta value due to lack of research and education in the field of pathology laboratory information systems –could that have a negative impact on strategy for pathology"?*

The participants acknowledged that there is little or no research or education in laboratory information systems in Australia. There is an undergraduate course in pathology informatics and laboratory management available at the researcher's university and for which the researcher has taught. The researcher explained that the course content does not contain any material on SISP, information systems effectiveness measurement or laboratory information systems development, and went on to add that – " *there is no material on strategy, strategic planning or strategic development and effectiveness measurement of laboratory information systems".* It was proposed by Participant 31 that scientists and medical people do not understand SISP and that a lack of research and education relevant to SISP has a negative impact on the performance and business outcomes of laboratories in both hospital and private pathology. Participant 31 added, for the hospital laboratory – "*the lack of strategy, planning and of information system development is such that the laboratory information systems cannot perform basic function such as electronic ordering of tests in the wards. Data entry is so slow that the laboratory can have a test result before the patient details are entered in the computer – the ward has to wait for the results. There is no strategic planning and the information system is not effective".*

The participants noted in their discussion that lack of strategic planning is an example of one of the problems that pathology laboratories in general face. The FG3 participants acknowledged that lack of research and education and lack of end-user involvement in planning contribute to this, but still does not give a full explanation for the attitude held by scientists, hospital management and doctors alike that the laboratory information systems have no strategic value. This research has shown that there is no provision of finance for strategic development of the laboratory information systems. The participants in FG3 agreed that this is due to the fact that the laboratory information system is regarded as a commodity in both the hospital and the private pathology environments and as such is seen to have no strategic value. Participant 34 expressed this succinctly– *"laboratory information systems have been commoditised to such a degree that they just are looking at outcomes not strategies – that's all. For* *laboratories to spend an unknown amount for an unknown outcome is a big risk when they now have something dependable and predictable – establishing a connection between business outcomes and laboratory information systems is the real trick, and in fact what your research is probably doing is establishing that this connection does not exist".*

Participant 33 made the further observation that management of both hospital and private pathology appear to prioritise the accounts/financial functions and any perceived management functions of the laboratory information systems because these areas are seen as areas of income production. Participant 34 noted that – *"the accounts department is seen to produce cold hard cash – spending in the laboratory would produce small intangible benefits only, and these would be very difficult to measure"*. Participant 33 added – "*hospital funding in Australia is based on case mix principles – that is patients in beds. The priority of hospital management is turnover of patients - there is no metric for better patient outcomes. There is no tie back to the actual business with pathology – there is no metric to say that if the hospital had a good pathology service that it would result in better patient outcomes".*

Following intense discussion about the issues raised above, the participants came to a conclusion that the hospital management apparently does not make the connection because of the commoditisation[5] of the laboratory information systems and services. Commoditization in this context relates to the definition given below, derived from a member of FG3. The nature of this commoditization can be illustrated by a comment

[5] Commoditisation may be defined as "*The process whereby product selection becomes more dependent on price than differentiating features, benefits and value added services."* (sensacom.com/web_glossary.html).

from Participant 31 who noted that– "*pathology is fundamental to the investigation of disease – but it is not seen as strategic in any way, shape or form, but it is fundamental to the process*". Participant 33 further added – "*It would be a subtle point to justify spending on the laboratory information systems in hospitals because of this view".*

The participants in FG3 noted that there is an enigma concerning the attitude with which pathology is held. Participant 32 explained – "*there is no recognition of the possibility that, with improved technology and information system effectiveness at some cost and effective planning, the pathology services could be delivered in a more timely and efficient manner"*. This, the participants noted, surely must contribute to better patient care and perhaps faster recovery and earlier discharge – hence enhancing the probability of a higher turn-around of patients and the attraction of more funds under the case mix funding process. The proposition put forward by the participants that the hospital laboratory information systems is widely regarded as a commodity and as such has no strategic value would then explain why the laboratory information systems have seemingly no priority when it comes to the provision of funds by hospital management for its development. This view was described by Participant 33 –"*This situation is compounded in no small way by the attitude that the laboratory information systems is a commodity – in the mind of management it is not seen to exist".*

The participants' proposition that the laboratory information system is a commodity would also contribute to understanding why there is no active development of the laboratory information systems in private practice pathology laboratories. Funding is fundamental, but not strategic, for the diagnosis of disease. This was stated bluntly by Participant 34 – *"the laboratories are pushed out as far as possible from high priority –*

they are a commodity." The researcher expanded on one element affecting management's apparent attitude towards pathology by mentioning the coning rules[6] as applied by Medicare (Australia's public healthcare system) –"*under the coning rules, private pathology suffers most. They are only paid for the three most expensive blood tests under these rules and if doctors order more than three tests, they don't get paid for them."* The participants in FG3 then agreed that these coning rules contribute to an apparent explanation for the observed managerial attitudes within the health vertical and contribute to the problems of lack of strategic development and capability that beset pathology laboratory information systems. The observed anomalies in the quantitative data analysis, that is, the dramatic change in beta weights of the financial considerations variables and the consistently higher score for laboratory expandability and adaptability over business-IT alignment, however, are in the opinions of the FG3 participants, still not fully accounted for, but some conclusions could be supported.

As a result of the laboratory information systems being viewed as a commodity, the following observations have support in the research data –

- The laboratory information system does not have any strategic value;
- The information system does not attract developmental spending;
- The scientists have lost interest in laboratory information systems and laboratory development in general;
- There is no encouragement or incentive to undertake research and education on laboratory information system involvement in SISP/strategic development of laboratory.

[6] Coning rules are part of the Federal Government Health policy relating to pathology testing in Australia. The coning rules apply to general practitioners ordering blood tests on non hospitalised patients, and allow for payment of the three most expensive tests ordered to the pathology practice. Test numbers in excess of three tests are not paid under the coning rules.

A fuller discussion on the attitudes to spending in both hospital and private pathology follows.

7.4 Functional vs strategic spending.

The researcher reported to the FG 3 participants that the conclusion made from the multiple regression results, combined with his laboratory experience in a senior departmental management role, suggest that there is no financial expenditure on laboratory information systems expansion in a strategic sense in Australia. The researcher asked the participants to consider the data analysis pertaining to private pathology (Ch.5) that showed for the initial multiple regression of the three independent variables "financial data valuable," "information format," and "information underlies change" against the mediator variable "financial information," the independent variable "information underlies change" had the highest beta score; in fact, it had the only significant score. This suggests, argued the researcher in FG3, that the financial information in private pathology underlies change. However, when the mediator variable, "financial information" was regressed against the SISP dependent variable, the beta score changed dramatically and became insignificant. This is a highly significant and unexpected finding when compared to other industry verticals studied in the research literature (Lincoln, 1986; Sugumaran and Arogyaswamy, 2004; Irani and Love, 2001). This, the researcher argued to the FG3 experts, suggests that unique to the pathology industry, the financial considerations are internal, that is, the financial considerations underlie change, but the change is functional, not strategic. The discussion on this proposition amongst the participants of FG3 was initiated when the researcher asked the group – *"given what is coming out in the discussion here and that* *the analysis findings are starting to be explained – do you think that the laboratory information system can be viewed by private pathology as a component of SISP?"*

Participant 31 began the discussion noting that - *"when you talk about SISP it just doesn't connect in a medical environment because it is not seen as strategy – it is just seen as a commodity. The laboratory information system has no priority as it is not seen as a strategic tool – it is seen as a commodity.*" Expenditure in private pathology laboratories, the participants concluded, is therefore functional spending, not strategic spending. The underlying consideration to spending in private pathology is cost cutting, not strategic development. Participant 33 added another perspective on the strategic ability of laboratories in the context of business-IT alignment by commenting that - *"the range of the cognitive gap between PC and mainframe is twenty five years of technology. IT should be business driven with IT going along for the ride – it should be their desire to become more up to date and have access to opportunities they would otherwise not have – if IT is driving this, it is almost doomed to failure. You would think that business and IT would want to be on the same page."*

The researcher then raised another issue relating to strategic development in private pathology, that being the drive for international expansion by two of the three major private pathology practices in Australia. Participant 32 commented – "*One would think there would be pressure brought to bear on these laboratories because of their overseas expansion – the introduction of such capabilities as a web based laboratory information systems with intranets and internets for improved and real-time communication, telemedicine for real-time review of cases from anywhere in the world and web based voice recognition software to eliminate transcription should provide a* *strategic advantage"*. Participant 35 commented – "*One would think that the laboratory management would find this not only attractive, but essential for growth"*.

The discussion by the SISP experts in FG3 relating to functional vs strategic spending has highlighted that both hospital and private pathology do not perceptibly undertake strategic spending. This was also supported by the analysis of the survey and demonstrated in that analysis by the marked decrease in beta weights for financial information between the first and second regressions. The discussion in FG1, FG2 and FG3 has also contributed to the understanding of why strategic spending does not occur in either hospital or private pathology in terms of what influences spending in each environment. In the hospital environment, the management of the hospital and the incumbent political party's view on health spending determines spending. Private pathology spending is concerned with cost cutting and maximising shareholder returns. Underlying both these scenarios is the fact that the laboratory information systems in both hospital and private pathology are regarded as a commodity. The participants of FG3 acknowledge that the combination of functional spending and the laboratory information systems being viewed as a commodity in this way has a significant negative impact on pathology's ability to undertake SISP, and this is demonstrated practically in the example relating to international expansion given above.

Again not all issues raised from the survey research or all of the outcomes from FG1 and FG2 had been dealt with by FG3 up to this point. The degree of laboratory information systems capability that is present in current laboratory information systems needed to be explored, especially since this variable was shown by the regressions to have the most influence on SISP in pathology, and the discussion of what emerged in FG3 is reported in the following section.

7.5 Information system functionality vs information system capability.

The participants acknowledged that what is under investigation in this research project is the capability of the laboratory information system, not its functionality, and its impact on SISP. They further noted that there is a difference between capability and functionality and to make this distinction has some ramifications, not only for the pathology industry, but also for some established business-IT models. One of the FG3 experts referred to one such model, that of Henderson and Venkatraman (1993) which the research had already prepared to test as it was a key part of the initial part of the research, reported in Chapter 2.

After distributing a diagram of the Henderson and Venkatraman strategic alignment model (1993), the researcher asked the group to explore the possible interpretation of the laboratory information systems capability in the context of the strategic alignment model (SAM) to obtain a fuller understanding of its impact on SISP and to help align the findings of this research with the established literature. The researcher asked – " *if one considers the Henderson and Venkatraman strategic alignment model in light of my second multiple regression findings – the IT strategy involves technical scope, IT governance, system competencies, IT architecture, processes and skills – these could be classified as functional components of an IT system. Does the result of the multiple regression, that is, the dominance of laboratory information systems capability suggest another component of their model hitherto unconsidered – information systems capability?"*

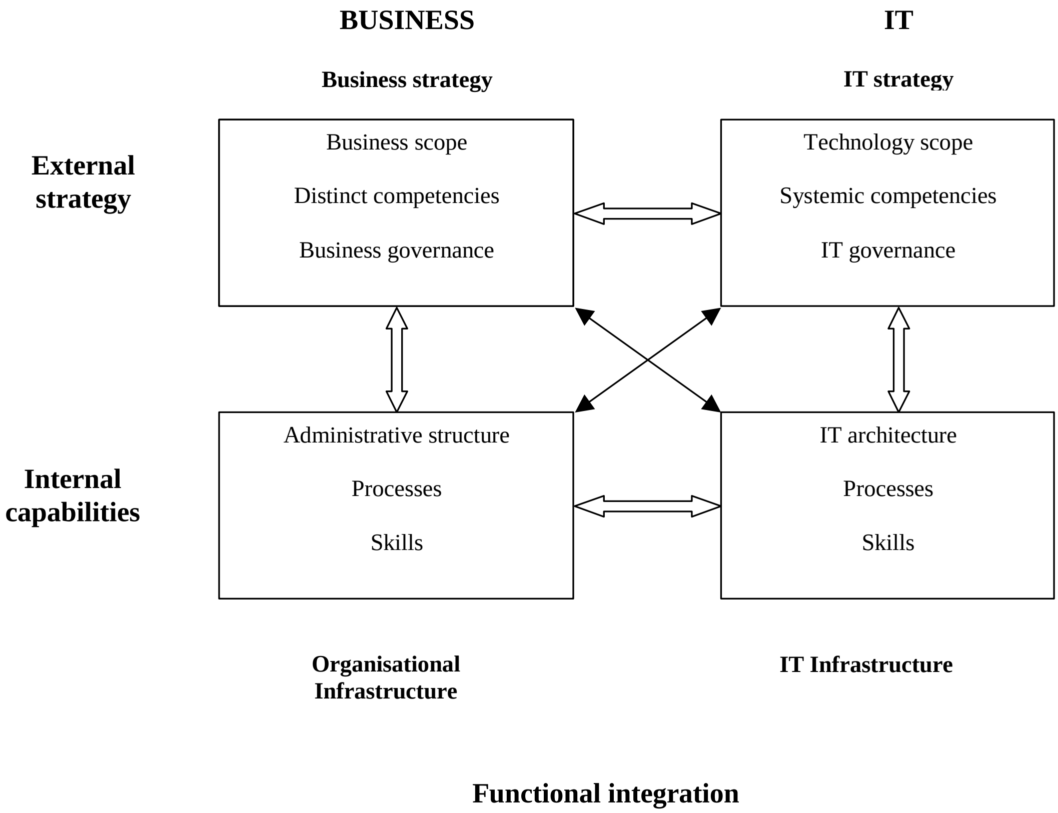

Figure 7.1 Henderson and Venkatraman Strategic Alignment Model.

The researcher described the model, saying – "*In the SAM, all four sections interact in the model to produce a cohesive, multi-dimensional relationship with good strategic fit. Each section and sub-section is dependent on the other components of the model for a complete business-IT relationship and successful and on-going alignment"*. Participant 34 commented – *"in the context of the findings in your research, one of the sub-sections, that of systemic competencies, which embraces what competencies of IT strategy can contribute positively to the creation of new business strategies, or better support existing strategies, has been shown to be lacking. This is due to a view held by the health vertical in general that the laboratory information system is a commodity, is not a strategic tool and therefore does not warrant allocation of funds for development and enhancement. In this context the SAM fails in pathology".*

The participants then discussed the concept that a system may be functional, but not capable, and the ramifications for SISP and business outcomes in pathology. An example was given by the researcher – " *The current laboratory information systems, as used in private and hospital laboratories alike, has the functionality to accept patient demographic information to identify patient results through unique identifiers, and place the results in the patient files for reporting. The current laboratory information systems can provide laboratory and management staff with data such as patient numbers for individual doctors, test numbers and limited financial data. These examples of laboratory information systems functionality have not changed or developed significantly since the laboratory information systems were written".* Participant 36 added – "*Laboratory information system capability, for example, could involve modern technologies such as telemedicine, wireless communications technology, voice recognition software, local area networks for dissemination of analyser graphics and the realisation of a paperless laboratory) to mention but a few. This would then allow for strategic expansion that is just not possible now".*

Following lengthy discussion, the participants in FG3 then agreed to one proposal that it is this lack of capability over the last twenty-five years or so since information systems were introduced to pathology laboratories that has led to the attitude now commonly held by scientists and management alike that the laboratory information system is a commodity. As such the laboratory information system has no strategic value and cannot be regarded as a component of SISP. Participant 32 asked – *"do people, because the laboratory information system is inflexible and not able to change, and because they are not involved in planning, draw the line then and say we can't do anything and throw their hands in the air and not bother?"* The participants agreed that because of this attitude, the laboratory information system is not recognised as being strategic now nor will it be in the future, and hence it is unlikely that laboratories will undertake any strategic planning.

7.6 Conclusions from FG3.

The aim of FG3 was to investigate and explore the key findings of both the analysis of the survey data and the key findings of FG1 and FG2. The outcomes are -

- The relevance/weight for components of established models, for example, the Henderson and Venkatraman strategic alignment model (SAM) may change from the expected in niche business verticals. The research has shown that in pathology the laboratory information system is regarded as a commodity, and as such, cannot meet the requirements for "systemic competencies" of the SAM. Hence, in this niche vertical, the Henderson and Venkatraman SAM fails.
- There is a distinction between functional and strategic cost-benefit (financial) considerations. The allocation of funds in pathology is not for business development or expansion and hence cannot be viewed as strategic.
- There is a distinction between information system functionality and capability. The current lack of capability of the pathology laboratory information systems to integrate with modern technology and to provide flexibility and scalability to enhance the strategic development of the business is confirmed by this research.
- The pathology information system is widely regarded in both hospital and private pathology as a commodity, and as such has no strategic value or competency. This prevents SISP, information system effectiveness and the strategic development of medical pathology.

- The pathology information system capability was found to be the over riding factor in laboratory strategic development. This research has shown a variance from the expected in significance of the recognised contributors to successful SISP (financial considerations, end-user involvement and business-IT alignment) as explained above and in the context of the peculiarities of the niche vertical of medical pathology. Therefore the degree of capability of the pathology information systems directly impacts with business outcomes in medical pathology. This research has shown that impact to be negative.
- SISP cannot take place in pathology laboratories. This research shows that there is no means by which pathology laboratories are able to do so. There is no research and education activities to keep staff abreast of developing technology and strategies for development; a lack of information system capability over rides the possibility of successful business-IT alignment; there is no strategic spending; end users are not involved in any planning or development exercises.

The three focus groups have contributed considerably to the explanation of the findings, both expected and unexpected, of the survey data. The implications of this and the impact on pathology practice will be discussed in detail in the following chapter.

CHAPTER 8 DISCUSSION AND CONCLUSIONS.

8.1 Chapter overview.

The aim of this thesis was to establish whether the effectiveness of pathology information systems impacts on business outcomes in pathology practice in Australia. This study is breaking new ground, as there is no evidence in the literature that a study of this kind has been done before in the pathology industry. In this chapter, there is also discussion of issues that arise from the research findings and their implications for both practitioners and academics are highlighted. These implications are particularly important for practitioners as the study offers the potential for the development of diagnostic tools that could provide a more standardised approach to strategic planning of information systems and information systems effectiveness measurement models.

This research has evolved the SISP/IS effectiveness composite model as a contribution to the development of diagnostic tools for SISP and information systems effectiveness measurement. This model combines the principles of SISP as a pre-cursor to the assessment of information systems effectiveness measurement on the basis that a project needs to undertake a properly structured SISP before the project effectiveness can be assessed. The SISP/IS effectiveness composite model then uses the achievement of a carefully researched and established business goal as the measure of information systems effectiveness. A diagrammatic representation of the SISP/IS effectiveness model is seen in Fig.8.1.

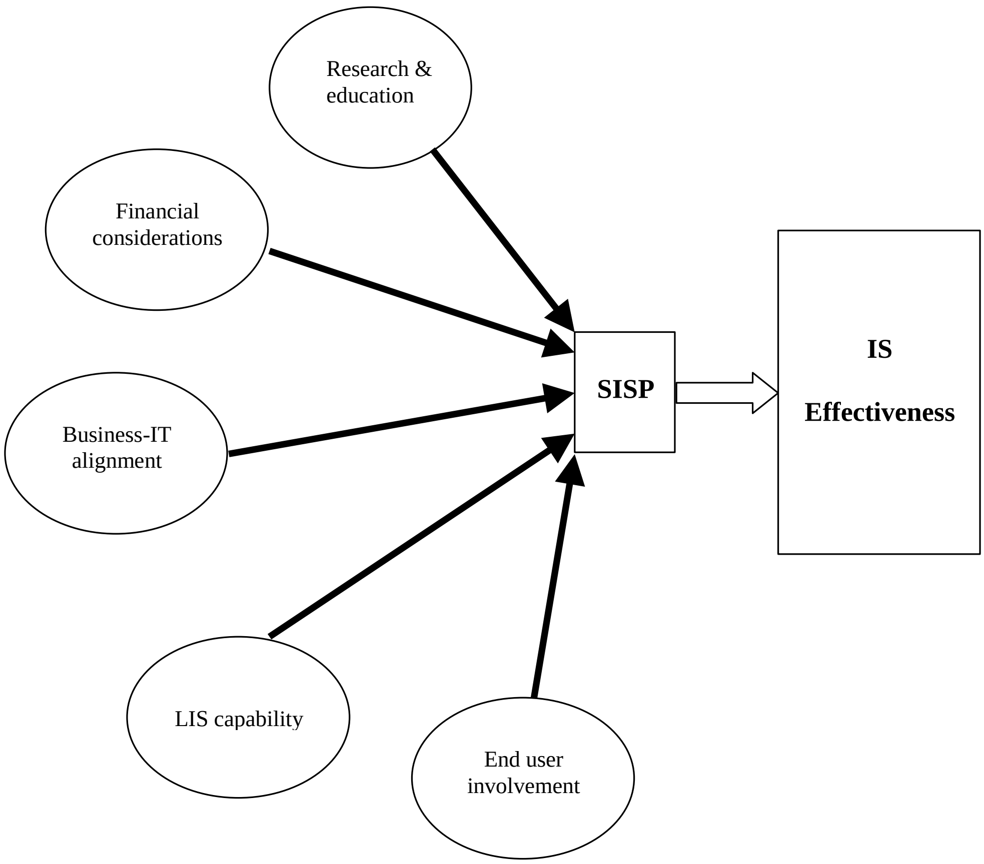

Fig. 8.1 SISP/IS effectiveness composite model

The commitment to both a wide area of investigation, to provide a holistic perspective on the effectiveness of information systems in pathology and their impact on strategic planning of information systems and business outcomes, and a micro-analysis, to investigate the content of relations between variables, yields a number of research limitations. These limitations are discussed in this chapter. The research process revealed some issues that could not be tested within this study. These issues are detailed as limitations and together with the findings of the research are put as suggestions for future research at the end of the chapter.

8.1.1 The thesis process

A unifying "process map" shows the navigation of this thesis, and this chapter draws on all four elements in that process map - the literature review, a survey, two industry focus groups and a focus group of experts - to derive a set of findings and conclusions. The research developed out of the researcher's own experience working in medical science. There was an obvious problem with pathology laboratories and information systems used in them. The researcher had tried to develop an alternative information system but this too had failed to attract any attention. The research began by investigating the existing literature and uncovering almost no research on pathology information systems. A subsequent investigation of the literature on information systems development and planning resulted in a review of current knowledge and research about strategic planning and SISP. This was then used to form a theoretical grounding for the research and existing models were adapted as a framework to underpin the research process. In addition the very small amount of research in this area was then used to extend that model. Key principles of SISP – business-IT alignment, end-user involvement in planning and financial consideration in planning – were wedded with two other concepts to frame the research.

Two periods of research activity – a survey, followed by three focus groups – were used to build enough data to develop an answer for the research question "How does the effectiveness of laboratory information systems impact on business outcomes in medical pathology practice"? The process map is illustrated in Fig. 8.2.

The conclusions derived from the analysis of the data collected are described in the next section.

8.2 Research process and key findings.

The aim of the study was to determine the level of strategic information systems planning and by what means information systems effectiveness is measured in private and public hospital pathology practices in Australia. The research utilised existing contributing components of SISP (business-IT alignment, end-user involvement and financial considerations) in addition to two other components (laboratory information systems capability and research) and tested them in the pathology industry in Australia to understand the relationship between the pathology information systems and business outcomes in pathology practice. Initially a search of the existing literature failed to provide any references to similar work being undertaken. The basic framework of the research had to rely of the application of SISP in other industries. The research presented in this thesis therefore was exploratory and attempted to fill the apparent gap of the application of strategic information systems planning in that industry.

This study evaluated the capacity of both hospital and private pathology practice to undertake strategic information system planning and information systems effectiveness measurement. The conditions that affect strategic planning as it currently occurs in the pathology industry were also evaluated.

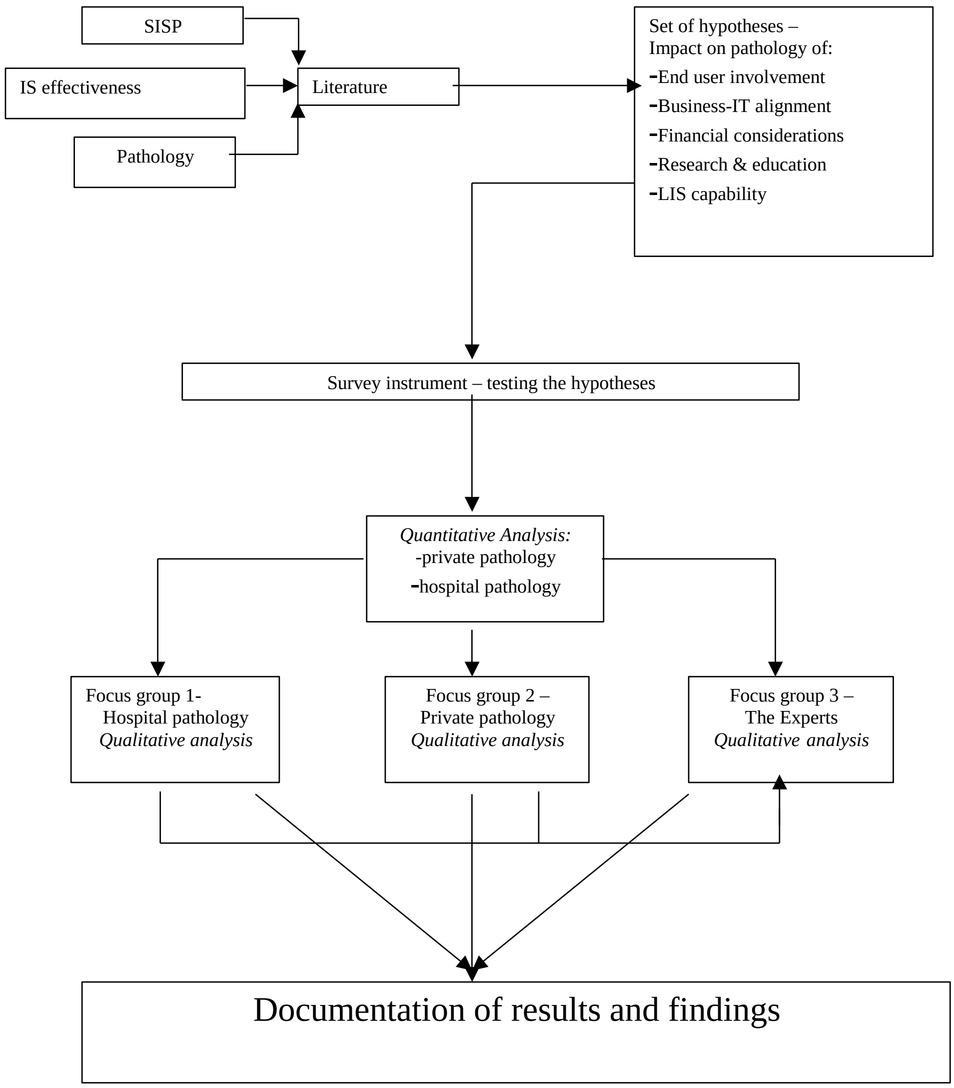

Fig. 8.2 The thesis process.

Table 8.1 summarises the key findings of this study in relation to the key concepts identified in the existing literature on SISP and business alignment and their relationship to information systems in the pathology industry in Australia. This Table offers a summary of what emerged from the research.

Table 8.1 A summary of the comparable findings in the literature review and data analysis.

Key concepts	**Research Literature Source**	**Existing research findings**	**Pathology IS research Findings & Comments** (related to this present study)
Business-IT alignment	Henderson & Venkatraman (1993) Grover & Segars (2005) Burn & Szeto (2000) Chan *et al*. (1997) King (1998) Chen & Reich (2007)	(1) Business-IT alignment is inherently of value & contributes to the organisations success. (2) Success comes from linking the IT plan to the business plan and this ensures congruence between business strategy and IT strategy. (3) Organisations that align business strategy & IT strategy outperform those that do not align	Business-IT alignment was not evident in this study in the pathology industry This study found that there was little alignment with respect to business objectives between scientists, management & the demands on IT in pathology laboratories. This research found little evidence of business-IT alignment in either private or hospital pathology
Business-IT alignment & competitive advantage	Wang & Tai (2003) Rondeau (2006)	(1) Business-IT alignment creates competitive advantage for the firm (2) Alignment requires continuous assessment by the firm to keep competitive advantage	There was poor awareness by stakeholders of the link between alignment and competitive advantage in pathology found by this study This research found no evidence of business-IT alignment in pathology

Key concepts	Research Literature Source	Existing research findings	Pathology IS research Findings & Comments (related to this present study)
IT/IS in pathology	Wells et al. (1996) Bender and McNair (1996) Boran *et al.* (1996) Anandarajan & Arinze (1998)	(1) A lack of IS development has the pathology industry lagging behind other knowledge based verticals	This research confirms that pathology IS development is lagging behind other knowledge based verticals
		(2) The OpenLabs project is an example of the application of SISP principles in pathology – a planning exercise using all the principles of SISP to achieve an established business goal	This research showed that none of the principles of SISP were evident in private or hospital pathology practice
		(3) Open architecture systems and Client server systems have been shown to increase flexibility & scalability into pathology IS resulting in enhanced business planning capability such as matching the organisation's information processing needs & interoperability.	This research showed that the pathology IS in use in the examples sampled in this study are unable to support modern technology such as open architecture and client server systems, and that the mainframe systems in use are not scalable and flexible
Alignment mechanism & measurement	Kearns & Lederer (2000) Chan *et al*. (1997)	1) Successful planning is enhanced by organisational leaders knowledge of IT	This research found that leaders in pathology have a poor knowledge of IT &/or strategy, and do not communicate with other stakeholders or co-plan with the end users
		(2) IT leaders should understand corporate strategy to ensure planning success	This research found that IT leaders in the pathology industry in Australia have a poor understanding of strategy

Key concepts	Research Literature Source	Existing research findings	Pathology IS research Findings & Comments (related to this present study)
SISP	Grover & Segars (2005) Earl (1993) Sullivan (1985) Sabherwal & King (1995) Boynton & Zmud (1987) Zmud *et al*. (1986) Lederer & Sethi (1998)	(1) The application of SISP principles to planning gives competitive advantage by enabling existing business strategies, improving customer satisfaction, enabling superior capabilities, providing advantage at lower cost and creating new business strategies (2) SISP involves a rational & structured approach that was found to be more effective and adaptable than highly structured approaches in the planning process.	The principles that underlie SISP are not evident in either the hospital or private pathology laboratories in this study. This study has shown that there is no structured approach to planning in private or hospital pathology
End-user involvement in planning	Sabherwal & King (1995) Grover & Segars (2005) Jaing *et al*. (2002) Hackney et al. (1999)	(1) End-user involvement helps to overcome business-IT misalignment by improving internal communication, enabling existing business strategies, providing better understanding of IT/IS potential and enhancing the quality of decision support. (2) Empowerment of end-users and a feeling of ownership helps the planning process and gives positive impression of IS that enhances its use.	This study found that end-users are not involved in planning –and that this compromises IS development, and leads to poor understanding of IS potential, poor decision making, compromised service quality & negatively impacts on business outcomes The study showed through lack of end-user involvement there was a lack of a feeling of ownership by the participants and this established a negative attitude towards the pathology IS and a lack of interest in its use

Key concepts	Research Literature Source	Existing research findings	Pathology IS research Findings & Comments (related to this present study)
SISP models	Nolan (1979) Porter & Miller (1985) Applegate *et al*. (1996) Greiner (1972) Wang & Tai (2003) Magal *et al*. (1998)	(1) Nolan's growth model – Six stages of growth – initiation, contagion, control, integration, data administration, maturity. This model represents a growth and learning model for organisations implementing IS to obtain success.	The existing models, i.e. Henderson and Venkatraman SAM, Delone and McLean success model, Wang and Tai organisational context model, Petter et al. and Porter and Miller life concept model were found not to have little applicability in the private or hospital pathology sites studied.
		(2) Life cycle concept model – This model illustrates how businesses develop and adapt through pressure on the business	This study found that the life cycle concept model was not evident in practice in either the private or hospital pathology laboratories studied.
		(3) Learning from crisis model – a model that demonstrates how businesses undertake learning and adapting through business crisis survival	This research found no evidence of the existence of crisis model learning in either the private or hospital pathology laboratories studied.
		(4) Information centers evolving by learning & adapting from clients ultimately become a corporate resource	There was no evidence for the existence of learning centers in private or hospital pathology in this research
		(5) Evolution of growth through slack' & 'control' – to achieve technology assimilation and to learn how to use new technologies more effectively	This research found that there were no methods of technology assimilation used in either private or hospital pathology laboratories studied.
		(6) Impacts of organisational contexts, content and process dimensions and planning system's capability are pivotal to successful IS planning	There was no evidence of the consideration of organisational contexts, process dimensions and planning system capabilities in either of the planning process in private or hospital pathology laboratories studied.

Key concepts	Research Literature Source	Existing research findings	Pathology IS research Findings & Comments (related to this present study)
IS evaluation	Irani & Love (2001) Symons (1991) Klecun & Cornford (2005) Grover *et al.* (1998) Smithson & Hirschheim (1998) Bannister & Remenyi (2000) Walsham (1993) Renkema & Berghout (1997) Forbes *et al.* (1999) Irani & Love (2002) Seymour (1991)	(1) The difficulties of evaluation of IT/IS benefits were found to be- excessive cost, extensive time frame and existing methods that are ineffective in the evaluation of IS projects/systems (2) The conditions for evaluation need to be defined to consider personal agendas and bias, that is, there needs to be an evaluation context established for meaningful evaluation (3) IS evaluation in health vertical is difficult because of complexity of industry, number of stakeholders and different organisational structures within related components of the industry (4) The emphasis on organisational change has introduced political, cultural and organisational aspects in the evaluation process that may influence the evaluative outcome to be incomplete, biased or superficial.	This study found that IS evaluation of pathology information systems is tenuous and is based on the functional requirements of the laboratory & not related to any strategic capability of the information systems. The research also found that scientists evaluated the development of a new technologically capable pathology IS as too expensive. This research found that there were management personal agendas and internal politics operating in public hospitals and this contributed to the pathology IS being evaluated as having little priority for planning and development Pathology IS were evaluated poorly in the hospital environment compared to other organisational structures. Consideration for investor stakeholders was given precedence in private pathology IS evaluation rather than investment in what they viewed as risky new IS. The research found that here was a stratification of personal evaluation of the pathology IS by different stakeholders for differing personal and/or political reasons This research found no evidence of IS evaluation tools or process in pathology.

Key concepts	Research Literature Source	Existing research findings	Pathology IS research Findings & Comments (related to this present study)
IS evaluation (continued)		(5) There is difficulty in assessing measuring tools for evaluation – traditionally technical aspects of a system have been evaluated but more recently organisational change aspects are being considered as at least equally important	This research has identified a void between pathology and other business verticals in terms of the knowledge of and application of organisational elements of IS and their consideration in the evaluation process
		(6) The literature highlights contradictions of outcomes with respect to the relationship between IT/IS investments and organisational productivity, and how this is measured	This research demonstrated some contradictions in the evaluation of the pathology IS in that productivity was measured as applicable to one functional component of the pathology IS and did not relate to the evaluation to overall organisational productivity

Key concepts	Research Literature Source	Existing research findings	Pathology IS research Findings & Comments (related to this present study)
IS effectiveness measurement	Grover & Segars (2005) Raghunathan & Raghunathan (1988) Premkumar & King (1992) Lederer & Sethi (1998) Youthas & Young (1998) Gation (1994) Grover *et al.* (1998) Saarinen (1996) Petter *et al.* (2008) Linclon (1986) Parasuraman (1985) Pitt et al. (2001) Delone & McLean (1992) Petter *et al.* (2008) Petter *et al.* (2008) Molla & Licker (2001) Delone & McLean (2004)	(1) Measurement of IS effectiveness methods commonly involves IS use, UIS, and decision support capability (2) There is controversy relating to UIS as a measure of IS effectiveness as it is debated whether UIS is a true indicator of IS effectiveness (3) Inefficient IS effectiveness measurement is due to the shortcomings of UIS as measure of IS effectiveness – UIS is a behavioural/ attitude phenomena and has little relationship with primary business goals (4) SESAME – represents another method of IS effectiveness measurement and is based on cost-benefit analysis. It has contributed to a more rational approach to IS effectiveness measurement by using a standardized methodology (5) SERVQUAL – represents another means of standardized assessment of IS effectiveness and measures IT department service quality as opposed to assessing applications	There was no objective means of assessing pathology IS effectiveness identified in this study in either private or hospital pathology. The controversy surrounding the use of UIS as a measure of IS effectiveness was encountered in this research in the context of recognition by participants that the pathology IS provided UIS for some functional data provision. There was, however, overall agreement by participants that the same data provision was not strategic and could not be used to assess IS effectiveness strategically This research revealed evidence that UIS is a personal view of the effectiveness of the pathology IS and as such did not relate to the business goals of the firms in this study. Functional decisions based on cost-benefit analysis and other financial considerations were found to occur in pathology IS development but were found not to apply to strategic development of pathology IS and its effectiveness assessment in either public or private laboratories in this research. This study identified a lack of an objective and formal method of assessing service quality in pathology

Key concepts	Research Literature Source	Existing research findings	Pathology IS research Findings & Comments (related to this present study)
IS effectiveness Measurement (continued)		(6) The 6 dimension Success model – system quality, information quality, service quality use, user satisfaction and net benefits are a basis for IS effectiveness measurement. (7) The Delone and McLean success model has been expanded to include the impact of service quality, knowledge management and e-commerce in response to the changing components and means of doing business.	This research found that the use of models for the assessment of IS effectiveness did not occur in pathology and that participants in the study were unaware of their existence. Knowledge management methods were found not to exist in pathology. The lack of pathology IS capability was found to exclude pathology from developing an e-commerce component to its business model(s)
Composite planning models	Singh (1993) Zhu & Kraemer (2005)	Most planning models incorporate strategic, tactical and operational levels, and have provision for an external feed back loop for continuous assessment to help review and keep plans current	There was no evidence of strategic, tactical or operational level strategic planning models found in this study in private or hospital pathology

Key concepts	Research Literature Source	Existing research findings	Pathology IS research Findings & Comments (related to this present study)
Planning project and team structure	Jiang *et al.* (2002) Gray & Larson (2000)	(1) Pre-planning partnering was implemented to look at IS planning and IS effectiveness success on the basis that the planning team is critical to project success and pre-planning partnering helps to remove potential conflicts	This research found that project planning, and consequently pre-planning partnering, did not to occur in pathology. The research found that there is an individual approach rather than a team approach to limited planning by individual stakeholders for development of functional tools to aid in a specific, unique task. These developments were found to have no strategic value by this study.
		(2) Team structure & relationship of members is critical to project success and building a cohesive motivated team is a prelude to the accomplishment of project goals	This finding by the research shows an attitude of individualism that has no concept or interest in a team approach to planning and development of the pathology IS.
		(3) Top management should support the team structure & make finance available for the pre-planning partnering and team building exercises.	This research found that management did not support a team approach to planning in private or hospital pathology

Key concepts	Research Literature Source	Existing research findings	Pathology IS research Findings & Comments (related to this present study)
Commoditisation of laboratory information systems	Friedberg (2008) Bossuyt *et al.* (2007)	(1) Pathology information systems are regarded as a commodity and as such are not seen to have any strategic value. – This compromises development of the pathology information systems as funds are not prioritized and made available for information systems development.	The research agrees that the pathology information systems are regarded as a commodity and that, in private pathology, a long-standing lack of capability of the pathology information systems and pressures for a maximum return to shareholders are significant contributors to the commodity view. Commoditisation in the hospital pathology environment was found to be due to pathology having a low priority for funding, as well as a long standing lack of capability of the pathology information systems.
		(2) Pathology information systems not viewed as a strategic tool due to lack of development and lack of technical capability. This compromises funding for development that further widens the technological void between pathology and other knowledge based business verticals.	This study found that commoditisation is present in both hospital & private laboratories–and that commoditisation undermines spending on development & negates a strategic view of pathology information systems. The research confirmed that there is a technological void between private and hospital information systems and the information systems of other knowledge based verticals

8.3. Key findings and discussion

The key findings from the above table for both private and hospital pathology are:

- There is a strong view within the medical industry as a whole that the pathology information system is a commodity and as such is not viewed as strategic. Hence the pathology information system does not attract funds for development;
- The mainframe pathology information systems are not scalable and flexible and are unable to support modern technology such as open architecture and client-server systems, and this impacts negatively on business outcomes in both private and hospital pathology;
- The pathology information systems were found to be functional and not strategic which compounded their lack of scalability and flexibility;
- There is no objective means of measuring and evaluating information systems planning effectiveness used by the private or hospital pathology;
- Spending on investment in pathology in both private and hospital pathology is functional and not strategic;
- Business-IT alignment and end-user involvement in strategic planning are not evident in either private or hospital pathology;
- The presence of a monopoly in private pathology practice negatively influences information systems development in both private and hospital pathology;
- Middle management in both private and hospital pathology practice is not IT aware, and the IT staff in both private and hospital pathology are not familiar with the business and strategic goals of the firm.

These key findings are instrumental in answering the primary research question “How does the effectiveness of laboratory information systems impact on business outcomes in medical pathology"? and the research sub-questions, "Does SISP occur in medical pathology in Australia" and " What are the determinants of information systems effectiveness in pathology laboratories in Australia"? These key findings and their impact and role in answering the research questions are discussed in detail below.

8.3.1 Commoditisation of pathology information systems – impact on strategy

There is a strong view within the medical industry, both public and private sectors that the pathology information systems are a commodity and as such are not viewed as strategic. Hence the pathology information systems do not attract funds for development. The pathology information systems were shown not to have any strategic value *per se* and did not attract funds for strategic development. Contributing factors to the pathology information system being regarded as a commodity were found to have two major differences – in the hospital scenario, hospital management regarded pathology in general, and the pathology information system in particular, with a very low priority compared to other departments and services. The hospital pathology department was therefore at the bottom of the list when it came to the allocation of funds for development. Private pathology also lacked strategic funding of the laboratory as a whole, and specifically the pathology information system. This study found that there are two factors that contribute to lack of funds in private pathology – private pathology is regarded as a limited monopoly in Australia as the are only three major players. There is therefore little incentive for change as each player has a sizeable share of the market and is making good profits. The second contributing factor to lack of funding in private pathology in Australia is that all three major firms are public companies and therefore concentrate on maximising profits to enable the best possible shareholder returns.

The discussions in each of the three focus groups determined that the pathology information systems were regarded as a commodity and as such have no strategic value. This view in both private and hospital pathology largely determines funding. The hospital pathology laboratory is dependent on government funding, the amount of which relates to the priority in which top management within the hospital holds pathology, and the philosophy of the incumbent political party. Private pathology, a commercial operation, may have a scientific mission, but typically it is subordinated to economic considerations and considered success only in terms of net return on investment. Competition based only on price and financial considerations leads to commoditisation and often results in a race to the bottom of quality (Friedberg, 2008). The pathology information systems therefore attracted little capital for strategic development in both the hospital and private pathology settings in this study.

8.3.2 Pathology information systems lack of capability – impact on strategy and business outcomes

The research has also shown that mainframe pathology information systems are not scalable and flexible and are unable to support modern technology such as open architecture and client-server systems and this impacts negatively on business outcomes in both private and hospital pathology.

The data collected in all parts of this study have shown that both the hospital and private laboratory information systems lack the capability to support technological and strategic change. The survey data showed that pathology information systems capability is the influence on the process of strategic information systems planning and of information systems effectiveness. The ability for staff in pathology to undertake successful strategic planning was therefore primarily dependent on the pathology information systems being capable in its ability to support strategic planning itself. The survey data, however, showed that the survey participants did not agree that the pathology information systems are capable (Chapter 5, Table 5.5), and this finding supports the earlier argument that lack of information system capability negatively impacts on business outcomes in pathology practice.

The pathology information systems were found to be functional rather than strategic in their use, which compounded their lack of scalability and flexibility. A distinction between information system functionality and capability was made in this research with respect to the pathology information systems in hospital and private pathology to assist in the determination of exactly what role the current pathology information systems play in strategic planning in pathology practice. In accordance with the Henderson and Venkatraman's (1999) Strategic Alignment Model (SAM), systemic capabilities can positively contribute to the creation of new business strategies, or better support the existing strategies. This research has shown that the pathology information systems in both hospital and private pathology lacked capability and that this has had a negative impact on business outcomes. The lack of capability of the studied pathology information systems thus affected the capacity of the organisations to establish effective strategic planning. This outcome supports the arguments of Rondeau *et al.* (2006); Hackney *et al*. (1999); Gerwin and Kolodny (1992); and Grover and Segars (2005) who argued that firms with high levels of organisational involvement in information systems related activities have higher levels of information systems management effectiveness.

8.3.3 Lack of use of objective means of information systems effectiveness measurement in pathology

This research demonstrated that in the pathology laboratories studied there was no objective means for measuring and evaluating information systems planning effectiveness. The literature studied in this research has cited a number of methods of assessing information systems planning effectiveness, the commonly used methods being information system use, user information satisfaction (UIS) and decision support capability. UIS is the more favoured of these success measures, but remains controversial as UIS is regarded as a behavioural/attitude phenomena and has little to do with the primary business goals of the firm (Grover and Segars, 2005; Raghunathan and Raghunathan, 1998; Lederer and Sethi, 1998). The data analysis in this study into both private and hospital pathology showed there was recognition of UIS as a indicator of information systems effectiveness on an individual level for the functional tasks of the pathology information system. All participants agreed however, that UIS was not a measure of strategic information systems effectiveness and concurred with the literature findings that UIS is unrelated to the business goals of the firm. In the context of the expansion into more modern business facilities, embracing service quality and e-commerce for instance, both private and hospital pathology information systems are unable to support this expansion which embraces a service centric approach. The means of measuring information systems effectiveness (Petter *et al.*, 2008) in terms of service quality (SERVQUAL for instance) is not able to be integrated into current mainframe pathology systems.

8.3.4 Strategic information systems planning was not evident in pathology

This research has found that strategic planning activities previously mentioned in the research literature (Grover and Segars, 2005; Grover *et al.*, 1996; Rondeau *et al.*, 2006; Petter *et al.*, 2008) were not as evident in pathology practice in Australia in the exemplars used in this study. There are two important aspects of strategic planning that have been underemphasized, and this was found to be the case in this study in pathology practice in Australia. The first is the planning process or how planning is accomplished. The second is planning evolution or how planning evolves as a learning exercise (Grover and Segars, 2005). Both perspectives can provide practical guidance on how organisations will change their planning process over time in an attempt to improve their effectiveness as well as leverage their investment in SISP. This research has shown that these planning activities were underemphasized in pathology practices to the detriment of business outcomes.

8.3.5 Financial considerations, business-IT and end-user involvement and their impact on planning

Financial issues relating to the pathology information systems and created by management in both private and hospital pathology were shown to have had a negative effect on pathology information systems effectiveness. Economic constraints within the healthcare system advocate the introduction of tighter control of costs. Based on cost information, proper decisions regarding priorities, procedure choices, personnel policies and investments can be made. This research has shown that hospital pathology has a low priority in the eyes of hospital management and as a result is not funded for development by the hospital management. Private pathology management has pressure and priority to maximise the return on investment to the investors, and as a consequence, funding for pathology information system development is not forthcoming.

Business-IT alignment and end-user involvement had a positive but small affect on strategic planning in the pathology practices studied. Business-IT alignment and end-user involvement in planning were not strong factors impacting on strategic planning in pathology practice in Australia. This research has shown that underlying this finding is a lack of understanding of the principles of strategic planning and their application and a lack of a cohesive approach to planning in pathology. Analysis of the research data pertaining to the FG1 and FG2 confirm that incremental development of pathology information systems is often an individual planning process, that is, a process for change is initiated by one person or one department. The participants in both focus groups gave examples of this approach and the examples demonstrated a lack of planning alignment and end-user involvement with the end result that the change initiated was not suited to the existing workflow systems. This research has further shown that due to lack of capability of the pathology information systems the alignment between business strategy and information systems was compromised. Grover and Segars (2005) argue that successful strategic planning of information systems should achieve alignment between the information systems and business strategy; should analyse and understand the business and associated technologies; should foster cooperation and partnership between managers and user groups; should anticipate relevant events/issues within the competitive environment and should adapt to unexpected organisational and environmental change. In this study of pathology information systems, both in the private and public sectors, there was little evidence of alignment between the information systems in use and business strategy; there was little evidence of all stakeholders being involved in analysis of either the business nor the technologies in use; there was significant evidence that there was poor co-operation and almost no partnership between management and end users; and there was little evidence of co-operative change. Change was often forced.

The research into pathology practice in this study has shown that end user involvement in the planning process does not occur significantly. The data collected in this study shows that there is a gap in the individual needs of the scientists and the IT staff, and that there is a clear lack of communication with respect to pathology information systems development. This lack of communication often resulted in change and enhancement to the pathology information systems by the IT staff without consultation with the scientists to the detriment of the pathology workflow system. In an organisational context, this represented an inability for the pathology practices in this study to undertake any co-ordinated integration or any implementation of change and development.

Wang and Tai (2003) argued that contextual factors are important in strategic planning of information systems. They suggest that stakeholders not understanding context may lead to the planning system being less adaptable to different organisational contexts and therefore be overly deterministic. There was little evidence in either the public or private pathology of context planning. The lack of significant business-IT alignment and end-user involvement in this study can be interpreted as undermining the planning system and information systems effectiveness that Wang and Tai (2003) alluded to, that is, commitment to planning, implementation mechanisms and acceptance of integration and planning mechanisms were compromised. These findings demonstrate that from the perspective of organisational and contextual considerations, hospital and private pathology practices in this study were lacking in an ability to undertake effective strategic planning.

The link between strategic planning and performance has been found to be inconsistent by Grover and Segars (2005) and Premkumar and King (1992). Some indicators suggested for assessment of information systems effectiveness have been information systems usage, user information satisfaction (UIS), quality of decision making, productivity from cost/benefit analysis and system quality (Ein-Dor and Segev, 1978). The most commonly favoured factors have been information systems use and UIS. However, because of a lack of a theoretical framework for placing UIS within the greater context of overall 'information systems effectiveness' its relevance as a performance measurement has been questioned (Grover and Segars, 2005). This research has found that there was some recognition by the participants in the survey and in FG1 and FG2 that UIS, when applied to some functional data provision, was a satisfactory measure of information system effectiveness. This research also showed, however, that UIS as an acceptable measure of information system effectiveness was an individual view, and that UIS as a strategic measure of information system effectiveness was unacceptable to the scientists as end-users. This view was supported by the research participants, who acknowledged that UIS has little, if any relevance to the business goals of the firm.

8.3.6 Service quality in pathology

The results of this research have shown that the effective use and further development of both hospital and private pathology information systems was compromised by the lack of attention by management given to the service quality in both the public and private sectors. The opportunity for the development of strategic plans involving the pathology information systems in an attempt to obtain a competitive advantage in the pathology industry was at best also compromised. This is attributable to the lack of capability of the existing pathology information systems to embrace modern technologies such as the internet, telemedicine and e-commerce shown by this research. The task-technology gap that is evident in pathology information systems has now expanded to include technical support for developing and efficient business trends that have a strong emphasis on service quality. This research has shown that existing pathology information systems are unable to accommodate such service quality analytical tools as SERVQUAL.

8.3.7 The impact of a monopoly in private pathology

The presence of a limited monopoly in private pathology, it can be argued, negatively influenced pathology information system development in private and hospital pathology in Australia. Private pathology practice in Australia consists of a limited monopoly of three publicly listed businesses. This research has demonstrated that the monopoly has had a two-fold impact on commoditisation of the pathology information systems in private pathology laboratories. The effects of the monopoly in private practice also impacted on those hospital laboratories that are managed and run by private pathology practices. Firstly, a monopoly tends to remove the need for development and innovation to achieve competitive advantage as a monopoly maintains an uncompetitive status quo. Secondly, and perhaps more dynamic in its impact on commoditisation and strategic spending, is that all three businesses in the monopoly are publicly listed and as such have a responsibility to their shareholders to maximise profit and stakeholder returns. For commercial pathology practice, the key drivers are economic. Industry requires a profit margin to appease the shareholder base and consequently must deliver services. Commercial operations may have a scientific mission, but typically it is subordinated to economic considerations and considered successful only if the net return is positive (Friedberg, 2008). This research has found that management decisions pertaining to laboratory equipment were based on cost analysis of reagents and had no strategic inferences. This determination by management also was shown to apply to the development of the pathology information systems. Spending was shown in this study to be functional and not strategic. To some extent this relates to the monopoly in private pathology practice in Australia.

8.3.8 Lack of awareness of IT and business principles in management and IT staff

Middle management was shown in this study not to be IT aware. The study also showed that the IT staff is not familiar with the business and strategic goals of the firms involved. This research has demonstrated that middle management in both private and hospital pathology is not aware of basic IT functionality and capability and this has been shown to have had a negative impact on any occurrence of pathology information systems development, and consequently on business outcomes. Middle management was not aware of more modern technologies such as open systems architecture and web based systems. The ramifications of this lack of understanding have in the past compromised local development of the pathology information systems with the end result being a lack of pathology information system capability. As the private pathology practices have expanded internationally, this research has shown that the lack of awareness of middle management of modern IT capability restricted the practices' globalisation efforts in terms of modern capable and flexible IT support for pathology information systems effectiveness.

It has also been demonstrated by this research that the IT staff in both private and hospital pathology lack an understanding of business in general and the strategic goals of the practice in particular. This was especially evident in the focus group analysis where is was stated that the IT department would often make information system changes without any consultation with pathology staff as to what the changes were and how the changes would impact the business workflow and goals of the pathology laboratory. The research has also shown there to be the presence of bias and personal agendas within the management and IT staff that have been cited by participants of the focus groups as being major contras to an open and team based approach to pathology information system development.

8.4 Summary

This research has investigated the level of strategic information systems planning in private and hospital pathology laboratories and its impact on business practice and development in pathology practice in Australia. The research also considered the role of two specific components introduced by the researcher relating to pathology laboratories, those being pathology information systems capability and the role of research and education in pathology information systems development and laboratory management.

The analysis of the data has shown that a lack end-user involvement and business-IT alignment negatively impact on strategic planning in pathology practice, as they do in many other businesses. The data in this study has shown that pathology laboratory information systems capability is the dominant determinant of strategic planning in pathology laboratories in Australia. The participants in the study acknowledged that both the hospital and private pathology laboratory information systems are not capable and as a result of this, effective strategic planning is unlikely to be able to occur in both hospital and private pathology in Australia.

This research also found that, whilst financial considerations were acknowledged as being important in the management of the laboratory, financial considerations had no strategic role, that is, spending in private and hospital pathology laboratories in this study is functional and not strategic. This finding is in keeping with the work by Mayer (1998) on cost analysis in pathology and its impact on pathology development. He found also that the emphasis in pathology was one of cost containment at the expense of development, that is, that pathology analysers are no longer being selected for their quality and capacity. The cost per test was the only consideration used by the pathology in his study.

8.5 Conclusions

The research project was undertaken to investigate how the effectiveness of pathology information systems impacts on business outcomes in hospital and private pathology in Australia. The results of the research have shown that there is indeed a negative impact on business outcomes, principally based on the fact that the pathology information system is regarded as a commodity by those in the health vertical, and that the pathology information system lacks capability and fails in its ability to support the strategic development of the business. The negative attitude with which the various participants regard the pathology information systems illustrates that, in their view, it is not capable and it is therefore not a strategic tool.

Spending in private pathology was found to be functional and not strategic, in keeping with Friedberg's (2008) comments that commercial pathology laboratories may have a scientific mission, but typically it is subordinated to economic considerations and considered successful only if net return is positive. The alignment between the pathology scientists and IT staff was found to be lacking which further compromised efficiencies of planning and development. This is in contrast to the OpenLabs project in the UK (O'Moore *et al.*, 1996; Boran *et al.*, 1994) where the development of pathology was the focus of strategic planning and the key indicator of success and effectiveness.

The research however is limited in its ability to generate significant generalisations but does create the opportunity for further research that will enable more generalisations to be developed in the future. The key findings of this research have demonstrated not only that both private and hospital pathology are unable to use the principles of strategic information systems planning and apply them to information systems development but also that information systems effectiveness is not able to be measured in either the private or hospital pathology exemplars in this study. The research has also demonstrated that planning principles, when applied to pathology, do not fit with any recognised models cited in this thesis. The Henderson and Venkatraman strategic alignment model (SAM), for example, has components of external strategy and internal capability in which the IT/information systems play a pivotal role. The lack of capability demonstrated by this research precluded the studied pathology information systems from achieving business-IT alignment in the way suggested by the model.

This research has found that both private and hospital pathology information systems in the Australian exemplars used, through their lack of capability, scalability and flexibility, were unable to support the technologies required to enable the use of indicative success factors in modern business - e-commerce technologies, knowledge management systems and processes and the use of effective service quality measures such as the SERQUAL application (Petter *et al.*, 2008; Delone and McLean 1995).

This research demonstrates that the pathology industry in Australia is lacking an organised and informed approach to strategic information systems planning, information system effectiveness measurement and the assessment of service quality. The technological void between pathology and other knowledge-based verticals could also be said to apply to business structure and existing planning processes.

8.6 Limitations of the research.

Throughout this study specific limitations were highlighted. The research design and methodology has limitations associated with this study being exploratory, the principal limitation being that, as an exploratory exercise, the methodology has no history of peer group review and acknowledgement of its validity as a research method. Despite a significant number of studies undertaken in other business verticals, this study breaks new ground and has had no established industry exemplar methodologies to follow.

The lack of sufficient responses to the survey instrument required a change in methodology to accommodate a lower sample number. In the original research methodology, structured equation modelling (SEM) was to be used as the pathway analysis technique. SEM requires a minimum sample number of approximately 250 samples for valid analysis results to be obtained (see Chapter 4 – methodology). The survey provided only 96 completed questionnaires, which was clearly an insufficient number for SEM. After extensive evaluation of alternate methods of pathway analysis, which included partial least squares and linear multiple regression, linear multiple regression was deemed to be the most suitable and peer group ratified method to use. The novelty of this approach is a matter for caution until future research confirms (modifies or rejects) the findings by following a similar research paradigm.

The measuring instrument can bear some inherent limitations as it relies on one person's knowledge and ability to accurately convey their impressions into the questionnaire. Hence, the use of perceptual measures from a single respondent could result in potentially subjective judgements.

In some instances the underlying assumptions in statistical methods can affect their validity and effectiveness. The lack of survey respondents was attributable a lack of the Australian pathology industry's willingness to participate in this research project, and this presented limitations for the selection of quantitative methodology, as stated above. The relatively small number of respondents may potentially limit the diverse attitudes and opinions expressed by the population under study. The lack of willingness to participate also had an impact on the selection of the qualitative method that is, the lack of willingness to participate and the lack of time to participate contributed to the selection of focus groups and not individual interviews for this research. Also, the researcher's cognition and experience influence the result interpretation. The result presentation relies on the researcher alone, which could be a limiting factor due to the researcher's ability to communicate and present the complexity of research. The limitations associated with focus groups as used in this research are a lack of privacy that may influence respondents' comments and difficulties in recording the focus group and analysis the open-ended responses.

8.7 Future research.

Future research should address the limitations pertaining to the methodology used and the conduct of this research. The first and perhaps the most significant limitation, that being the lack of willingness of the industry to participate in this research project, needs to be overcome. This is a major problem and a means for persuading the pathology industry to participate in future research projects such as this thesis is unclear to the researcher. Perhaps an awareness by the pathology industry that there is active research now being undertaken in the vertical and that this research is making findings that will be beneficial to the vertical's business infrastructure and outcomes may allay some of the hesitancy and fears expressed by senior executives of pathology practice in this project. A larger number of participants and a willingness to participate would introduce more flexibility into the selection of research methodologies for future research i.e. SEM and one on one interviews would be available for use in methodologies of the future. The results obtained by a more extensive methodology base would serve to enrichen the research process and its outcomes through the achievement of a more confident level of generalisation.

Addressing the limitations found in this research would assist in obtaining an increased awareness of the pathology service in its rightful role as a consultancy service. This would contribute to pathology not being regarded as a commodity, which would result in a more favourable position for provision of funds for development and change in pathology in general.

8.7.1 Reverse SISP – a developing concept

Conventional SISP (Grover and Segars, 2005; Grover *et al.,* 1996; Petter *et al.,* 2008) may be regarded as a planning exercise where the driver for change is initiated from within the business/firm, and may be driven by events such as –

1. a perceived advantage of an IT development to enhance business goal(s);
2. solution to internal problems i.e. mainframe to open-architecture (OpenLabs);
3. market research and interpretation of change in factors such as political and economic developments to get competitive advantage;
4. economic and business factors.(Grover and Segars, 2005; Grover *et al.,*1996)

The mechanism for conventional SISP involves such principles as business-IT alignment, end-user involvement, pre-planning partnering and financial considerations (cost-benefit analysis) working together in a cohesive team effort to undertake to plan for, and execute, change (Grover and Segars, 2005; Grover *et al.,* 1996). This study has highlighted that an alternative perspective might be possible. Reverse SISP represents a demand on a participant of a vertical for change from other participants in that vertical. This change is in keeping with strategic developments of the vertical as a result of strategic pressure on the vertical. Reverse SISP is a situation whereby external factors and strategic pressure are brought to bear on the component of the vertical by other associated components of that vertical. The concept of reverse SISP arises from considerations of scenarios pertaining to hospital and private pathology as a result of external pressure, such as the implementation of the Healthsmart project, the State Government project for the implementation of a standardises IT platform for public health throughout Victoria. If other departments change, pathology will have to follow suit – the change in the other departments via Healthsmart will force it to. The decision to change will be out of the pathology's hands.

The concept of reverse SISP is based on change being initiated by external drivers for change, most likely from a closely related participant component of the same industry vertical. Reverse SISP results from considerable strategic pressure being placed on the vertical component lacking comparable technologies/business practices. In the case of the Healthsmart scenario, pathology is subject to external drivers to change, that is, other related hospital departments (radiology, cardiac catheter department). The drivers are that pathology is required to update its pathology information system to be able to accommodate the same ICT platform as the other departments and the hospital in general. There is a need to study the implications of reverse SISP in the application of the principles of SISP to other studies of pathology information systems and information systems in other verticals.

8.8 Implications of this study for practice and research

The implications of the pathology information system being strategically incapable are both practical and academic. The practical implication is that the development and expansion of both hospital and private pathology in Australia is not supported by an efficient, modern IT platform. The ability to integrate modern ICT such as the internet, or even Web2, with voice over internet protocol (VOIP) telephony and intranets, for example, would provide more efficient information dissemination and co-operation amongst staff, especially when the international expansion of pathology in Australia is considered. This would enhance internal efficiencies that could lead to improved cost-effectiveness in the production of test results. The pathology information system would have the capacity to integrate with established technologies such as telemedicine and web-based voice recognition programs that would lend support to such strategic ventures as international expansion and the removal of workplace boundaries. The assessment of pathology information system effectiveness would be facilitated more objectively.

The ability to integrate the pathology information system with commercially available financial software packages could have sufficient positive impact to allow a change in business structure from a pyramidal hierarchy to a series of laterally linked self-funded business units. This could provide such management facilities as best practice and benchmarking, goal setting, and real-time cash flow, balance sheet and profit/loss statements that are currently unavailable.

The academic implication relates to assessing the effectiveness of the pathology information system. Without the ability to undertake strategic planning, there is little means of assessing information system effectiveness. This research has evolved a strategic planning information systems effectiveness model where the determinate for information system effectiveness is the attainment of a clearly established business goal that has been set after extensive analysis of the planned project and with the input of all relevant stakeholders. By way of publications relating to any effectiveness model, a more standardised approach to planning may evolve. This research has also highlighted the lack of formal education in pathology of strategic planning of pathology information systems and business in general, and discussions with course leaders following the findings of this research may lead to incorporation of strategic planning of pathology information systems and business principles into curriculum of future pathology practitioners.

The problem of solving the inefficiencies in both hospital and private pathology laboratories is widespread and complex. Firstly, there needs to be an awareness of the depth of the problem and this research will help in illuminating the general lack of ability for change. There needs to be a recognition that the systems (workflow and pathology information system) may not be as efficient as some people regard them. There needs to be a change in attitude towards the pathology information system in terms of priority for funding and recognition that the pathology information system may in fact be a strategic tool. The pathology information system may also be regarded as a critical component of a service centric industry if it can be developed to be able to integrate with service quality measurement tools such as SERQUAL. The possible ways forward mentioned above could see large improvements made to this important aspect of healthcare and save a considerable amount of money, but any approach needs input and cooperation from all parties to be successful. Reading and research by all parties to understand the nuances of strategic planning of information systems is critical to the way forward, without this in place progress and development would suffer the same negative outcomes as seen in the pathology industry now.

Bossuyt *et al.* (2008) argue that pathology services should capitalise on the knowledge of the clinical staff and expand their business models to include service provision by way of clinical consultation to advise doctors on which test to order to best investigate the patients symptoms. Comments made by the participants of FG3 support Bossuyt *et al.'s* (2008) concept in the context of pathology being fundamental to the investigation of disease and that if services were improved by better alignment of tests requested with the disorder being investigated, pathology services could be delivered more effectively. The two possible benefits of this are a means of expanding a business that is seen in the eyes of most clients as a commodity with no strategic value, and a means to reduce the public cost of health by reducing the requesting of inappropriate blood tests. A study in the context of a change of attitude towards pathology in terms of pathology being viewed as an active consultancy service and what impact this would have on the commodity view and hence a more favourable provision of funds for development could provide the basis to initiate a change in the role of pathology services in general.

REFERENCES:

Abdi, H. (2003): *Encyclopaedia of Social Sciences Research Methods,* Lewis-Beck, M., Bryman, a. and Futing, T. (Eds), Thousand Oaks, CA., Sage.

Alter, S.I. (1992): *Information Systems: A Management Perspective,* Addison-Wesley, Reading, MA.

Anandarajan, M. and Arinze, B. (1998): Matching client/server processing architectures with information processing requirements: A contingency study, *Information and Management*, 34, 265-274.

Applegate, L.M., McFarlan, F.W. and McKenney, J.L. (1996): *Corporate Information Systems Management: Text and Cases*, Irwin/McGraw-Hill, Boston, 1996.

Avison, D. and Fitzgerald, G. (1995): *Information systems development: methodologies, techniques and tools*, NY, McGaw-Hill.

Baets, W. (1992): Aligning information systems with business strategy, *The Journal of Strategic Information Systems*, 1(4), 205-213.

Baets, W.J. (1996): Some empirical evidence on IS strategy. Alignment in banking. *Information and Management*, 30(4), 155-177.

Bagozzi, R. (Ed.) (1994): *Principles of Marketing Research,* Blackwell Publishers, Oxford.

Bannister, F. and Remenyi, D. (2000): Acts of faith: instinct, value and IT investment decisions. *Journal of Information Technology*, 15, 67-77.

Baroudi, J.J. and Orlikowski, W.J. (1988): A short-form measure of UIS: A psychometric evaluation and notes of use, *Journal of Management Information Systems*, 4(4), 44 – 59.

Barribeau, P., Butler, B., Corney, J., Doney, M., Gault, J., Gordon, J., Fetzer, R., Klein, A., Rogers, C.A., Stein, I.F., Steiner, C., Urschel, H., Waggoner, T., and Palmquist, M. (2005): Survey Research, Writing @ CSU, Colorado State University Department of English. Retrieved 27th September, 2008 from http://writing.colostate.edu/guides/research/survey

Baskerville, R. and Lee, A.S. (1999): Distinctions among different types of generalizing in information systems research, in L.Introna, M.Myres and J.I.DeGross (Eds), *Organisational processes: Field studies and theoretical reflection on the future of work,* New York: Klewer Academic Publishers, 49-65.

Belkin, M., Corbitt, B. and Peszynski, K. (2008): Multi-dimensional modelling in the health industry, *Encyclopaedia of Healthcare Information Systems,* Vol.111, Hersey, New York.

Bhattacherjee, A.(2001): Understanding information system continuance: an expectation-confirmation model, *MIS Quarterly*, 25(3), 351-370.

Blaikie, N. (2003): *Designing Social Research*, Polity Press, CB2 1UR, Cambridge, UK.

Bokhari, R.H. (2005): The relationship between system usage and user satisfaction: a meta-analysis. *The Journal of Enterprise Information Management*, 18(2), 211-234.

Boomsma, A. (1982): "The robustness of LISREL Against Small Sample Sizes in Factor Analysis Models," in *Systems Under Indirect Observations, Part 1*, K.G. Joreskog and H.Wold (eds), North Holland, Amsterdam, 149-174.

Boran, G., O'Moore, R., Grimson, W., Peters, M., Hasman, A., Groth, T. and Van Merode, F. (1996): A new clinical laboratory information system architecture from the OpenLabs project offering advanced services for laboratory staff and users, *Clinica Chimica Acta*, 248, 19-30.

Bossuyt, X., Verweire, K. and Blanckaert, N. (2007): Laboratory medicine: Challenges and opportunities, *Clinical Chemistry*, 53(10), 1730-1733.

Boynton, A.C. and Zmud, R.W. (1987): Information technology planning in the 1990's: Directions for practice and research, *MIS Quarterly*, 11(1), 58-71.

Brender, J., Magdal, U., Wiegell, B., Schioler, T. and McNAir, P. (1993): Problem-oriented management of laboratory work through dynamic test scheduling, *Clinica Chimica Acta*, 222, 57-69.

Brender, J. and McNair, P. (1996): User requirements on the future laboratory information systems, *Computer Methods and Programs in Biomedicine*, 50, 87-93.

Brewer, G.D. (1983): Assessing outcomes and effects, in Cameron, K.S. and Whetten, D.A., (eds), *Organisational effectiveness: A Comparison of Multiple Models*, Academic Press, San Diego CA.

Broad, S.A. (1997): LIMS – A catalyst for re-engineering, *Laboratory Automation and Information Management*, 33, 9-12.

Bryman, A. (2004): Focus Groups. *Social Research Methods*, 2nd Ed., Oxford University Press, New York, NY. Chapter 16.

Burn, J.M. and Szeto, C. (2000): A comparison of the views of business and IT management on success factors for strategic alignment. *Information & Management*, 37(4), 197-216.

Byrd, T.A., Lewis, B.R. and Bryan, R.W. (2006): The leveraging influence of strategic alignment on IT investment: An empirical examination, *Information and Management*, 43, 308-321.

Cameron, K.S. and Whetten, D.A. (1983): Organisational effectiveness: one model or several? in Cameron, K.S. and Whetten, D.A. (eds), *Organisational Effectiveness: A Comparison of Multiple Models,* Academic Press, San Diego, CA.

Campbell, B. (2005): Alignment: Resolving ambiguity within bounded choices, PACIS, Bangkok, Thailand, 1-14.

Cerveny, R. and Clark, T. (1985): Conversations on "Why information systems fail and what can be done about it", *Systems, Objectives, Solutions,* 1, 149 – 154.

Chan, Y.E. and Huff, S.L. (1993): Strategic information systems alignment, *Business Quarterly,* 58(1), 51-55.

Chan, Y.E., Huff, S.L., Barclay, D.G., and Copeland, D.G. (1997): Business strategic orientation, information systems strategic orientation and strategic alignment, *Information Systems Research*, 8(2), 125-150.

Chan, Y.E. and Reich, B.H. (2007): IT alignment: what have we learned? *Journal of Information Technology,* 22, 297-315.

Chi, G. 2005, 'A Study of Developing Loyalty Model', PhD Thesis, Oklahoma State University.

Chin, W.W. (1998): "The Partial Least Squares Approach for Structural Equation Modelling," in *Modern Methods for Business Research,* G.A.Marcoulides (ed.), Lawrence Erlbaum Associates, Mahwah, NJ., 295-336.

Chin, W.W. and Newstead, P.R. (1999): "Structural Equation Modelling Analysis in Small Samples Using Partial Least Squares," in *Statistical Strategies for Small Sample Research,* R.H.Hoyle (ed.), Sage Publications, Thousand Oaks, CA., 307-341.

Choe, J-M. (2003): The effect of environmental uncertainty and strategic applications of IS on a firm's performance, *Information and Management*, 40, 257-268.

Coakes, S.J. (2005): *SPSS: Analysis Without Anguish: Version 12.0 for Windows,* John Wiley and Sons, Australia.

Connell, N.A.D. and Young, T.P. (2007): Evaluating healthcare information systems through an "enterprise" perspective, *Information and Management,* 44, 433-440.

Conrath, D.W. and Mignen, O.P. (1990): What is being done to measure user satisfaction with EDP/MIS, *Information and Management,* 6, 7-19.

Cook, T.D. and Campbell, D.T. (1978): "The design and conduct of quasi-experiments and true experiments in field settings," in M.D.Dunnette (Ed), *Handbook of industrial and organisational psychology,* Chicago, Rand McNally. P.223-326.

Coombs, C.R., Doherty, N.F. and Loan-Clarke, J. (2001): The importance of user ownership and positive user attitudes in the successful adoption of community information systems, *Journal of End User Computing,* 13(4), 5-16.

Cowan, C., Gray, C. and Larson, E. (1992): Project partnering, *Project Management Journal*, 22(4), 5-11.

Cresswell, J. (2003): *Research Design – Qualitative, Quantitative and Mixed Methods Approaches*, 2nd Ed., Thousand Oakes, Sage.

Cron, W.L. and Sobal, M.G. (1983): The relationship between computerisation and performance; a strategy for maximising the economic benefits for computerisation, *Information and Management,* 6, 171-181.

Cudeck, R. and Hensly, S.J. (1991): "Model Selection in Covariance Structure Analysis and the 'Problem' of Sample Size: A Clarification," *Psychological Bulletin,* 109, 512-519.

Davern, M. and Kauffman, R. (2000); Discovering potential and realising value from information technology investments, *Journal of Management Information Systems,* 16(4), 69-78.

Davis, F.D. (1989): Perceived usefulness, perceived ease of use, and user acceptance of information technology, *MIS Quarterly,* (13:3) September, 319-339.

Davis, G.B. and Olson, M.H. (1985): *Management Information Systems*, McGaw Hill, New York, 1985.

De Leede, J., Looise, J.C. and Alders, B. (2002): Innovation, improvement and operations: An exploration of the management of alignment, *International Journal of Technology Management,* 23(4), 353-368.

DeLone, W.H. and McLean, R.E. (1992): Information systems success: The quest for the dependent variable, *Information Systems Research,* 3(1), 60–95.

DeLone, W. and McLean, E.R. (2003): The DeLone and McLean model of information systems success: a ten year update, *Journal of Management Information Systems,* 19(4), 9-30.

DeLone, W.H. and McLean, E.R. (2004): Measuring e-commerce success: applying DeLone and McLean information systems success model. *International Journal of Electronic Commerce*, 9(1), 31-47.

DOH (1997): *The New NHS: Modern. Dependable.* HMSO, London.

DOH (2002): *Delivering the 21st Century IT Support for the NHS: National Strategic programme,* HMSO, London.

Doll, W.J. (1985): Avenues for top management involvement in successful MIS development, *MIS Quarterly,* 9(1), 17-35.

Doll, W.J., Xia, W. and Torkzadeh, G. (1994): A confirmatory factor analysis of the end-user computing satisfaction instrument, *MIS Quarterly,* 18(4), 453-461.

Dooley, L.M (2002): *Advances in developing human resources.* Thousand Oaks, CA: Sage.

Earl, M.J. (1993): Experiences in strategic information systems planning, *MIS Quarterly*,17(1), 1-24.

Ein-Dor,P. and Segev, E. (1978): Organisational context and the success of MIS, *MIS Quarterly*, 24(10), 1-24.

Eisenhardt, K.M. (1989): Making fast strategic decisions in high velocity environments, *Academy of Management Journal*, 32(3), 543-576.

Falk, R.F. and Miller, N.B. (1992): *A Primer of Soft Modelling,"* The University of Akron Press, Akron, OH.

Farbey, B., Land, F. and Targett, D. (1999): The moving staircase: problems of appraisal and evaluation in a turbulent environment, *Information Technology & People*, 12(3), 238-252.

Fishbein, M. (1967): Attitude and the prediction of behaviour, in M. Fishbein, (Ed). *Reading in Attitude Theory and Measurement*, New York, Willey, 477-492.

Fishbein, M. and Ajzen, (1975); Belief, Attitude, Intention and Behaviour: *An Introduction to Theory and Research*, Addison-Wesley Reading, MA.

Flaval, D.J. and Williams, J. (1996): *Strategic Management,* Prentice Hall, New York.

Fornell, C. and Larcker, D.F. (1981): *Outsourcing information technology: Contracts and the client/vendor relationship.* Oxford: Templeton College.

Frank, I.E. and Friedman, J.H. (1993): A statistical view of chemometrics regression tools, *Technometrics*, 35, 109-148.

Fredrickson, J.W. (1984): The comprehensiveness of strategic decision processes: extension, observations, future directions, *Academy of Management Journal*, 27(3), 445-466.

Friedberg, R.C. (2008): Time for a reality check. A hospital-based laboratory's perspective, *Arch. Pathol. Lab. Med.*, 132, 781-784.

Friedman, B. (2005): What's ailing pathology: why informatics will provide strong medicine.
https://www.labinfotech.org/LIS2006/Presentations2005/Friedman_las_vegas_200
cited 18/9/2006.

Gallies, R.D. and Samogyi, S.K. (1987): *From data processing to strategic information systems – a historical perspective, in Towards Strategic Information Systems,* Abacus Press, London.

Gallies, R.D. (1991): Strategic information systems planning: myths, reality and guidelines for successful implementation, *European Journal of Information Systems,* 1(1), 55-64.

Garson, .D, (Copyright 1998, 2007 – accessed 16th June, 2006), www2.chass.ncsu.edu/garson/pa765/factor/htm

Gation, A.W. (1994): Is user satisfaction a valid measure of system effectiveness? *Information and Management,* 26 119-131.

Gerwin, D. and Kolodny, H. (1992): *Management of Advanced Manufacturing Technology: Strategy, Organisations and Innovation*, Wiley, New York, NY.

Gibbs, A. (1997): Social Research Update 19, University of Surrey, UK.

Glynn, C.J., Herbst, S., O'Keefe, G.J., Shipiro, R.Y. and Lindeman, M. (2004): *Public Opinion,* Boulder CO, Westview Press, p.312.

Goldschmidt, H.M.J., de Vries, J.C.M., van Merode, G.G. and Derks, J.J.M. (1998): A workflow management tool for laboratory medicine, *Laboratory Automation and Information Management,* 33, 183-197.

Goodhue, D., Lewis, W. and Thompson, R. (2006): "PLS, Small Sample Size and Statistical Power in MIS Research," in *Proceedings of the 39th Hawii International Conference on Social Sciences,* R. Sprague Jr. (ed.), Kaurii, Hawaii.

Gorla, N. (1989): Identifying MIS research issues using a research framework, *Information and Management,* 17, 131-141.

Gray, C.F. and Larsom, E.W. (2000): *PROJECT management: The Managerial Process.* Irwin, McGaw-Hill, Boston.

Greiner, L.E. (1972): Evolution and revolution as organisations grow, *Harvard Business Review,* 50(4), 37-46.

Grover, V., Jeong, S.R. and Segars, A.H. (1996): Information systems effectiveness: The construct space and patterns of application, *Information and management,* 31, 177-191.

Grover, V., Teng, J., Segars, A.H. and Fielder, K. (1998): The influence of information technology diffusion and business process change on perceived productivity: the IS executives perspective, *Information and Management,* 34, 215-221.

Grover,V and Segars, A.H. (2005): An empirical evaluation of stages of strategic information systems planning: patterns of process design and effectiveness. *Information & Management,* 42, 761-799.

Gummesson, E. (1991): *Qualitative Methods in Management Research,* Sage Publications, London.

Hackney, R., Kawalek, J., and Dhillon, G. (1999): Startegic information systems planning: perspectives on the role of the end-user revisited, *Journal of end-user computing*, 11(2), 3-12.

Hair, J.F., Anderson, R.E., Tatham, R.L., and Black, W.C. (1998), *Multivariate Data Analysis,* (5th ed.), Prentice-Hall International Inc., Upper Saddle River, New Jersey, USA.

Hair, J, Black, W, Babin, B, Anderson, R & Tatham, R. (2006), *Multivariate Data Analysis ─ Six Edition*, New Jersey: Prentice-Hall.

Hamilton, S. and Chervany, N.L. (1981): Evaluating information system effectiveness – Part 1: Comparing evaluating approach, *MIS Quarterly*, 5(4), 79-86.

Helland, I.S. (1990): PLS regression and statistical methods, *Scandinavian Journal of Statistics*, 17, 97-114.

Henderson, J.C., Rockart, J.F and Sifonis, J.G. (1987): Integrating management support systems into strategic information systems planning, *Journal of Management Information Systems*, 4(1), 3-14.

Henderson, J.C. and Sifonis, J.G. (1988): The value of strategic IS planning: Understanding consistency, validity and IS markets, *MIS Quarterly*, 12(2), 187-200.

Henderson, J.C. and Venkatraman, N. (1993): Strategic alignment leveraging information technology for transforming organisations, *IBM Systems Journal*, 32(1).

Hines, T. (1998): *Management Information for Marketing and Sales,* Butterworth-Heinemann, Oxford.

Hines, T. (2000); An evaluation of two qualitiative methods (focus group interviews and cognitive maps) for conducting research into entrepreneurial decision making, *Qualitative Market Research: An International Journal*, 3(1), 7-16.

Hirscheim, R. and Smithson, S. (1986): A critical analysis of information systems evaluation, Research and discussion paper – RDP 86/13, Oxford Institute of Information Management.

Horngren, C.T. and Foster, G. (1991): *Cost Accounting. A Managerial Emphasis.* 7Th Ed., Prentice Hall, New Jersey.

Hoskuldson, A. (1988): PLS regression methods, *Journal of Chemometrics*, 2, 211-228.

Hoyle, R. Ed. (1995): *Structural Equation Modelling: Concepts, issues and applications,* Thousand Oaks, CA., Sage Publications. An introduction focusing on AMOS.

IBM Corporation (1981): Business systems planning – information systems planning guide, GE20-0527-3.

Irani, Z. (2002): Information systems evaluation: Navigating through the problem domain, *Information Management*, 419, 11-24.

Irani, Z. and Love, P.E.D. (2001): Information systems evaluation: past, present and future, *European Journal of information Systems,* 10, 183-188.

Irani, Z. and Love, P.E.D. (2002): Developing a frame of reference for ex-ante IT/IS investment evaluation, *European Journal of Information Systems,* 11

Ives, B., Olson, M.H. and Baroudi, J.J. (1983): The measurement of user information satisfaction, *Communications of the ACM,* 26 (10), 785-793.

Jackson, D.L. (2003): “Revisiting Sample Size and the Number of Parameter Estimates: Some Support for the N:q Hypothesis,” *Structural Equation Modelling,* 10, 128-141.

Janesick, V.J. (2000): The choreography of qualitative research designs; minuets, improvisations and crystallisation, in N.K.Denzin and Y.S.Lincoln (Eds), *Handbook of qualitative research,* (2nd ed., p.379-400), Thousand Oaks, CA, Sage.

Jennex, M.E. and Olfman, L. (2002): Organisational memory/knowledge effects on productivity: a longitudinal study. In *proceeding of the Thirty-Fifth Hawaii International Conference on Systems Sciences* (Sprague Jr, R.H., Ed.), p.109, IEEE Computer Society Press, Big Island, Hawaii, USA.

Jiang, J.J., Klein, G. and Discenza, R. (2002): Pre-project partnering impact on an information system project, project team and project manager, *European Journal of Information Systems,* Vol.11, 86-97.

Johnson, R.B. and Onwuegbuzie, A.J. (2004): Mixed methods research: a research paradigm whose time has come, *Educational Researcher,* 33(7), 14-26.

Kahneman, D., Slovic, P. and Tversky, A. (1982): *Judgement under uncertainty: Heuristics and biases,* Chichester, NY, Cambridge University Press.

Kaplan, B.(1987): The medical computing ‘lag’: perceptions of barriers to the application of computers to medicine, *International Journal of Assessment Health Care,* 3(1), 123-126.

Kearns, G.S. and Lederer, A.L. (2000): The effect of strategic alignment on the use of IS-based resources for competitive advantage, *Journal of Strategic Information Systems,* 9(4), 265-293.

Kearns, G.S. and Lederer, A.L. (2003): A resource-based view of strategic IT alignment: How knowledge sharing creates competitive advantage, *Decision Sciences,* 34(1), 1-29.

Kidder, L.H. and Judd, C.M. (1986): *Research Methods in Social Relations,* 5th Ed., New York, Holt, Rinehart and Winston.

King, W.R. (1988): How effective is your information system planning? *Long Range Planning*, 21(5), 103–112.

Kitzinger, J. (1995), BMJ Education and Debate Series: Qualitative research; introducing focus groups. http://www.bmj.com/cgi/content/full/311/7000/299

Kivijarvi, H. and Saarinen, T.(1995): Investment in information systems and the financial performance of the firm, *Information and Management*, 28, 143-163.

Klecun, E. and Cornford, T. (2005): A critical approach to evaluation, *European Journal of Information Systems*, 14, 229-243.

Kline, P., (1994), *An Easy Guide to Factor Analysis*, Routledge, London and New York.

Krieg, A.F., Israel, M., Fink, R. and Shearer, L.K. (1978): A approach to cost analysis of clinical laboratory services, *American Journal of Clinical Pathology*, 69, 525-536.

Kulkarni, U.R., Ravindran, S. and Freeze, R. (2006): A knowledge management success model: theoretical development and empirical validation. *Journal of management Information Systems*, 23(3), 309-347.

Larson, E. (1997): Partnering on construction projects: a study of the relationship between partnering activities and project success, *IEEE Transactions on Engineering Management*, 44(2), 188-195.

Laudon, K.C. and Laudon, J.P. (1991): *Management Information Systems: A Contemporary Perspective*, (2nd Ed), MacMillan, New York, NY., USA.

Le Blanc, L.A. (1991): SOS: An assessment of DSS performance, *Information and Management*, 20, 137-148.

Lederer, A.L. and Sethi, V. (1996): Key prescriptions for strategic information systems planning, *Journal of Management Information Systems*, 139!0, 35-62.

Lederer, A.L. and Sethi, V. (1998): The implementation of strategic information system planning methodologies, *MIS Quarterly*, 12(3), 444-461.

Levy, D.L. (2000): Applications and limitations of complexity theory in organisation theory and strategy, in J.Rabin, G.J. Miller and W.B. Hildreth (eds.) *Handbook of Strategic Management*, 2nd edn, New York: Marcel, 67-87.

Li, M. and Ye, L.R.(1999): Information technology and firm performance: linking with environment, strategic and managerial contexts, *Information and Management*, 35, 43-51.

Lincoln, T.J. (1976): *The Future Constraints*, The Oxford Centre for Management Studies Top Management Briefing report.

Lincoln, T.J. (1980): *Information System Constraints – A Strategic Review,* IFIP Congress.

Lincoln, T. (1986): Do computer systems really pay off ? *Information and Management,* 11, 25–34.

Lincoln, Y.S. and Guba, E.G.(1985): *Naturalistic Inquiry,* Beverley Hills, CA, Sage.

Linberg, K.R. (1999): Software developer perceptions about software project failure: A case study, *The Journal of Systems and Software*, 49(2/3), 177-192.

Loehlin, J.C. (1992): *Latent variable models: An introduction to factor, path and structural analysis.* Hillsdale, N.J: Lawrence Erlbaum, 2nd Ed.

Lucas, H.C. (1981): *Implementation – the Key to Successful Information Systems*, Columbia University Press, NY.

Luftman, J., Kempaiah, R. and Nash, E. (2005): Key issues for IT executives 2005. *MIS Quarterly Executive,* 5(2), 81-101.

Lyytinen, K. (1987): *A Taxonomic Perspective of Information System Development: Theoretical Constructs and Recommendations* in Critical Issues in Information Systems Research, Boland, R.J. and Hirschheim, R.A., (eds) John Wiley, New York, 3-41.

MacCallum, R.C., Browne, M.W. and Sugawara, H.M. (1996): "Power Analysis and Determination of Sample Size for Covariance Structure Modelling," *Psychological Methods,* 1, 130-149.

Magal, S.R., Carr, H.H. and Watson, H.J. (1988): Critical success factors for information centre managers, *MIS Quarterly,* 12(3), 412-425.

Mahmood, M.A., Hall, L. and Swanberg, D.L. (2001): Factors affecting information technology use: a meta-analysis of the empirical literature. *Journal of Organisational Computing and Electronic Commerce,* 11(2), 107-130.

March, I.G. and Simon, H.A. (1963): *Organisations.* New York, John Wiley and Sons.

Marcoulides, G.A. and Saunders, C. (2006): PLS: A silver bullet? *MIS Quarterly,* 30(2), 3-9.

Mason, R.O. (1978): Measuring information output: A communication systems approach, *Information and Management,* 1(5), 219-234.

Mayer, M. (1998): Laboratory cost control and financial management software, *Clinica Chimica Acta*, 270, 55-64.

McBride, N. (1998): Towards a dynamic theory of information systems planning in *Proceeding of the 3rd UKAIS Conference,* Lincoln University, 218-230.

McKay, J. and Marshall, P. (2001): The IT evaluation and benefits management life cycle. In *Information Technology Evaluation Methods and Management* (Grembergen W.V., Ed), 44-56, Idea Group Publishing, London, UK.

McLean, E.R. and Soden, J.V. (1977): *Strategic planning for MIS,* New York: Wiley.

Merton, R. (1987): The focuses interview and focus groups: continuities and discontinuities, *Public Opinion Quarterly*, Vol.51, p.550-566.

Menachemi, N., Saunders, C., Chukmaitov, A. and Matthews, M.C. (2007): Hospital adoption of information technologies and improved patient safety: A study of 98 hospitals in Florida, *Journal of Healthcare Management,* 52(6), 398-411.

Miller, J. and Doyle, B.A. (2001): Measuring the effectiveness of computer-based information systems in the financial services sector, *MIS quarterly*, March, 107-124.

Mingers, J. (2001): Combining IS research methods – towards a pluralist methodology, *Information Systems Research,* 12(3), 240-259.

Moad, J. (1989): Asking users to judge IS, *Datamation*, 3 (21), November 1, 93-100.

Molla, A. and Licker, P.S. (2001): E-commerce systems success: an attempt to extend and respecify the DeLone and McLean model of IS success. *Journal of Electronic Commerce Research,* 2(4), 131-141.

Morgan, D.L. (1997): *Focus Groups as Qualitative Research,* 2nd Ed., London, Sage.

Morse, J. (1991): On the evaluation of qualitative proposals, *Qualitative Health Research*, 1(2), p.147-151.

Mumford, E., Hirschheim, R., Fitzgerald, G. and Wood-Harper, T. (1985): *Research Methods in Information Systems,* North Holland, Elsevier.

Neuman, W.L (2003): *Social Research Methods: Quantitative and Qualitative Approaches.* Pearson Education, Inc., New York.

Nolan, R.L. (1979): Managing the crises in data processing, *Harvard Business review,* 57(2), 115-126.

Nunnally, J.C. (1978): *Psychometric Theory (2nd ed),* New York: McGraw-Hill.

Nunnally, J.C. & Bernstein, I.H. (1994): *Psychometric Theory (3nd ed),* New York: McGraw-Hill.

O'Brien, K. (1993): Improving survey questionnaires through focus groups. In Morgan, D. (Ed), Successful focus groups: advancing the state of the art. London, Sage. P.105-118.

O'Moore, R.R., De Moor, G., Boran, G., Gaffney, P., Grimson, J., McNair, P., Groth, T., Nykanen, P., Eller, J., Yearworth, M., Willems, J., Brender, J., Scott, P., Schilders, L., Clarke, B., Peters, M., Grimson, W. and McAllister, B. (1994): OpenLabs: the application of advanced informatics and telematics for optimisation of clinical laboratory services, *Computer Methods and Progress in Biomedicine,* 45, 137-140.

Parasuraman, A. (1988): SERVQUAL: A multi-item scale for measuring customer perceptions of service quality, *Journal of Retailing,* 64(1), 12-40.

Parasuraman, A. (1991): Refinement of reassessment of the SERVQUAL scale, *Journal of Retailing,* 67(4), p.420.

Parasuraman, A. (1993): Research note: More on the improving service quality measurement, *Journal of Retailing,* 69(1), p.140.

Parasuraman, A. (1994): Reassessment of expectations as a comparison standard in measuring service quality – implications, *Journal of Marketing,* 58(1), p.111.

Parasuraman, A., Zeithaml, V.A. and Berry, L.L. (1985): A conceptual model of service quality and its implications for future research, *Journal of Marketing,* (49) Fall, 41-50.

Peters, T. (1999): The WOW project, *Fast Company,* Vol. 24, 118-134.

Peters, T. and Homer, J. (1996): Learning to lead, to create quality, to influence change in projects, *Project Management Journal,* 27(1), 5-11.

Petter, S., DeLone, W. and McLean, E. (2008): Measuring information systems success: models, dimensions, measures, and interrelationships, *European Journal of Information Systems,* Vol. 17, 236-263.

Pitt, L.F., Watson, R.T. and Kavan, C.B. (2001): Service quality: a measure of information systems effectiveness, *MIS Quarterly,* June, 173-187.

Prekumar, G. and King, W.R. (1992): An empirical assessment of information systems planning and the role of information systems in organisations, *Journal of Management Information Systems*, 9(2), 99-125.

Porter, M.E. and Millar, V.E. (1985): How information gives you competitive advantage, *Harvard Business Review,* 63(4), 149-160.
Porter, M.E. and Olmsted Teisberg, E. (2004): Redefining competition in health care, *Harvard Business Review,* 82(64), 64-76.

Powney, J. (1988): Structured eavesdropping. *Research Intelligence: Journal of the British Educational Research Foundation,* 28, 10-12.

Pyburn, P.J. (1983): Linking the MIS plan with corporate strategy: an exploratory study, *MIS Quarterly,* 7(2), 1-14.

Raghunathan, B. and Raghunathan, T.S. (1988): Impact of top management support on IS planning, *Journal of Information Systems*, 2(2), 15-23.

Ragowsky, A., Ahituv, n. and Neuman, S.(1996): Identifying the value of importance of an information system application, *Information and Management,* 31, 89-102.

Rai, A., Lang, S.S. and Welker, R.B.(2002): Assessing the validity of IS success models: an empirical test and theoretical analysis, *Information Systems Research,* 13(1), 5-69.

Ramamijan, V. and Venkatraman, N. (1987): Planning system characteristics and planning effectiveness, *Strategic Management Journal*, 8(5), 453-468.

Reich, B.H. and Benbasat, I. (2000): Factors that influence the social dimension of alignment between business and information technology objectives, *MIS Quarterly,* 24(1), 81-113.

Reich, B.H. and Benbasat, I. (2003): Measuring the information systems – business strategy relationship, in *Strategic Information Management – Challenges and Strategies in Managing Information Systems*, R.D.Galliers and D.E.Leidner (eds)., Butterworth Heinemann, Oxford.

Remenyi, D., Williams, B., Money, A., and Swatz, E. (1998): *Doing Research in Business and Management – an Introduction to Process and Methods,* Sage Publications, London.

Renkema, T.J.W. and Berghout, E.W. (1997): Methodologies for information-systems investment evaluation at the proposal stage – a comparative review, *Information and Software Technology,* 39, 1-13.

Revere, L. and Roberts, R. (2004): Improving resource efficiency through management science, *Journal of Healthcare Management*, 49(5), 324-335.

Rondeau, P.J., Ragu-Nathan, T.S and Vonderembse, M.A. (2006): How involvement, IS management effectiveness, and end-used computing impact IS performance in manufacturing firms, *Information and Management*, 43, 93-107.

Rubin, H. (2004): Into the light. In *CIO Magazine*. http://www.cio.com.au/index.php/id;1718970659, accessed on July, 2004.

Rushinek, A. and Rushinek, S.F. (1986): What makes users happy? *Communications of the ACM*, 29(7), July, 594-598.

Saarinen, T. (1996): An expanded instrument for evaluating information system success, *Information & Management,* 31, 103-118.

Sabherwal, R and King, W.R. (1995): An empirical taxonomy of the decision making process concerning strategic applications of information systems, *Journal of Management Information Systems,* 11(4), 177-214.

Sabherwal, R., Jeyaraj, A. and Chowa, C. (2006): Information systems success: individual and organisational determinants. *Management Science,* 52(12), 1849-1864.

Sambamurthy, V., Venkatraman, S. and Desanctis, G. (1993): The design of information technology planning systems for varying organisational contexts, *European Journal of Information Systems*, 2910, 23-35.

Sarantakos, S. (2005): *Social Research (3rd ed.)*, New York: Palgrave Macmillan.

Schwalbe, K. (2000): *Information Technology Project Management,* Course Technology, Cambridge, MA.

Seddon, P., Graeser, V. and Willcocks, L. (2002): Measuring organisational IS effectiveness: an overview and update of senior management perspectives, *The Data Base for Advances in Information Systems*, 33(2), 11-28.

Seddon, P. and Yip, S-K. (1992): An empirical evaluation of user information satisfaction (UIS) measures for use with general ledger accounting software, *Journal of Information Systems*, 6(1), 75-98.

Sedera, D., Gable, G. and Chan, T. (2004): A factor and structural equation analysis of the enterprise systems success measurement model. In *Proceeding of the Twenty-Fifth International Conference on Information Systems* (Applegate, L., Galliers, R. and DeGross, J.I., Eds) p.449, Association for Information Systems, Washington, DC, USA.

Segars, A.H. (1997): Assessing the unidimensionality of measurement: a paradigm and illustration within the context of information systems research, *Omega*, 25(1), 107-121.

Segars, A.H. and Grover, V. (1998): Strategic information systems planning success: an investigation of the construct and its measurement, *MIS Quarterly*, 22(2), 139-163.

Singh, S.K. (1993): Using information technology effectively, *Information and Management,* Vol.24, 133-146.

Smithson, S. and Hirschheim, R. (1998): Analysing information systems evaluation: another look at an old problem, *European Journal of Information Systems,* 7, 158-174.

Steiner, G.A. (1979): *Strategic planning: what every manager must know,* Free Press, New York.

Strassman, P.A. (1984): Information technology and productivity, *PITCOM,* 3(1), 1-19.

Strauss, A. and Corbin, J. (1998): *Basics of qualitative research: Techniques and procedures for developing grounded theory,* Thousand Oaks, CA, Sage.

Srinivasan, A. (1985): Alternative measures of system effectiveness: Association and involvement, *MIS Quarterly,* 9(3), 243-253.

Stockberger, D.W. Correlation: Introductory Statistics: Concepts, Models, and Applications. http://business.clayton.edu?arjomand/book/sbk17.htm (Accessed 9th August, 2007).

Sugumaran, V. and Arogyaswamy, B. (2004): Measuring IT performance: "Contingency" variables and value modes, *The Journal of Computer Information Systems,* 44(2), 79-86.

Sullivan Jnr, C.H. (1985): Systems planning in the information age, *Sloan Management Review,* 26(2), 3-12.

Symons, V.J. (1991): A review of information systems evaluation: content, context and process. *European Journal of Information Systems,* 1(3), 205-212.

Tallon, P., Kraemer, K. and Gurbaxani, V. (2000): Executives perceptions of the business value of information technology: a process-orientated approach, *Journal of Management Information Systems,* 33(2), 145-173.

Tashakkori, A and Teddlie, C. (2003): *Handbook of Mixed Methods in Social and Behavioural Research,* Thousand Oaks, Sage.

Teddlie, C. and Tashakkori, A. (2006): *A general typology of research designs* featuring mixed methods, *Research in the Schools,* 13(1), p.12.

Tenenhaus, M. (1998): *La regression PLS,* Technip, Paris.

Teubner, R.A. (2007): Strategic information systems planning: A case study from the financial services industry, *Journal of Strategic Information Systems,* 16, 105-125.

Thurstone, L.L. (1935): *The Vectors of Mind,* University of Chicago Press, Chicago.

Thurston, L.L. (1947): *Multiple Factor Analysis: A Development and Expansion of the Vectors of Mind,* University of Chicago Press, Chicago.

Torke, N., Boral, L., Nguyen, T., Perri, A. and Chakrin, A. (2005): Process improvement and operational efficiency through test result autoverification, *Clin. Chem.* 51, 2406-2408.

Trice, A.W. and Treacy, M.E. (1986): Utilisation as a dependent variable in MIS research, *Proceeding of the 7th ICIS,* 227-239.

Van Merode, G.G., Hasman, A., Derks, J., Schoenmaker, B. and Goldschmidt, H.M.J. (1996): Advanced management facilities for clinical laboratories, *Computer Methods and Programs in Biomedicine*, 50, 195-205.

Venkatraman, N. and Ramanujaman, V. (1987): Planning system success: a conceptualisation and an operational model, *Management Science,* 33(6), 687-714.

Walsham, G. (1993): *Interpreting Information Systems in Organisations.* Wiley, Chichester, England.

Wang, E.T.C and Tai, J.C.F. (2003): Factors affecting information systems planning effectiveness: organisational contexts and planning systems dimensions, *Information & Management,* 40, 287-303.

Weill, P. and Olson, M.H. (1989): An assessment of the contingency theory of management information systems, *Journal of MIS,* 6(1), 59-85.

Weill, P. and Olsen, M.H. (1989): Managing investments in information technology mini-case examples and implications, *MIS Quarterly,* 13, 3-17.

Wells, I.G., Farnan, L.P., and Rayment, M.W. (1996): Client/server computing: is this the future direction for the clinical laboratory? *Clinica Chimica Acta,* 248, 31-38.

Wilcocks, L. (2000): Evaluating the outcomes of information systems plans – managing information technology evaluating technologies and processes, in *Strategic Information Management – Challenges and Strategy in Managing Information Systems,* R.D. Galliers, D.E. Leidner and B.S.H. Baker (eds)., Butterworth Heinemann, Oxford.

Yap, C.S. and Walsham, G.(1986): A survey of information technology in the UK service sector, *Information and Management,* 10(5), 267-274.

Youthas, K. and Young, S.T. (1998): Material matters: Assessing the effectiveness of materials management IS, *Information and Management,* 33, 115-124.

Zeithaml, V.A., Berry, L.L and Parasuraman, A. (1993): The nature and determinants of customer expectations of service, *Journal of the Academy of Marketing Science,* 21(1), Winter, 1-12.

Zinn, J., Zalokowski, A. and Hunter, L. (2001): Identifying indicators of laboratory management performance: A multiple constituency approach, *Health Care Management Review,* 26(1), 40-53.

Zhu, K. and Kraemer, K.L. (2005): Post-adoption variations in usage and value of e-business by organisations: cross-country evidence from the retail industry. *Information Systems Research,* 16(1), 61-84.

Zikmund, W.G. (1997): *Business Research Methods,* The Dryden Press Harcourt Brace College Publishers, New York, USA.

Zmud, R.W., Boynton, A.C and Jacobs, G.C. (1986): The information economy: a new perspective for effective information systems management, *Database,* 18(1), 17-23.

Appendix A

MULTI-DIMENSIONAL MODELLING IN THE HEALTH INDUSTRY.

Markus Belkin *

School of Business Information Technology

RMIT University

mbelkin@bigpond.com

Brian Corbitt

School of Business Information Technology

RMIT University

brian.corbitt@rmit.edu.au

Konrad Peszynski

School of Business Information Technology

RMIT University

konrad.peszynski@rmit.edu.au

INTRODUCTION

Today's information rich and knowledge-based business society relies heavily on Information Technology (IT) and Information Systems (IS) design to enable the business to operate effectively and create a competitive advantage. Firms must align their IS design and performance with the core business competencies and business goals of the firm. There are multiple paths towards this end and inefficiencies and conflicts may arise when the firm's IS strategies diverge from the business goals. This is no different in the health industry where conflicts exist between IS infrastructure and development, and business goals. The existence of inflexible mainframe IS unable to support modern technology such as the Internet, telemedicine, wireless technology and real-time management software has compromised the business goals and business development in the health vertical to the extent that it has now fallen behind other comparable knowledge industries.

Where reference is made to more cohesiveness between IS capability, independence of the IS department and the alignment of business goals, there is no mechanism or detail given on how this is achieved. Grover and Segars (2005) claim that while there have been studies that examine the "what" questions in Strategic Information System Planning (SISP), particularly concerning the issue of IS – business alignment, there has been little on the "how" questions.

A multidimensional cohesive model for IS planning and measurement of IS effectiveness has been developed as a means to more integrated planning and a simpler but more realistic means of assessing the effectiveness of the IS in business. The multidimensional cohesive model is applied to the selection and implementation of an information system in the health industry. The implications this has on the health industry include the opportunity to change to a more efficient business structure, a means to implement a modern technology (web) based IS and an inherent capacity for change management.

BACKGROUND

Strategic Information System Planning (SISP) has evolved in method and style over the last decade on the basis that it is important because it emphasises the need to bring Information Technology (IT) to align with and sometimes influence the strategic direction of the firm (Grover and Segars, 2005). In rich IT environments this has a recognised relevance to competitiveness. However, although much has been studied with respect to business and IT alignment, little research has been undertaken into the mechanisms of SISP, including process planning.

Grover and Segars (2005) examined the evolution and maturing of SISP from the early 1970s and made several important observations. This was later supported by other researchers such as Earl (1993) and Sabherwal and King (1995). They found that many studies focussed on planning content with particular interest in methods and measurement of alignment between business and IS strategy (Burn and Szeto, 2000, King, 1998). They observed that these studies did little to illuminate the organisational aspects of planning.

Early studies by Pyburn (1983), in an attempt to identify institutionalised planning dimensions, actions and behaviours, made field observations which noted the existence of both a *rational/structured* process and a *personal-informal* process. Earl (1993) made similar observations when he distinguished SISP approaches based on the degree of rationality and adaptability built into the planning process. Earl (1993), however, noted a hybrid organisational system of planning which seemed to be more effective than the highly structured and less adaptable rational approaches. This observation was ratified by the work of Sabherwal and King (1995).

More recent studies by Segars (1997) and Segars and Grover (1998) described and measured planning process dimensions and found hybrid systems tended to be more successful, and seemed to apply generally to a variety of industries. Through their research Grover and Segars (2005) identified six important process dimensions of SISP: comprehensiveness; formalisation; focus; flow; participation; and consistency. These dimensions are robust in describing the SISP design and extend beyond the methodological-based and less generalisable descriptions of planning.

Wang and Tai (2003) add to the dimensions for success in SISP with their work on organisational contexts, commenting that most process oriented research has recommended using integration and implementation mechanisms while not considering the possible contingent effect of contextual factors. They suggest that this may lead to the planning system being less adaptable to different organisational contexts and therefore be overly deterministic.

Wang and Tai (2003) acknowledge that although their work is generally supported by empirical data, a theory of IS planning is currently lacking. Their results did however support the contention that IS planning is a rational-adaptive process, supporting the claims of Earl (1993) and Grover and Segars (2005).

The link between strategic performance and planning has been found to be inconsistent by Grover and Segars (2005) and Premkumar and King (1992). Some indicators suggested for assessment of IS effectiveness have been IS usage, user information satisfaction (UIS), quality of decision making, productivity from cost/benefit analysis and system quality (Ein-Dor and Segev, 1978). The most commonly favoured factors have been IS use and UIS. However, because of a lack of a theoretical framework for placing UIS within the greater context of overall 'IS effectiveness' its relevance as a performance measurement has been questioned (Grover and Segars, 2005).

Grover and Segars (2005) argue that successful SISP should achieve alignment between IS and business strategy; analyse and understand the business and associated technologies; foster cooperation and partnership between managers and user groups; anticipate relevant events/issues within the competitive environment and adapt to unexpected organisational and environmental change. This multidimensional conceptualisation approach is supported by Delone and McLean (1992).

However, further research is needed in order to define the construct space for effectiveness criteria. Delone and McLean (1992, 2003) have initiated research to this end with their IS Success model. Their model consists of six interdependent constructs, including: system quality; information quality; use; user satisfaction; individual impact; and organisational impact (Delone and McLean, 1998). The measure of overall success should combine individual measures from these constructs to create a comprehensive scheme for performance.

Grover and Segars (2005) have developed a theoretically based construct space for IS effectiveness, which complements the IS Success of Delone and McLean (1992). Their construct model provides a means of cross-validating the IS Success model and introduces a relative standard used for assessing performance.

To build a complete picture of IS effectiveness, evaluation must be conducted from both a macro (organisational) and micro (individual) view. Such evaluation is necessary because IS supports individual as well as organisational decision making and can also provide competitive advantage.

From the organisational effectiveness literature, Brewer (1983) argues that there are three types of evaluation: process; response; and impact. Process evaluation involves the assumption that organisational members work to ensure efficient use of resources when resources are limited. This assessment is based on user dependence on IS, user perceptions of system ownership and the extent to which IS is disseminated throughout organisational administration and operating procedure.

Response evaluation assesses the individual or the organisation to the IS service or product. This assessment has significance in respect of user resistance to innovation and implementation. Any resistance or habitualisation must be identified to ensure successful implementation. This assessment also considers complex variables such as user’s beliefs and attitudes toward IS in general which are important for fulfilment of IS planning (Grover and Segars, 2005).

Impact evaluation represents the most comprehensive and most difficult to assess evaluation. It is associated with the direct effects of IS implementation on the individual and/or the organisation.

Grover and Segars (2005) model produces six classes of IS effectiveness measurement, which define the overall construct space for IS effectiveness. As shown in Figure 1, the evaluation of IS is initiated by choice of the relevant evaluative referent. The first three classes of effectiveness measures are associated with macro (organisational) evaluation.

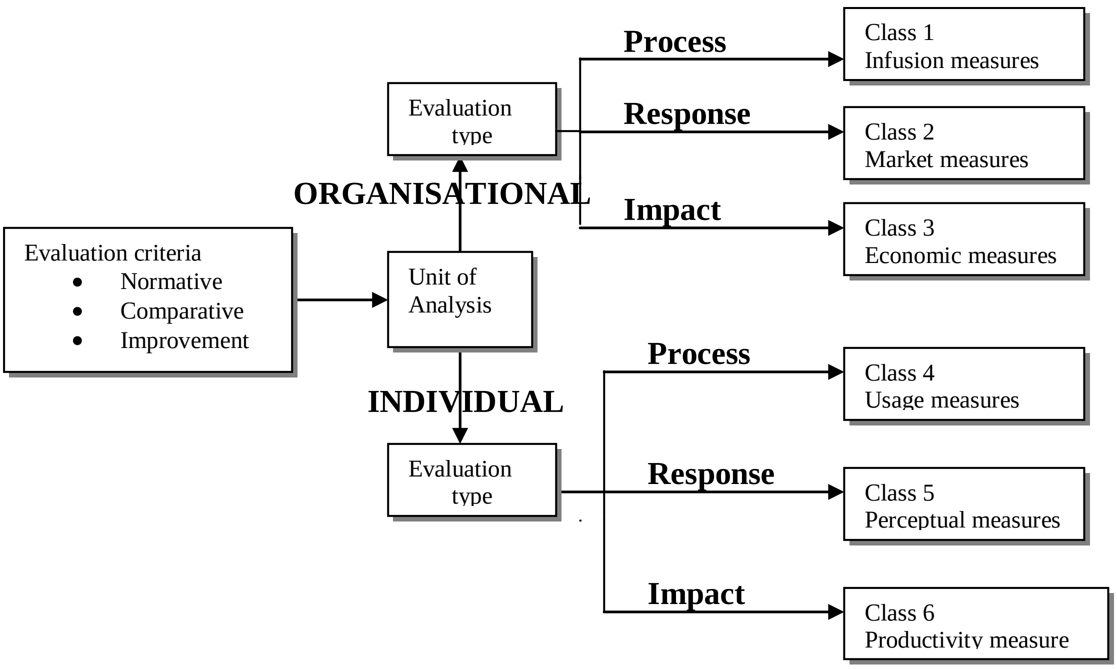

Figure 1. The construct space for IS effectiveness (based on Grover and Segars, 2005)

From their empirical work developing this model, Grover and Segars (2005, p. 782) state “it seems that both theoretical depictions strongly imply that IS effectiveness is multidimentional in terms of types of measures and level of analysis.” This supports their earlier stated contention, and supports the argument by of other authors (Earl 1993; Pyburn 1983; Sullivan 1985).

Further research by Grover and Segars (2005) on evaluation perspective raises questions asking from whose perspective the evaluation is being carried out for. Though IS may be viewed as effective from one standpoint, it may be viewed as the opposite from another. Cameron and Whetten (1983), suggest that one reason that no ‘best’ criterion exists is because there is no ‘best’ constituency. As such, Grover and Grover (2005) state that for the evaluation of IS effectiveness, the specific views of all groups should be considered because they help to increase awareness of the value of the IS and help the understanding of the multidimensionality of IS effectiveness.

MAIN FOCUS

The literature on the approach to measurement of IS effectiveness show a great variation in the measurement techniques and the possibility of inefficiencies in the deployment of effectiveness measures through personal agendas or bias in the management team. Several authors exploring SISP, such as Pyburn (1983), Earl (1993) and Sabhewal and King (1995), agree that the planning process is most successful when rational and adaptive pathways are used in the design process. However, there is no mechanism suggested for possible pathways for this to happen. It is believed that there are several other shortcomings in the planning models presented in business: IT misalignment; no consideration for team member selection in either top down or bottom up situations; no consideration as to how people communicate to make plans, that is knowledge management/extraction and organisational learning; clear definition of business goals by thorough business analysis, involving stakeholders from management to end-users required; and ensuring that the current IS hardware/software has the capability to handle the planned IS changes.

The literature cited on effectiveness measure is in a more confused state with so many criteria for measurement quoted. These criteria are clearly uni-dimensional and seem to be dissociated from what SISP is attempting to achieve. That is, the original stated business goal(s) conjoined with the IS pathway during the SISP. The models presented by Grover and Segars (2005) and Wang and Tai (2003) are in themselves a demonstration of inadequacy. The arrows in Figure 1 representing direction and pathways are all represented as being unidirectional. This implies that the models have a start and a finish. They are static, single event models. They would therefore be inconsistent with on-going support and 'fine-tuning' of SISP and maintenance of any competitive advantage gained with first implementation. Therefore an alternative model is proposed based on a case study in Medical Pathology in Australia.

The case study is presented at two levels – the overall pathology practice and a specific pathology department. In the overall pathology practice there was a merger of two pathology practices, one large and one medium sized into one practice. The work load for staff doubled overnight. The IT system of the larger practice was retained as the new groups IT platform. This was in theory totally inadequate, and was proven to be so in practice in a short period of time post-merger. No business analysis pre-merger was performed to assess the existing systems capability to cope with doubling the workload.

The IT platform consisted of an older mainframe computer which ran in-house developed software. The software was written in a totally unsuitable language for scientific applications (COBOL) and the storage capacity of the system was such that records could only be held on the system for one month before having to be transferred to Microfiche. The system was in fact solely a database and had no laboratory functionality to capitalise on the technology capability of the practices' analysers (applications that assist with quality control data and graphs, diagnostic graphics, work lists, management statistics and utilise LANs). This greatly compromised the functionality of the laboratory and the service to referring medical practitioners. There were personal agendas (software designer's claim, "*we are the bigger laboratory so we know best*") and cost considerations which determined the decision to stay with this unsuitable antiquated IT platform.

At the practice department level, the haematology department used analyses which are capable of extensive data and graphics generation for both diagnostic and quality control purposes. Each analyser has a PC which acts as a controller for the analyser and a data/graphics generator. The ability to disseminate the graphics would render the department paperless saving time and consumables and increasing efficiency considerably. Incumbent mainframe systems are unable to accommodate this facility and unless a supplementary graphics capable IT system is implemented, this great opportunity for efficiency improvement and consumable cost reduction is lost. Management data from mainframe systems is statistically based providing information as requested on types and numbers of tests performed, the number of tests from each referring doctor and workstation performance. Enhancement of computer-based management performance, such as roster generation, reagent tracking and supply chain management in real time is not possible on existing systems due to lack of graphics capability. Many management functions are therefore still performed manually by department senior staff.

As in the example of the overall laboratory case, the drivers for decisions for choice of analysers and IT systems are still made by top level management with little consultation with end-users, and are cost based. The situation of the IT and business misalignment cited above (Grover and Segars, 2005) is applicable and the agendas also embrace self preservation of employment.

Both examples presented in the case study show how inadequate planning (SISP) and personal agendas have and are still compromising the efficiency and adaptability to modern technological change in medical pathology. This is believed to affect the bottom line. Continuation with existing IT infrastructure in medical pathology is broadening the gap with modern technology and increasing the degree of difficulty for change. The realisation of stakeholders of proper SISP and criteria for assessment of the effectiveness of IS other than cost considerations applies to medical pathology as rigorously as it does to any business. A change in attitude towards SISP and the adoption of processes based on the model proposed in this paper could revolutionise the medical pathology industry by facilitating a major change in its business infrastructure from a pyramidal hierarchy to laterally linked self funded business units. The models proposed in this paper offer a mechanism for enhanced SISP and measurement of IS effectiveness, leading to the development of a cohesive business model.

The Cohesive Business Model (CBM) comprises two overlapping and coexisting units. The change source consists of two main functions. It is the ‘innovation’ part of the CBM as it relies on the interaction of experienced people to capture ideas, knowledge through experience and historical data. Through careful business analysis the ideas and innovations are formatted into plans, models and processes to carry them to implementation. The plans and models define team selection and project management as well as an absolute definition of the business goal(s) in the SISP. This process then provides the firm with an inherent facility for change management, as represented in Fig.2.

The process source also consists of functions. It is the ‘integration’ part of the CBM as the models and processes from the change source are integrated into the business and the business change is effected. The end users provide feedback to the innovators which gives information regarding client issues as the perceptions are at the coal face. The process source unit is where quality management takes place through interaction and feedback at the client interface.

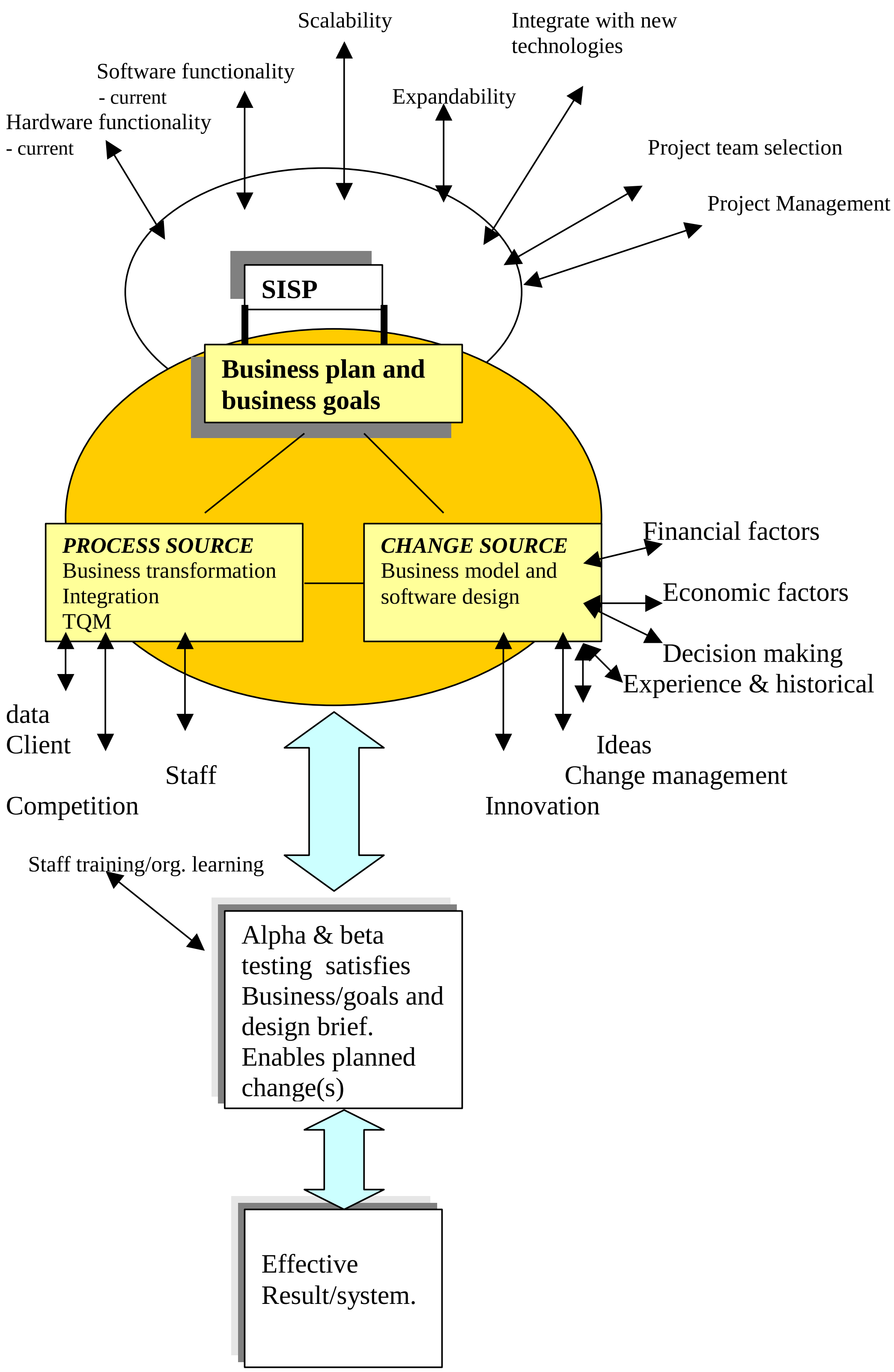

Fig.2 – *Cohesive Business Model.*

The change source (innovation side) of the CBM works closely with the IS department. This relationship differs from what is a common situation cited in the literature where the IS department is dominant in the relationship with the business managers. This model is driven by business and recognises the IS department as a valuable, essential partner to advise on the best way to integrate the latest IT developments into the CBM. The IS department's facility for development of software and technical back-up is defined in the plans, models and processes of the innovation. The involvement of the IS department, together with the innovation and project management teams in staff training and alpha and beta testing of the developed IS is imperative to the success of that project.

The CBM is multidimensional and is supported by provision for assessment of internal and external factors that may affect the implemented model in a positive or negative way. The links between components of the CBM, unlike other models cited in the literature, are bi-directional. The CBM is dynamic and fluid and has the facility to respond to the potential influences quickly and effectively to ensure that the business maintains its functionality and competitive advantage.

FUTURE TRENDS

A review of literature on Laboratory Information Systems (LIS) and laboratory management systems relative to the case study in this paper acknowledges a need for improvement in effectiveness and efficiency in clinical laboratories. In efforts to achieve this, several different approaches by authors have been taken. These include the functional process approach of Goldschmidt et al. (1998), the accountants perspective of Revere (2004), the cost analysis approach of Mayer (1998) and the LIS requirements for the future work of Bender and McNain (1996). Bender and McNain's (1996) work supports and promotes the use of open architecture systems, which implies that the market will develop modular, scalable and cost-effective LIS without the dependence on individual manufacturers and hardware/software systems that characterise current systems.

There is a marked diversity in these approaches with perhaps only the work of Bender and McNain (1996) considering the LIS as a whole. Their approach is truly significant when considering the IS management misalignment problems cited earlier in this paper. Our planned future research centres on the implementation of a modular, real-time management system, designed by the researchers for the clinical laboratory using principles of the CBM. The possibility that the system will enable laboratories to change their business infrastructure as well as improve efficiency, introduce new technologies and reduce costs will be investigated. The expected positive effect this approach will have on IS/business misalignment will also be investigated.

CONCLUSION

SISP is recognised as an event that results in the building of an IS to support a business goal. The ability of the IS to attain that business goal must surely be the measure of the effectiveness of the SISP. Many of the quoted measures of effectiveness of SISP and IS should be regarded as part of the planning brief so that they are inherently achieved by the IS during the processes of alpha- and beta-testing, the user friendliness, usage, cost/benefits, ROI.

The adoption of the alternative model and its approach to SISP introduces a multidimensional approach to SISP. The multidimensional approach is bi-directional in that it allows for an inherent change management facility in the SISP, which keeps the process abreast of changing internal and external influencing factors to the benefit of the firm. Competitive advantage is maintained through more rapid response to these changes. Future research will test the model presented in this paper.

The multidimensional approach to SISP also allows for more standardisation in design process by defining what is a design component of IS and what is an indicator of effectiveness of the IS. More research needs to be undertaken to fully elucidate these definitions to further enhance our understanding of this complex environment.

REFERENCES

Bender, J. & McNair, P., (1996). User requirements on the future laboratory information systems, *Computer Methods and Programs in Biomedicine*, 50, pp.87-93.

Brewer, G.D., (1983). Assessing outcomes and effects, in Cameron, K.S. and Whetten, D.A., (eds), *Organisational effectiveness: A Comparison of Multiple Models*, Academic Press, San Diego CA.

Burn, J.M. & Szeto, C., (2000). A comparison of the views of business and IT management on success factors for strategic alignment. *Information & Management,* 37(4), p197-216.

Cameron, K.S. & Whetten, D.A., (1983). Organisational effectiveness: one model or several? in Cameron, K.S. and Whetten, D.A. (Eds.), *Organisational Effectiveness: A Comparison of Multiple Models*, Academic Press, San Diego, CA.

Delone, W.D., & McLean, E.R. (1992). Information Systems Success: The Quest for the Dependent Variable. *Information Systems Research*, 3(1), pp. 60-95.

Delone, W.D., & McLean, E.R. (2003). The Delone and McLean Model of Information Systems Success: A Ten-Year Update. *Journal of Management Information Systems*, 19(4), pp. 9-30.

Earl, M.J., (1993). Experiences in strategic information systems planning, *MIS Quarterly*, 17(1), pp. 1-24.

Ein-Dor, P. & Segev, E., (1978). Organisational context and the success of MIS, *MIS Quarterly*, 24(10), pp. 1-24.

Gerwin, D. & Kolodny, H., (1992). *Management of Advanced Manufacturing Technology: Strategy, Organisations and Innovation*, Wiley, New York, NY.

Goldschmidt, H.M.J., de Vries, J.C.M., van Merode, G.C. & Derks, J.J.M., (1998). A workflow management tool for laboratory medicine, *Laboratory Automation and Information Management*, 33, pp.183-197.

Grover, V & Segars, A.H., (2005). An empirical evaluation of stages of strategic information systems planning: Patterns of process design and effectiveness. *Information & Management,* 42, pp. 761-799.

Hackney, R., Kawalek, J., & Dhillon, G. (1999). Strategic information systems planning: perspectives on the role of the end-user revisited, *Journal of end-user computing*, 11(2), pp. 3-12.

King, W.R., (1988). How effective is your information system planning? *Long Range Planning*, 21(5), pp. 103 – 112.

Mayer, M., (1998). Laboratory cost control and financial management software, *Clinica Chimica Acta*, 270, pp. 55-64.

Pyburn, P.J., (1983). Linking the MIS plan with corporate strategy: an exploratory study, *MIS Quarterly*, 7(2), pp. 1-14.

Revere, L., (2004). Improving resource efficiency through management science, *Journal of Healthcare Management,* 49(5).

Sabherwal, R & King, W.R., (1995). An empirical taxonomy of the decision making process concerning strategic applications of information systems, *Journal of Management Information Systems,* 11(4), pp. 177-214.

Segars, A.H. & Grover, V., (1998). Strategic information systems planning success: an investigation of the construct and its measurement, *MIS Quarterly*, 22(2), pp. 139-163.

Wang, E.T.C & Tai, J.C.F., (2003). Factors affecting information systems planning effectiveness: organisational contexts and planning systems dimensions, *Information & Management*, 40, pp. 287-303.

KEY TERMS

Bi-directional modelling: A business or functional model in which data is exchanged to and from all components of the model in real time.

Cohesive Business Model: A multi-dimensional business model developed for information systems planning and measurement of IS effectiveness based on the clearly defined business goals of the firm and with an inherent capacity for change management. This model is fluid, dynamic and on-going.

IS effectiveness: The ability of an IS to meet the success criteria as determined by the firm.

IT misalignment: A difference in the developmental pathways of the IT department and the business goals and competencies of the (same) firm.

Laboratory Information System (LIS): An IS in a medical laboratory for data and record collection and storage, results handling and dissemination and functional statistics generation.

Multi-dimensional modelling: A process of business modelling based on rational/structured and personal/informal processes that are fluid and dynamic and on-going. This process considers the relationship between all components of the model bi-directionally and continuously.

Strategic Information System Planning (SISP): The planning of an information system based on many described and measured processes and aligned with the business goals and competencies of the firm undertaken to increase the competitive advantage of the firm.

Uni-dimensional modelling: A process of business modelling based on rational/structured and personal/informal processes that are finite - it has a beginning and an end. This process considers the relationship between all components in one direction only and is a static process.

Appendix B

How does the effectiveness of laboratory information systems impact on business outcomes in medical pathology in Australia?

A survey of laboratory, management and IT staff.

Markus Belkin,
PhD Intern,
School of Business Information Technology,
Business portfolio,
RMIT University,
Melbourne, Australia.

How does the effectiveness of LIS impact on business outcomes in medical pathology in Australia?

A survey of laboratory, management and IT staff.

Please consider the following items and questions pertaining to the attributes of your practices' laboratory information system (LIS). Evaluate how capable you feel, from your own experiences, your LIS is in performing the tasks mentioned to ensure the overall system is efficient and effective within your organisation. Below is reproduced a scale from 1 to 6 with each number representing a degree of importance. Using the descriptions provided with this scale, circle the number you feel most represents your evaluation of the importance of each of the attributes listed on the following pages.

Strongly disagree					*Strongly* agree
1	2	3	4	5	6

Item 1 : Do management decisions based on cost-benefit analysis impact on laboratory planning? In answering this question rate each factor in terms of importance that:

1. Financial information is available in real time 1 2 3 4 5 6
2. Financial information is available in uniform format across the departments in the organisation 1 2 3 4 5 6

3. The financial information format is intuitive and easy to use/understand

1 2 3 4 5 6

4. The financial information contributes significantly to the management of the department 1 2 3 4 5 6

5. It is top management who requires this financial information

1 2 3 4 5 6

6. Financial considerations are the sole driver for change in the department 1 2 3 4 5 6

7. This financial information enhances your management skills

1 2 3 4 5 6

8. This financial information enables you to meet budgets

1 2 3 4 5 6

9. The implementation of process changes is supported by this financial information 1 2 3 4 5 6

10. Financial considerations are responsible for most changes & developments 1 2 3 4 5 6

11. Statistical data such as test numbers, doctor numbers and turn-around time are routinely provided by the current LIS

1 2 3 4 5 6

12. This data (Q11) is useful for lab/dept management

1 2 3 4 5 6

Item 2: Does a lack of functionality of the LIS impact on laboratory planning? In answering this question rate each factor in terms of importance that:

1. The current LIS allows for automation of:

• Rosters	1	2	3	4	5	6
• Labour costing per shift	1	2	3	4	5	6
• Reagent stock control	1	2	3	4	5	6
• Reagent ordering	1	2	3	4	5	6
• Staff efficiency analysis	1	2	3	4	5	6
• Reagent wastage calculation	1	2	3	4	5	6

2. The current LIS is web based 1 2 3 4 5 6
3. The current LIS can support web based technology such as telemedicine, voice recognition and intranets 1 2 3 4 5 6
4. Commercial financial & management software can be integrated with the current LIS (ie MYOB, Quicken) 1 2 3 4 5 6
5. The current LIS can support graphics displays from the analysers 1 2 3 4 5 6
6. The current LIS has a interface that is common to all analysers 1 2 3 4 5 6

7 The current LIS is -

- Stable ie low percentage of downtime 1 2 3 4 5 6
- Scalable for future expansion of technology ie client-server and web technology 1 2 3 4 5 6
- Scalable for future expansion of the laboratory in Australia 1 2 3 4 5 6
- Scalable for future expansion of the laboratory Internationally 1 2 3 4 5 6
- Sufficient in database capacity 1 2 3 4 5 6
- Accurate in its data output 1 2 3 4 5 6
- Flexible in its data and reports formatting 1 2 3 4 5 6
- Enabled for remote operation ie off-site logon and functionality 1 2 3 4 5 6
- Able to support mobile hardware such as wireless hand helds and laptops 1 2 3 4 5 6

Item 3: Does lack of end-users involvement in the LIS planning process impact on system effectiveness? In answering this question rate each factor in terms of importance that:

1. Adequate training and documentation in all facets of LIS capability is provided 1 2 3 4 5 6

2 The IT dept responds quickly to requests for changes and enhancements 1 2 3 4 5 6

3. The IT dept supports users in preparing proposals for new system enhancements and developments 1 2 3 4 5 6

4. The IT staff are very familiar with end user operations of the LIS

   1 2 3 4 5 6

5 The end uses have significant input into what IT services are provided 1 2 3 4 5 6

6. The end users have a positive attitude towards IT staff

   1 2 3 4 5 6

7. The end users have a feeling of participation in the operation and development of the LI 1 2 3 4 5 6

6. The end-users are involved in planning groups for LIS change and enhancement/development 1 2 3 4 5 6

Item 4: Does a high level of business – IT alignment produce effective LIS planning? In answering this question rate each factor in terms of importance that:

1. Communication between department management staff and IT staff is open and fruitful 1 2 3 4 5 6
2. The department heads and senior IT staff continuously work together to develop and monitor the LIS 1 2 3 4 5 6
3. A strategic plan is prepared for developing the LIS

   1 2 3 4 5 6

4. Who is involved in the strategic planning process

- IT staff 1 2 3 4 5 6
- Laboratory management staff 1 2 3 4 5 6
- Laboratory end-users 1 2 3 4 5 6
- Pathologists 1 2 3 4 5 6
- Middle management staff 1 2 3 4 5 6
- Outside consultants 1 2 3 4 5 6

5. The current LIS is compatible with and complementary to the business objectives of the senior management

   1 2 3 4 5 6

6. The planning process involves extensive group discussions prior to change 1 2 3 4 5 6

7. There is laboratory staff involvement in the implementation of change/enhancements 1 2 3 4 5 6

8. There is alignment between the objectives of the laboratory staff requirements and IT department staff requirements for the LIS

   1 2 3 4 5 6

Item 5: Does a lack of LIS research impact on system planning? In answering this question rate each factor in terms of importance that:

1. Journals on the following subjects are available to IT staff
   - Strategic Information Systems Planning 1 2 3 4 5 6
   - Information System effectiveness measurement

     1 2 3 4 5 6
   - Health Informatics 1 2 3 4 5 6
   - Computing in laboratory/clinical medicine

     1 2 3 4 5 6
2. Journals on the following subjects are available to laboratory and management staff
   - Strategic Information System Planning 1 2 3 4 5 6
   - Information Systems effectiveness measurement

     1 2 3 4 5 6
   - Health Informatics 1 2 3 4 5 6
   - Computing in laboratory/clinical medicine

     1 2 3 4 5 6
   - Laboratory Information Systems 1 2 3 4 5 6
   - Information and Management 1 2 3 4 5 6
3. Senior laboratory staff should have post graduate qualifications in:
   - Management information systems 1 2 3 4 5 6
   - Health/laboratory informatics 1 2 3 4 5 6
   - Computing 1 2 3 4 5 6

- Management 1 2 3 4 5 6

4. Business management staff should have post graduate qualifications in:
   - Business 1 2 3 4 5 6
   - Business Information Technology 1 2 3 4 5 6
   - Management 1 2 3 4 5 6
   - Management Information Systems 1 2 3 4 5 6

5. Availability of journals would enhance the development of the LIS 1 2 3 4 5 6
6. Availability of journals would enhance the management of the firm 1 2 3 4 5 6
7. Post graduate qualifications would enhance the development of the LIS 1 2 3 4 5 6
8. Post graduate qualifications would enhance the management of the firm 1 2 3 4 5 6
9. Laboratory staff belong to management groups/forums 1 2 3 4 5 6
10. IT staff belong to management groups/forums 1 2 3 4 5 6
11. Laboratory staff belong to LIS groups/forums 1 2 3 4 5 6
12. IT staff belong to LIS groups/forums 1 2 3 4 5 6

13. Articles are presented at the AIMS conference on:

• LIS	1	2	3	4	5	6
• Management Information Systems	1	2	3	4	5	6
• Laboratory Management	1	2	3	4	5	6
• Computers in laboratory medicine	1	2	3	4	5	6

14. The School of Laboratory Medicine offers post graduate courses in:

• LIS	1	2	3	4	5	6
• Management Information Systems	1	2	3	4	5	6
• Laboratory Management	1	2	3	4	5	6

15. The IT staff are actively involved in research into LIS

1 2 3 4 5 6

16. The IT staff are actively involved in research in laboratory management 1 2 3 4 5 6

17. The laboratory staff are actively involved in research into LIS 1 2 3 4 5 6

18. The laboratory staff actively involved in research into laboratory management 1 2 3 4 5 6

How does the effectiveness of LIS impact on business outcomes in pathology in Australia.

A survey of laboratory, management and IT staff.

Demographic details:

1. Age:

☐ Under 21 ☐ Between 30 and 40

☐ Between 21 and 25 ☐ Between 40 and 45

☐ Between 25 and 30 ☐ Between 45 and 55

☐ Over 55

2. Gender:

☐ Female ☐ Male

3. Qualifications – Science/Medicine/Pathology

☐ B.App.Sc (Lab Med) ☐ MB.BS., FRCPA.

☐ Grad year ☐ Grad year

☐ B. Sc(Computer science).

☐ Other - ☐

4. Number of years of laboratory experience:

- ☐ Less than 5 years
- ☐ 10 to 15 years
- ☐ 5 to 10 years
- ☐ More than 15 years

5. Position held/classification:

- ☐ Grade 1
- ☐ Grade 3
- ☐ Grade 2
- ☐ Grade 4
- ☐ Department head
- ☐ Management
- ☐ General Pathologist
- ☐ Specialist Pathologist
- ☐ IT Department

6. Qualifications – Business/Management

- ☐ B.Bus(Management)
- ☐ B.Comm/ Econ
- ☐ B. Acc/CPA
- ☐ B.Bus(Info Tech)
- ☐ Post grad Quals(Y/N)

What are PG qualifications? ☐

7. INTEREST GROUPS/ASSOCIATIONS

- ☐ Management
- ☐ Information technology
- ☐ Business
- ☐ Other - ☐

Appendix C

Plain Language Statement

Dear ……………………………

My name is Markus Belkin.

I am undertaking a study titled "How does the effectiveness of laboratory information systems impact on business outcomes of medical pathology " through the School of Business Information Technology, Faculty of Business, RMIT University, Melbourne, as a PhD candidate.

The aim of the project is to study laboratory information systems and business models in medical pathology laboratories and to assess their adequacy in providing successful business outcomes for the laboratories.

I am writing to invite you to participate in this important project.
Participation is, of course completely voluntary and you may withdraw at any time.
Participation will involve you answering a number of survey questions in relation to the management of medical pathology laboratories and the performance of current laboratory information systems. You will also be invited to provide any additional information that you might think is relevant. This should take no more than 15 minutes of your time.

Responses to the survey will be analysed and used as a basis for constructing a model for the future management of medical pathology laboratories.
I would hope to publish some of the findings in scholarly journals.

I can assure you that all replies will be treated in the utmost confidence, and neither individuals nor organizations will be named in this thesis or in any subsequent publications.

All the data collected will be stored in a secure filing cabinet in the Business Information Technology school at RMIT University for a period of up to 5 years, as provided for under the RMIT Ethics policy.

Contact for further general information:

Professor Brian Corbitt,
Senior supervisor and Head of School,
Business Information Technology,
RMIT University,
Melbourne.
Phone: 9925 5808
E-mail: brian.corbitt@rmit.edu.au

Contact for further information regarding ethics issues:
Professor Sinclair Davidson
Phone: 9925 5869
e-mail : sinclair.davidson@rmit.edu.au

Appendix D

FOCUS GROUP QUESTIONS

BACKGROUND – This research was initiated from my own experiences in the laboratory. The literature review revealed a number of recognised contras to successful information system planning and positive business outcomes. The proposals for the research questionnaire were based on these contras and applied to medical pathology in Australia.

The questionnaire contained 64 questions relating to the 5 proposals and was sent to private and hospital laboratories in Melbourne and Western Australia. The objective was to have the questionnaire completed by staff representing all work groups associated with the LIS and it s use and development. (laboratory staff- senior and junior, management, IT and pathologists). The response rate was approximately 30%. The data was analysed using a number a statistical techniques to identify the significant factors pertaining to the proposals and multiple regression was used to help identify pathways in a "structural model".

The focus group we are about to conduct will further investigate the conclusions and serve to triangulate the research back to the literature.

1. Conclusion:
The findings from the questionnaire indicate that current LIS does not support laboratory and business development in pathology – particularly in areas of expansion and integration –

Do you agree?
If so, why?
If not, why not?
What moderating factors might have influenced this result?

2. Conclusion:
The research found that financial considerations are the sole driver for change in the laboratory –

Do you agree?
Is so, why
If not, why not?
If not, what would you claim to be important to implement change in the laboratory?

3. Conclusion:
The results of the research found that the lack of end-user involvement in LIS/IT planning and development compromises the outcome.

Do you agree?
If so, why?
If not, why not?
How could/would you involve end-users in the planning process?

4. Conclusion:
The research found that co-operation between management and the IT department is not prevalent in pathology –

Do you agree?
If so, why?
If not, why not?
Are there any moderating factors that might have influenced this result?
What could be done to enhance more co-operation?

5. Conclusion:
The investigation showed that research into LIS and its role in pathology management/business is practically non-existent –

Do you agree?
If so, why?
If not, why not?
How do you rate research and further education with respect to improving laboratory management and business outcomes in pathology?

Final questions –
Would your current LIS benefit from a change of IT?
If so, how would that impact on business and what type of change in IT would you look for or expect?
Is there anything extra you would consider important when implementing a LIS that has not already been covered?

Appendix E - Invitation To Participate

I, ……………………………………………………………….

Wish to participate in interviews being conducted by Markus Belkin, in the course of him gathering data for his research titled "How does the effectiveness of laboratory information systems impact on business outcomes in medical pathology?"

I understand that the participation is voluntary and that all responses are to be treated as confidential, the data will be stored securely and that the entire process is covered by the RMIT Ethics policy.

Signature: ……………………………………… Date: ……………………………..

Witness: ……………………………………….. Date: ………………………………

Contact Details

Mr Markus Belkin, 1/7 Black Street, Brighton, 3186.
Phone: 9593 3428
Fax: 9593 3428

E-mail: markus.belkin@rmit.edu.au

Professor Brian Corbitt,
Head, School of Business Information Technology, RMIT University,
GPO Box 2476V, Melbourne, 3000.

Phone: 9925 5808
Fax: 9925 5850

E-mail: brian.corbitt@rmit.edu.au

Any further enquires may be directed to the Chair of the Ethics Committee, Faculty of Business, RMIT University.

Professor Sinclair Davidson,
Research Development Unit, Faculty of Business, RMIT University,
GPO Box 2476V, Melbourne, 3000

Phone: 9925 5869

E-mail: sinclair.Davidson@rmit.edu.au