

Technology Management, Transaction Processes and Governance Structures

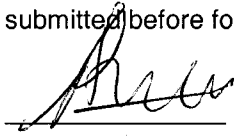
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A thesis submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Doctor of Philosophy.

Johannesburg, 2003

Declaration

I declare that this thesis is my own, unaided work. It is being submitted for the degree of Doctor of Philosophy in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.



(Signature of Candidate)

11 day of December (year) 2003

Preface

This thesis gives a holistic view of technology management across the value chain of firms. It does this from an economic perspective with 3 objectives in mind. Firstly it links technology management, transaction processes and governance structures, secondly economic theories of firms (resource based view and transactional cost economics views) are formed and each view is evaluated to determine the superior view. Thirdly the technological effects of the organizational and environmental evolution are studied.

This thesis draws on previous work in technology management, strategic management, organizational and transactional cost economics and operations management. This thesis makes a contribution to knowledge in demonstrating linkages between parts of firms and other firms. Parts of this research have been published by Siriram and Snaddon (2003a, 2003b) in two articles firstly: Linking technology management, transaction processes and governance structures and secondly: Verifying links in technology management, transaction processes and governance structures.

This thesis lays the foundation for further work in linking technology management, transaction processes and governance structures.

Siriram, R and Snaddon, D.R. (2003a) Linking Technology Management, Transaction Processes and Governance Structures, Technovation, TECH 950, Article in Press.

Siriram, R and Snaddon, D.R. (2003b) Verifying links in Technology Management, Transaction Processes and Governance Structures, Technovation, TECH 1021, Article in Press.

Abstract

This thesis focuses on technology management within and between firms. The effects of technology management on transaction processes, and the mechanisms for effective governance of technology are studied.

A model incorporating different schools of thought including technology management, strategic management, organizational and TCE (transactional cost economics) and operations management is built.

The model has subsets of technology management, transaction processes and governance structures. The model is then tested within an investigative framework, which includes organizational determinants, competitors and external factors. The testing is on firms that adopt or implement technologies. Technological firms are categorized into user firms and system integrator firms. User firms are firms that adopt technologies; system integrator firms are firms that are involved in the implementation of technologies and help user firms.

Statistical analysis is used to test correlations between these two types of technological firms. An expert panel is used to understand the differences and similarities between the two types of technological firms. Different links are significant in this model and the following conclusions may be drawn: firstly that technology management, transaction processes and governance structures are linked; secondly that the transaction cost economic view and the resource based view are both important for competitive advantage and neither is superior to the other; and thirdly that the effects of technological change on the organizational and environmental evolution are significant.

This thesis lays the foundation for further work towards integrating technology management, transaction processes and governance structures. In addition lessons for managers involved in technological decisions are also provided.

Dedication

To my wife Priscilla and children Christopher and Chantel who encouraged me to complete this thesis.

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List of Abbreviations

AMT	Advanced Manufacturing Technologies
AS/RS	Automatic storage and retrieval systems
BPR	Business Process Reengineering
CAD	Computer aided design
CAE	Computer aided engineering
CAM	Computer aided manufacturing
CAPP	Computer aided process planning
CEO	Chief executive officer
COO	Chief operations officer
CNC	Computer numeric control
CIM	Computer integrated manufacture
CITC	Correlated item total correlation
CRM	Customer relationship management
DNC	Direct numeric link
EC	European communities
EDI	Electronic Data Interchange
ERP	Enterprise Resource Planning
FMS	Flexible manufacturing systems
FSR	Firm specific resource
GT	Group Technology
JIT	Just in time
ICT	Information communications technology
IEM	Integrated enterprise modelling
IO	Industrial organisational theory
IT	Information technology
KBT	Knowledge based theory
MES	Manufacturing execution systems
MIS	Management information systems
MPS	Master production schedule

MRP I	Materials requirements planning
MRP II	Materials resources planning
NC	Numeric control
OM	Operations management
RBV	Resource based view
R&D	Research and development
SBU	Strategic business unit
SCP	Structure-conduct-performance theory
SM	Resource-based strategic management
TCE	Transaction cost economics
TQM	Total quality management
US	United States of America
WBS	Whole business simulator
WWW	World-wide-web

1 Introduction

1.1 Background

During the last two decades we have seen a phenomenal amount of technological change, which is having an impact on the way business is conducted and the way it will be conducted in the future. The marketplace has new technologies which affect the way firms function. Examples are the Internet, e-commerce, cell phone technology, e-mail, remote office concepts, etc. Firms are competing in global markets and they have to keep abreast of the latest technologies to sustain competitive advantage. The effects of globalisation are felt as firms trade electronically in virtual markets over the World Wide Web. Global communications like the Internet and electronic mail have made it possible for firms to co-ordinate activities worldwide.

Front office technologies have to be synchronised with back office technologies in design, manufacturing and business planning (i.e. management and administration) using such systems as CAD (Computer aided design), CAM (Computer aided manufacture), MIS (Management information systems), ERP (Enterprise resource planning), etc. Front office technologies create a push-and-pull system for buying and selling, which back office technologies have to support. Figure 1.1 shows the relationship between front and back office technologies. Front office technologies include those relating to the buying and selling side. Back office technologies include technologies that exist within and between firms. Technologies emerge and progress from state-of-the-art to obsolescence even before firms master their full potential. It is therefore essential that firms adopt relevant technologies that enhance their resources across different functional disciplines to improve the output of goods and services, thus attaining competitive advantages.

Firms obtain their inputs from capital, labour and materials, which they convert into outputs, i.e. goods and services that markets require. The conversion of inputs into outputs consists of a transformation process in which various disciplines of inter-firm and intra-firm activities are put together to achieve competitive advantage. The co-ordination of activities within and between firms may create competitive advantages. Activities may include technologies, technological resource skills, firm competencies, transaction processes, knowledge management, technological sourcing, organisational learning and relationship management. Technologies that give benefits in terms of cost, quality, speed, dependability and flexibility are what make the activities between sections of the firm and other firms cost-effective, efficient and reliable. Scholars from various disciplines such as technology management, strategic management, organizational and TCEs (Transactional cost economics) and operations management are working towards improving the competitiveness of firms. However each of these scholars are specialists in their own areas and therefore there are

gaps in the integration of these disciplines. This thesis attempts to close some of the gaps between technology management, strategic management, organizational and TCEs, and operations management.

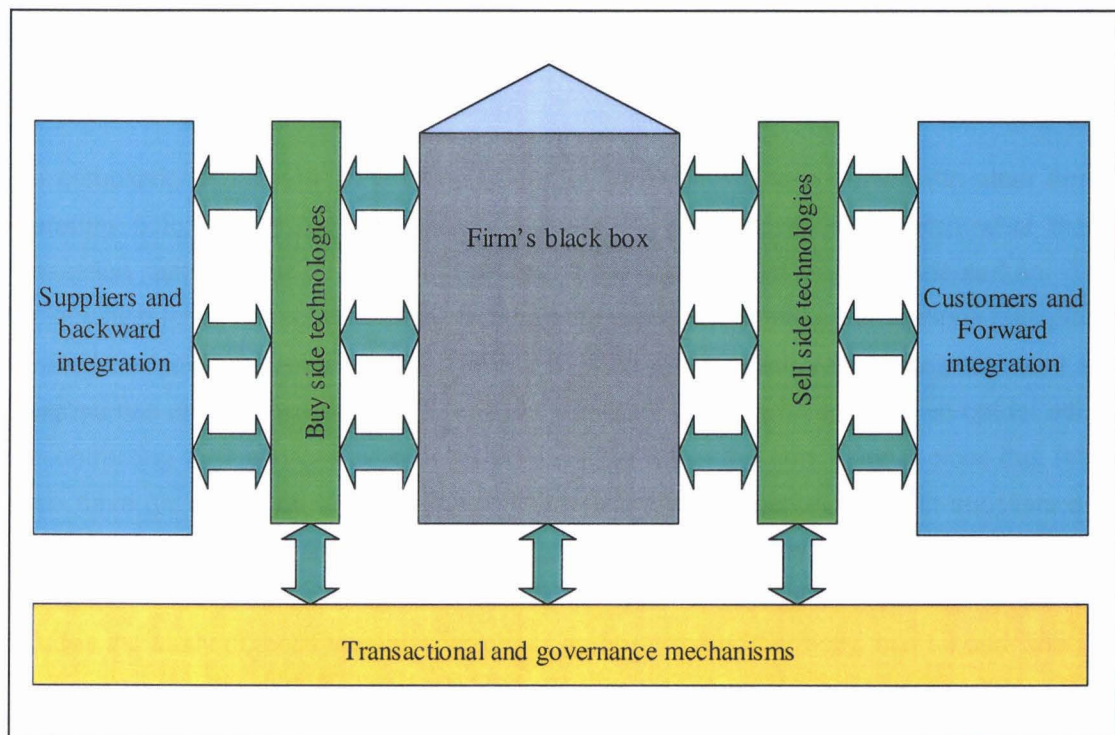


Figure 1.1: Front office and back office technological interfaces

Technology management focuses on the management and use of technology. This involves managing organizational responses to changing technologies, e.g. identifying and using information technology, using technology to offer new services, developing organizations that can make the most cost-effective, efficient and reliable use of established technologies, etc. Strategic management focuses on ensuring that the firm's overall vision is met through the implementation of strategic plans focusing on long, medium and short-term goals. Transaction costs are created as relationships develop within sections of firms and other firms. The transaction cost goal is to reduce transaction costs within and between firms. The activities within sections of firms and other firms are complex because they consist of technologies, people and processes, which have to interact with each other to achieve the output that firms require. As a result of these many activities between technologies, people and processes, other requirements arise. These requirements include technological sourcing, knowledge management, relationship management and organizational learning. These additional requirements need to be co-ordinated in a cost-effective, efficient and reliable manner to achieve competitive advantage.

The field of organisational economics looks at the way organisational learning is incorporated and how firms manage to create and maintain an organisation that is receptive to continuous improvement and learning. The various methods of learning and the impact of technological

change on competencies are researched. With technological change comes the learning of new technologies and new processes, i.e. competence enhancement, but what also goes hand in hand with this process is the redundancy of older technologies, which destroys competence. Knowledge management, organizational learning and relationship management are some of the avenues that are looked into for integrating the different activities within and between firms.

The complexity of these links is compounded by firms having to compete with other firms. Therefore before firms reduce transaction costs, they first have to establish what these transaction costs consist of. It is only then that a reduction in cost can be embarked on. The way in which firms interact with each other and the place where these transactions take place is called the 'governance structure'. It follows that the way in which transaction processes are designed has an influence on the governance structure. For example, firms can opt for either subcontracting their services or keeping the services within the firm. The choices that firms make have an impact on the way firms will interact with the market, i.e. with suppliers and customers. The choices firms make depend on the resources they obtain to improve criteria like cost, quality, speed, dependability and flexibility. The field of operations management includes the study of these variables which, when co-ordinated correctly, can be combined to achieve cost-effective, efficient and reliable outcomes for competitive advantage.

1.2 *Statement of the problem*

The problem is to establish links between technology management, transaction processes and governance structures. The study aims to concentrate on transaction processes and governance structures within and between firms. Technology management is examined from a technological implementation perspective with the emphasis on process technologies. Researching the effects of technology management on transaction processes and investigating the effects of technology management on governance structures will form the core of this thesis. Technological product innovation will not form part of this research. The research will focus on the electronics and electrical engineering industry and IT industries.

The TCE and RBV (Resource based view) of firms are studied. An attempt is made to establish the superior theory. The incorporation of the KBV (Knowledge based view) of the firm and the dynamic capabilities view will also be used in conjunction with TCE and the RBV. In addition the effects of technology management on the organisational and environmental evolution will be studied.

1.3 *Research questions*

There are two central questions, namely:

- CQ1: How do changes in technology affect transaction processes?
- CQ2: How do changes in technology affect governance structures?

CQ1: The benefits of technological implementations with regard to transaction processes are investigated. Transaction processes include transactional cost reduction, transactional value-added activities and manufacturing mix criteria (i.e. cost, quality, speed, dependability and flexibility). For example developments in IT may change the way in which tasks and activities between firms are carried out. Tasks and activities between sections of firms can be carried out electronically, thus making it possible for people to communicate faster over distances. The ease of transacting may increase transaction frequency, transaction repeatability, transactional history, transactional diversity, etc. As a result of these benefits, some advantages may be realised. For example, transactional frequency may increase the accumulation of knowledge and information between partners; transactional repeatability may reduce opportunistic behaviour; transactional history may reduce risks in terms of information sharing as partners transact more frequently; and transactional diversity may increase as information and knowledge sharing increases, etc.

CQ2: looks at the extent to which technological implementations have affected information flow and knowledge transfer between key partners within and between firms, the extent to which firms have changed strategic partners as new partners were no longer capable of competence in newer technologies. Another aspect considered is the extent to which technology management has improved the following: social networks and embedded ties, supplier closeness, communications trust and goodwill and improved market opportunities through partnering. Finally the extent to which technological implementations have improved network structures with key partners is considered. These links are important. For example, information flow and knowledge transfer could lead to transactional improvements as discussed above. These transactional benefits may lead to better relationship management with strategic alliances, joint ventures and other technology partners. As a result of better relationship management, social networks and embedded ties may develop. This could lead to supplier closeness, communications, trust and good will between firms and technology partners. This kind of relationship may lead to reduced risk regarding technology partners. Through relationship management, knowledge management and organisational learning may develop as firms increase their information and knowledge by transacting business with other firms. Relationship management and organisational learning are new forms of governance that may lead to better competitive advantages.

1.4 Research objectives

The objectives of the research are:

- To understand the links between technology management, transaction processes and governance structures.
- To investigate parts of core competence (RBV) and transaction cost economic (TCE) views and to determine the superior theory or link parts of both theories.

- To investigate the technological effects of organisational and environmental evolution on firms' competitive advantage.

To achieve the objectives of the research, a model linking technology management, transaction processes and governance structures is constructed. This model is referred to as the 'technological framework'. Thereafter the model is linked to an investigative framework introducing other factors like organisational determinants, competitors and external factors, etc. Using these models (i.e. the technological framework and investigative framework) the objectives of the research are analysed.

1.5 Research context

The study will address firms in the South African industry but also draws from research done in the United States, Japan and Europe. The research is focused on the management and use of technology rather than on technology creation. The problem setting focuses on the areas of technology management, strategic management, organizational and TCE's to operations management.

1.6 Hypothesis

There are two hypotheses that are posited in this thesis, namely:

- H1: Firms that adopt new technologies grow at different rates to other firms that maintain older technologies.
- H2: Managers rate manufacturing mix criteria more important than technological leadership.

1.7 Assumptions

The first assumption made in this thesis is that technology is a driver for competitive advantage. Technology forces firms to improve manufacturing mix criteria, which in turn influences transaction processes and governance structures. Firms react to market threats, market opportunities and other external factors, which forces them to initiate competitive advantages.

The cost-effective, efficient and reliable use of technology creates opportunities for firms to improve transaction processes. Firms obtain their inputs from capital, labour and material and transform these resources into goods and services. The black box view of firms considered the transformation processes as being hidden from the environment and this box was not open to the other firms in the transactional chain or network. Recently, however, a great deal of attention has been focused on the transactional processes within the black box. The transactional processes within the black box create the interplay involving manufacturing mix variables, which creates opportunities for competitive advantages. The assumption that technology is the driver for competitive advantage follows from the fact that as firms adopt new technologies they will experience advantages in the output of goods and services. Other

firms which do not adopt new technologies or which are unable to compete, will be left behind in the competitive environment.

The second assumption is that niche marketing is vital if firms are to remain competitive. Here one is talking of servicing the specialised needs of profitable smaller markets rather than producing standardised products for mass consumption. On the other hand, mass customisation is also required. These two needs require two different approaches to the market and it is assumed that firms require both outputs to remain competitive. Niche marketing is required for high profits and mass customisation is required for base load in business volumes, which create stability.

1.8 Limitations

The research will be focused on the electronic and electrical engineering industry and the IT industries. The reasons for this are as follows:

- Many of the tasks required by these rapidly changing industries will, with relatively minor modifications, be appropriate for other industries.
- These three industries are at the greatest risk regarding the manufacturing mix variables.
- Both these industries demand competitiveness in technological use regarding the transactional process and governance structures.

The focus of this thesis is to explain how firms grow or fail in a technological environment. The approach is relevant to a Schumpeterian analysis of innovation based on competition, price/performance rivalry, increasing returns, and the destruction of existing competencies (by adopting new technologies). The basis is that firms are forced into technological investment and implementation as a result of market threats, market opportunities and other external factors.

The research will be limited to the use of technology rather than the development of technology. Therefore the relationships in respect of R&D teams, the role of technology gatekeepers, the staffing of R&D industries, etc., is not considered. Even though product technology gives way to process technology it is the implementation and effective use of technology that creates a competitive advantage, hence the focus of this thesis.

Managers are the catalysts for the interactions between the various sections of a firm and managers are responsible for the effective implementation and use of technology. The following are some examples that support this idea.

- Managers manage the adoption and use of new technologies, e.g. managing the implementation of information technology, making process changes, managing MIS projects.

- Managers manage people who are being confronted by new technology, e.g. change and conflict management in re-engineering processes.
- Managers use new technology to solve current business problems, e.g. using automated products or processes to improve efficiency and decrease dependence on traditional suppliers. Examples include EDI (Electronic data interchange) and other similar technologies to develop new business arrangements with suppliers and customers. The Internet and e-commerce are also being used to create new customer and supplier relationships.
- Managers use their business skills to solve technological problems, e.g. using negotiation skills to setup strategic technology alliances. This could include building incentive/reward systems to motivate technologically sophisticated employees.

Furthermore, the management of firms' responses to rapidly changing technologies will include the identification, implementation and use of technology to offer new services to suppliers and customers. Therefore this thesis hopes to present useful lessons for managers who are involved in technological implementations

The effects of globalisation and the drivers for globalisation do not fall within the scope of this thesis.

1.9 Benefits of this work

This thesis links technology management, transaction processes and governance structures so that managers in firms may understand the various links involved in the management of technology and by understanding these links may be able to interact in a more competitive manner in a changing economy. It does this from a wide perspective. Of all the influences in an organization's environment, technology is the key factor that may provide competitive advantages. Technology may provide managers with opportunities to gain competitive advantage over competitors, but technology management is linked to other factors. The interlinking of these other factors is what brings firms competitive advantage. Some of these other factors include management styles giving rise to alternative means of technological sourcing, knowledge management, organizational learning and relationship management, etc. A technological framework introducing technology, management, transaction processes and governance structures is developed. Thereafter this framework is linked to an investigative framework, which includes factors like organizational determinants, competitors, external factors and manufacturing mix processes. This combined model is then used to verify the objectives of the research. Benefits for managers in firms could be as follows:

- To understand the broader technological framework and investigative framework so that technological investment decisions are focused on competitive advantages.

- To align business strategy and technological strategy so that better competitive advantages are achieved.
- To present lessons for managers who are involved in technological implementations.

These benefits may allow firms to improve and sustain competitive advantage.

1.10 Preview of the Research

Figure 1.2 gives a preview of the research. A brief overview of each chapter is discussed next.

In chapter 2 there is a discussion on significant prior research in the areas of technology management and transaction cost economies (transaction processes and governance structures). The investigative framework is introduced. Competitive theories of the firm are then studied. This leads on to the competitive forces model, the RBV and TCE views of the firm, after which the theories are integrated. Technology management, transaction processes and governance structures are then studied. The role of technology as a change agent for firms is discussed and the effects on transaction cost economics and the resource based view of the firm are argued. The implications for operations management and firm competitiveness in terms of the manufacturing mix variables are also discussed.

The construction of the technological framework incorporating technology management, transaction processes and governance structures follows in Chapter 3. Links between technology management, transaction processes and governance structures are proposed. This is followed by the integration of the technological framework into an investigative framework, with other factors being introduced into the model. These factors include organizational determinants, competitors and external factors. Further links are then developed to these factors. The integrated model is then used to evaluate the RBV and TCE views of the firm to either determine the superior view or integrate both views. In addition, other factors are introduced to investigate the effects of organizational and environmental evolution on firms' competitive advantage.

Chapter 4 contains a discussion on setting metrics for technology management, transaction processes, governance structures, central questions, subproblems and hypothesis.

A discussion on the research methodology employed follows in Chapter 5. This includes questionnaire design, data reliability and validity, expected results, industry selection and questionnaire circulation. The research objectives are also discussed.

Chapter 6 discusses the research results. This includes the pre-test, pilot test, interview process and analysis of results.

Chapter 7 is devoted to a discussion of the research with regard to germane articles that have been used in the construction of the theoretical framework.

Chapter 8 concludes the thesis. This includes the investigative processes, research findings and avenues for further research.

The appendices and references are presented next.

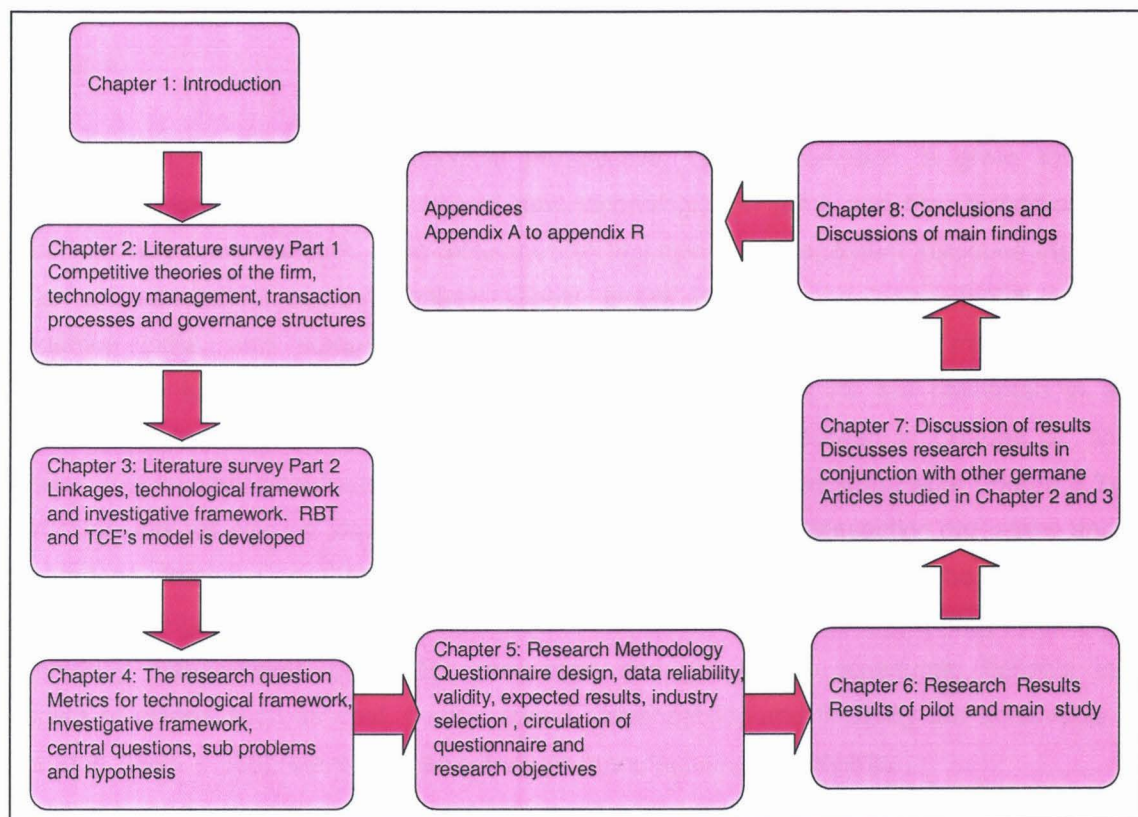


Figure 1.2: Preview of the research

2 Literature Survey, Part 1

This thesis focuses on technology management and the effects of technology management on transaction processes and governance structures. The research encompasses the fields of technology management, strategic management, organizational economics and TCE's, and operations management. Competitive theories of the firm, i.e. RBV and TCE, are first studied. A foundation for integrating technology management, transaction processes and governance structures is then established. Thereafter technology management and its influences are studied, followed by the study of transaction processes and governance structures. This chapter leads to the design of a framework for understanding the important links between the economic aspects of technology management, transaction processes and governance structures.

This thesis focuses on a technological perspective, i.e. consideration is given to the identification, implementation and use of new technologies in firms and how technologies affect the way firms transact. The influences of technology management introduce inputs, which are needed for competitiveness. These inputs include technologies, technological resources skills, firm competencies, technological sourcing, knowledge management, organisational learning and relationship management. These inputs are presented in a technological framework (Figure 3.1) this framework will be discussed in Chapter 3. In addition this technological framework is tested within an investigative framework (Figure 3.3) this framework will also be discussed in Chapter 3. The effects on transaction processes and governance structures are then related to technological implementation as can be seen in the frameworks (Figure 3.1 and 3.3) that will follow in Chapter 3. It will be shown that by linking technology management, transaction processes and governance structures, benefits in respect of criteria such as cost, quality, speed, dependability and flexibility are achievable. Snaddon (1996, p.388) refers to these criteria as manufacturing mix criteria.

In this thesis firms and the interaction of firms in markets are scrutinized. There have been attempts to build models of the firm (e.g., Hay & Morris, 1991, see Appendix M). Some of these have relied on variables influenced by transaction processes (e.g., White, 1996, see Appendix N) and some work has been undertaken on the importance of these variables (e.g., Ferdows and de Meyer 1990 suggest that quality is of major importance while cost is of minor importance, see Appendix O). Meredith (1987) has shown how various technologies may impact these variables (see Appendix P). These models suggest, that such links could be placed into a model and tested. In this thesis two models are proposed i.e. the technological and investigative framework.

Firms are next analysed by looking into the black box with regard to relationships between suppliers, sections of firms, customers, competitors and other stakeholders. This is seen as a

complete chain, which has to be managed to make the firm competitive. Operations management makes considerable use of technologies for the execution of day-to-day tasks in firms to improve manufacturing mix criteria in the delivery of goods and services. Some examples of technological systems can be seen in inventory management, scheduling of tasks, forecasting, order processing and many other activities. Some of these activities occur within firms (sections of firms) and some activities are between firms. Technologies that are adopted within firms, i.e. sections of firms, are termed 'back office technologies' and those which are adopted between firms, i.e. suppliers and customers, are termed 'front office technologies'. Much of the back office technology is concerned with information processing where customers have little contact. Front office technology is the key to link customers or suppliers in the front office with the information-processing power of the back office. Such front office technologies include e-commerce, electronic purchasing, etc. The application of front office technologies improves CRM, whereas the implementation and integration of back office technologies brings about benefits in manufacturing mix. However, to obtain meaningful benefits from technological change and to fully assess a firm's technological needs and options, it is necessary to understand the transformation processes in firms, i.e. the transformation of resources into the goods and services the firm produces.

This process involves the interaction of different factors. These factors are depicted in Figure 2.1 and include organizational determinants [2.1], competitors [2.2] and external factors [2.3]. In Figure 2.1 the investigative framework proposed integrates these fields and shows the links between technology management, transaction processes and governance structures. Figure 2.1 (the investigative framework) will be discussed in detail in Chapter 3. In Chapter 3 a technological framework linking technology management, transaction processes and governance structures is also developed. The technological and investigative are then linked.

These models (the technological and investigative framework) are used to look at the different views of the firm, namely the RBV and TCE view. Not many scholars have attempted to integrate the RBV and TCE views of the firm. This thesis attempts to develop such linkages should they exist. These links are necessary to understand the integration of computerised business systems across the value chain. Such systems exist in design, manufacturing and business planning or administration. Examples of such systems include CAD, CAM, ERP, e-commerce, etc. The benefits and risks associated with such technologies are shown in Table P1 (Appendix P). This research will investigate the usage of such technologies to show the potential improvements in manufacturing mix criteria should they exist.

Over the last five years the development of enabling technologies such as e-commerce, ERP, MES, MIS etc. has forced firms into understanding electronic transactions. This new way of trading is seen as a catalyst for change in TCEs. The following are some examples of technological implementations:

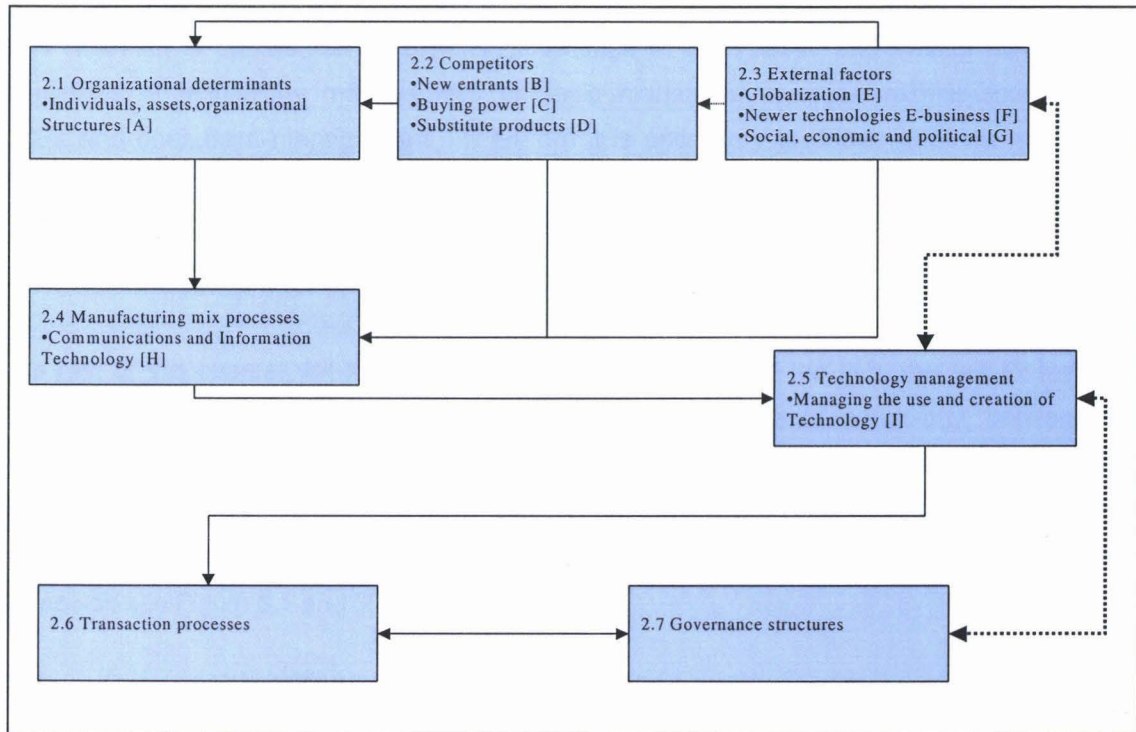


Figure 2.1: The investigative framework

- Managers manage the adoption and use of new technologies, e.g. managing the adoption of information technology, making large process technology changes and managing MIS implementation projects. Such projects have potential benefits in the transfer and flow of information through the firm, i.e. sections of firms, thereby improving communication and information transfer within the firm.
- Managers use new technologies to solve current business problems, e.g. using innovative products or processes to decrease dependence on traditional suppliers, using EDI and similar new technologies to form different types of transactions with suppliers and customers. This leads to benefits in transaction processes and governance structures. For example the characteristics of a transaction change as a result of technology and such characteristics include transactional frequency and transactional certainty/uncertainty. In the case of governance structures, supplier selection criteria, supplier asset specificity, supplier technological investment strategies, etc are considered.
- Managers use their business skills to solve technological problems, e.g. using negotiation skills to set up strategic technology alliances.
- Managers manage people who are being confronted by new technologies, e.g. change and conflict management in re-engineered and downsized firms. Individuals in the firm often resist the implementation of new technologies. Such conflict can destroy the implementation. It is therefore necessary that managers manage such conflict situations thorough the mechanisms of organisational

learning such as developing the capacity to learn and absorptive capacities, i.e. having the ability to learn.

This research is augmented by experts' knowledge of the causes and effects across the disciplines of technology management, strategic management, organisational economics, TCEs and operations management. Therefore it is necessary to define what we mean by technology, transaction processes and governance structures because this could have different meanings to the different disciplines. These definitions and further explanations of these areas are given in sections 2.4, 2.5 and 2.6 respectively.

The rest of this chapter will focus on the competitive theories of the firm, this will thereafter lead to economic theories (e.g. RBV and TCEs) then definitions of technology, transaction processes and governance structures will be discussed. A detailed literature survey is then conducted to determine the building blocks for technology management, transaction processes and governance structures. These building blocks are then used to construct the frameworks in Figure 3.1 and 3.3.

2.1 Competitive Theories of the Firm

The competitive theories of the firm, namely the RBT (Resource based theory) (or RBV) and TCE theories (or view) play a significant role in linking technology management (i.e. RBT/RBV), transaction process and governance structures (i.e. TCE theory/view). Many researchers have conducted research in either RBT or TCE theories but not much research has been conducted across and between these two theories. Some of the arguments posed about the RBT and TCE theories are as follows:

- Lorenzoni and Lipparini (1999, p.319) say that one of the common weaknesses of TCE and RBV is that their focus is on single firms and on single transactions, thereby providing less insight into network structures as firms interact with other firms.
- Amundson (1998) describes relationships between TCEs, RBV techniques and OM (Operations management) techniques. Many of the OM techniques that he describes can be compared to RBTs and TCEs, viz:
 - Amundson (1998, p.329) says that the RBV postulates that firms are composed of bundles of resources, and that resources possessing certain specific characteristics have the potential to create competitive advantage and in some cases sustainable competitive advantage.
 - Amundson (1998, p.349) states that the contribution from the RBV to OM is that resources provide competitive advantage for the firm. The TCE questions initially focused on the existence of firms and firm boundaries but the recent trend has been towards supplier relationships, strategic alliances, distribution strategies ,etc.

- Tallman (1991, p. 69) says that Dunning (1988) has attempted to combine IO (Industrial organization theory) theories, which is largely a strategic behaviour perspective, and TCE theories without much success.

From these arguments it can be seen that there are many perspectives regarding the RBT and TCE theories. Each of the theories have relative advantages and disadvantages. Firms interact with suppliers and customers in network structures and these structures are formed as firms build relationships with other firms. Such relationships are built as firms transact with each other. Transactional mechanisms are governed by contracts between firms, either arm's length contracts or relationships based on trust. It is therefore necessary that TCE and the RBV accommodate linkages between firms. This thesis will attempt to bring these theories closer together so as to provide a foundation for their understanding. Teece, Pisano and Sheun (1997) have attempted to link IO and RBV. Teece, Pisano and Sheun (1997, p.511) point out that the strategic view whereby rents are created at industry or sub-sector level, rather than firm level lies in the area of IO. They say firms' strategies are often based on FSRs (firm specific resources). FSRs and the correct utilisation thereof determine the extent to which firms will generate abnormal returns. This means that the strategic behaviour of firms is what will generate abnormal returns. This view may be likened to Amundson's (1998, p.329) with regard to firms possessing bundles of resources, which with certain characteristics may create competitive advantage and in some cases sustainable competitive advantage.

The IO theory can be related to OM techniques for firm-specific assets. Some evidence in support of this is discussed next.

- Schonberger (1994, p.3) focuses on the transformation process, i.e. the conversion of inputs (material, labour, and capital) into the outputs (i.e. goods and services), which is in essence the RBT.
- Tallman (1991, p.70) proposes a resource-based strategic model (SM), which addresses the link between the RBTs and strategy. He says strategies are devised for firms to protect and exploit their FSRs, to gain competitive advantage in the market place.
- Teece, Pisano and Sheun (1997, p.511) recognise that differences do occur as a result of firm-specific assets but differences occur largely as a result of scale. Therefore linking the RBT to strategy will have benefits in the goods and services the firm produces.

In recent theories like the Dynamic capabilities model, Teece, Pisano and Sheun (1997) looks at the development and management of changing competencies in firms (could be viewed as RBT) and the strategies to link changing competencies. Many parallels could be drawn between this thesis and the research conducted by Teece, Pisano and Sheun (1997) regarding the relative importance or superiority of either the RBT or TCE theory. However,

before a detailed discussion on these theories is conducted a brief discussion on the competitive forces model by Porter (1991) follows as an introduction to the various theories.

2.1.1 Competitive Forces Model

Porter (1991, p.101) points out that in order for a firm to hold an attractive relative position, with industry structure being constant, the firm should possess a sustainable competitive advantage. He separates competitive advantage into two basic categories, namely:

- Firstly, having a lower cost than rivals.
- Secondly having, the ability to have a price advantage as a result of lower cost.

The following arguments are posed as substantiation for the competitive forces model:

- Competitive advantage is dependent on scope, which includes the array of product and buyer segments.
- The geographic locations in, which the firm competes.
- The degree of vertical integration.
- The extent to which related business is linked to co-ordinated strategies.

Some authors refer to this as the 'outside-in approach' as the initial focus is on the competitive environment rather than the resources of the firm.

The competitive forces model is aimed at altering a firm's position in industry by focusing on competitors and suppliers. Firms develop competitive advantages by having impediments to competitive forces, e.g. barriers to entry. The investigative framework for this thesis, as shown in Figure 2.1, addresses the competitive forces environment. The five forces in the competitive forces model are entry barriers, threat of substitution, bargaining power of buyers, bargaining power of suppliers, and rivalry among industry incumbents (Porter (1998, p.35)). The modules relating to the competitive forces model are organisational determinants, competitors and substitute products. Organizational determinants can be linked to the buying power of buyers and competitors linked to substitute products, bargaining power of suppliers and rivalry among industry incumbents.

Porter force 1 (entry barriers) and Porter force 5 (rivalry among industry incumbents) can be combined and argued as follows. The intensity of competition and rivalry among firms puts emphasis on supplier relationships to create barriers to entry. This is because intense rivalry among firms reduces profitability, with lower pay-offs. Firms must capitalise on supplier relationships to form strategic alliances and partnership agreements to reinforce network structures and increase barriers to entry. Relationships between buyer and seller should extend beyond arm's length contracts to include trust and partnership-type relationships. Some evidence in support of relationship management is provided by:

- Hamel (1991, p.95) who cites Ouchi (1980) who speaks of clan type relationships.
- Gulati (1998) refers to clique-type relationships.

These styles of relationships create barriers to entry for competitors and substitute products. In addition, impediments to entry create barriers to entry. Some techniques that may be utilised for creating impediments to entry include:

- Pay-off. The higher the pay-off the more likely the entry, all else remaining equal.
- Exit costs. Failure costs influence the rate of entry. The higher the exit costs, the lower the rate of entry.
- Specific assets. Porter (1998, p.38) and Williamson (1981, p.1546) provide support for specific assets.
 - The higher the specific asset costs, the lower the rate of entry. Organisations with high specific asset costs find exit costs relatively high and therefore firms are reluctant to enter into such markets. High asset specificity can be said to raise barriers to entry. An example of high asset specificity is given by Porter (1998, p.36), he says that the introduction of computer systems in the airline industry is raising barriers to entry by requiring investments in hundreds of millions of dollars.
- Economies of scale create excess capacity.
- Reputation effects. Ring and Van de Ven (1992, p.489) provide support for reputation effects.
 - For example, reputation effects may increase through increased transactional frequency. As firms transact more frequently with each other they can accumulate knowledge about each other, thereby leading to long-term relationships. These long-term relationships may be more conducive to creating competitive advantages, which may be improved through closer communication, trust and goodwill.
- Licensing and patents.
- Learning curve effects. This can be linked to the higher levels of organisational learning. The benefits lie in knowledge transfer and integration, the sharing and transfer of knowledge within and between firms. Knowledge acquisition and technology transfer can occur through supplier and customer relationships, including joint ventures, mergers and acquisitions.

Porter force 3, addresses the threat of substitute products in the industry. The presence of substitute products reduces pay-offs as customers have the option of choosing other products with the same or similar characteristics at reduced prices. Substitute products have significant effects when demand is constrained as customers are easily moved over to substitute products when demand cannot be satisfied. Therefore capacity constraints and economies of scale are important criteria to consider in markets, that have a large number of substitute products i.e. positive cross elasticities. Wernerfelt (1984, p.173) also agrees that the availability of substitute resources will tend to reduce returns to the owners of the resource.

Porter force 4, addresses the buying power of buyers in firms and the potential power of suppliers. Buyer power implies that influential buyers in firms can force down prices or influence quality levels, thus creating opportunities for higher pay-offs. However more recently partnership agreements have been based on closeness communications, trust and goodwill for the mutual benefit of firms and their suppliers. Buying purely for the purposes of price reduction is a short-term goal. In a similar manner, the power of suppliers can be used to increase the cost of input materials and services and therefore a trade-off relationship based on a partnership approach is more conducive to competitive advantage. Porter (1991, p.102) says that a firm's strategy is embedded in the way in which the firm links the many activities in its value chain relative to its competitors. To achieve such value it is necessary to extend links outside the firm to include suppliers, customers, joint ventures and channels within the firm.

Some additional arguments in support of competitive strategies are discussed next.

- Porter (1991, p.102) says that creating linkages involves human resources, purchased inputs and technologies, which can be broadly defined to include organizational determinants. In addition this requires tangible and intangible assets that are within the firm and external to the firm. Some assets external to the firm are tangible assets like contracts, while most are intangible assets like brand names, relationships and networks. To perform tasks it is necessary to link skills, organisational routines and knowledge. These links may be formed through relationships and network structures with suppliers and customers.
- Teece, Pisano and Sheun (1997, p.511) argue that competitive strategies are often aimed at altering the firm's position in the industry through competitors and suppliers. The authors go on to argue that some industries or subsectors of industries become more competitive because of the industry's ability to develop impediments to competitive forces (i.e. barriers to entry). Teece, Pisano and Sheun (1997, p.511) say that rents are created largely at the industry or subsector level rather than firm level and differences among firms relate to scale rather than firm specific assets. The author maintains that economic rents in the competitive force's model are monopoly rents, and firms in industry are able to earn rents when they can impede the competitive forces. In the transaction cost economies approach, this resistance can be carried out by suppliers which have a low re-win rate on contracts, where relation-specific investments were not adequately in place or where opportunistic behaviour on the part of suppliers can prevent entry from competitors.
- Shapiro (2002, p.8) says that global competition has reached a stage where as soon as one firm has achieved a position of excellence, then so have its rivals. The shift in technology to the Internet, WWW, e-mail, telecommunications, and computer networks is forcing firms to collaborate, integrate and innovate. This leads to linking

the various sections of firms, and other firms like customers and suppliers, into a network structure focusing on optimising the links within and between firms.

- Roth (2002, p.1) says the explosion of information presents a cross-industry business opportunity. Firms that can quickly extract critical pieces of information from the sea of accessible data and transform them into valuable business assets are in a strong position to dominate their markets.

The competitive advantage of firms includes resources like tangible and intangible resources like technological resource skills, firm competencies, reputation, knowledge, relationships, etc. These resources will be used as building blocks in the construction of the technological framework (Figure 3.1). The linking of these resources from a resource perspective is covered in the next section, i.e. RBV. Porter (1991, p.107) says that the RBV has been proposed by some authors like Peteraf (1990) as being an alternative theory to strategy.

2.1.2 Resource Based View

The resources of a firm are utilised in the production of goods or services. These resources include tangible and intangible resources. The resources the firm has and the ability of the firm to utilise these resources is what gives firms competitive advantages. Some evidence in support of firms' resources for competitive advantage is discussed next.

- Wernerfelt (1984, p.172) defines a resource to mean anything that could be thought of as a strength or weakness of a firm. He quotes the following examples as resources: brand names, in-house knowledge of technology, employment of skilled personnel, trade contacts, machinery, efficient procedures, capital, etc. The author also says that these resources are difficult to imitate.
- Porter (1991, p.107) says competitive advantages are valuable resources or competencies that the firm possesses. Porter (1991, p.108) says that successful firms are successful because they have successful resources, which are valuable. He says that resources are valuable because they are superior to use, hard to imitate, difficult to substitute and more valuable within the firm than outside the firm.
- Mauri and Michaels (1998, p.212) have learned from the RBV that it is unique resources from which firms derive sustainable competitive advantage. The authors term these 'core resources' and the strategies that are based on them, 'core strategies'.
- Moller, Johansen and Boer (2003, p.369) argues from a resource-based perspective that it is the special blend in a firm's pool of resources, which constitutes its competitive advantage.

These arguments clearly highlight the characteristics of firms' resources. In summary, firms' resources are valuable resources, that are difficult to imitate and give the firm competitive advantage. Do valuable resources for firms exist in products, manufacturing mix criteria or both? These are questions that managers need to ask. For example, let us consider product features, which are easily imitated and therefore not considered to be core resources. Core

resources are resources that are not easily imitated. Research evidence shows that it takes about 3-5 years for firms to duplicate resources. This situation creates a resource position barrier. Wernerfelt (1984, p.173) defines a resource position barrier as being partially analogous to entry barriers, since they contain the mechanisms that create an advantage over another resource holder. In addition he says that resource position barriers indicate a potential for high returns, since one competitor will have an advantage. Mahoney and Pandian (1992, p.364) say that firms select their strategies based upon their resource capabilities. Put simply, a firm may have competitive advantage not because it possesses better resources but because it has the ability to utilise these resources to create competitive advantage. In other words, the firm possesses pools of resources that have certain characteristics which, if utilised in an appropriate manner, will lead to competitive advantages. Strategies for the effective utilisation of firms' resources are important drivers to resource benefits. Some arguments that support strategies for FSRs are discussed next.

- Tallman (1991, p.71) says "Strategies and FSRs interact to generate competitive advantage for the firm." The author also asserts that only FSRs that are compatible with market characteristics are likely to generate economic rents.
- Mahoney and Pandian (1992, p.363) say that the resource-based view incorporates the contributions to strategic management to explain how firms generate rents. Mahoney and Pandian (1992, p.364) defines rents as 'the return in excess of a resource owner's opportunity costs'. The author adds that a firm selects its strategy to generate rents based upon its resource capabilities. Mahoney and Pandian (1992, p.365) say that "rent theory allows us to clarify the SWOT framework by identifying exactly what can be real 'strengths' and firm capabilities for strategic advantage."
- Porter (1991, p.108) maintains that resources are vulnerable to changes in technology, competitor behaviour, or buyer needs which an inward focus of resources will overlook, and it is therefore the collective advantage from all sources that determines relative performance. Conditions which make a resource vulnerable include buying power of suppliers, substitutability, 'imitate-ability', bargaining power of buyers etc.,. These can be likened to Porter's five forces model.

The competitive forces model also allows for the extension of the RBV for market variables. Models like the competitive forces allow an outward focus so that firms can accommodate the vulnerability of resources that are created by industry factors that force technological change, competitor behaviour, etc.

Some benefits of the RBV are discussed next.

- Wernerfelt (1984, p.172) says that the RBV provides a basis for addressing some key issues in respect of strategy formulation for diversified firms, viz.:
 - "On which of the firm's current resources should diversification be based?"
 - "Which resources should be developed through diversification?"

- “In what sequence and into what markets should diversification take place?”
- “What types of firms will it be desirable for this particular firm to acquire?”
- Mahoney and Pandian (1992, p.363) say that:
 - The RBV incorporates traditional strategy views concerning a firm's distinctive competencies and heterogeneous capabilities.
 - The RBV provides a framework for scholars from the areas of strategy, organisational economics and industrial organisation to interact within the conversation of strategic management.
- Amundson (1998, p.349) says “The RBV hold that firms are bundles of resources, and that resources possessing certain specific characteristics have the potential to provide competitive advantage, and in some cases sustainable competitive advantage.”

The benefits of the RBVs are evident from the discussion. Having discussed firm resources and the RBV, resource categories are discussed next.

Porter (1991, p.109) divides resources into three categories:

- Firstly, the intermediate link between activities and resources.
- Secondly, resource skills and organisational routines.
- Thirdly, resources as external assets such as reputation and relationships.

The categorisation by Porter is especially important. The link between activities and resources allows the firm to allocate the best resource to the activity. The utilisation of technology to improve manufacturing mix criteria for economies of scale and scope are important drivers that link tasks to activities. This depends on resource skills and organisational routines. Firms have to possess the necessary technological skills to create the best fit of activities and resources. Simply possessing the resources and not having the skill and knowledge to effectively utilise this resource is not good enough. External assets like the firm's reputation and the networks that the firm has with other firms like suppliers and customers contribute to firm resources. External resources can also be obtained as the firm forms links with other firms. Figure 2.2 gives a representation of the resource categories. From Figure 2.2 building blocks for the RBV may be considered. For example resources from other firms could be seen as a means of technological sourcing to improve knowledge management. Through technological sourcing links to firm's technological resource skills and firm competencies may develop. Therefore with regard to Figure 3.1(technological framework) the following links between technological sourcing, technologies, technological resource skills and firms competencies are considered important.

Mahoney and Pandian (1992, p.364) say the RBV stimulates discussion within mainstream strategy research, organisational economics and industrial organization research, as well as

providing a framework for discussion between these research perspectives. Authors like Tallman (1991) have supported the approach to strategic management. Tallman (1991, p.69) introduces the SM (resource-based strategic management) model, which combines resources and strategy. The SM model looks at strategies from a firm specific level. Some supporting arguments in terms of the SM model from Tallman (1991, p.70) are discussed next.

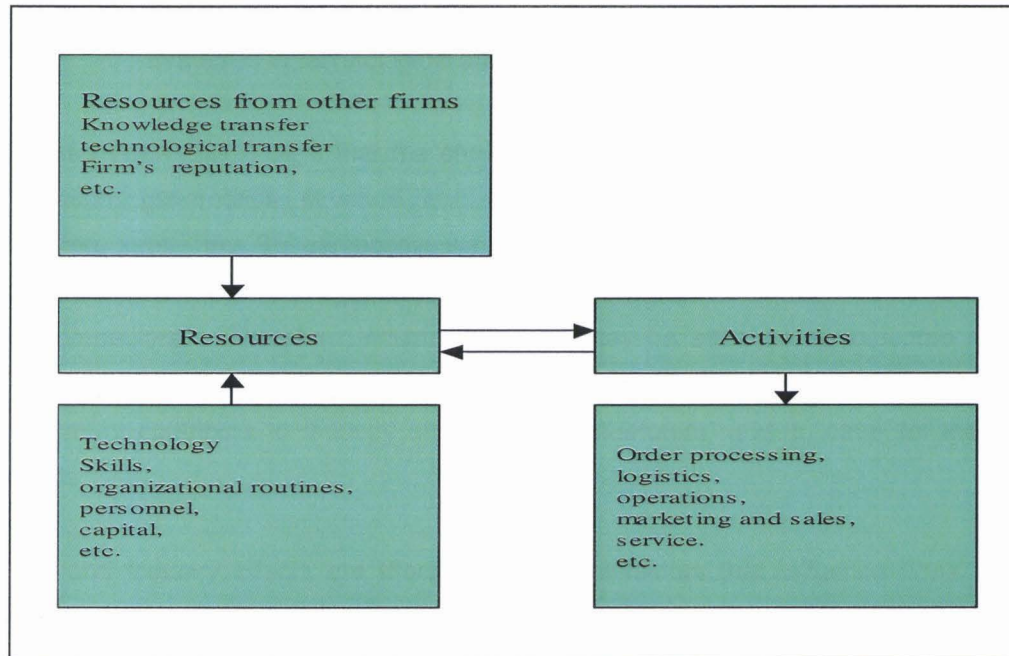


Figure 2.2: Resource categories

- Competitive strategies in SM are based on firm specific strategies rather than on industry or subsector action or oligopolistic collective action.
- The SM model can be seen as a means of gaining extraordinary profits from the combinations of strategy and structure, which exploit FSRs within a certain environment. As the environment changes, firm-level strategy and structure must also change to fit the new conditions.
- “Strategic management integrates strategic behaviour and structural efficiency in a unifying model.”

The SM model proposed by Tallman (1991) shows benefits in terms of the RBV.

Other evidence in support of resource utilisation is provided by the following two authors, amongst others:

- Wernerfelt (1984, p.173) examines circumstances under which resources will lead to higher returns over longer periods of time. He uses the competitive forces model to present an argument. There are general effects that cover the bargaining power of suppliers and buyers as well as the threat of substitute products or resources. These general effects all have the common outcome of diminishing returns to the holders of the resource.

- Mauri and Michaels (1998, p.213) argue that while successful firms develop resources that create competitive advantage, other firms are able to adopt or copy these resources and as a result reduce competitive gaps. Such patterns become industry characteristics over time. Therefore the resources firms develop and muster must be core resources that are difficult to copy, thus giving firms competitive advantage. The author also identifies convergent patterns for core strategies in technological and marketing differentiation.

Tallman (1991, p.71) says that the choice of strategy guides the decisions about resource allocation, governance structure and environmental interaction. Tallman (1991, p.71) therefore says: "In a SM perspective we would expect that higher performance will result from a more effective fit of strategy, structure, and environment for an individual firm in relation to its competitors." Therefore industry structure may be seen as an outcome of firm-level competition, the influence of market effects like competitor behaviour and the buying power of customers contribute to industry effects. Firms therefore have to cater for these industry effects.

Firm and industry effects are therefore important factors that influence firms' competitive advantages. Firm and industry effects may create opportunities for diversification. Diversification may give rise to improved performance. However diversification and performance require firm resources. To get a better understanding of firm competitive advantages, firm and industry effects, diversification and performance and firms resources as a motivation for growth refer to Appendix S. The transaction cost economic models are discussed next.

2.2 Transaction Cost Economic Theories

Williamson (1991, p.75) maintains that business strategy is a complex subject and spans the different functional areas of the business including marketing, finance, manufacturing, etc, and in addition is interdisciplinary. He adds that the field of business strategy is becoming increasingly important as business expands internationally, especially with the growth of multinational firms. Firms may therefore be seen as a network composed of links between the different sections of the firm and other firms. Each link in the network is an interface to another section or another firm. By improving the flow of information and knowledge through the network, firms may obtain benefits in manufacturing mix criteria. Therefore each of the links in the network has the ability to improve the firm's competitive advantage. Other authors who subscribe to the creation of linkages as a source of competitive advantage include the following:

- Porter (1991, p.102) says that "A firms strategy is manifested in the way in which it configures and links the many activities in its value chain relative to

competitors.” The value chain is described as separating activities that produce, market and deliver products and those that provide support for these activities.

- Shapiro (2002, p.viii) says the boxes people operate in are based on activities, computers, people or departments within a firm. It is in the lines, interconnections and interdependencies between boxes that innovation occurs. Focusing on the connections, i.e. connections between boxes, ideas, firms or other industries, gives rise to innovative thinking, which is one of the fundamental elements of success, success being one of the ingredients for competitive advantage.

Hence forming better network structures may lead to competitive advantages. However with network structures comes the problem of governance with managing the different aspects of the links which include technologies, administration, planning and control, etc. Rumelt, Schendel and Teece (1991, p.22) refer to a framework from literature surveys on TCEs. They point out the importance of governance and establishing the right match between technological use and system ownership, administration, planning and control. This, they maintain, is an important framework from a TCE perspective. Many authors argue about the relevance of TCEs to business strategy. Some of the views are as follows:

- Doz and Prahalad (1991, p.148) say that transaction cost analysis, with its assumptions about human beings and organizations, prohibits itself from addressing managerial issues.
- Tallman (1991, p.70) argues that transaction cost theory is an economic theory concerned with organisational structure and does not address strategy. He says that TCE theory relies on technological or economic determinism to dictate efficient structures for firms under static conditions.
- Rumelt, Schendel and Teece (1991, p.14) argue that the transaction cost branch of organisational economies has the greatest affinity with strategic management.

Rumelt, Schendel and Teece (1991, p.14) point out that TCE rests primarily on the issues of bounded rationality, asset specificity and opportunism. Williamson (1981, (p.1545-1546)) defines these terms as follows:

- Bounded rationality: people act within rational limits based on their experience and training.
- Opportunism: people behave in a guileful and self-seeking manner.
- Asset specificity: once an investment has been made, both buyer and seller are operating in a bilateral exchange relation for a considerable period thereafter. In addition, buyer and seller will make special efforts to ensure that the exchange relation has good continuity properties.

The basic stance taken by Williamson is that transactions should take place in a manner that best economises on the costs imposed by bounded rationality and opportunism.

Tallman (1991, p.70) adds that strategies are devised as a firm's attempt to identify, protect and exploit its skills and assets (i.e. resources) or FSRs, to gain competitive advantage. In addition the authors have the following views on TCE:

- Rumelt, Schendel and Teece (1991, p.24) say that “Transaction costs are the costs of organising the economic system”. Internal structures, managerial control systems, and the positioning of the boundaries of the firm all impact on transaction costs which, in turn, are related to some of the resource allocations within the firm.
- Tallman (1991) maintains that TCE theory, on the other hand, tries to reduce transaction costs or improve transaction value added without strategic considerations.
- Lorenzoni and Lipparini (1999, p.319) say that TCEs focuses on how to integrate the various activities to lower transaction costs.
- Doz and Prahalad (1991, p.148) confirm that transaction cost analysis prohibits the addressing of managerial issues, as a result of its limitations regarding individuals (*opportunism and bounded rationality*) and firms (as a network of relationships).

In essence the TCE viewpoint is structured to compensate for transaction costs as a result of the behavioural assumptions of opportunism and bounded rationality. The behavioural assumptions are discussed next.

Behavioural assumptions

Dyer (1997, p.535) argues that transaction costs arise as a result of fear of opportunism and that they increase with an increase in asset specificity because more complex governance structures are required to administer them. Therefore transaction cost economics generally focuses on improvements in transaction or relation-specific investments. The behavioural assumptions of bounded rationality and opportunism have to be governed in a cost-economising manner. Williamson (1991, p.79) summarises the ramifications of the behavioural assumptions in three points:

- In view of bounded rationality, all complex contracts are unavoidably incomplete and many complex incentive alignment processes cannot be implemented.
- In view of opportunism, the reliance on contractual promise is hazardous.
- Added value will be obtained by organising in a manner so as to economise on bounded rationality and safeguard transactions against opportunism.

Safeguards against these ramifications are the essence of the behavioural assumptions.

Tallman (1991, p.70) argues that transaction costs are seen mainly as contributing to the design and subsequent performance of the resulting firm's structures, whereas strategy focuses on initiating decisions. Tallman (1991, p.71) goes on to argue that cost efficiency, including efficiency in transaction costs is a major part of the performance feedback to managers and outstanding performance will improve the chosen strategy and structure. Transaction processes are required to ensure that defined transaction processes (business processes) and activities support strategy. The linking of resources to activities needs to be

administered by a TCE framework that incorporates system ownership, administration, planning and control. This leads to the question of governance and network structures.

Governance and network structures

Williamson (1991, p. 76) argues that the efficiency approach to business strategy is in need of a well-focused perspective. He says that the primary reasons for this are because business strategy has a broad mandate and TCEs also covers a wide range of issues from an economising perspective. If, as he maintains, economy is the best strategy, then the efficiency perspective needs to be heard. Lorenzoni and Lipparini (1999, p.332) suggest the TCE view should be coupled with the RBV and KBT. This will integrate the competencies and knowledge across firm boundaries to create a broader framework within which to understand sources of competitive advantage. Lorenzoni and Lipparini (1999, p.332) adds TCEs is limited in its ability to describe changes in the structure of lead firm networks because the focus on costs overlooks opportunities that can evolve out of intensive relationships.

Williamson (1991, p. 80) asserts economists have only recently conceded that firms' effects matter. A key step is the identification of performance attributes with regard to the governance structures that matter in the design of reduced forms. The author argues that the type of governance extends to include hybrid modes like long-term contracts, franchising, joint ventures, etc. that are located between markets and hierarchies.

TCE theories are limited to the study of the behaviour of individuals in firms and their relationships in networks. The overall objective is to obtain productivity gains through the process of transaction cost reduction by relation-specific interests. Transaction costs arise as a result of the threat of bounded rationality and opportunism within and between firms. Governance structures are put in place as safeguards against opportunism. The managerial implications of strategy and resource utilisation are therefore ignored. The coupling of the TCE, RBV and KBT, as suggested by Lorenzoni and Lipparini (1999, p.332) has much merit as it provides opportunities for developing and obtaining resources, linking them with effective administration, planning and control systems. In addition it also caters for knowledge transfer and integration within and between firms.

Having discussed the major economic theories, the implications for this thesis is it shows competitive theories play a significant role in linking technology management, transaction processes and governance structures. Some examples showing the links between the RBV and TCE view are discussed next. The RBV could include technologies, relationships that need to be managed, etc. These relationships that need to be managed can be linked to relationship management. Relationship management may be seen as part of governance structures. Relationship management relies on other factors like organizational learning, which is also another aspect of governance structures. Managing relationships may link to improved knowledge management, which is also another aspect of governance structures.

Through the RBV transaction processes may be improved. Transaction processes may be seen as subdivided into transaction cost activities, transaction value added activities and manufacturing mix criteria (i.e. cost, quality, speed, dependability and flexibility). Through governance structures relationship management and technological sourcing may give rise to better knowledge management i.e. information flow, knowledge transfer, etc. Better knowledge management will improve transaction processes. It may therefore be argued, technology management may be seen from a RBV and transaction processes and governance structures from a TCE view.

In conclusion competitive theories of the firm (2.1), competitive forces model (2.1.1), resourced based view (2.1.2) and transaction cost economic theories (2.2) are used to form a basis for the integration of theories (2.3). Integration between the different schools of thought may lead to models that may be constructed having the following building blocks:

- Technology management encompassing technologies, technological resource skills and firm competencies.
- Transaction processes
- Governance structures encompassing knowledge management, technological sourcing, relationship management and organizational learning.

These building blocks are used in Figure 3.1. For example technology management in general may have building blocks like technologies (3.1.1) and technologies may comprise subsets like technology strategy (a). These subsets are shown in Figure 3.1. Integration of the different subsets of technology management, transaction processes and governance structures are also apparent from the dynamic capabilities model. The dynamic capabilities view and further evidence in support of the dynamic capabilities view is discussed in more detail in Appendix Q. However integration of theories (2.3) are next studied this then leads to a discussion on technology management (2.4), transaction processes (2.5) and governance structures (2.6)

2.3 Integration of Theories

As mentioned by Williamson (1991, p.75) the two approaches to business strategy can be studied under the headings of strategizing and economising. The first heading, strategizing, is concerned with the power perspective while the second one economising, is principally concerned with efficiency, which encompasses governance costs as well as production costs. In terms of this thesis the two theories concerned with efficiency may be likened to the RBV and the dynamic capabilities view. Much has been said about the RBV already and no further attention will be devoted to it here. Teece, Pisano and Sheun (1997, p.510) recognise that aspects of the dynamic capabilities view is supported by other authors some of the following authors amongst others that are cited are Nelson and Winter (1982), Prahalad and Hamel (1990), Teece (1976, 1986a, 1986b, 1988), etc.

Even though many companies such as IBM, Texas Instruments, and Phillips have followed a resource-based approach, Teece, Pisano and Sheun (1997, p.515) argue that it is not enough to support a competitive edge. He says: "Winners in the global marketplace have been firms that can demonstrate timely responsiveness and rapid and flexible product innovation, coupled with the management capability to effectively co-ordinate and re-deploy internal and external competencies." He refers to this approach as 'dynamic capabilities'. The ability to develop internal competencies and re-deploy effectively is also part of diversification strategy, and these views are also shared by the following authors amongst others:

- Wernerfelt (1984, p.173) points out that what a firm wants is to create a situation where its own resource position directly or indirectly makes it difficult for other firms to catch up. This can be seen as a mechanism for barriers to entry. Therefore, from a RBV perspective, resources can be viewed as an aid to management strategies that could be used for developing new capabilities for competitive advantage.
- Porter (1991, p.110) says that a firm should not only be able to choose among well-defined options from its resources it must also be able to create new options. That is stretching the barriers of the resource to develop better resources for competitive advantage.
- Teece, Pisano and Sheun (1997, p.514) maintain that the resource-based perspective focuses on strategies for exploiting existing firm-specific assets.
- Gardner and Ash (2003) presents a preliminary framework for managing change in firms. The framework adopts information systems and e-commerce as a core element of business strategy. This framework lays the foundation for managers to link customers and suppliers so that the resource barriers of the firms may be improved.

These authors describe the options available to create competitive advantages by developing core resources and re-deploying them outside the firm to create and expand resource utilisation and benefits, which could lead to sustainable competitive advantage.

Combining schools of thought

The four schools of thought discussed above are different. The competitive forces and strategic conflict models emphasise a strategic platform, while the resource-based approach and the dynamic capabilities approach emphasise an economising platform. Neither of these models or approaches is better than the next. The challenge is to choose the appropriate approach for the problem at hand. The competitive forces and strategic conflict model see profits stemming from strategising in terms of limitations from competition. The dynamic capabilities and resource-based approach see competitive advantage stemming from high-performance routines, inside the firm, which are dedicated by processes and paths. Williamson's transaction cost theory suggests that economising is more fundamental than

strategising. Teece, Pisano and Sheun (1997, p.528) suggest that only in special cases will too much strategising lead firms to under-invest in core competencies and neglect dynamic capabilities, and thus hamper long-term competitiveness. Teece, Pisano and Sheun (1997, p.520) say that focus needs to be defined in terms of distinctive competencies or capabilities and not products. "Products are the manifestations of competencies, as competencies can be moulded into a variety of products." The capabilities approach places emphasis on the internal processes of firms as well as how they are deployed and how they will evolve.

Therefore the dynamic capabilities and resource-based approach allows us to link technological change, transaction processes and governance structures. Lorenzoni and Lipparini (1999, p.332) say: " (t)he TCE perspective should be coupled with the RBV and KBT assumptions and that the integration of competencies and combination of knowledge across a firm's boundaries is an important goal of managerial action."

These are used to build a model of the firm in Chapter 3 linking technology management, transaction processes and governance structures. Each of these areas is discussed next.

2.4 Technology Management

Having discussed competitive theories of the firm, TCE theories and RBVs of the firm, potential benefits for improving firms' competitive advantages through technology management may be identified. The Hay and Morris model (Figure M1) shows the effects of technology management on firms' profit and growth. From Figure M1 it can be seen that management is the agent of change that affects efficiency, investment in R&D, technology, economies of scale and firms' profit and growth. Other authors like Stonehouse et al (2000, p.46) also note that superior performance depends upon the ability of managers to turn resource inputs into core competencies more effectively than competitors. Resource inputs may include technologies, individuals in firms, etc. The Hay and Morris model shows the interplay of managers in firms as they adopt and implement technologies in an effort to improve firms' profit and growth. From a RBV, FSRs may lead to competitive advantages through technology management. This focuses attention on the technological assets and technological resource skills that are necessary for technology management. As firms muster the skills required for technological use, the benefits follow in terms of efficiency (i.e. manufacturing mix variables), which may lead to competitive advantages and finally to the profit and growth of firms. Therefore the leveraging of technology management (i.e. technological assets, technological resource skills and firm competencies) in an era of rapidly changing technologies may open up avenues for competitive advantage. Firms' competencies may be created through technologies and technological resource skills that are required for their competitiveness.

Emerging technologies may be seen as the introduction of newer technologies that offer additional or different benefits to existing technologies. Technologies exist in many forms and Day and Schoemaker (2000, p.8) give an overview of emerging technologies to include new distribution models, changes to production processes, new product features, new dimensions of competition, etc. Therefore technologies may be seen as including many aspects of the firm. Abernathy and Clark (1984, p.5) remind us that a firm's product features, i.e. performance, reliability, availability, ease of use, aesthetic appearance, image and others are important contributors to performance. A firm will be competitive when it achieves a position of advantage in one of these dimensions or a combination of them, i.e. when it is valued by customers and superior to competitors. The author argues that it is not only the product features of a firm that are a source of competitive advantage but also the management of the tangible and intangible resources the firm uses to produce the product. Such resources include material, individual skills and relationships and relevant knowledge. In achieving such a competitive advantage, the firm has to acquire resources and capabilities. These resources and capabilities may develop into firm competencies that are necessary for technology management. These capabilities may be said to lie in process technologies. Pisano (1994, p.88) defines process technologies as ultimately a set of technical choices that are embodied in a set of operating routines. In terms of this thesis, operating routines can be seen to exist in transactional processes. Through technology management, firms may change or adopt new transaction processes and governance structures that may lead to improvements conducive to competitive advantage. These resources and capabilities may include technological sourcing, knowledge management, relationship management and organisational learning activities in an organisation. The first step is in understanding technology management and its components before its effects may be explored.

2.4.1 What is technology management?

Firstly we begin with a definition of technology management, which will be used as a basis for the rest of this thesis. Thereafter a discussion on technology cycles follows, giving the various stages in the cycle. The effects of technological innovation, i.e. technological discontinuities, eras of ferment, dominant designs and eras of incremental change are discussed. These include competence enhancing and competence destroying effects. Technology is then viewed from a systems standpoint. In addition, technological evolution and the effects on the organisation are considered. Thereafter influences of technology are discussed. This section introduces the framework of technological change for the interaction of organisational economics and operations management.

The term 'technology management' is overused and a general definition can be found in any modern dictionary. Day and Schoemaker (2000, p.2) describe technology in a broad sense as the process of transforming basic knowledge into useful application. Tushman and Anderson (1986, p.439) cite Rosenberg (1972) who defines technology as those tools,

devices and knowledge that mediate between inputs and outputs (A: Process technology) and or create new products or services (B: Product technology). These two complementary definitions are used.

- Process technologies are technologies, that the firm adopts to turn the inputs (i.e. labour, material and capital) into outputs (i.e. goods and services). Process technologies include CAD, CAM, ERP, etc.
- Product technologies are those products or services the firm produces. Process technologies enhance the firm's capacity to improve manufacturing mix criteria for production.

Technology management may also be described as technological innovation and it encompasses the fields of invention and commercialisation. Porter (1998, p.70) describes innovation as including both technology and methods, encompassing new products, new production methods, new ways of marketing, identification of new customer groups, etc. The focus in this thesis is on the issues relating to technological adoption, the effects on new production methods and the associated benefits that lead to competitive advantage. These effects may be expected in improvements in transactional cost reduction, transactional value added or manufacturing mix criteria. Porter (1998, p.45) gives the following reasons as causes of innovations leading to competitive advantages:

- New technologies: technological change can create new possibilities for product designs, marketing, production, delivery and other ancillary services.
- New or shifting buyer needs: competitive advantage is often created when buyers develop new needs or their priorities change significantly.
- The emergence of a new industry segment: the opportunity for creating advantages arises when new industry segments emerge.
- Shifting input costs or availability: competitive advantages change when significant changes occur in absolute or relative costs of inputs like labour, raw materials, energy transportation, communications, media, or machinery.
- Changes in government regulations: in areas of product standards, environmental conditions, restrictions on entry and trade barriers.

Technology management can therefore be seen as encompassing many different activities that may lead to competitive advantages. Abernathy and Clark (1984, p.4) postulate that it is the technological innovation/management that may influence a variety of economic factors in different ways, thereby giving rise to differing views on the influence of changes in technology. Technology management is seen as a core resource, which can be leveraged to gain competitive advantages. This core resource can be seen as a core competence. Prahalad and Hamel (1996, p.69) maintain core competence consists of three parts. Firstly a core competence provides access to a wide variety of markets, secondly a core competence should make a significant contribution to the perceived customer benefits of the end product and thirdly a core competence should be difficult for competitors to imitate. In addition, the difficulty will increase with the combination of individual technologies and production skills. In

other words, competitors may be able to imitate some of the core competence resources but it will become more difficult to imitate the patterns of internal co-ordination and learning in the execution of the core competence. Drejer and Sorensen (2002, p.390) says, "(a) key feature of core competencies is that their effect can only be "measured" at the level of the consumer. If a core competence does not create value for the consumer, it will fail to result in any competitive advantage for the corporation." Therefore core competence may be seen as the glue that may be used to link the diverse production skills and integrate different technologies across the value chain. Links may give us a better understanding of the associated benefits from core competencies.

Before attempting to develop linkages it is necessary to define, technology management, transaction processes and governance structures. What follows is a definition of technology management and its effects before a similar discussion on transaction processes (section 2.5) and governance structures (section 2.6) is embarked upon.

Many authors have attempted to relate the effects of technology management to firms' structures. Tushman and Anderson (1986, p.440) say that since technology has been taken as a given, there has been a lack of clarity concerning how and why technologies change and how technological change affects environmental and or organisational evolution. Tushman and Anderson realise that technological implementation i.e. (A: Process Technology) influence the way the firm functions either within the firm or between firms. One of the objectives of this thesis is contained in the second part of Tushman's statement i.e. to discern how technological change affects the organisational and environmental evolution. However, the effects of Tushman and Anderson's views on technological management and the influences on TCE and the RBV are not mentioned and this is one of the things that this thesis will try to establish. There are some authors amongst others who provide reasons for technological change, namely:

- Tushman (1986, p.440) suggests that technology seems to evolve in response to the interplay of history, individuals and market demand. He cites the following as evidence.
 - Morison (1966) and Sahal (1981), they maintain "Technology seems to evolve in response to the interplay of history, individuals, and market demand".
 - Schmookler (1966) views technological progress as a function of economic demand and growth.
 - Gilfillan (1935) suggests that technological change is a function of historical necessity.
- Porter (1991, p.111) says: "Firms create and sustain competitive advantage because of the capacity to continuously improve, innovate, and upgrade their competitive advantages over time." The author also argues that upgrading is the

process of shifting advantages through out the value chain to more sophisticated types by employing technologies and higher levels of skills. These are technologies and technological resource skills to develop firms' competencies.

The Hay and Morris model (Figure M1) is close to the proposition made by Tushman and Anderson (1986). The interplay of individuals can be related to the actions of managers as they adopt and implement technologies to improve the firms' efficiency [6], investment in R&D [5], technology [1], thereby affecting the economies of scale [4] and the firm's profit and growth [14]. The market demand is related to barriers to entry [8], market profitability [12] and market growth [16]. Finally, history affects the existing product technologies that are used to implement process technology. Technological change, technological discontinuities, technology cycles, etc., all come into play.

In this thesis Tushman's reasons are taken as the basis for the discussion that follows.

2.4.2 Technological Strategy

Burgelman, Maidique and Wheelright (1988, p.1) note that technology is a resource which, when managed for competitive advantage, requires integration into a firm's strategy. Strategy involves the internal and external analysis of firms. Stonehouse et al (2000, p.46) characterised internal analysis as the firm's resource capabilities and competencies, the way the firm configures and co-ordinates its key value adding activities, organisational structure and characteristics, organisational performance measured as the strength of its products, i.e. brand name, price, reputation, etc. The focus in this thesis is on the first three characteristics: resource capabilities and competencies; configuration and co-ordinating value chain activities; and organisational structure and characteristics. External analysis is concerned with firm's competitive environments and the effects of globalisation. This includes customers, competitors and suppliers. In terms of this thesis the salient points of the internal and external analysis will be expanded upon in the investigative framework. The remainder of this section is devoted to the relevance of internal and external analysis to technology management and the linkages to TCEs, RBT and competitive theories of the firm.

Firstly we begin with a firm's internal analysis. Internal analysis involves firm-specific resources. Authors like Prahalad and Hamel (1996) have given evidence that the internal resources of a firm are more important than industry effects for sustainable competitiveness. Competitive theories of the firm, TCEs and RBTs have already highlighted the importance of firm specific-resources for firm performance and growth. The RBV of the firm has provided substantial literature in support of core capabilities and competencies. The TCE view has expanded on organisational structure and characteristics. Integration of theories in terms of competitive theories of the firm (Porter (1991)) and the dynamic capabilities view (Teece, Pisano and Sheun (1997)) have opened a discussion around the configuration and co-ordinating activities along the value chain. McLaughlin et al (2003) by means of a case study

have demonstrated how one US manufacturing firm used IT to improve its external downstream supply chain processes (value chain processes). The case study encompassed the areas of system implementation strategy and an implementation and maintenance phase. Some of the benefits gained include reduction of excessive paper handling, improvement in load consolidations, improvement in carrier and service mode selection, rate reduction from carriers (i.e. freight agents), etc. As can be seen benefits lie in the improvement of value chain activities. The central theme of this thesis is research on value chain activities, which includes technological change and the associated impact on transaction processes and governance structures.

For external analysis, Porter's Five Forces Model and the RBV provide a framework for expansion. Porter's model looks at the position of the firm relative to its competitors. The RBV looks at the firm's *resources and capabilities* and how it can develop these resources and capabilities to obtain competitive advantages. Capturing the external environment is a process by which firms form network structures with other firms to gain information and knowledge. Such networks are formed through suppliers, customers and competitors. Supplier networks are formed as firms outsource activities, which other firms can perform more economically. Strategic alliances, joint ventures and mergers are also formed so that firms can strengthen their position relative to competitors. Hamel, Doz and Prahalad (1996) propose collaboration with competitors in terms of joint ventures, outsourcing agreements, product licensing and co-operative research. Strategic alliances can strengthen both firms against rivals even though one partner may be better off than the next (Hamel, Doz and Prahalad (1996, p.133). The intent, however, is to strengthen the network structure and keep firms peripheral to the structure out of the competitive environment. The authors say that using an alliance with a competitor to acquire new technologies or skills is not devious but it reflects the commitment and capacity of each partner to absorb the skills of the other (Hamel, Doz and Prahalad (1996, p. 134). Cohen and Levinthal (1990, p.128) note that the ability to exploit external knowledge is a critical component of innovative capabilities. Thus firms forming alliances with other firms purely for the purposes of knowledge acquisition is an indication of the firm's willingness to develop learning. Others like Williamson may see this as opportunistic behaviour however, such alliances will not last as one of the partners will not be able to provide advantages for the other partner to stay in the alliance. Hamel, Doz and Prahalad (1996, p.595) say in such cases the weaker firm is forced to reveal more of its internal operations to keep the other partner interested.

The nature of the business environment is such that obtaining reliable external information is necessary so that the firm can make decisions about its strategic future (Stonehouse et al (2000, p.72). This includes the macro and micro-environment. Stonehouse et al (2000, p. 73) maintain that: "changes in the macro environment at both global and national levels cause changes in customer needs, products and production techniques, competition, and industry

and market structures". Porter's Five Forces Model does a reasonable job at looking at the micro-environment and has already been discussed under competitive theories of the firm. The macro-environment opens the arena for the effects of globalization. Stonehouse et al (2000, p.77) cites Yip (1992) who proposes four categories for assessing industry and market globalisation: these are market, cost, government and competitive drivers. In terms of the investigative framework for this thesis, the effects of globalisation will be studied under external factors, which include social, economic and political issues. Globalisation will have the effects of increasing the threats to entry, the threat of substitute products, buyer and supplier relationships and competitive rivalry. These are the issues firms will have to cope with to sustain competitive advantages. Such competitive advantages can be obtained through improving resource skills and competence, knowledge and technology acquisition, organisational learning, improving value chain activities, supplier and competitor relationships, etc. In other words, firm competencies, managers must identify and develop these firm competencies for competitive advantage. Some authors refer to firm competencies as critical success factors. Stonehouse et al (2000, p. 98) say that critical success factors are fundamental to the success of all business in a particular industry and associated markets.

Technology is developed and implemented to solve specific problems or improve certain situations so firms can grow and become profitable. According to the Hay and Morris model, technology affects capital growth, giving economies of scale. Some authors like Goldhar and Jelinek (1983, p.142) differentiate between economies of scope and economies of scale. Economies of scale and scope enable the firm to improve profit and grow. This is achieved through technological investments creating barriers to entry, thereby increasing market profitability, technological investments enabling concentration through market and product differentiation leading to diversification and better margins and hence improved firm profit and growth. The different technological typologies (section 2.4.4) from non-assembled products to open systems all add to the big picture, that is to create opportunities for competitive advantages. Managers are striving to match the competitive advantages of global rivals. These include moving manufacturing off-shore to obtain the benefits of lower labour cost, rationalising product lines to capture global economies of scale, quality circles and just-in-time production, and adopting Japanese human resource practices in an endeavour to be competitive, such initiatives also extend to include strategic alliances with competitors (Hamel and Prahalad (1996, p. 430)).

Hamel and Prahalad (1996) propose an extension of competitor analysis. Instead of analysing firm's current resource base and identifying opportunities to improve relative to competitors, (strategic fit) it may be more beneficial to leverage current resources to reach possible unattainable goals (strategic intent). The focus on the second is for the purpose of increasing organisational learning to outperform competitors. Hamel and Prahalad (1996, p.433) say: "The goal of strategic intent is to fold the future back into the present". The

authors pose the following question: "What must we do differently next year to get closer to our strategic intent?" instead of asking "How will next year be different from this year?" So to in technological strategy the goal is to stretch limited resources instead of fitting existing resources to current opportunities. This supports the premise that a firm's effects dominate over time and this view is shared by the following authors amongst others Porter (1991), Mauri and Michaels (1998), Wernerfelt (1984) and Mahoney and Pandian (1992). Marginal improvements, competitor's technology, manufacturing mix improvements, marketing, etc do not constitute strategic intent. Strategic intent means fundamentally changing the rules of the game, thereby placing competitors at a disadvantage (Hamel and Prahalad (1996)). Therefore keeping abreast of the latest technologies and technological timing is crucial to competitiveness. Knowing when to invest in a particular technology, be it product or process technology, is a competitive advantage that will allow firms to leapfrog their competitors, thus creating windows of opportunity to sustain and improve their profit and growth.

Tushman and Rosenkopf (1992, p.316) state that technology builds on the work of sociology, history, economics and industrial engineering. Tushman and Rosenkopf (1992, p.316) argue that technological change can be characterised by sociocultural evolutionary processes of variation, selection and retention. Variation is driven by stochastic technological breakthroughs, giving rise to technological discontinuities, which results in periods of incremental change. Tushman and Rosenkopf (1992, p.316) cite Jenkins (1975) who says these periods of incremental change may be interrupted by subsequent technological breakthroughs. Tushman and Rosenkopf (1992, p.316) maintain that a technology cycle consists of four components, namely technological discontinuities, eras of ferment, dominant designs and eras of incremental change. Figure 2.3 illustrates the relationship between the four components in a technological cycle.

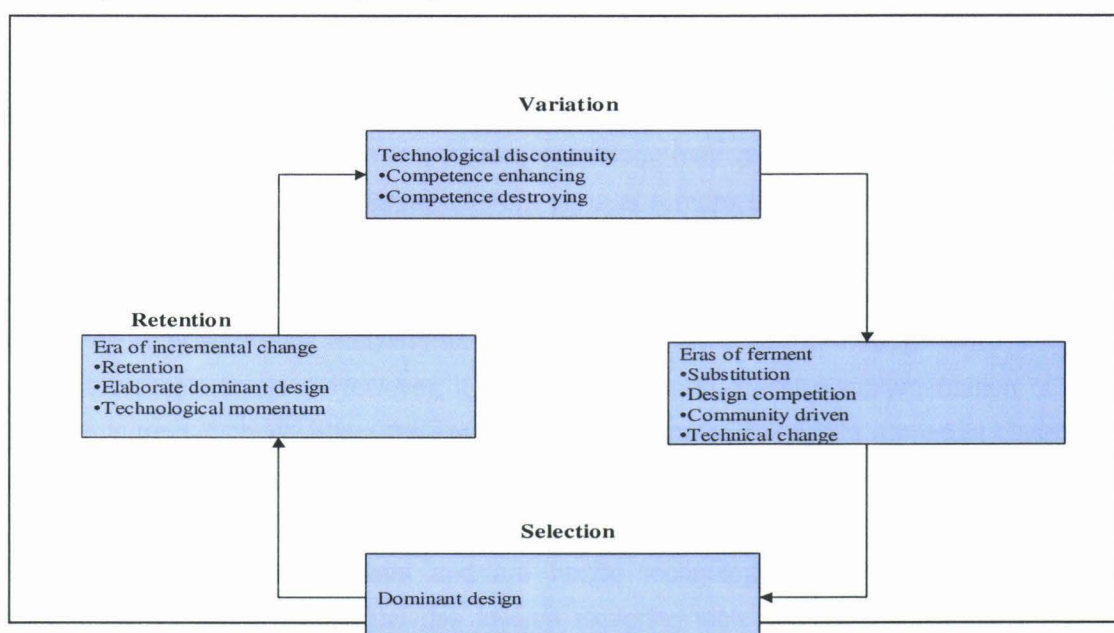


Figure 2.3: A Technology Cycle adapted from Tushman and Rosenkopf (1991, p.317)

Technology cycles are discussed next.

2.4.3 Technological cycles

Abernathy and Clark (1984, p.4) recognise that some technologies disrupt, destroy and make established competence obsolete, while others refine and improve. Technologies are used in firms to improve competitive advantage. Managers are faced with new and emerging technologies daily. They face decisions on which technologies to invest in. Should they invest in older technologies? Should they keep existing competence or should they invest in new and emerging technologies? That may destroy existing competencies. The decisions that managers make may give rise to technological changes. These technological changes need not be seen as negative. Firms can implement competence destroying technologies that may allow them to leapfrog their competitors and gain better competitive advantages. These may be seen as technological discontinuities. These discontinuities may become market standards or benchmarks, which may be likened to dominant designs. Technological discontinuities are events, that are caused by either push or pull technologies. Pull technologies are usually caused by industry or global effects such as e-commerce, which is pulling firms into another way of transacting with each other. Push technologies result when firms adopt newer technologies, which eventually become industry or global norms. In terms of the e-commerce arena, push technologies will occur within firms as they try to cope with the effects of the pull technology. These push technologies will then become industry norms.

To understand the effects technological discontinuities, era of ferment, dominant designs and era of incremental change are discussed next.

Technological Discontinuities

Technological change or discontinuity can partly destroy or enhance the competence of firms in an industry. Competence enhancement requires new skills, abilities and knowledge in both the development and production of products. Abernathy and Clark (1984, p.6) suggest that technology implementation in process technology may require new procedures in the handling of information, but utilising different skills is a more effective way. In this manner barriers to entry could be raised by making competition by rival firms difficult. In addition they also say that technological implementation can have the opposite effect of disrupting and destroying competence by reducing existing resources, skills and knowledge while they are below acceptable levels. However, it is a fact that the successful implementation of new technology fundamentally alters the set of relevant competencies within a product class that already exists because new techniques and methods have to be learnt and mastered to become effective in the use of the new technology. Furthermore, the older technologies and methods are no longer relevant and are hence technology-destroying. Technological implementation and technological use involve exploring technologies in three dimensions, namely: the degree of automation of the technology, the scale of the technology and the degree of integration of the technology. No technology operates without human intervention.

To some extent all technologies would involve some form of human intervention. Therefore technological implementation can either increase the competence in a firm or destroy it. Tushman and Anderson (1986, p.442) characterise technological discontinuities as either competence enhancing or competence destroying. There are other mechanisms for minimizing competence destroying or even improving competence enhancing effects. For example Lane and Lubatkin (1998, p.461) citing Grant and Baden-Fuller (1995), suggest that through learning alliances, firms can improve capability development and minimize exposure to technological uncertainties by acquiring and exploiting knowledge developed by others. This would include technological integration across the firm from suppliers to customers.

Individuals in firms operate, maintain and use technologies in performing their tasks. Sometimes managers introduce new technologies into firms, that make the older technology obsolete and in such cases the individuals have to acquire new skills in mastering the newer technologies. Often the older technologies become obsolete and the skills that individuals needed to use these older technologies are no longer required and thus competence is destroyed. In other instances managers introduce technologies, that build or add onto the older technologies, in which case the skills that individuals needed to use on the older technologies are enhanced and the process is thus competence enhancing. Managers introduce technologies in firms to improve the manufacturing mix criteria, thereby improving the flow of goods and services to the customer with the intention of improving customer satisfaction and eventually the profitability of the firm. It is not the intention of managers to either destroy or enhance competence. However competence destruction or enhancement are the outcomes or symptoms of technological implementation. Competence destroying and competence enhancing discontinuities are discussed next.

Competence destroying discontinuities

Competence destroying discontinuities arise when different technological knowledge or concepts are required to provide new or better goods or services. In acquiring such new knowledge, the existing expertise is regarded as obsolete. An example is manual purchasing systems in organisations being replaced by an electronic medium such as EDI and the Internet. Individuals who would have performed these tasks throughout history required different skills; older individuals would have to master skills in computer literacy to remain in their jobs. Dewhurst, Martinez-Lorente and Sánchez-Rodríguez (2003, p.356) gives examples of competence destroying effects from the IT industry, they say that IT may also reduce job satisfaction and diminish skill requirements by: routinising work; subdividing work into small, highly specialised and repetitive tasks, subjecting humans to machine control; replacing low-level clerical jobs with high-skill professional jobs; and automating the more mundane tasks. From this they argue that IT applications lead to deskilling. The rapid introduction of such technologies can only lead to further deskilling. Usually firms that currently do not hold a very strong position in the value chain/network structure introduce these types of technologies. These firms adopt a strategy that will give them leverage in obtaining a competitive advantage

and by doing so they weaken the network structure. This has the effect that current business partners no longer have a competitive edge with their alliances, hence they have to seek alternative partners that have, or together will have, a competitive edge. Firms change partners because existing partners are no longer capable of new competence in the area. This type of strategy is known as structure-loosening events (Madhavan, Koka, Prescott (1998, p.444)).

Bower and Christensen (1995, p.44) says that the kind of technological change that damages established firms generally has two main characteristics: firstly the technologies typically have a different package of performance attributes, which are not at the outset valued by the existing customers. Secondly the performance attributes that the existing customers do value, change at such a rate that the new technology can invade established markets. Only at this point will established customers want such a technology, i.e. after structure-loosening. Firms' adopt technologies that enable them to improve manufacturing mix criteria, improve market share and hence growth and profit of the firm. However they should be wary of the technologies they invest in, for the fear of the technology being obsolete.

Madhavan, Koka and Prescott (1998, p.440) introduce the concept of network structures. They say network structures are a key influence on performance and industry evolution and managers engage in strategic manoeuvring to secure positions in their industry's network. Managers therefore enter into strategic alliances to gain access to key technologies or resources. These key technologies or resources may provide better competitive advantage. Firms therefore try to position themselves centrally in a network structure. Firms that are peripheral in the network structure introduce structure-loosening events, which gives them the opportunity to position themselves in more dominant positions. Structure-loosening events create an opportunity for all players in the market to have an equal opportunity to network with other partners, except the firm that is introducing the new technology. Madhavan, Koka and Prescott (1998, p.446) say structure-loosening events provide the following added benefits for the peripheral firms: they radically change the basis for competition in the industry, where previously powerful firms may be constrained in their ability to create new networks quickly because of their prior commitments to existing partners. Competence enhancing discontinuities may provide further benefits.

Competence enhancing discontinuities

Competence enhancing discontinuities build on existing know-how. For example in computer technology, developments in the microprocessor represented a fundamentally different way of transferring information. Upton (1995, P.84) also supports this view, when he argues that: "People count more than machines". Computers should complement rather than replace the skills of individuals. Therefore competence enhancement has more support than competence destruction. Competence enhancing events are introduced by firms that are currently dominant in the network structure. This strategy is called 'structure reinforcing' (Madhavan,

Koka, Prescott(1998, p.444)). Structure-reinforcing events allow firms that are currently dominant to retain their dominance for an extended period of time. These firms will exploit existing technologies in which they are competent or exploit existing business partnerships until they exhaust the competitive capabilities of the technologies or alliances. Madhavan, Koka, Prescott (1998, p.445) say that firms introducing structure-reinforcing events build upon and extend currently accepted bases of competition in industry.

The danger facing these firms is that should the bases for competition change, due to customer preference or the introduction of newer technologies through structure-loosening events, these firms will be at a disadvantage. Bower and Christensen (1995, p.43) suggests that the most consistent pattern in firms is the failure of leading firms to stay at the top of their industries when technologies or markets change. His statement verifies the effect of structure-loosening events. Madhavan, Koka and Prescott (1998, p.445) point out additional benefits of structure-reinforcing events: firstly the dominant firms will become more dominant in the network secondly their powerful position in the network allows them a better opportunity to capitalise on the event than the more peripheral firms. Madhavan, Koka and Prescott (1998, p.445) add that central firms have the opportunity to increase their centrality and attract more partners. Similarly peripheral firms will find it even more difficult to attract partners. In other words, technological discontinuities force firms to cope with the effects of competence enhancing and competence destroying technologies, which creates an era of ferment as firms compete for old and new technologies.

Eras of Ferment

Technological discontinuities give rise to eras of ferment. Therefore as technological change increases, eras of ferment also increase. Tushman and Rosenkopf (1992, p.318) state that: "Technological discontinuities usher in an era of experimentation as organizations struggle to absorb (destroy) the innovative technology. This era of ferment is characterised by two distinct processes: competition between old and new technological regimes and competition within new technical regimes." Eras of ferment are characterised by substantial uncertainty as rival technologies and communities compete for dominance. Foster (1988, p.220) says that the essence of managing technology well is the ability to make smooth and timely transitions to new technologies with superior performance improvement. The competition between old and new technologies is fierce. Older technological orders seldom vanish as these technologies are protected by the firm's corporate culture. Foster (1988, p.222) says that a firm's product and production technology is an integral part of its corporate culture. Therefore when the technology changes, the whole corporate culture must change as well, and this is a difficult and painful process. Teece, Pisano and Sheun (1997, p.523) argue that new products employing different standards often appear with alacrity in market environments experiencing rapid technological change, and incumbents can be readily challenged by superior products and services that yield switching benefits. Tushman and Rosenkopf (1992, p.319) cite Clark (1985) who states that during eras of ferment, substitution processes and

design competition are associated with substantial technical and market uncertainty. Bower and Christensen (1995, p.45), however, warns against disruptive technologies. He says that disruptive technologies introduce a different package of attributes to what mainstream customers value and in addition perform far worse along one or two dimensions that are important to customers. On the other hand, sustaining technologies tend to maintain a rate of improvement, i.e. they give the customer more or better in the attributes they already have.

Managers must be wary of disruptive technologies as they tend to create new markets, which later threaten leading firms. For example, managers in firms that invest and implement in process technologies must be aware of the performance trajectories of the technologies they utilise. Bower and Christensen (1995, p.45) defines performance trajectory as “the rate at which the performance of a product has improved, and is expected to improve, over time.” Knowing this, managers must be aware of disruptive technologies that could be implemented by competitors to create structure-loosening events. Managers in firms must realise that technological investment is linked to the firm’s strategic objectives, i.e. to add capacity, improve processes, or develop new products etc.

Bower and Christensen (1995, p.47) says that these proposals take place at lower levels of the organisation, normally in the form of engineering proposals. Managers then use analytical planning and budgeting systems to select the projects that they will invest in. The author warns that because managers are evaluated on their abilities relating to project feasibilities, they will normally opt for the projects that are least risky. This is a type of opportunism that Williamson (1981, p.1545) refers to. Managers therefore opt for projects that will sustain their position in the firm. Bower and Christensen (1995, p.48) further adds that “careers are safeguarded by giving known customers what they want.” However, the danger here is that firms that gave customers product performance and met customer requirements, were hurt by the very technologies their customers led them to ignore (Bower and Christensen (1995, p.44)). Bower and Christensen (1995, p.44) say the processes and incentives that the firm employs with its main customers work so well that they eventually blind those firms to important new technologies in emerging markets.

Tushman and Rosenkopf (1992, p.320) maintain that the degree of uncertainty during eras of ferment may be contingent on the knowledge base, it may take longer for the technical and market forces to sort out rival designs than for competence-enhancing technical change to take place. The authors also argue that those firms and/or communities or organisations that defend older technologies prolong uncertainty before accepting that the new technology will become dominant. This is so because the choice of abandoning existing know-how in the face of competence destroying technical change creates uncertainty as to whether the new technology will provide the benefits envisaged. The era of ferment is closed by a dominant design.

Dominant Designs

The dominant design is the stage in the technology cycle that marks the end of the era of ferment. Once a dominant design emerges, future technological progress consists of incremental improvements elaborating on the standard already created. The dominant design continues until the next dominant design emerges, that is at the next technological discontinuity. Once a dominant design emerges, technological uncertainty decreases. Uncertainty associated with substitute or design competition decreases. After a dominant design emerges there is a shift from variation to incremental change. Tushman and Rosenkopf (1992, p.321) state that dominant designs permit more stable and reliable relations with suppliers, vendors and consumers.

Managers in firms that propose technological investments normally invest in technologies, that are necessary to retain their current customers but fail to make certain about other technological investments that customers of the future will demand (Bower and Christensen (1995, p.43). They are reluctant to invest in disruptive technologies, because such investments are risky and the safeguards against failure are weak. Williamson (1981, p.1545) uses the terms 'opportunism' or 'bounded rationality'. Bounded rationality could occur when the managers do not know any better as they are not acquainted with the potentials and risks associated with newer technologies. Rosenthal (1984, p.204) provides evidence from the CIM industries where he noticed that the decisions to adopt expensive factory automation technologies were often made by managers who lacked the background to access such technologies. In addition, staff lacked the vision to appreciate the strategic implications of the implementation of such technologies.

Furthermore Tushman and Rosenkopf (1992, p.321) state that from a customer's perspective, dominant designs reduce product class confusion and promise a decrease in product cost. Furthermore compatibility and integration can be achieved if the product is part of a larger system. It is easier for managers to compete for funds that enhance the capability of an existing system than to obtain funds for a new system that will create competence destroying events and resistance to change in the firm.

Era of Incremental Change

After a dominant design emerges, technical progress is driven by incremental innovations. These innovations improve on and extend the dominant design. Tushman and Rosenkopf (1992, p.323) cite Von Hippel (1987) who says that during periods of incremental change, informal know-how trading occurs between competitors. Over time, periods of normal technology development build more inter-linked competencies between technological communities and suppliers, vendors and customers. During periods of incremental change, managers must be careful not to invest in capacity that is not required. Making process improvements that customers do not require, results in high overhead costs, which inevitably increases the cost of the firm's goods and services. It is during this period that vendors of

product technologies build in facilities, that do not provide the returns on the subsequent investments. Managers should take cognisance of such issues. During periods of incremental change, managers must be aware of other technologies that emerge, i.e. the next dominant design. Abernathy and Clark (1984, p7.) provide four different types of innovation scenarios that affect technological implementations: These innovation scenarios may be linked to technology management portfolios. These scenarios are discussed next.

- Architectural innovation is the use of new concepts in technology to establish new market linkages, i.e. opening up new market opportunities through the use of existing technologies. The effect on production and technical systems is to conserve and strengthen established designs.
- The market niche phase, which consists of opening new market opportunities through the use of existing technology. Abernathy and Clark (1984, P.11) say that in some instances the changes in technology are trivial but they do have an impact on productive systems. However in this context technical knowledge is incremental.
- Regular innovation involves change that builds on established technical and production competence, which is applied to existing markets and customers. The effect of these changes is to entrench existing skills and resources. The outcomes are possible strengthening of production competence and also linkages to customers and markets. This has a positive effect on competence enhancing events (Tushman (1986)), and structure-reinforcing events (Madhavan, Koka and Prescott (1988)).
- Revolutionary innovation disrupts and renders established technical and production competence obsolete, i.e. it is competence destroying (Tushman (1986)).

Abernathy and Clark (1984, p.15) assert that regular innovation that uses skills in equipment serves to increase minimum economies of scale and makes established processes more specific and rigid. Abernathy and Clark (1984, p.18) also maintain that regular innovation follows the emergence of a dominant design. Regular and revolutionary innovation forms the basis for technological change, which causes firms to compete in order to improve manufacturing mix criteria and improve firm profit and growth. In such cases the competitive advantages of firms change the way they are structured and the manner in which they transact with other firms. Technology is a resource that firms need to leverage to obtain competitive advantages. Technology does not live in isolation; it is part of a business system that exists in firms and together with other firm resources can create valuable opportunities for competitive advantage.

2.4.4 Technology as a systems context

The benefits of technological integration are derived from combining separate technology units into one synchronised system. These technology units exist in different areas of the firm

from marketing, engineering, manufacturing and distribution to logistics, etc. Goldhar and Jelinek (1983, p.144) state that as sophisticated information systems integrate the work of production through the different sections of the firm from design to implementation and as information accumulates, it becomes easier to collect more data and thereby optimise, monitor and control systems. Firstly, there is faster throughput of information and/or materials through the firm. Secondly, as a consequence of faster throughput response and reaction times are faster due to the availability of more timely information. Thirdly, information and material flow is simple and predictable, thus making planning, control and forecasting more accurate. Benefits lie in improvements in manufacturing mix criteria.

Technology is developed to solve problems in a particular context; technology is not developed in isolation. Usually there is a need for a specific product, which is to be linked to other subsystems. Technological design involves both subsystem developments and integration across subsystems. Therefore the greater the number of subsystems, the greater the number of interfaces and interdependent demands on the systems. Hence the more complex the system the greater will be the requirement for improved communication interfaces between the various subsystems. Furthermore, the more central the subsystem, the greater will be the impact on the overall system. To understand the interfaces of the various subsystems to the overall system one needs a typology of products. Tushman and Rosenkopf (1992, p.325) distinguish four types of products ranging from simple to complex, viz.:

- Non-assembled products: Technological progress occurs either in process or materials. Process technology optimisation of subprocesses leads to better process cost, quality, speed, dependability and efficiency (i.e. manufacturing mix criteria). Dimensions for improvement are also easily measured, for example price/unit, price/performance, etc. Substitute processes may also trigger design competition between rival designs. The choice between alternative processes is driven by the interaction of professionals in a single industry sector such as steel, cement, information technology, etc.
- Simple assembled products: Technical progress occurs either through process, materials and/or product substitution. This is the most primitive form of technical progress. The use of standardised or interchangeable parts or the combination of subsystems results in a more efficient process. Independent of process innovation, technical progress can also be achieved by using product substitution. Substitute products can alter the price/performance of simple assembled products. As in the case of non-assembled products, dimensions for improved are also easily measured. Industry standards are driven by technical and engineering considerations as shown in Table 2.1 below.
- Closed products are bounded where open systems are unbounded. In closed systems the set of subsystems has a clear boundary. Closed assembled

systems are produced by single organisations. Closed systems are composed of a set of component subsystems or simple products that are linked together through linkage and interface technologies. Tushman and Rosenkopf (1992, p.332) say that technical progress occurs at the subsystem, linkage and interface levels of analysis.

- In open systems, component subsystems are dispersed and are not enclosed. Open systems are the most complex form of technological systems. These systems are composed of a set of closed systems that are linked together through interface technologies. Open systems have no boundaries. Tushman and Rosenkopf (1992, p.333) state that in open systems the product is not self-contained but is a function of networked components working together over a distance, e.g. television, radio, power, telephone, inter-net, computers and railroads. Unlike closed systems, open systems must cope with technological interdependence and economies of scale via multiple organisations operating at a distance.

Table 2.1: Technology framework for open systems

	Technological discontinuity	Era of ferment	Dominant design	Era of incremental change
Driver	Chance and individual genius	Technical change at the core subsystem, linking or interface level	Core subsystem, linking or interface substitution	Technical and social momentum
Basis	Competence enhancing or destroying at the core subsystem, linking or interface level	Competition among alternative component and interface designs	Drivers dimensions of merit	Competence enhancing
Arbiter	Network of organisations, community of practitioners, suppliers, governmental units, and customers	Multiple, diverse organisational, professional, governmental communities	Multiple, diverse organisational, professional, governmental communities	Network of organisations, community of practitioners, suppliers, governmental units, and customers
Influence of social, political organisational dynamics	High	Pervasive	Pervasive	High

Figure 2.4 shows the representation of technological systems within and between firms. Management systems like ERP, Internet-based technologies etc, are open systems that are used within and between firms as they transact with each other. Communication and information flow occurs within and between firms. Open technological systems are used to

co-ordinate and facilitate the interfaces between closed technological systems to optimise manufacturing mix criteria. Simple assembled and non assembled products occur at the lower subsystem levels and are the basis upon which closed systems operate. As technologies evolve, the interfaces between different technologies change and therefore firms have to adapt to such changes in the way they transact within the firm and with other firms.

Technology Evolution

Management must consider the possibility that it could enhance or destroy existing systems or competencies. Mature industries also experience discontinuities. Management of firms must develop competencies that will survive technological revolutions. During an era of ferment, several competing systems emerge. Therefore there is a delay due to incremental change. This delay offers management an expectation of a single design to appear. During this era several companies compete for the standard system. Hence this era offers an opportunity for organisations to standardise on the system and offer features of merit that do not already exist.

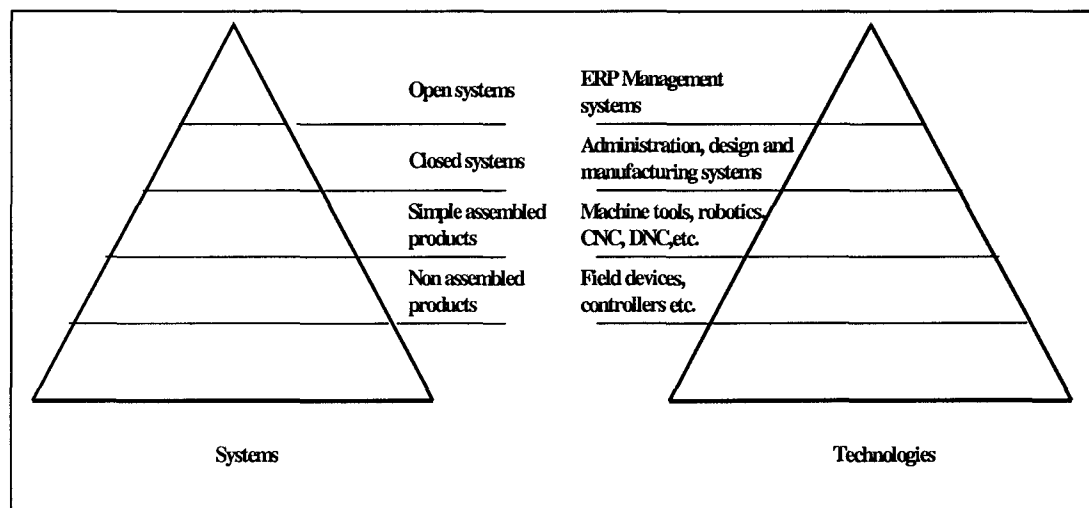


Figure 2.4: Hierarchical representation of technological systems in firms

During eras of incremental change, technical progress is driven by logic within the technology product class and by the influence of industry. Organisational processes change the selection of the product classes.

Process technology comes in many different forms. All firms make choices regarding their technology. However, there are many different ways of implementing any technology. Technological implementation involves thinking in three dimensions, i.e. the degree of automation of the technology, the scale of the technology and the degree of integration of the technology. Technological implementation involves three steps: firstly to create and simplify, secondly to automate and thirdly to integrate processes or functions. The benefits of integration lead directly to improvements in transaction processes with regard to transactional

cost reduction, transactional value added and manufacturing mix criteria. These competitive advantages could include better communications and information flows between suppliers and sections of firms. However, to make the most of technological innovations, managers must capitalize on technological transactions and ensure smooth transitions between old and new technologies.

Timing Technological Transitions

Technological discontinuities are one of the most disruptive challenges facing firms. The impact of these discontinuities results in firms losing market share and becoming less competitive, thereby being forced to reduce costs. Cost reductions take different forms. Some of these include downsizing, process optimisation, and alternative means of sourcing or outsourcing, etc. These cost reduction initiatives are focused on effecting improvements in manufacturing mix criteria. The adoption of newer technologies results in the firm restructuring and reorganising its processes and functions to maximise benefits from technological adoption. However the amount of improvement that is possible is limited by the difference between the current state-of-the-art and the technical limit. This difference is called the technical potential (Foster (1988, p.216)). Most firms do not realise where the technical limit is and hence invest large sums of money in newer technologies, thereby producing less improvement since the most benefit possible has already been obtained from partial adoption of technology. For example, a firm may invest in e-commerce for its order-processing functions but if such a firm has a small dedicated customer base, there would be a low return on the investment because the benefit is small relative to the large investment that is required. Other technologies such as EDI could give a much higher return on the investment with equal gains in process efficiency. Firms must be made aware of the technical limits of product technologies in the adoption of new technologies for process improvements. The development and maturation of product technologies can be mapped against the corresponding development and maturation of process technologies as depicted in Figure 2.5 showing the S-curve phenomenon. In addition firms must be aware when product technologies are in danger of being replaced by newer technologies, which would offer better process improvements and also affect the rates of return on technological investments.

According to the S-curve phenomenon, all R&D work is carried out in the context of technical limits. Early in the development phase knowledge is limited and progress is usually slow, but development then picks up and typically reaches a maximum when about half the technical potential is realised. At this point the technology is constrained by its technical limits and the rate of performance improvement begins to slow down and the law of diminishing returns sets in (Foster (1988, p.217)). Usually competitor technologies start being developed during the period of maximum progress and these competitor technologies create threats to the current technology. This period creates windows of opportunities for new technological development, and firms that adopt and use technologies must be aware of them because the potential benefits of the newer technology could offer better improvements in innovation.

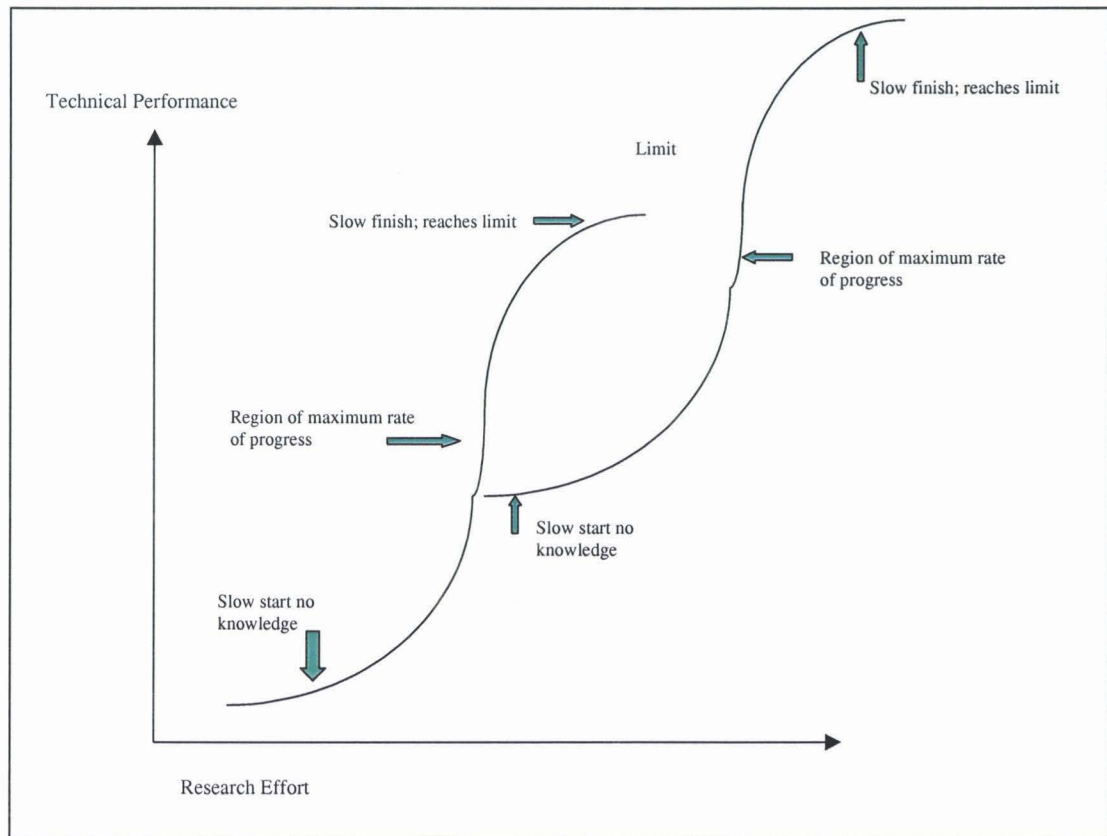


Figure 2.5: The S-curve phenomenon (Source: adapted from Foster (1988, p.217))

Knowing when to invest in the implementation of new technologies is certainly important. Foster (1988, p.220) says that in a symmetrical S-curve, half the potential for improving the technology remains to be exploited when R&D productivity has reached its maximum. At the midpoint, the bugs are out of the system and the adoption of such technologies of firms would be realistic since it can easily take up to 5 to 10 years to develop new technology. During the second half of the development, minor changes are made to the product to improve its capabilities, thus offering further improvements in the use of the technology. The model developed by Abernathy and Utterback (1988, p.27) shows that at some point in the product development cycle a dominant design emerges. Competitors standardise on general design features at this stage. Process technology improvements become apparent as competitors try to reduce cost and improve quality, hence striving for improvements in manufacturing mix criteria. Manufacturing processes become efficient and capital-intensive. Figure 2.6 below shows the model described by Abernathy and Utterback (1988, p.27).

Nicholas (2003, p.49) gives examples from the IT industry, he says "Given the rapid pace of technology's advance, delaying IT investments can be another powerful way to cut costs while also reducing a firm's chance of being saddled with buggy or soon-to-be obsolete technology." Nicholas adds the smartest users of technology like Dell and Wal-Mart stand out they stand back from the cutting edge, waiting to make purchases until standards and best

practises solidify. For the purposes of strategic intent it is necessary that firms be aware of the patterns of innovation so that they can invest intelligently in technologies to obtain maximum benefit from the investment.

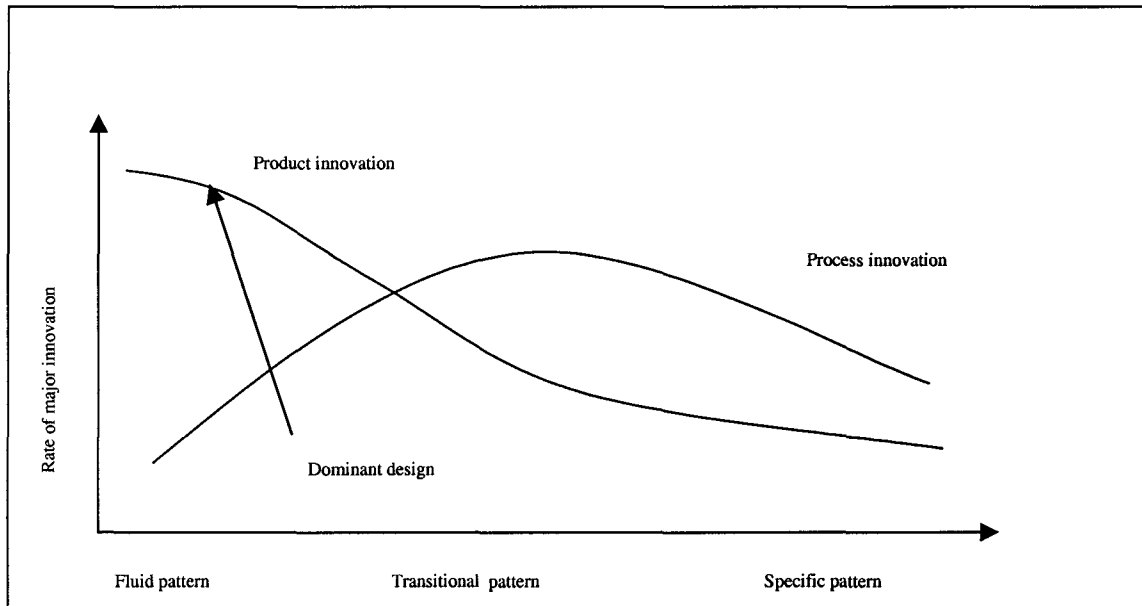


Figure 2.6: Patterns of innovation (Source: Abernathy and Utterback 1978, p.27)

Investment in technologies in the specific pattern will not bring about maximum gains as dominant designs and process innovations will have stabilised and any investment made in process technologies will allow competitive advantages to be limited. Moreover, newer technologies will be introduced by competitors. Firms should invest in process technologies just after the transitional stage, when process innovation is almost reaching maturity. The technology provider will bring about minor changes to product development and reduce product costs. But the early investment made by technology users will have greater spin-offs in their ability to attain competitive advantages before the rest of the industry. This is true for technology users in implementing technology solutions for their firms.

Firms can use lead users to test technology implementation scenarios before embarking on major process technological investments. Lead users and early adopters of technology usually have the ability to leapfrog their competitors from improvements in supply chain management through the adoption of new technologies. Von Hippel (1988, p.352) say lead users are those whose present needs will become general in a market, months or years in the future. Since lead users are familiar with conditions which lie in the future for most others, they also provide feedback to marketing research for needs forecasting because they have a to fill the need they experience. Von Hippel (1988, p.357) says that lead users are positioned to benefit significantly from obtaining a solution to the need they wish to fulfil. They generally have the benefit of early adoption of new technologies. Just as product innovators search for lead users, so firms that adopt new technologies can also search for lead users for their firm's

strategic alliances, a process in which partnering relationships could be used. Technologies exist across the value chain of firms. Appendix R gives a more detailed discussion on technological implementation from a value chain perspective.

Technological cycles are used to indicate that technologies change and managers in firms must be aware of the changes in technological cycles from technological discontinuities, eras of ferment, dominant designs and era of incremental change. Managers that are not aware of these trends may be seen to be not fully aware of technological developments, and therefore could be seen as making incorrect technological decisions. Having understood the technological cycles, managers involved in technological implementations from value chain perspectives to CIM will have an advantage over other managers who do not have such knowledge.

Having completed the discussion on technology management, the literature analysis is used to move towards the models (Figure 3.1 and 3.3) in chapter 3 and develop the metrics used in Chapter 4. In addition it lays the foundation for discussions on transaction processes.

2.5 Transaction processes

A firm processes transactions as follows: it obtains inputs or resources from markets, transforms them and delivers goods and services to markets. The firm may be regarded as an organisation with co-operative and authoritarian structures. These structures consist of a functional system and an information system, assets and liabilities and a judicial person. Nelson (1991, p.67) says that "Structure involves how a firm is organized and governed, and how decisions actually are made and carried out, and thus largely determines what it actually does, given the broad strategy." Transactions occur between these structures. Structures occur within the firm and between firms. Therefore transactions also occur within and between firms. Due to the complexity of the different structures, it is necessary to describe transactions. Alchian and Woodward (1988, p.66) describe a transaction to include both exchanges and contracts. They say that an exchange is a transfer of property rights to resources that involves no promises or latent future responsibility. In contrast a contract promises future performance, because one party makes an investment, the profitability of which depends on the other party's future behaviour. Having described transaction processes further examples pertaining to transaction processes are discussed next.

2.5.1 What are transaction processes?

Transactions occur in many forms. Some of these forms include materials processing, information processing and customer processing, etc. Managers (judicial persons) adopt technologies such as CAD, CAM, MIS, ERP, etc. process transactions economically. Figure R1 shows the different technologies that are adopted across the value chain. Through technological investment managers can integrate the different functions in a firm. The WBS

model proposed by Love and Barton (1996, p.6) and the IEM model proposed by Krause et al (2001, p.218) shows the possible implementation of technologies to form a coherent system. Even though these models (mainly WBS) are proposed as models that can assist managers in making investment decisions, it gives an idea of what a coherent system may look like. Through the implementation of such technologies, managers can improve transactional flow. Some of the advantages associated with the co-ordination and integration of technologies include:

- Information flow and knowledge transfer.
- Improvements in manufacturing mix.
- The elimination of paper and the costs associated with its use.
- The facilitation of simultaneous engineering.
- Automation and communication within the firm.
- Reduction of costs for transaction processing.

These transactions occur within and between firms. Within firms transactions occur between departments, sections of firms and others, such as markets. In this model the buyers from one firm interact with the sales staff from the other firm. A transaction process begins when a purchase order is placed with one of the firms and is concluded when the goods or services are delivered and the buyer pays the invoiced amount to the seller. This process seems simple but it involves a range of activities between the two firms. The WBS and the IEM model proposed by Love and Barton (1996) and Krause et al (2001) gives an overview of this transaction process. It can be seen that various technologies can be adopted in a transaction and the effective use of technology can improve the transaction process. Technologies used could include the following:

- EDI between buyer and seller or e-commerce technology between buyer and seller.
- Engineering, manufacturing and business planning systems for the buyer and seller.
- Electronic funds transfer between buyer and seller.

The integration of technologies across engineering, manufacturing and business planning creates opportunities for cost reduction in transaction process. The choice of whether to conduct transactions within firms (sections of firms) or markets provides the economic rationale necessary to practise the make or buy decision. When services within the firm become costly, managers seek alternative means of obtaining these services and such alternative means may result in contracting these services from the market. Such contracting means include strategic alliances, joint ventures, mergers and acquisitions. Hamel, Doz and Prahalad (1996) propose collaborating with competitors for competitive advantage. Collaboration enables firms to form networks with other firms. Forming networks with other firms may be important for competitive advantage.

Jarillo (1988) proposes an addition to the transformation or transaction process. He proposes the concept of strategic networks. Firms act in a complex environment and firms act in relationships with many other firms. Jarillo (1988, p.32) sees "Networks as complex arrays of relationships between firms. Firms establish those relationships through interactions with each other. These interactions imply investments, which gives consistency to the network. Competing is more a matter of positioning one's firm in the network than attacking the environment." Jarillo (1988, p.32) sees "strategic networks as long-term, purposeful relationships among unique but related profit organisations, which allow the firms in the network to gain and sustain competitive advantage vis-a-vis against their competitors outside the network." The concept of the network involves a hub firm, which sets up the network and plays a pro-active role in it. The foundation of the network is based on co-operation between firms in it. Madhavan, Koka and Prescott (1998, p.439) assert that inter-firm relationships, especially strategic alliances between partners, offer significant flows of knowledge and other resources, which are crucial to competitiveness. The authors say that the structure of the industry network plays an important role in the performance of firms and in industry evolution. Hamel, Doz and Prahalad (1996, p.598) suggest that the success of collaboration lies in the firm's ability to acquire knowledge from its competitor-partner and the ability to transfer such knowledge through the firm. Information without transformation of knowledge is fruitless. Gulati (1998, p.305) says that firms may also use their network contacts to create control benefits by utilising the advantage position in the network to play off one partner against the other. This could be seen as one of the benefits of having more than one partner in the network, which could reduce the risk associated with moral hazard and hold up.

Williamson, however, proposes that firms will opt for the most cost-effective solution in establishing relationships within the firm or in markets. If the costs inside the firm are higher than obtaining the same resource outside the firm, the firm will opt for the market. In such situations there are additional costs such as the cost of opportunism, early mover advantages, strategic advantages, etc., which may force the firm to obtain the resource from within the firm. The latest state-of-the-art technologies that are adopted within firms often create opportunities for technological advantage. Gulati (1998, p.306) also reminds us that the influence of networks on firms changes over time if the content of information flowing through the network changes. This is true because networks have influence primarily through the channelling of information. Therefore it is important to assess the content of information flowing through those networks that change over time. Hamel, Doz and Prahalad (1996, p.592) quote a Japanese manager working in a company who identified what information had been collected by employees involved in alliances and then passed the information on to the appropriate departments. Such co-ordinated efforts in information transfer are examples of the firm's ability to enhance learning from the competitor-partner.

In view of the benefits associated with network structures, firms should identify other firms that have certain competitive advantages. Firms should then form alliances with these other firms, enabling themselves to create strategic advantages over other firms. In addition, technologies between firms can also create strong network relationships. These technologies can be used as barriers to other firms who may attempt to break into the network structure. Such technologies could include hardware and software technologies between firms. Examples could include a conveyer line between a buyer and seller who are located in close proximity to each other, which could create barriers to entry for another supplier who intend breaking into the network structure. An example is also quoted by Dyer (1997, p.549) where a Nissan seat supplier decided to build its plant on the property adjacent to a Nissan assembly plant. This decision was made because Nissan had a minority equity position in the supplier and the two parties had developed a high level of relational trust. Once this site-specific investment was made, the parties discovered that rather than transport the seats by truck, it would be more economical to build a conveyer belt to carry the seats between the two plants. The investment in the conveyer belt was made jointly between Nissan and the supplier. This is an example of a high degree of information sharing and trust, which has resulted in higher levels of relation-specific investments. Another example could be an automated order processing system between the buyer and seller with bar code scanning facilities for goods identification and receipt this could also create opportunities for strong network structures. However, it must be noted that eventually it is a good product, together with good customer relationships, that will ensure that the relationship between buyer and seller remains healthy. Both parties need to add value to the alliance to sustain its existence; barriers to entry may only prolong the closure of a poor alliance.

Madhavan, Koka and Prescott (1998, p.440) argue that external relationships have the added advantage of providing access to key resources such as raw materials, information, technology, markets, or other crucial performance requirements. These added advantages may be too costly to develop within the firm. However, obtaining such services outside the firm has consequences for the current cost structure of the firm. For example, the current structures that are in use have to be made redundant because they are no longer cost-effective. Redundancies could take the form of downsizing, involving retrenchments, which often have consequences regarding loss of know-how, etc.

There are different forms of inter-firm relationships. Jarillo (1988, p.34) depicts the graphical relationship of economic organisation as follows:

The upper left-hand quadrant consists of markets, which are defined by Williamson. The lower left-hand quadrant is typical of labour-management relationships, i.e. a hierarchical organisation. The lower-right hand quadrant is devoted to Clans i.e. long-term relationships, carried out through specified contracts within the formal environment of an organisation.

Clans have the ability to eliminate transaction costs. Clannish type relationships have also been proposed by Hamel (1991, p.95) who cites Ouchi (1980). Other researchers have noted formations such as cliques (Gulati (1998, p.299)). Choi and Hartley (1996, p.333) cites Martin Christopher (as quoted in Hastings (1994)) when they say that when supplier relationships are built on long-term, clan-like relationships, this is one of the company's strongest barriers to entry for competitors. Madhavan, Koka and Prescott (1998, p.440) argue that inter-firm networks are strategic resources that manager's design and develop over time to meet their objectives.

	Zero Sum Game	Non Zero Sum Game
Legal Form	Classic Market	Strategic Network
Hierarchy	Bureaucracy	Clan

Figure 2.7: Modes of organising economic activity (Jarillo (1988, p.34))

Jarillo refers to the upper right-hand quadrant as strategic networks, consisting of a hub firm with an array of relationships with firms in the network. Jarillo (1988, p.34) argues the difference between Williamson and Ouchi is that Williamson sees opportunism as the key motivator but Ouchi sees fairness as the key motivator. Madhavan, Koka and Prescott (1998, p.441) say that understanding how industry events can shape networks has managerial implications including:

- Articulating what network changes to expect when specific types of industry events take place, and
- determining how to use the anticipated network changes to a firm's specific advantage.

Madhavan, Koka and Prescott (1998, p.442) say that the centrality of a firm in a network is an important factor because being well-connected has strategic advantages since each contact is a potential source of relevant information, resources, or influence. Therefore a highly central firm in the network is likely to be connected to many more partners than a less central firm. Therefore firms which realise the importance of centrality will continually be trying to improve their position in the network by connecting with more and more central partners. Gulati (1998, p.308) says that the proximity of a firm in an alliance influences the confidence and trust of each partner, because both have greater information and the network creates a deterrent for opportunistic behaviour that will damage the reputation of the firm that errs opportunistically.

Madhavan, Koka and Prescott (1998, p.442) state that since firm centrality is such a key resource, changes in the relative centrality of firms are important indicators of structural change. Therefore it is necessary for firms to select technically capable partners to maintain

the relative stability of the network. This has also been mentioned elsewhere (e.g. Choi and Hartley (1996), selection criteria for suppliers and partners)). Madhavan, Koka and Prescott (1998, p. 443) postulate that it is only key industry events that are the cause of network restructuring. These events include major technological developments, entry of a resourceful and determined competitor, changes in regulatory infrastructure, or a dramatic shift in consumer preferences. Therefore such industry events would fundamentally change the basis of competition. Firms may then find that they need access to a different set of resources than those provided by their current partners (Madhavan, Koka and Prescott (1998, p.443)). On the other hand, there may be some industry events that strengthen a partner's position in a network. Madhavan, Koka and Prescott (1998, p.444) aver that industry events are either structure-reinforcing or structure-loosening events, and that both these events alter the structure of the network where:

- *Structure-reinforcing events benefit firms that are already powerful in the network, extend and strengthen a current competitive regime and are initiated by firms that are currently strong in the network. These are competence enhancing events. Dominant firms in the network have a better opportunity to capitalise on the event than do more peripheral firms. These events are likely to be caused by improvements in technology, for example incremental progress through the interaction of many firms which may result in improvements in manufacturing mix capabilities.*
- *Structure-loosening events radically change the basis of competition (and can be seen as competence destroying), therefore firms need to look for new partners, firms already powerful in the network have no automatic benefit from the change. Therefore all firms in the network are equally likely to benefit. Powerful firms in the network may be constrained in their ability to quickly change partners due to prior commitments to existing partners, such as high asset specificity, etc. Finally, the latter are more likely to be introduced by firms that are currently peripheral in the network. This can be done by the adoption of new technology or some other means.*

Having described transaction processes, the costs associated with transaction processes are discussed next. Transaction costs are looked into from a value chain perspective.

2.5.2 Transaction costs: a value chain perspective

To understand the way firms integrate activities and decide which activities should be sub-contracted, it is necessary to view firms from a value chain perspective. Jarillo (1988, p.35) says that viewing the firm as a value chain, i.e. collections of activities that add value between suppliers and customers, makes it possible to apply Williamson's concepts as he refers transaction costs to specific activities, which are easily assimilable into functions. The value chain will also enable authors to consider the reduction of transaction costs in non-value adding activities and the elimination thereof. This perspective is also supported from the RBV

of the firm, i.e. concentrate on core critical resources, which would lead to competitive advantages. Arguing from a TCE perspective, Jarillo (1988, p.35) says that it is the final cost of an activity that matters, even if that activity is performed within the firm or subcontracted. In this thesis activity may be likened to transactions.

Jarillo (1988, p.35) differentiates between internal cost (IC), external cost, which is the price charged by a subcontractor (EP) and transaction cost (TC). The total external cost is therefore (EC), which is $EP + TC$. He draws the following conclusions:

- When $EP + TC > IC$ the activity will be integrated.
- When $EC + TC < IC$ the activity will not be integrated, and thus will be more effective than its competitors. TC thus forces integration.

Jarillo (1988, p.35) says that the network arrangements allow a firm to specialise in those activities of the value chain that are needed for competitive advantage. Therefore the other activities can be subcontracted to other firms in the network that can perform these activities more efficiently, taking into consideration cost, quality, speed, dependability and flexibility (manufacturing mix criteria). Stonehouse (2000, p.231) notes that decreasing knowledge of a particular technology causes the firm to seek alternative means for acquiring such know-how. In such cases the firm may opt for a range of alternatives from internal development and acquisitions to joint ventures. In so doing the firm forms network structures with other firms. The advantage of network arrangements is that firms perform activities that are essential to them but at the same time do not have fixed commitments. Thus networking offers cost advantage for firms to stay inside the network because of economies of scale and competence. Economies of scale arise from growth, and firms grow within their function, i.e. by practising horizontal integration and/or by incorporating other functions within the firm, thereby practising vertical integration.

However Blois (1990, p.495) disagrees with Jarillo (1988), arguing that where $EP + TC < IC$ the customer will integrate only if the entire TC is borne by the customer. Where this is not the case, the conclusion that the customer should integrate is incorrect. Blois (1990, p.495) says that the decision of a customer or supplier to transfer all of the transaction costs to its partner depends upon the attitudes of both firms to the transaction. The current trend is to evaluate suppliers according to the profitability of the supply relationships in the long-term, which is more important than short-term gains. Under such circumstances customers are unlikely to transfer their transaction costs to their suppliers' unless such a cost transfer would result in an increase in joint profits and no decrease in the suppliers profits.

In addition, Blois (1990, p.495) argues that using the transfer-pricing model it is impossible to show that increases in transaction costs incurred by a supplier and its customer can result in the combined profits of the supplier and the customer being increased. The author maintains that the application of transfer pricing is only considered in the context of vertically integrated

organisations. The reason given is that the assumption in economic analysis is that outside of vertical integration a customer and supplier will both seek to maximise their own profits. The Ronen and McKinney transfer pricing model referred to by the author shows that neither party need suffer reduced profits; therefore an increase in the total transaction costs need not be detrimental to either supplier or customer and may even be beneficial to one or both parties. The transfer-pricing rule thus makes it feasible for independent suppliers and customers to reach agreements to co-operate in such a way as to maximise their joint profits. Such co-operation will have cost implications, i.e. additional transaction costs.

This complex network relies on each firm in the network to perform efficiently and effectively to sustain the network. Furthermore, the more firms that are incorporated into the network, the more complex the management and control of the network. The relationships between the various firms in the network influence its final output. All transactions flow through the network and these include materials, information and sometimes people. The network consists of customer-supplier relationships formed by different sections of the firm.

Jarillo (1988, p.36) states that the basic condition for effectiveness is firstly technological, i.e. external costs must be lower than internal costs, and secondly there should be the possibility of lowering transaction costs. The author defines efficiency, on the other hand, as the gain to be obtained from being part of the network, which over the long run is seen to be more beneficial than the profits to be obtained from not being part of the network. There are two reasons for this. First, by being part of the network, greater gains are realised in terms of superior performance and secondly, the sharing mechanisms in the network are fair. Therefore the author argues that efficiency and effectiveness are the basic conditions for the existence of networks. Just as Williamson sees opportunism as a cost, Jarillo sees trust and fairness as an integral part of the network in maintaining relationships. Gulati (1998, p.308) suggests that trust not only makes greater information flow possible but it also provides for the ease of interaction and the flexibility of each partner, which contributes to the success of the alliance or network. Barney and Hansen (1994, p.175) conclude from literature surveys that it is behavioural researchers who are dissatisfied with economic scholars who suggest that: "trust will only emerge in an exchange when parties to that exchange erect legal and contractual protections (called governance mechanisms) which make it in their self-interest to behave in a trustworthy manner" (Williamson (1975) and others).

Jarillo (1988, p.38) says that establishing an efficient network is a means of lowering transaction costs because it is these costs that lead firms to integrate instead of opting for market relationships, which offer further advantages of specialisation for the suppliers and the contracting firm. Subcontracting in a networking context is merely a means of transferring risk to the firm, which can manage the risk more efficiently and effectively. Some authors argue that the risk is transferred to defenceless subcontractors. However, risk-sharing is a

fundamental component of network relationships for long-term success of the relationship. Williamson maintains that firms should be responsible in their subcontracting behaviour and managers must not subcontract for the fear of failure, since this kind of behaviour may be seen as opportunistic. As already mentioned elsewhere, concentrating on critical core resources can lead to competitive advantages and can create avenues for strategic intent options, which can cause the organisation to be more inventive (Prahalad and Hamel (1989)).

Dyer (1997, p.535) maintains that the value chain in modern economics consists of inter-firm specialisation, which includes input and output relations with other firms. These input and output relations are linked to a narrow range of activities in the value chain. Such transactions or relation-specific investments between firms result in productivity gains along the value chain. However such input and output relations cannot be achieved without cost. Costs are created when firms put safeguards in the value chain for fear of opportunism. This scenario requires us to consider the relationship between sections of firms and the various contract types, viz. classical, neo-classical and relational contracts.

- In a classical contract the identity of the parties is irrelevant, breach of contract is not well-documented and therefore predictable, and finally the agreement is not conclusive.
- In a neo classical contract the outcomes are either not known or too costly to be known. This implies that adaptations will not be evident until specific circumstances arise. When these circumstances arise, parties will have claims on each other.
- In a relational contract, the contract depends on the investment characteristics that are required to satisfy the customer and producer's requirements. Where investment characteristics are non-specific, the market may be used. The relational contract is similar to the neo-classical contract except for the duration and complexity, which leads to the creation of a society where norms and a mini-society are created.

Having defined the different contractual mechanisms, sections of firms are discussed next.

2.5.3 Sections of firms

Transactions occur across different sections of a firm. In many firms these sections are standalone functions. The transfer of information across and between these functional areas can lead to competitive advantages in manufacturing mix criteria. Typical problems that are related to information flow between and within sections of a firm include:

- Long lead times.
- Not everybody is focused on customer satisfaction.
- Passing the problem over to the next section.
- No clear owner of the value chain process.
- Duplication of tasks and information.

Typical information and knowledge flow in a firm can be depicted as shown in Figure 2.8.

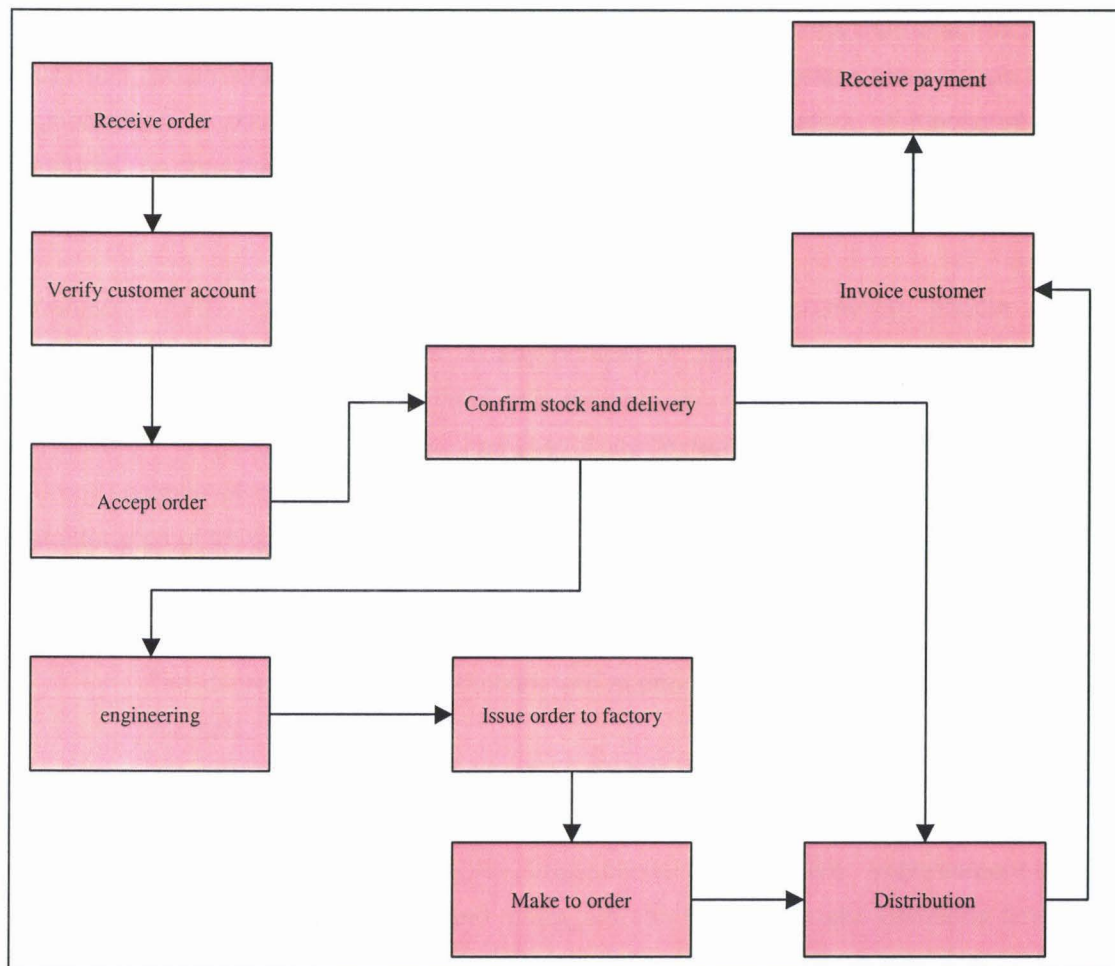


Figure 2.8: Information flow

The flow of information, people and material is complex. Having the ability to economize on transaction costs, transactional value and manufacturing mix criteria may give competitive advantages. Managers may use technologies to improve the transaction processes in respect of transaction costs, transaction value and manufacturing mix criteria. These technologies include AMTs, ranging from design, manufacturing and business planning. Transaction processes occur within organizational structures. Organisational structures also contribute towards better transaction processes and manufacturing mix criteria. Hierarchical functions, managers as controllers, management control systems, fragmented work, duplication of functions etc, are all factors that affect transaction processes. Efficient networking within firms also contributes to competitive advantage. Transaction processes and transaction costs are fundamental to organisational design and technological implementation. Technology assists in destroying barriers between the different sections of the firm to improve information flow and knowledge transfer. The WBS model proposed earlier is one of the possible options that technology can offer to improve transaction processes between and within firms. Technology systems adopted in engineering,

manufacturing and management are all parts of a whole system working together to improve information flow and knowledge transfer to improve firm profit and growth. The Hay and Morris model also supports the stance that managers make decisions that affect technology investment, which eventually lead to firm profit and growth. Therefore there needs to be a transformation in management techniques towards network clusters of functional areas, managers as coaches/enablers, knowledge-sharing systems, relationship management, strategic alliances, etc.

Williamson (1981, p.1544) states that transactions occur between people across “technologically separable interfaces” in any number of places. Places could be between departments in the firm, sections of firms or in markets, etc. The basic unit of analysis is the transaction. Technology, however, has the ability to facilitate transactions between the different sections of the firm. Williamson (1981, p.1546) quotes the following attributes or characteristics of transactions that determine the place where transactions occur.

- The frequency with which transactions occur,
- The uncertainty to which transactions are subject,
- The degree to which transactions are supported by durable, transaction-specific interests.

Technologies in engineering, manufacturing and management assist with improvements in transaction frequency, transaction reliability, transactional durability, etc. Improvement is as a result of data more readily available and managers can therefore make decisions timeously and accurately. Customer supplier relationships are sometimes built on joint investments in technology; for example a joint investment in a manufacturing plant. In such a joint venture transactions are said to be ‘transaction-specific’. Transaction-specific interests focus on asset specificity, which can arise in three ways:

- site specificity, successive linking of relevant firms/organisations so as to economise on inventory and transportation expenses;
- physical asset specificity, for instance where specialised tooling/equipment is required to produce a part; and
- human asset specificity, which arises in a learning-by-doing fashion.

The importance of asset specificity is that once the investment has been made, the buyer and seller are operating in a bilateral or quasi-lateral relation. The seller and buyer are locked into the transaction. The supplier of the equipment is constrained insofar as the value of the equipment is large compared to the specialised use of the equipment. The buyer, on the other hand, cannot turn to an alternative supplier for the equipment because the cost of obtaining unspecialised equipment is also high. Williamson (1981, p.1546) states that where asset specificity is great, buyer and seller will make special efforts to design an exchange

relation that has good continuity properties. In such relationships goodwill, trust and fairness are ingredients for the long-term success of all parties involved in the agreement.

Alchain and Woodward (1988, p.71) argue that asset specificity is not the be-all and end-all and that human resources and labour play an equally important role. The author suggests that Williamson should have reinforced the idea that firms are owned, controlled and administered by capital but labour plays an equally important role. This form of autonomous contracting opens the way for market contracting and internal organisation. Resource management is critical as a particular skill often rests with a few individuals in the firm and the loss of such individuals will put the firm at a disadvantage. This is supported by human asset specificity and learning-by-doing. Cohen and Levinthal (1990, p.542) propose the concept of absorptive capacity, which they define as the ability to evaluate and utilize outside knowledge. This is largely a function of the level of prior related knowledge. Therefore prior related knowledge confers an ability to recognize the value of new information, assimilate it and apply it to commercial ends. This essentially is what absorptive capacity is. Hamel, Doz and Prahalad (1989, p.595) say that the potential for the transfer of information is greatest when a partner's contribution is easily transported (e.g. engineering drawings, computer tapes, or in the heads of a few technical experts). However, manufacturing excellence consists of a range of activities e.g. employee training, integration of suppliers, value engineering, etc., which are not easily transferable and can only be adopted in a piecemeal fashion.

Schonberger (1994, p.7) shows a model of firms having four basic functions that must be managed: money, design, demand and operations. He calls these 'line functions'. The author says that as firms grow, line functions become the first departments such as the departments of finance, research and development, marketing and operations. For successful business the business team must integrate and plan strategy in all four areas. A comprehensive strategic plan deals with issues affecting the whole firm, including employees, markets, location, line of products and services, customers, capital and financing, etc. Only when the business plan is formulated correctly are the four functional areas mutually reinforcing and compatible. However the author argues that this seldom is the case. Tallman (1991, p.71) supports this view, commenting that the choice of strategy guides decisions about resource allocation, governance structures and other environmental action. The correct strategy for the business, however, is to satisfy the customer requirements.

Meeting customer requirements consists of transforming inputs into outputs. The inputs consist of people, capital, natural resources, materials and technology. The inputs are transformed to the outputs, i.e. goods and services. The performance objectives of suppliers are influenced by the customer's preferences, competitor actions and the stage of the product or service in its life cycle. The performance objectives are the manufacturing mix criteria.

Table 2.2 below gives a graphical representation of the impact of performance objectives on products, services and processes.

2.5.4 Transactional framework

Transaction processes determine how firms function. The processes and technologies that are used in daily activities are subject to change, which make firms compete for old and new technology regimes. The degree of the frequency and uncertainty of transactions influences the contract types, i.e. classical, neo-classical and relational contracts. Firms often produce forecasts and estimates of planned orders to their suppliers, and the accuracy and integrity of these forecasts affect the transactional frequency and transactional certainty or uncertainty. Having reliable forecasts enables the suppliers to produce in advance, but having inaccurate forecasts causes suppliers to doubt the forecasts and therefore become noncommittal towards deliveries, which negatively affects manufacturing mix criteria. Due to the unreliability of transactional information, firms opt for contracts that will provide accurate transactional information. Latest developments in technologies make forecasts and estimates scientific, thereby reducing the error rate. Goldhar and Jelinek (1983, p.144) assert that as computer information systems integrate sections of firms, manufacturing departments come to rely on science rather than art.

Table 2.2: The impact of performance objectives on products, services and processes

Performance Objective	Influence of good product/ service design	Influence of good process design
Quality	The ability to improve and prevent potential defects in products or services	The ability to streamline and standardise processes in order to meet product design specifications
Speed	Ability to produce rapid product innovations and process ongoing customer demand rapidly to the market	Timely transfer of information and materials to the customer with the minimum amount of disruption
Reliability	Through the establishment of standardised processes and methods reliability in each process can be obtained	The provision of reliable staff and technology
Flexibility	Allows for variations in customer demand through rapid product changes or customer order modifications	Through standardisation and streamlined processes quick changes can be made to customer demands
Cost	Cost reduction can be achieved through continuous improvement and value engineering principles and partnership agreements with suppliers and customers.	Streamlined and standardised processes offer economies of scale for high utilisation of resources and hence low-cost processes

The criterion for organising transactions should be one of cost economising. This consists of two parts, one of which is to economise on production expenses and the other to economise on transaction costs. This may be viewed as obtaining benefits in transaction costs and increasing transactional value simultaneously. The two parts need to be analysed simultaneously, but the focus in this thesis is on the latter. This thesis will also demonstrate that information flow and knowledge transfer can be considered as drivers for improvements in manufacturing mix criteria. The criteria for organizing transactions are important and these

will next be discussed. Williamson (1981, p.1547) identifies three principles of organisational design: asset specificity, the externality principle and hierarchical decomposition.

- The asset specificity principle focuses on the transformation of an exchange relation between buyer and seller.
- The externality principle focuses on the pursuit of subgoals in executing contracts, where parties in contract pursue private goals, which may be different from the contract's intended purpose. These two principles influence the contract form, which is either within firms (internal organisation) or markets.
- The hierarchical decomposition principle deals with the efficacy of the internal organisation and whether sound principles of internal organisation design are respected.

Transactions will be carried out in markets unless market exchange results in high transaction costs, which case transactions will revert to being within firms. Williamson (1981, p.1547) identifies the following three cost advantages of market procurement:

- Static scale economies can be fully exhausted by buying rather than making if the firm's needs are small relative to the market.
- Markets can aggregate uncorrelated demands, thereby realizing risk-pooling benefits.
- Markets may enjoy economies of scope in supplying a related set of activities of which the firm's requirements are only one.

The author maintains that transactions will be carried out in markets unless transactions' cost disabilities appear. Economies of scale arise from growth, and firms grow within the same function called 'horizontal integration' and or by incorporating other functions, which is called 'vertical integration'.

Asset Specificity Principle

The production cost advantages of markets and the comparative governance costs of markets increase as assets become progressively specific. The agent who was initially successful in obtaining a contract that resulted in a bilateral relation, realises certain advantages upon contract renewal because other investments such as durable specific assets are put in place, which could also include a learning-by-doing modus operandi during contract execution. This situation puts other agents at a disadvantage at contract renewal stage because durable specific assets will have to be supplied by the new agent should he be successful in winning the contract.

The learning-by-doing advantage during contract execution puts the current supplier in a strong position because often these skills were learnt during contract execution and the new agents will not have the advantage of learning without a cost advantage. In addition, relationships are built up between buyer and seller, which further reinforces the opportunity for contract renewal with the current seller. This creates a relationship of trust and fairness

between buyer and seller. The buyer is to an extent at risk because the seller has developed an advantage in contract execution and should the seller not be able to meet certain specific standards, the buyer is at risk. Since the use of highly specific assets requires sacrifices in productivity, both sellers and buyers will insist upon contractual safeguards before undertaking projects that are highly asset-specific.

The internal organisation of the firm protects against bilateral trading relations. Williamson (1981, p.1549) identifies the following advantages of internal organisations against bilateral relations:

- Common ownership reduces the incentives of the trading units to pursue local goals.
- Internal organisation is able to invoke fiat to resolve differences whereas costly adjudication is needed when an impasse develops between autonomous traders.
- Internal organisation has easier and more complete access to the relevant information when disputes must be settled.

The externality principle-forward integration

The externality principle applies to the distribution stages, unlike the asset specificity principle, which applies to backward, forward and lateral integration. The concerns in the externality principle are those concerned with substandard or substitute quality for a branded good or service. Such substitution of quality results in high measurement costs by the buyer. This takes the form of inspecting and controlling the quality of parts and materials that have been purchased earlier from lateral suppliers. The difference in costs of the quality control process and the cost savings from integrating distributors influences transaction costs. This situation occurs at the interface of production and distribution.

Williamson (1981, p.1549) argues that the effect of substitute quality by distributors becomes a concern when such substandard quality affects the reputation of the product and hence also affects the sale of the product by other distributors or retailers. He maintains that if the quality enhancement or degrading thereof gives rise to positive or negative externalities, the originators can incompletely appropriate the benefits or costs. However, failure to extend quality controls over distribution will result in sub-optimisation. Therefore obligational market contracting, e.g. franchising, is used as an alternative to forward integration into distribution.

Other types of integration include horizontal and vertical integration. These integration types are discussed next.

- Horizontal integration occurs when output rises with the same type of work and therefore economies of scale may arise. Alchain and Demsetz (1972, p.794) explain this in terms of teamwork. They see the synergy of team production as the binding force in organisations. Such synergy lowers costs because functions

can be centralised and hence costs can be lowered. The authors also add that people wish to join firms, as they perceive that they may “shirk work”. To overcome this shirking, monitoring is required.

- Backward integration may be explained by allowing a firm to take control of its suppliers. It is often used either to gain cost advantages or to prevent competitors gaining control of important suppliers. It is thus an important strategy in creating barriers to entry. Backward integration is sometimes considered a strategically defensive move. Schonberger (1994, p.294) says that backward integration provides the added advantage of the buyer no longer having to perform expediting functions. However he adds that backward integration is a major financial commitment that consumes a large amount of management time. The disadvantage, however, is that when the buyer manages to maintain an acceptable working relationship with the new company, the economies of scale will vanish. As other suppliers upgrade their performance, the buyer will find it difficult to consistently upgrade performance in the acquired company. Backward integration should be used when the buyer can create barriers to entry by integrating suppliers with strategically important resources, which once acquired by the buyer will provide a competitive edge. Backward integration should not merely be used to satisfy the short-term goals of unreliable suppliers. Backward integration should not go against the principles on core critical resources, which are required for competitive advantages.
- Vertical integration may be explained by means of contracting behaviour. The firm may arise as people enter into contracts or agreements. Initially costs are ignored and in their place two assumptions regarding behaviour are inserted. Forward integration takes an organisation closer to its markets and allows more freedom for a firm to make direct contact with its customers. Therefore forward integration is considered to be an offensive strategic move.

Pycraft et al (1997, p.181) give a graphical representation of backward and forward integration as depicted in Figure 2.9 below. Once it has established the extent of expansion, a firm must decide how far it wishes to integrate. Pycraft et al (1997, p.183) discuss the effects of vertical integration discussed in terms of the manufacturing mix or what are sometimes called ‘performance objectives’. Table 2.3 below summarises the author’s viewpoint.

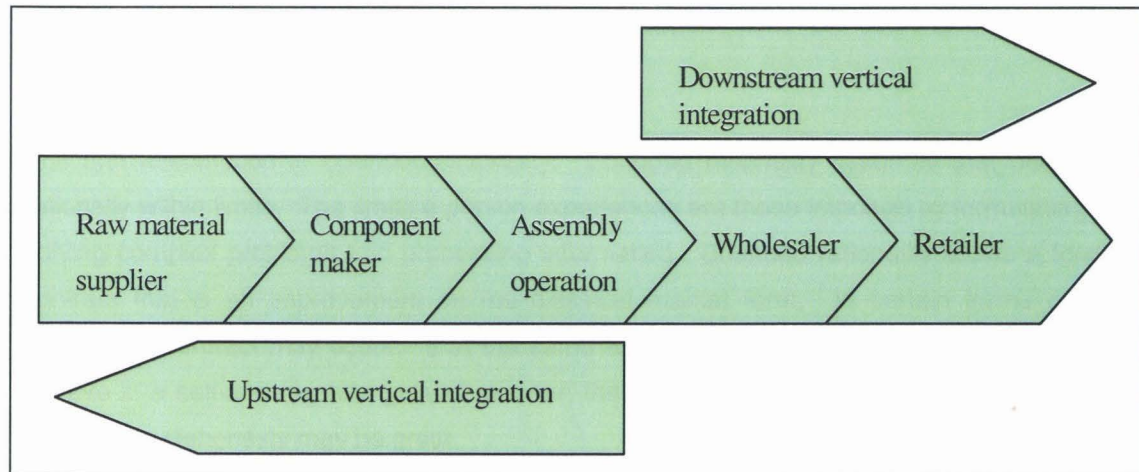


Figure 2.9: The direction of backward and vertical integration

Table 2.3: The effects of vertical integration on the performance objectives

Performance Objective	Effects of vertical integration
Quality	Potential benefits arise from close relationships of customers and suppliers.
Speed	Closer synchronisation of schedules speeds up the throughput of materials and information along the network. Close relationships between customers and suppliers assist in accurate forecasting.
Reliability	Improved communications as a result of closeness between customer and suppliers can give better forecasts which will result in more accurate deliveries
Flexibility	Vertical integration has the added benefit of guiding technological developments as well as denying them to competitors. Volume and delivery flexibility can be dictated to match downstream fluctuations.
Costs	Potential for cost-sharing exists

Having looked between firms, internal organization is next discussed.

Internal organization

The problems facing the internal organisation are those of bounded rationality and opportunism. These problems, however, are compounded by the varying changes in internal organisation. Merely transferring a transaction from the market into the firm does not itself imply that the activity or task will be effectively carried out. Considerations regarding the grouping of people and information processing for decision making are also important. Internal incentives and information flows need to be aligned to organise internal information and improve transaction processes. The alignment of resources and activities as proposed by Porter (1991, p.109) supports the linkages between information flow and decision making. The hierarchical decomposition principle recognises the need to divide problems into manageable units and thus makes it possible sections of firms to be organised. Porter (1991, p.109) identifies activities such as order processing, logistics, operations, marketing and

sales, service, etc. that could be likened to sections of firms. In view of these considerations, the two assumptions of bounded rationality and opportunistic self-seeking with guile are discussed next.

The first assumption is bounded rationality. Bounded rationality assumes that people act rationally within limits. The limits a person experiences are those imposed by formulating and solving complex problems and processing information. Bounded rationality allows a form of contract that is an improvement on the classical market form. In certain forms only an incomplete contract may occur. If at the same time that bounded rationality occurs, people behave in a self-seeking and guileful manner, then promises may be dishonest and the cost of reducing dishonesty may be great.

Self-seeking with guile is the second assumption, which Williamson (1981, p.1545) terms 'opportunism'. This does not necessarily mean that people are dishonest. This could imply that people have limited or incomplete knowledge about market opportunities and are therefore unable to predict the future and derive implications from predictions. Moreover, people do not know everything and they make mistakes. In addition, each person may know different things. When differences of opinion arise between people they will act in a self-seeking manner. Further evidence of this sort of behaviour is given by Bower and Chistensen (1995, p.48) "Risk is reduced-and careers are safeguarded-by giving known customers what they want".

Alchain and Woodward (1988, p.67) further expand opportunism to include moral hazard and hold-up. The authors differentiate as follows:

- Hold-up and specificity: resources dependent upon one another are referred to as 'specific' or 'inter-specific' and those firms making investments specific to other assets will seek protection against reneging or hold-up by the other parties.
- Moral hazard is a form of opportunism That arises in agreements in which at least one party relies on the behaviour of another party and information about the behaviour is costly. For example, a firm hires a manager who has sub-goals, that are different from those of the owners. The manager can act in his own self-interest and the means of the owners to know exactly what the manager intends doing are too costly. The degree to which resources are subjected to moral hazard depends on their "plasticity" and on monitoring costs. For example cash is plastic but very easy to track. Oxley (1997, p.392) says that moral hazard usually arises when contracts are incomplete because of gaps in specification. He refers to the following example, the holder of a technology may find a better partner and so deliver inferior technology to its partner than what was promised in the original agreement.

To attempt to maximise profits under these conditions, it is important to economise on all costs, including the place where transactions occur. (Williamson terms this place the 'governance structure'). This place where transactions occur could be a section in the firm.

Assessing the organisation in economic activity requires the evaluation of a variety of markets, hierarchical and mixed modes. The modern corporation is an avenue that could be used as a means of reducing transaction costs. To achieve this, the firm needs to be viewed as a governance structure. Williamson (1981, p.1564) summarises that the transaction cost approach of the firm as follows, saying that it requires that:

- The transaction be made the principal unit of analysis.
- An elementary appreciation for "human nature as we know it" supplant the fiction of economic man.
- Transactions be dimensionalised.
- Rudimentary principles of market and hierarchical organisation be recognised.
- Transactions are assigned to the organisation within governance structures in a way that economises on transaction costs.

The literature survey on transaction processes shows us that there are characteristics of transactions such as transaction frequency, transaction certainty/uncertainty, transaction specific interests, and transaction costs that can be influenced by technology. The inherent linkage between transaction process and technology is information flow and knowledge transfer. Therefore the effects of information flow and knowledge transfer and technological change effects would be considered in the investigative framework. In addition information flow and knowledge transfer will be discussed as subsets to knowledge management in Chapter 3. Thereafter metrics for transaction processes will be developed and discussed in Chapter 4.

The linkage relating to governance structures has been suggested in terms of opting for contractual behaviour as safeguards against inaccurate information flow and faulty data integrity within and between firms. Governance structures are next discussed.

2.6 Governance structures

Having looked at transaction processes, a framework for transacting is discussed next. There are many frameworks for transacting within and between firms, therefore the next sections are directed towards these frameworks, which include governance structures, hierarchical governance patterns, supplier relationships and supplier roles, responsibilities and selection.

2.6.1 What are governance structures?

The place where transactions occur is called the 'governance structure'. This place could be in markets, firms and mixed modes, e.g. franchising. The decision where to transact depends

on the comparative costs of planning, adapting and monitoring task completion under alternative governance structures.

Governance structures tell us where transactions occur, and in this proposal the focus is on firms and in mixed modes where relationships develop. Governance structures are necessary to reduce transaction costs and to overcome opportunism. The modern corporation is complex in its size, diversity and internal organisation. The modern corporation tends to economise on transaction costs. Williamson (1981, p.1544) states that a transaction occurs when goods or services are exchanged across a technologically separable interface.

Hierarchical Governance Patterns

Williamson (1981) defines the governance hierarchy as the administration, direction, or management of information flow through the organisation by making decisions, suggestions, orders etc. This takes many forms such as putting-out, inside and outside contracting, federated groups, peer groups, employer–employee authority, and the unitary, multidivisional, or holding company forms of governance. He calls these governance structures U (unitary), M (profit centre) and H (holding) forms respectively.

The aim of the above is to match governance structures to the attributes of transactions in a discriminating way. Transactions are described in terms of three attributes: frequency, uncertainty and asset specificity. The governance of recurring transactions is weakened as asset specificity increases. Dyer (1997, p.535) substantiates this by saying that as asset specificity increases, more complex governance structures are required. This means that more complex contracts are required to administer the transaction process. The reason for this is that as assets become specific to a single use or user and less transferable to other uses and users, the production cost advantages decrease. Williamson (1991a, p.81) states that TCEs holds that price, technology and governance are determined simultaneously. Therefore considering the supply of a good or service and assuming that technologies give production cost advantages, but pose contractual hazards (because of asset specificity). Such transactions will have a moral hazard reflected in the price unless safeguards are provided in terms of the price (governance structures). This statement is also supported by Williamson (1991b, p.282), where he states that asset specificity increases the transaction costs for all forms of governance. Other authors like Dyer (1997, p.536) further separates transaction costs into the following four categories:

- Search costs include costs required for information gathering to identify potential trading partners.
- Contracting costs are those costs associated with negotiating and writing an agreement.
- Monitoring costs are those costs relating to monitoring of the agreement to ensure that that each party fulfils the predetermined obligations.

- Enforcement costs are those costs associated with ex post bargaining and sanctioning a trading partner who defaults on the agreed obligations.

Dyer (1997, p.536) argues that “Although investments in specialization boost productivity, the incentive to make transaction-specific investments is tempered by the fact that the more specialized a resource becomes the lower its value in alternative uses.” This situation increases the opportunity for opportunism. To safeguard against opportunism firms adopt a variety of governance structures. These include the classical, neo-classical and relational contract. In addition to these contracts, various authors have proposed self-enforcing agreements, for example private ordering or trust, relational or goodwill trust, reputation, financial hostages and specialised hostages. Thus firms have a number of ways of protecting themselves against the hazards of opportunism.

Dyer (1997, p.537) says that there are costs associated with constructing governance structures and these costs are referred to as ‘set-up’ costs. They include the writing of contracts, building personal trust, creating financial hostages, etc. These costs are considered as a subset of transaction costs. Dyer considers the governance set-up costs to be costs incurred in setting up the initial contract or agreement, which influence the ongoing transaction costs i.e. search costs, contracting costs, monitoring costs and enforcement costs.

A research study conducted by Dyer (1997, p.540) examined transaction relationships in the USA and Japan and the findings indicate that transaction costs do not necessarily increase with an increase in relation specific investments in the auto industry. The research conducted does not support the argument by Williamson (1991b, p.282) to the effect that “asset specificity increases the transaction costs of all forms of governance”. Dyer (1997, p.541) argues that Japanese transactors have adopted more efficient safeguards than the USA transactors, and therefore have minimised transaction costs by effectively aligning transactions with governance structures. Dyer (1997, p.543) provides the following reasons for the lower transaction costs of Japanese automakers as compared with their US counter parts.

- Repeated transactions with a small set of suppliers: Japanese automakers opt for a smaller group of suppliers and therefore have more transactions with the same suppliers. The author suggests that repeated working with fewer suppliers’ results in lower transaction costs.
- Economies of scale and scope from transacting with a smaller supplier base: the research indicates that on average Japanese suppliers sell much larger volumes of goods to automakers than do US suppliers. These activities reduce transaction costs because firstly the cost of information sharing goes down due to repeated transactions as a result of the economies of scale in transacting.

Furthermore, the type of information collected by the automaker in controlling functions such as management, finances, production processes is the same. In addition ex ante and ex post bargaining costs are reduced due to economies of scale.

- Extensive inter-firm information sharing, which reduces asymmetric information: Japanese automotive manufacturers share more information than their US counter parts and are therefore able to reduce opportunism and information asymmetry. This ability to share information reduces transaction costs. The relationship between transaction costs and information sharing follows from neo-classical economies, i.e. transaction costs are assumed to be zero because firms have perfect information. He argues that transaction costs are negligible if perfect information sharing is obtainable. Dyer identifies the following variables of information sharing among Japanese auto-makers: trust with confidential information; share information on detailed cost structures; sharing information with supplier with cost reduction; sharing information with suppliers to assist with quality improvement; and sharing information to assist suppliers with delivery/inventory management. Dyer (1997, p.546) quotes procurement managers of Japanese firms as saying that Japanese auto-makers only deal with suppliers who are willing to share information. Suppliers who are not willing to share information are immediately left out. Furthermore, suppliers who are not willing to share information are regarded as not being trustworthy and are therefore eliminated. Barney and Hansen (1994, p.175) say that economically orientated researchers argue that it is difficult to distinguish between partners who are actually trustworthy and those who claim that they are trustworthy. Therefore governance structures are used as an effective means of assuring efficient transactions or exchanges.

The benefits of information sharing lie in the reduction of contracting and monitoring costs because Japanese firms do not take their suppliers for granted regarding supplier performances and therefore verify the capabilities of the supplier through cost, quality and production information. Dyer (1997, p.547) thus provides the following argument: the greater the degree of information sharing between transactors, the lower the information asymmetries and the lower the transaction costs. One must note however that information sharing is costly to establish, maintain, collect and distribute and therefore a trade-off between information sharing costs and contracting and monitoring costs must be established. The cost of establishing information-sharing processes is part of the cost of the governance structure set-up cost.

- Use of goodwill trust instead of contracts, which are required for infinite and finite time horizons respectively: Dyer (1997, p.547) argues that these types of safeguards presumably have high initial set-up costs but once they are in place they have lower maintenance costs. Japanese automakers rely on relational trust and financial hostages such as stock ownership. Japanese automakers have ownership in many of their affiliated suppliers, which is an indication of a credible commitment that one firm makes to another. Dyer (1997, p.548) argues that the short-term costs relating to investments in financial hostages are high relative to writing a contract. However, once these costs have been realised and the supplier relationships develop over time, the transaction costs will decline. In this way self-enforcing safeguards can control opportunism over an infinite time horizon. The research by Dyer (1997, p.549) indicates that the average length of a contract by US automakers in 1989 was 2.3 years, which dropped to 1.2 years by 1984. This requires contract re-negotiation and the setting up of new contracts, which leads to high search and contracting costs.

To sum up Japanese automakers minimise transaction costs by minimising search, contracting, monitoring and enforcement costs over the long term. This is achieved by using self-enforcing safeguards rather than formal contracts. On the other-hand, US automakers opt for contracting relationships with a large number of suppliers, thus incurring considerable search and contracting costs. Barney and Hansen (1994, p.183) use Toyota as an example: "Toyota's supply relationships are deeply embedded in long-standing networks of social and economic relationships." These social governance mechanisms gave Toyota and its suppliers the advantage of engaging in very vulnerable exchanges (due to high transaction-specific investments that lead to high risk and hold up) with substantially fewer forms of governance, thereby providing a competitive advantage against other firms such as General Motors. Overall the author (1994, p.183) concludes that the cost of creating semi-strong form trust at Toyota has been substantially lower than the cost of creating semi-strong form trust at General Motors.

- Investments in co-specialised assets; Japanese supplier relationships tend to develop over time as firms make initial investments, share information, build trust and discover new ways to enhance performance. Dyer (1997, p.549) found that the level of relation-specific investments made by suppliers was influenced by the automakers' strategy regarding supplier management and governance. Japanese automakers were more willing to make credible commitments to their suppliers regarding investments made the suppliers, i.e. Japanese automakers were willing to grant suppliers component business for the duration of the pay-

back period or longer. Evidence of this can be seen in the high re-win rate of suppliers regarding component business. In this way suppliers could realise the return on the investment. On the other hand, US firms were reluctant to make long-term agreements with suppliers, where the duration of the agreement would exceed the length of the contract. Therefore US suppliers refused to make relation-specific investments with a payback period longer than the length of the contract. Dyer thus argues that firm-level (buyer) strategies towards governance influences both transaction and production costs. Dyer (1997,p.550) says that if one supplier uses special purpose technologies and assets for production while another refuses for reasons of opportunism, the suppliers will have different production costs. Thus governance of supplier relations has an effect on production costs by influencing the relation-specific investments in the relationship. The author argues that co-specialised investments increase the transactor's interdependence and serve as an economic rationale for co-operative, long-term relationships. Dyer (1997, p.550) proposes a curve linear relationship between asset specificity and transaction costs, with trust as a moderating variable (Figure 2.10). Transaction costs are high in the initial stages of the investment as firms invest in safeguards for specific assets, but once trust is achieved and specialised investments are made, the transaction costs may actually decrease.

Dyer (1997, p.552) points out that the cost of building trust includes the opportunity cost of not taking advantage of one's suppliers and the loss of opportunity to use lower cost suppliers if they are available. However, Hamel Doz and Prahalad (1996, p.593) maintain that forming alliances to gather information from a partner is a sign of an organisation committed to learning. When comparing Western and Japanese firms Hamel, Doz and Prahalad (1996, p.593) found that Japanese firms emerged from an alliance stronger than their Western counterparts, because the Japanese firm had made a greater effort to learn. Creating a learning organisation is one of the critical resources that is required for profit and growth. Therefore Japanese procurement practises are not absolutely superior they may be superior in the long term and only if gains can be made from relation-specific investments. However, an efficient governance mechanism (i.e. trust) can lower transaction costs and increase relation-specific investments under the conditions where relation-specific investments create economic value and therefore offer a competitive advantage. As is evident from the study made by Dyer (1997), trust is an important factor in collaboration. Trustworthiness in exchange relationships is discussed next.

Barney and Hansen (1994, p.176) define trustworthiness as follows: "an exchange partner is trustworthy when it is worthy of the trust of others. An exchange partner worthy of trust is one that will not only exploit others vulnerabilities." The authors also note that while trust is an

attribute of a relationship between exchange partners, trustworthiness is an attribute of individual exchange partners. They differentiate between the following types of trust:

- weak form trust
- semi-strong trust and
- strong form trust.

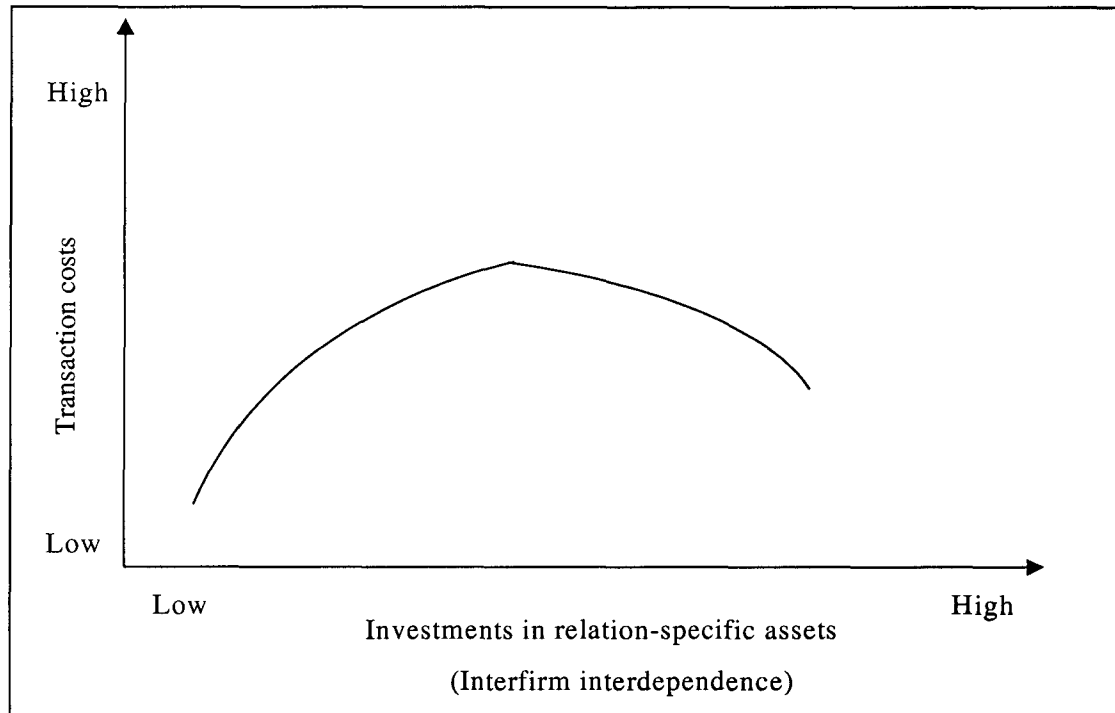


Figure 2.10: The relationship between asset specificity and transaction costs adapted from Dyer (1997, p.551)

Weak form trust does not depend on the erection of contractual or other forms of transaction/exchange governance. It also does not depend upon commitments by parties in a transaction to be trustworthy. However, trust emerges in this type of transaction because there are limited opportunities for opportunism. Substantial governance or other costs will not be incurred while partners do obtain trust in this weak form. Weak form trust exists where firms do not make transaction-specific investments on each other because transactions in these types of markets are not subject to significant exchange vulnerabilities, and therefore weak form trust will suffice. However, should the market change, other types of trust will become applicable for instance semi-strong trust. This occurs when significant exchange vulnerabilities exist as a result of adverse selection, moral hazard, hold-up or other sources. The authors say that trust can still emerge under these circumstances if parties to a transaction/exchange are protected through various governance devices. These governance systems provide a means of imposing costs on parties to a transaction/exchange who behave opportunistically. Governance mechanisms therefore control opportunistic behaviour because if the cost of the opportunistic behaviour is greater than the benefit to be obtained from the behaviour, partners will behave in a trustworthy manner.

However, there is a cost of governance. In some cases intermediate market forms such as strategic alliances may even be formed to ensure hierarchical forms of governance. This would occur should the levels of semi-form trust not be adequate. In strong form trust, trust emerges where significant transaction/exchange vulnerabilities exist even though elaborate social and economic forms of governance may or may not exist. This is the case because opportunistic behaviour would violate values, principles and standards of behaviour or the parties in the transaction/exchange. The authors stress that this type of trust does not emerge from the structure of the governance but rather reflects the values, principles and standards that the partners bring to the transaction/exchange. However Barney and Hansen (1994, p.181) point out that even if a firm has a strong form of trustworthy culture and associated control mechanisms, it is not necessary for each individual in the firm to be of strongly trustworthy.

Economies of scale can only be realised when a firm operates the asset under its own internal direction, that is when its services are obtained externally by contract. The transactions in question take place within a bilateral structure and the governance costs of markets increase relatively.

Where investment characteristics are non-specific the market may be used. When investment characteristics become idiosyncratic, Williamson concludes that alternative governance structures coupled with a relationship (relational contracting) are cost minimising. Relational contracting may be divided into bilateral governance and unified governance.

- Bilateral governance contracts are used for mixed investment characteristics. Bilateral governance includes the purchase of raw materials in the market; the formation of bilateral agreements with specific subcontractors on large contracts. These types of contracts are typical for cross license or technology-sharing agreements
- Unified governance contracting is used where investment characteristics are idiosyncratic. Unified governance forces the firm into an internal labour market. The internal labour market may also lead to the development of contracts suitable for jobs rather than individuals. Examples include unilateral licensing agreements, long-term supply contracts, etc.
- Equity-based alliances, examples include joint ventures and research corporations. This is a classic form of hybrid organisation involving the creation of a new entity jointly owned and operated by two or more collaborating firms. The joint venture depends on the continued operation of each firm, which posts a bond equal to its equity share. The returns to each partner are based on profits of the venture as a whole and are usually distributed in proportion to the equity share. Administrative controls include a board of directors typically comprising

members of partner firms in proportion to the equity share. This is a means of providing information flow to the parent firms.

Coase (1937, p.340) differentiates between relational and market contracting as follows:

- As the firm size increases the costs associated with arranging transactions rise. When the marginal costs of organising extra transactions within the firm are equal to that of the market or another entrepreneur then the firm will decide to opt for the market.
- The production manager, when organising internally, without the benefit of the market, may fail to make best use of resources. A point will be reached where such loss of resources of internal work is equal to the increased costs of using the market.
- When the price of one or more of the internal factors rises relative to the market. For example labour may prefer to accept lower wages to be in charge of their own small business. The agreement given is that internal relational transactions will be preferred.

Coase maintains that until the costs of organising an extra transaction within the firm become equal to the costs of carrying out the same transaction by means of an exchange on the open market or the costs of organising in another firm. Alternatively the firm will expand to a size where the cost of the last internal transaction undertaken is equal to that undertaken external to the firm, i.e. in the market. Then the firm will opt for the make or buy decision. Hagedoorn (1993, p.381) shows that there are two basic categories for firm partnerships, i.e. market and technology-related motives. Hagedoorn (1993, p.382) says inter-organisational modes of technology partnering such as joint ventures are applied by firms if they aim to obtain a larger span of control. This is the case when firms aim at a wider set of objectives than they intend, to improve innovative efforts, such objectives include both market access and technology-related motives. Firms achieve governance over their strategic alliances with equity investments and shareholder control partners. Contractual agreements demand less control through administration and supervision and are more suited to agreements, that are less complex regarding their span of objectives. Oxley (1997, p.387) proposes that in choosing among different inter-firm alliance types, the logic of TCEs suggests that more hierarchical alliances will be selected for transactions where contracting hazards are more severe.

Supplier development represents a transaction-specific investment by the buying firm. This transaction-specific investment has transaction costs these costs pertain to the management of buyer-seller relationships. However transaction costs are not the only focus, focus is also directed towards transaction value, which can be developed through supplier, closeness, communications, trust and goodwill. These transaction value activities are viewed as forms of governance. Should these transaction value activities not be properly managed, other problems may develop. These problems could include quality defects, inaccurate delivery promises, etc. Krause (1999, p.206) argues that supplier performance problems vary from

quality defects, late delivery dates and lags in the adoption and implementation of new technologies in respect of new processes and products. These performance problems may increase transaction costs and may also lead to transaction uncertainty and reduce transaction value. Krause (1999, p.206) adds that long-term relationships may yield more certainty for buying firms regarding supplier performance. As can be seen, supplier relationships are important.

2.6.2 Supplier relationships

Schonberger (1994, p.275) discovered that the focus on supplier relationships started in the 1980s and early 1990s. The old adversarial approach began shifting to an approach of partners in profit. The following are some of the authors who support this view:

- Hartley, Zirger and Kamath (1997, p.58) maintain that: “Even though a new product’s cost, quality and performance are affected by supplier’s, researchers have just began to explore, in depth management of buyer-supplier interface during product development.” The authors say that the overall project time performance is significantly related to the percentage of supplier’s activities that are completed on-time. Therefore the suppliers on time performance is linked to the buyer’s ability to successfully complete its product development on time.
- Carr and Pearson (1999, p.499) say that supplier management represents an investment by the buying firm in the supplier that may reduce transaction costs and yield a more co-operative relationship. Supplier management may include exchange of personnel, training and education of suppliers personnel, and the possibility of direct capital investment.

Table 2.4 below shows the comparison of the two approaches as seen by Schonberger and Knod (1994, p.276). There is a move away from the black box view of the supplier’s system to a partnership view.

Supplier relationships may also include transaction-specific interests. Krause (1999, p.207) citing Krause (1997) gives some examples of transaction specific interests, viz.

- Formal evaluation
- Certification programmes
- Supplier recognition
- Training and education.

From a transaction cost point of view, contracting relationships among firms constitute the central focus. Carr and Pearson (1999, p.498) cite Frazier *et al.* (1988, p.65) transaction costs are also described as the cost of managing the relationship and include costs associated with negotiating, implementing, coordinating, monitoring, adjusting, enforcing and exchange agreements. This is evident in Japanese firms.

Table 2.4: Supplier Relationships Schonberger and Knod (1994, p.276)

Description	Adversary	Partnership
Tenure	Brief	Long-term and stable
Type of agreement	Sporadic purchase orders	Exclusive or semi-exclusive contracts, usually at least one year
Number of sources	Several sources per item for protection against risk and for price competition	One or a few suppliers for each item or commodity group
Volume of business	Limits on amount of business with any one supplier	High; sometimes supplier dedicates small plant to single supplier
Price/costs	High on average; low buy-in bids (below costs) can lead to unstable suppliers	Low; economies of scale; suppliers can invest in improvements
Quality	Uncertain; reliance on receiving inspections	Quality at source; supplier uses statistical process control and TQM
Design	Customer developed	Make use of supplier's design expertise
Delivery frequency/order size	Infrequent, large lots	Frequent small lots, JIT
Order Conveyance	Mail	Long term: contracts Short term: kanban, phone, fax, EDI
Documentation	Packing lists, invoices, count/inspection forms	Sometimes no count, inspection, or list - just monthly bill.
Delivery Location	Receiving dock and stockroom	Direct to point of use
Openness	Very little black box	On-site audits of supplier, concurrent engineering/design, visits by front line associates

Helper and Levine (1992, p.561) say that a key part of Japan's competitive advantage comes from longer term supplier relationships between automakers and their suppliers. Carr and Pearson (1999, p.502) say that once a high degree of trust is established between the buyer and supplier firms, the effects are improvements in level of communication, co-operation and co-ordination. Carr and Pearson (1999, p.502) cites Clark (1989), saying that Japanese auto firms cultivate their suppliers through investments, sharing of knowledge and joint problem solving. As a result, suppliers search for the best ways to meet the needs of the buying firm's product design and development. Helper and Levine (1992, p.561) say that in the US the norm for the last half-century has been adversarial relationships with suppliers. Only in recent years have US automakers began to move toward a more cooperative system. Evidence in support of this is given by Carr and Pearson (1999, p.503) who use the Ford motor company as an example where buyer-supplier relationships were transformed from adversarial into co-operative relationships. Helper and Levine (1992, p.562) say that the recent trend from an adversarial to a participative relationship among US automakers is largely because firms' oligopoly rents may prefer inefficient arm's length relations to long-term contracts. This is only

allowed if the arm's length supplier relationship reduces the ability of the supplier to bargain for a share of the oligopoly rents. The authors argue that where entry into the final-product market reduces the oligopoly rents, the purchasing firm is less concerned about rent protection. In this situation the downstream firm establishes efficient relationships with its suppliers.

However Helper and Levine (1992, p.562) maintain that where the final-product market rents decline, customers and suppliers are more likely to agree on long-term contracts. The authors say that as long as the Japanese suppliers continue to meet the manufacturer's expectations, the supplier can count on the relationship continuing indefinitely. Moreover, the authors say that the relationship between supplier and manufacturer in Japanese firms is mostly implicit: the authors quote the following (1992, p.563) "if the supplier experiences a problem with cost or quality, the automaker will attempt to work things out before switching to another supplier." This kind of relationship leads to high levels of relationship-specific investments by both sides. Suppliers make large fixed investments in areas of mutual interest such as quality control training and retention of product-design staff.

These investments allow the firms to engage in customer-specific activities, which include value engineering and analysis. Investments in communication and information sharing are also common. The following two authors support this view:

- Hagedoorn (1993, p.372) says that one of the motives that lead companies to co-operative efforts is related to the sharing and further advancement of research and the restricted diffusion of technological knowledge amongst participating companies.
- Hamel (1991, p.90), however, provides evidence that in alliances there are often substitution intents where firms (at least in the beginning) substitute their partners competitiveness in a particular skill area for their own lack of competitiveness.

Hagedoorn (1993, p.572) supports this view by arguing that no company will have total competence in every field of technology and therefore a concrete evaluation of possible synergies might at some stage in a particular technology cycle warrant a joint undertaking with another company. Hamel (1991, p.99) says that there are two basic processes in any alliance i.e. value creation and value appropriation. Hamel (1991, p.100) says that bargaining power and internalising the skills of partners are the two mechanisms available for extracting value from an alliance. "Bargaining power at any point in time within an alliance is, *ceteris paribus*, a function of who needs whom the most." This is perceived as the strategic importance of the alliance to each partner and the attractiveness of alternatives to collaboration. Hamel, Doz and Prahalad (1996, p.592) suggest that a strategic alliance can strengthen both partners against outsiders even though one partner may be better off than the other.

In contrast, in the US suppliers are more likely to make long-term investments where they are tied in by long-term contracts with the manufacturer. In the US where suppliers had problems with rising costs or quality the manufacturer switched to another supplier. The US manufacturers had many suppliers per part and used short-term contracts. Cases in CAPP (computer-aided process planning) indicate that there are many different designs for the same part, which could also be influenced by the different suppliers. Choi and Hartley (1996, p.333) say that once a supplier becomes part of a well-managed and established supply chain, this will have a lasting effect on the competitiveness of the entire supply chain. Helper and Levine (1991, p.564) report that in the years between 1983 and 1988, the average length of a written contract doubled in length, as did the percentage of suppliers who said that their customers (manufacturers) would help them rather than switch to another supplier. This is a drive towards fairness and trust as proposed by Jarillo.

Helper and Levine (1992, p.564) try and answer the question why US manufacturers are slow to adopt long-term contracts, given the success rate of these contracts. The authors agree that neither Japanese culture nor organisational innovations are the appropriate reasons. The authors propose a model of market structure on organisational responses for potential rent losses from specific investments. The model suggests that a high level of customer market power increases the hold-up problem (holding the other partner to ransom). A supplier could hold up an oligopolistic customer for relationship-specific rents and product-market rents. Relationship-specific rents are those extra rents that consumers are willing to pay for improved co-operation with suppliers. Product-market rents are those rents received by the manufacture/customer for selling its product when it has an arm's length relation with suppliers.

In conclusion the purchaser can choose either low asset specificity with arm's length governance or high asset specificity with long-term contracts. In TCEs asset specificity is assumed to be exogenously determined by technology and governance structure follows from the degree of asset specificity. In the model proposed by Helper and Levine when the purchaser enters into a highly specific relationship with the supplier, the purchaser can be held up, that is if the supplier goes on strike and thus dissipates both product-market and relationship specific rents. A solution to the hold-up problem could be vertical integration. However the aforementioned authors argue that this solution is more common in firms with product-market rents because these purchasers will be less willing to risk being held up by their suppliers. Several others have discerned other problems resulting from vertical integration, viz. diseconomies of scale in managing and the loss of high-powered incentives for the supplier.

Finally Helper and Levine (1992, p.573) point out that in future Japanese manufacturers should move away from long-term contracts towards arm's length relations and vertical

integration. This should be a move to protect their rents because the final product-market rents will increase as compared to previously where the final-product market rents were low. The reasons for the increase in final-product rents are due to the higher bargaining power of suppliers. The argument posed by Helper and Levine is that in terms of transaction cost economies, profit maximisation does not completely ensure efficiency. The main reason for this is the bargaining between private and social efficiency.

Lorenzoni and Lipparini (1999) conducted a study on Italian firms in the packing machinery industry. The firms in the study were of medium size, and were part of larger industrial companies specialising in the production and design of special purpose machines for packaging tasks. Lorenzoni and Lipparini (1999, p.321) found that the following factors were responsible for the distinctive competence of these firms, namely:

- The ability to create value for customers by introducing new brands or by making minor improvements on past designs.
- Faster entry to market than competitors.
- Reliability on external specialised sources of knowledge.
- Ability to act as system integrators, i.e. the ability to offer a wide ranges of products and complete production lines. This was possible through the acquisitions and collaborative agreements.

Lorenzoni and Lipparini (1999, p.322) say the recent trends among customers in the pharmaceutical and food industries is to purchase machines from a single source rather than constituent parts from different suppliers. The reason for this is possibly that customers were confronted with a variety of constituent parts, which they often had to integrate. This assembly process would leave the customer the risk of covering costs that were not specified at the design stage, such as the interfacing and commissioning of the entire unit. By purchasing from a single supplier the risk of incomplete design considerations is passed on to the supplier and, in addition, delays in lead-time between the various suppliers would be reduced to the lead-time from a single supplier. This trend forced the medium-sized packaging firms to enter into collaborative agreements with other firms to gain access to external specialised knowledge and therefore have the ability to supply a complete solution as in the case of an entire line. Lorenzoni and Lipparini (1999, p.324) maintain that the make or buy decision is influenced when complementary capabilities and sharing of resources with suppliers provide greater efficiency. When this occurs, firms opt for buying rather than making. The authors provide evidence that these advantages occur when external firm's possess distinctive capabilities, volume advantages, or operate in situations with low asset specificity.

Lorenzoni and Lipparini (1999, p.329) suggest that firms restructure their networks because of key industry events, which include technological advancements, entry of prominent competitors, or a radical shift in consumer behaviour. These events could result in firms

opting for more external resources or being compelled to enter into new relationships to obtain competencies outside the firm. Hagedoorn (1993, p.378) says that the most significant motives for strategic alliances are technology complementarity, reduction of innovation time-span, market access and influencing of the market structure. During the period 1988 to 1995 Lorenzoni and Lipparini (1999, p.330) observed the following developments between lead firms and their suppliers:

- The number of first-tier suppliers decreased while the quality and content of relationships improved.
- The activities of first-tier suppliers were focused on becoming specialised component makers.
- First-tier suppliers reduce production costs as a result of economies of scale from the larger customer base of the lead firm.
- The average duration of relationships between lead firms and first-tier suppliers was 14 years. This assisted in developing relationships based on trust, thereby reducing transaction and co-ordination costs.

These benefits were achieved by initiatives taken by the lead firm such as upgrading of supplier evaluation systems and frequent seminars that were organised with key suppliers on issues such as TQM techniques, stock reduction, strategic cost analysis and other techniques, which provided continuous improvement. The trend was to abandon arm's length transactional governance and enter into relational exchange relationships. Furthermore, buyer experiences led to cost reduction on governing market contracting agreements.

The more firms transact with each other, the potential to lower transaction costs are increased therefore permitting subcontracting to suppliers who are developing their own competencies, which has the end result of lowering overall production costs in the network. Lorenzoni and Lipparini (1999, p.332), citing Bradach and Eccles (1989), argue that familiarity between organisations as a result of prior alliances convinces firms to progressively use less hierarchical structures in organising new alliances. Furthermore Lorenzoni and Lipparini (1999, p.333) argue that the reliance on trust may eliminate the need for formal contracts and serve as a safety net against opportunistic behaviour, (as also suggested by Williamson) and hence reduce co-ordination costs.

Having laid the foundation for supplier relationships, supplier roles, responsibilities and selection are discussed next.

2.6.3 Supplier roles, responsibilities and selection

The importance of supplier relationships was highlighted in section 2.6.2. The present section is devoted to the expected roles, responsibilities and selection processes that have to be adopted to gain benefits from suppliers or other partners. The following are some authors' view on the matter:

- Hamel (1991, p.85) asserts that inter-partnership learning constitutes the determinants of intent, receptivity and transparency, i.e. concern over the intent of partners (collaborative versus competitive, internalisation of partner skills versus mere access), concern over the openness of the partner, i.e. transparency and concern over the firm's ability to absorb skills from its partner, i.e. receptivity.
- Choi and Hartley (1996, p.334) say that previous studies on supplier selection have not adequately focused on issues such as closeness of the relationship and continuous improvement capabilities.
- Hartley, Ziger and Kamath (1997, p.61) subscribe to this school of thought, saying that "Communication between the buyer and supplier can reduce and facilitate interpretation of data so that a shared understanding is developed quickly." These authors say that communication between buyer and seller can take different forms. The richest form is face-to-face communication, followed by telephonic communication and then written communication. Frequent communications using a rich medium allows the buyer and supplier to develop a common interpretation of information. This reduces delays caused by mistakes and misunderstandings.
- Krause (1999, p.219) also finds that inter-firm communication is an important factor for supplier development. However, supplier commitment to the development process must be a prerequisite and in addition competitive market influences buying firms to manage suppliers from a strategic perspective. Krause (1999, p.221) also found that the rate of technological change in the buying firm's industry was not a predictor in the buying firms' perception of their suppliers and the type of relationships they had with them.

These issues now form an integral part of purchasing decisions. Helper and Levine (1992), Hagedoorn (1993), Schronberger (1994) and Lorenzoni and Lipparini (1999) are some of the authors who have identified and referenced cases where supplier closeness, communications, trust and goodwill and continuous improvement capabilities have played an important role. The recent focus on ISO 9000, however, is forcing firms to look at issues of continuous improvement and teamwork. Choi and Hartley (1996, p.334) note that US auto assemblers are adopting a tiered approach to supplier management similar to the Japanese auto industry. In the US a large share of control over quality, cost and delivery is transferred to the direct (first-tier) suppliers and, in addition, direct suppliers have assumed responsibility for a large number of components and subassemblies. The authors say that evidence is provided whereby auto assemblers now look for suppliers who are knowledgeable regarding production processes and are capable of handling product design. Choi and Hartley (1996, p.334) point out, however, that it is unknown whether the direct suppliers have transferred these techniques of supplier selection to their own suppliers.

The closeness of supplier relationships depends upon how often suppliers communicate with their suppliers, what means of communication are, what the content of the communication is, etc. In a research study on US assemblers conducted by Choi and Hartley (1996) using 26 supplier selection criteria, the eight top-rated criteria were supplier finances, consistency, relationship, flexibility, technological capability, customer service, reliability and price. The criteria included the following variables:

- Finances
 - Financial conditions
 - Profitability of supplier
 - Financial records disclosure
 - Performance awards
- Consistency
 - Conformance quality
 - Consistent delivery
 - Quality philosophy
 - Prompt response
- Relationship
 - Long-term relationship
 - Relationship closeness
 - Communication openness
 - Reputation and integrity
- Flexibility
 - Product volume changes
 - Short set-up time
 - Short delivery lead time
 - Conflict resolution
- Technological capability
 - Design capability
 - Technical capability
- Service
 - After sales support
 - Sales rep's competence
- Reliability
 - Incremental improvement
 - Product reliability
- Price
 - Low initial price

We can draw parallels between the manufacturing mix criteria of cost, quality, speed, dependability and flexibility and the above-mentioned criteria. In addition fairness and trust, as proposed by Ouchi and Jarillo, are important criteria. Barney and Hansen (1994, p.176) say

that in many ways opportunism is the opposite of trust and a firm's actions are opportunistic to the extent that they take advantage of another firm's exchange vulnerabilities. Barney and Hansen (1994, p.177) say while trust is the mutual confidence that one's vulnerabilities will not be exploited in a transaction or exchange, different forms of trust exist in different transactions, as already discussed earlier.

In conclusion the following authors are quoted:

- Choi and Hartley (1996, p.341) maintain that selecting suppliers based on the potential for close long-term relationships is considered most important by firms. On all three tier levels, price was the least important, quality and delivery were the most important, and technological capability and financial considerations were given a high priority.
- Hartley, Zirger and Kamath (1997, p.62) say that a history of working together helps the supplier to understand the customer needs, which would help the supplier to avoid time-consuming product or process redesign. These authors say that the use of technically capable suppliers increases the percentage of activities that are completed on time and therefore a high priority should be placed on careful supplier evaluation and selection. Hartley, Zirger and Kamath (1997, p.67) quote results from a research study stating that the spread of customer evaluation techniques was distributed as follows: low cost (24%), and high quality (22%) were the most frequently mentioned reasons for selecting a supplier. Manufacturing technology (13%) and technical skills (11%) were the other criteria. The same authors (1997, p.68) maintain that the research reinforces the mutual benefits of transferring best practises between buyers and suppliers rather than managing the interface.
- However, Hamel (1991, p.84) says that as long as the suppliers skills are relevant only in the specific outputs of the venture, they have no value outside the narrow terms of the agreement.
- For the buyers, Choi and Hartley (1996, p.341) rate in order of importance consistency (quality), reliability, relationship, technological capability, flexibility, price, service and finances. Quality as the highest-ranking criterion quality was also identified by another author namely Dickson as cited by Choi and Hartley (1996, p.341). It also must be noted that quality and delivery are rated as one criterion and not separate criteria since good quality with bad delivery is just as bad as not having the product, at least for as far as supplier selection is concerned.

Hartley, Zirger and Kamath (1997, p.68) argue that the effective management of the buyer-supplier interface does not significantly improve supplier performance but that buyers should adopt techniques for selecting suppliers because of their strong technical capabilities. Hartley, Zirger and Kamath (1997, p.69) propose "Early supplier involvement and frequent

communication may increase goodwill, may improve the nature of the buyer-seller relationship and may lead to long-term mutual benefits.”

Chapter 2 comprised a discussion on technology management and the effects of technology management on transaction processes and governance structures. Competitive theories of the firm i.e. RBV and TCE were first studied. A foundation for integrating technology management, transaction processes and governance structures was then established. Thereafter technology management and its influences were studied, followed by the study of technology management (2.4), transaction processes (2.5) and governance structures (2.6). This chapter leads to frameworks for understanding the important links between the economic aspects of technology management, transaction processes and governance structures. The literature survey in Chapter 1 and Chapter 2 is used as a basis for the construction of Figure 1.1. Building blocks for technology management, transaction processes and governance structures are then established. Some of these building blocks include technological strategy (a), technological investment (b), technological change (c), technological implementation (d), etc. These frameworks and building blocks are discussed next in Chapter 3.

3 Literature Survey, Part 2

In Part 1 of the literature survey, the foundation for technology management and the effects on transaction processes and governance structures were discussed. Part 2 of the literature survey explores the linkages between technology management, transaction processes and governance structures. In addition, the investigative framework for this thesis is constructed.

As stated in “Limitations of thesis, Chapter 1, section 1.8”, the work is limited to market threats and opportunities, which may force firms to improve manufacturing mix criteria through technology management. These market threats force the firm into creating new competitive advantages through new technologies, different technological resource skills and firm competencies. Market threats may be introduced by means of structural loosening events (Madavan, Koka and Prescott (1998, p.444)). This requires the firm to develop new resources and competencies as existing technologies, resources and competencies become less competitive. On the other hand market opportunities that arise as a result of structural reinforcing events (Madavan, Koka and Prescott (1998, p.444) require that the firm build on existing technologies, resources and competencies to improve competitiveness.

Figure 3.1 gives a graphical representation of the linkages between technology management, transaction processes and governance structures. The linkages incorporate the areas of technologies and technological resource skills that create the foundation for developing firm competencies. Technological resource skills should match the technological requirements for strategy, investment, change and implementation. Therefore technological resource skills should cope with competence enhancing and competence destroying technologies. Technologies and technological resource skills, form the basis for a firm's competence in technology management. Having established firm competencies in technology management, technology management may provide benefits in transaction processes. These benefits in transaction processes may lead to changes in governance structures. Firm competencies consist of core competencies and general competencies/capabilities. Firm competencies, for technology management and its effect on transaction processes and governance structures, may be measured by means of the manufacturing mix criteria.

Stonehouse et al (2000, p.200) say the development of core competencies is based on knowledge management and organisational learning. However firm competencies are necessary to link the different resource categories i.e. human, financial, physical, technological or informational. Firm competencies are necessary to form the right mix between technologies and technological resource skills. Firm competencies together with technological sourcing may create avenues for knowledge management. The approach then is that firm competencies are necessary prior to successful knowledge management, which could lead to organisational learning.

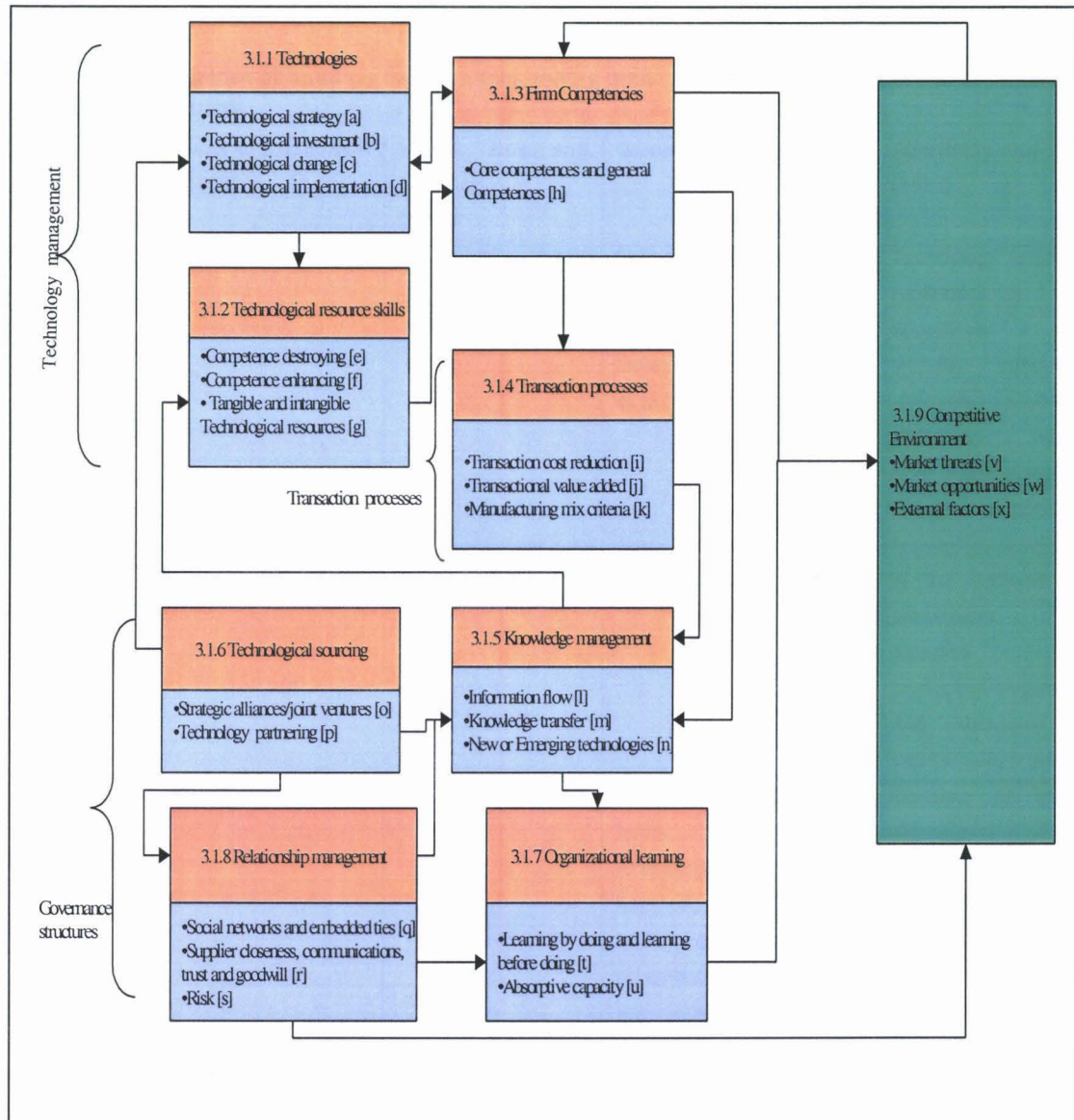


Figure 3.1: Linking technology management, transaction processes and governance structures

Having established a base for knowledge management within and between firms, the climate for organisational learning and relationship management may be created. Effective knowledge management and a learning organisation supported by relationship management may create competitive advantages.

Having introduced Figure 3.1, section 3.1 looks at the details of the model.

3.1 Linking technology management, transaction processes and governance structures

In Figure 3.1, technology management is linked to transaction processes and transaction processes are linked to governance structures. Lane and Lubatkin (1998), Hamel, Doz and Prahalad (1996), Stonehouse et al (2000) and Abernathy and Clark (1984) give some

evidence of possible links between technology management, transaction processes and governance structures. Table 3.1 demonstrates the relationships.

Table 3.1: Comparison of linkages between technology management, transaction processes and governance structures

Domain of activity	Lane and Lubatkin (1998)	Hamel, Doz and Prahalad (1989)	Stone house et al (2000)	Abernathy and Clark (1984)
Technologies			Technology is a strategic asset consisting of tangible and intangible technologies (Stonehouse et al (2000, p.223)).	Technology exists in production and operations and includes resources, skills and knowledge. Knowledge extends from engineering and design disciplines to knowledge embedded in the systems and procedures to organise production/manufacturing (Abernathy and Clark (1984, p.5-6)).
Technological resource skills			Human asset specificity in terms of intangible technologies. "The knowledge of how something is made may be embodied in heads of a few key individuals". (Stonehouse et al (2000, p.228).	Consists of labour, managerial and technical skills of individuals. Skills and knowledge embodied by individuals and the relation to teamwork, procedures, methods, etc (Abernathy and Clark (1984,p.6)).
Firm competencies			Resources and capabilities form core competencies. Core competence must be perceived to add customer value of the product, superior, complex, difficult to imitate, durable, non-substitutable and adaptable. Stonehouse et al (2000, p.126)	The foundation of a firm's position is based on a set of material resources, human skills and relationships, and relevant knowledge. These are the competencies that the firm requires to build the product features that the market place requires. ((Abernathy and Clark (1984, p.5)).

Knowledge management	"If a student firm wishes to learn some valuable knowledge developed by another firm, the student firm's ability to internalise that knowledge is greater when their knowledge-processing systems are similar". Lane and Lubatkin (1998, p.465)	The success of collaboration lies in a firm's ability to acquire knowledge from its competitor-partner and be able to transfer such knowledge through the firm (Hamel, Doz and Prahalad (1996, p. 598)	The two challenges facing knowledge management are the transformation of individual and tacit knowledge into organisational Knowledge and creating an organisational context which encourages and facilitates the development of new knowledge through organisational learning (Stonehouse et al (2000, p.365))	
Technological sourcing		A strategic alliance can strengthen both firms against outsiders even as it weakens one partner against the other (Hamel, Doz and Prahalad (1996, p.592)	Having identified weaknesses or gaps in technology capabilities, management have a number of options to build new capabilities, the decision is to develop in-house or look externally (Stonehouse et al (2000, p.230)). Recent years have shown a rapid growth in alternative means of technology acquisition and development given the pace of technology change, shortening product life cycles and global competition (Stonehouse et al (2000, p.232)).	
Organisational learning	There are three methods of learning new external knowledge, i.e. passive, active and interactive. (Lane and Lubatkin (1998, p.462)).		"Organisational learning and knowledge building is based on individual knowledge and learning, which is stored and shared". (Stonehouse et al 2000, p.200)). Knowledge must be disseminated and diffused throughout the organisation, i.e. knowledge transfer and information flow.	

Relationship management			"Core competences are often based upon external and/or collaborative relationships". (Stonehouse et al (2000, p.127)).	Market and customer relationships include customer base, customer applications, channels of distribution, customer knowledge and modes of communication. (Abernathy and Clark (1984, p.5)).
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Within technology management, technological strategy, technological investments and technological changes have to be implemented. Implementation gives technological benefits (summarised in Table 3.1, adapted from Abernathy and Clark (1984, p.5)).

Abernathy and Clark (1984, p.5) provide possible linkages between firm competence, impact of implementation and technological benefits. Technology management includes technologies in design and manufacturing, the skills required for technological implementation and the associated technological investment. Technology implementation is a subset of technologies, which improve firm competencies in terms of skills required for competitive advantage. Table 3.2 presents a list of the major competitive ingredients divided into two groups. The first group focuses on the capabilities of the firm in technology and manufacturing. Abernathy and Clark (1984, pp.6) use the words 'technology' and 'production'. The second group deals with markets and linkages to customers. Abernathy and Clark (1984, p.5) use the terms 'market' and 'customer', the associated terms used in this thesis are 'transaction processes' and 'governance structures'.

In addition, Stonehouse et al (2000, p.227) say that technology is a strategic asset consisting of tangible and intangible technologies. Tangible technologies exist in the products that firms produce and can be reverse-engineered by other firms to obtain trade or other secrets. Firms should therefore find some means to protect tangible technologies. This protection could include licensing and patents. Intangible technologies, on the other hand, are process technologies that are utilised in the manufacture of products. Such technologies are hidden as they reside within firms and are embodied within certain employees and firm processes. Therefore it is difficult for other firms to acquire such technologies from reverse engineering. However, other mechanisms for technology transfer exist, such as technological sourcing and knowledge management, which can be enhanced through relationships with customers, suppliers and competitors.

Table 3.2: Firm competence showing impact of implementation and technological benefits, adapted from Abernathy and Clark (1984, p.5)

Firm competence	Impact of implementation	Technological benefits
Technology management		
Technologies in design Manufacturing systems (i.e. Design and manufacturing based technologies)	Improves established design and strengthens existing structures.	Offers new designs making existing structures obsolete, places demands for new production systems, procedures and organisation.
Skills (labour, managerial and technical) Materials/supplier relations	Extends viability of existing skills reinforces application of current materials/suppliers.	Destroys value of existing expertise, extensive material substitution, opening new relations with new vendors.
Technological investment (Impact of technological investment i.e. competence enhancing/destroying)	Extends existing capital equipment	Extensive replacement of existing capital equipment with new types of equipment establishes links to whole new scientific disciplines/destroys value of existing knowledge base.
Transaction processes and governance structures		
Relationship with customer base	Strengthens ties with established customers.	Attracts extensive customer groups/creates new markets.
Customer applications	Improves service in established applications.	Creates new set of applications/new set of customer needs
Channels of distribution and service (supplier relationships)	Builds on and enhances the effectiveness of established distribution network/service firms.	Requires new channels of distribution/new service, after market support.
Customer knowledge	Uses and extends customer knowledge and experience in established products.	Intensive new knowledge demand of customer; destroys value of customer experience.
Modes of customer communication (supplier relationships, means of communication)	Reinforces existing modes/methods of communication	Totally new modes of communication required (e.g. field sales engineers)

Focusing again on technology management, transaction processes and governance structures, Abernathy and Clark (1984, p.5) state that the impact of innovation on competition depends on its capacity to influence a firm's existing resources, skills and knowledge. Firms implement intangible process technologies in design, manufacturing and business planning, which may improve manufacturing mix criteria like cost, quality, speed, dependability and flexibility. The model proposed by White (1996, p.324), shows the relationship between manufacturing capabilities (manufacturing mix criteria) and a firm's performance. The implication is that competition is caused by market threats and therefore firms are forced into technology implementation to sustain competitive advantage. Abernathy and Clark (1984, p.6) add that process innovation may have an effect on competition by raising barriers to

entry, reducing the threat of substitute products and making competing technologies (or perhaps other firms) less competitive.

The thrust of this thesis is the impact of technology management on transaction processes and governance structures, where technology management encompasses the areas of technological strategy, technological investment in design, manufacturing and administration, the associated technological change and technological implementation. In terms of Figure 3.1, technology management will include technologies [3.1.1], technological resource skills [3.1.2] and firm competencies [3.1.3]. Transaction processes, and governance structures will include knowledge management [3.1.5], technological sourcing [3.1.6], organisational learning [3.1.7] and relationship management [3.1.8]. Relationship management encompasses social networks and embedded ties, supplier closeness, communications, trust and goodwill and risks. Relationship management can be improved through technological sourcing, which includes strategic alliances/joint ventures and technology partnering.

Following from the discussion it may be concluded that there are links between technology management, transaction processes and governance structures. Some of these links may be related as follows:

- In terms of Figure 3.1 technologies [3.1.1] and technological resource skills [3.1.2] are needed to create firm competencies [3.1.3], to improve transaction processes [3.1.4]. Technological resource skills [3.1.2] are necessary to manage resources, technologies being one resource to create firm competencies [3.1.3]. Stonehouse et al (2000, p.49) expand resources to include human, physical, financial, technological and informational resources. These other resources (human, financial and physical) are necessary to support the technological resource. Williamson (1981, p.1546) looks at transaction-specific interests in terms of human, physical and site asset specificities. Human resources as individuals in the firm, needed to manage and implement technology; financial resources are needed for technological investment; and physical resources are considered in terms of site location.
- In figure 3.1 it is shown that firm competencies [3.1.3] required for transaction processes [3.1.4] are affected by market threats. Firms are therefore forced to invest as a result of technological discontinuities. These technological discontinuities create technological change. Technological change may be perceived as either competence enhancing or competence destroying technologies, which in turn affect technological resource skills and firm competencies. Williamson (1981, p.1546) refers to transactional frequency, transactional certainty/uncertainty and the degree to which transactions are supported by durable transactional specific interests. These transactional attributes may be likened to process improvements, which may result in

improvements in transaction processes [3.14] i.e. transactional cost reduction [l], transactional value added [j] and manufacturing mix criteria [k]. Therefore transaction process [3.1.4] improvements may improve transactional frequency, transactional certainty/uncertainty and transaction-specific interests.

- In terms of Figure 3.1, other links may include knowledge management [3.1.5], technological sourcing [3.1.6], organizational learning [3.1.7] and relationship management [3.1.8]. Knowledge management [3.1.5] is required to extend the resource barriers of the firm to incorporate new knowledge. Knowledge management [3.1.5] is further supported by technology sourcing [3.1.6] as firms collaborate with other firms. Firms develop relationships with customers, suppliers and competitors, and these relationships may be conducive to mutual benefit and competitive advantage over other firms.

In terms of Figure 3.1, relationship management [3.1.5] and technology sourcing [3.1.6] may be related. Hagedoorn (1993, p.376) provides evidence of modes of technology co-operation and the effects on governance structures as summarised in Table 3.3. As support for these links, Table 3.3 shows the relationships between the modes of technology co-operation and the effects on governance structures. Rating the effects of technological co-operation against governance structures shows that one-directional technology flows, customer and supplier relationships are priority ratings for effective governance. In terms of this thesis one-directional technology flows can be related to knowledge management, and customer and supplier relationships can be related to relationship management. Evidence of this is provided by at least the following authors:

- Hamel, Doz and Prahalad (1996, p.593) say that successful firms use the alliance to build skills in areas outside the formal agreement and systematically diffuse new knowledge though out their firms.
- Hagedoorn (1993, p.373) argues that "joint activities are merely a cover-up attempt to quickly absorb innovative capabilities from others."

One-directional flow provides evidence that firms form partnerships merely to imitate the other partner's knowledge.

Figure 3.1 shows that technological sourcing has an affect on relationship management, which affects organisational learning. Evidence of this is provided by at least the following authors:

- Hamel, Doz and Prahalad (1996, p.592) say a strategic alliance can strengthen both firms against outsiders even as it weakens one partner against the other.
- Hagedoorn (1993, p. 373) also says that an agreed technology transfer from one partner to another can also be a motive for inter-firm co-operation. This

technology transfer can equip one partner or both partners to leapfrog their competitors.

The effects may be related to information flow and knowledge transfer with associated benefits in organisational learning.

Direct investment, technology exchanges and joint R&D seem to have the same effect. Joint ventures seem to be negligible.

Table 3.3: Assumed relationships between modes of technology co-operation and the effects on governance structures (adapted from Hagedoorn (1993, p.376))

Effects on governance structures	Modes of technology co-operation					
	Joint Ventures	Joint R&D	Technology Exchange	Direct Investment	Customer supplier relationships	One Directional technology flows
Cost economising	-	-	+++	-	+++	+++
Mixed strategy	-	+	+	+	+	+
Long-term positioning	+++	+++	-	+++	+	+
Rating	1	3	3	3	5	5

- : Little or negligible relevance
+ : indication of growing relevance

The links depicted in Figure 3.1 may occur as follows:

- Firstly, as result of market threats and opportunities, firms are forced to react by improving firm competencies for competitive advantage.
- Secondly these competitive advantages could include the firm's position relative to its competitors, price, product features, etc.
- Thirdly, to achieve competitive advantage, the firm needs to make improvements in firm competencies such as transaction processes and manufacturing mix criteria, etc.
- Fourthly, in addition to creating firm competencies, technologies are implemented. The technologies implemented are either competence enhancing or competence destroying.
- Fifthly, technological resource skills are required to cope with technological discontinuities. Technological resource skills are embodied in individuals and these skills are required for firm competencies. The matching of the right resource skills with the right technologies is needed for firm competencies, i.e. tangible and intangible technologies.

The problem with technology management is not usually the technology, but the individuals. Obstacles to change include the culture and attitude of individuals in firms. The culture of a company represents the assumptions, beliefs and unwritten rules by which a company operates and exists. In addition, tacit knowledge is possessed by a few key individuals and has to be extracted and dispersed through the rest of the firm. Change has to take place

within these beliefs. Therefore knowledge management may be necessary to bring new technologies and knowledge into the organisation so that the firm is continuously faced with the latest technologies and knowledge in the competitive environment. Technological sourcing through joint ventures, strategic alliances and technology partnering with customers, suppliers and competitors may also add to the knowledge pool. In this way the firm may be pushed into a continuous learning process and thereby create a learning organization.

Organisational learning in firms may be enhanced through technological sourcing from other firms. Relationships are formed with other firms through network structures formed through backward and forward integration. Such network structures require that firms monitor and control the flow of information within and between firms. This is necessary so that firms are protected from other firms that form relationships merely to benefit from the host firm. Technological implementation may affect the frequency, uncertainty and durability of transaction-specific interests.

Section 3.1.1 focuses upon the subsets of technology management as indicated in Figure 3.1

3.1.1 Technologies

In Figure 3.1, technologies [3.1.1] and technological resource skills [3.1.2] are required to create firm competencies [3.1.3] for technology management. Using the AMT definition, technologies exist in design, manufacturing and business planning or administration. Technologies are limited to technological strategy [a], technological investment [b], technological change [c] and technological implementation [d], i.e. the management and use of technology. Technologies affect technological resource skills [3.1.2] in terms of competence destroying [e], competence enhancing [f] and tangible and intangible technological resources [g]. Competence destroying [e] and competence enhancing [f] skills depend upon tangible and intangible technological resources [g]. Porter (1991, p.106) argues that simply having pools of skills, knowledge or other resources is not a guarantee of success; it is having the right ones that count. Therefore in terms of this thesis, firms need to find the right match between technologies [3.1.1] and technological resource skills [3.1.2].

Burgelman, Madique and Wheelwright (1988, p.1) say that technology is a resource which, when managed for competitive advantage, requires integration into a firm's strategy. Hayes, Pisano and Upton (1996, p.686) argue that firms have initiated a number of initiatives to improve competitive advantage. These initiatives span many improvement programmes like TQM, JIT production, DFM (design for manufacturability), lean manufacturing, re-engineering, benchmarking and team approaches for management. However, not many of these initiatives have been met with much success. The authors say the main reason for the lack of success is that these initiatives or improvement programmes do not constitute a strategy to improve competitive advantage. Hayes, Pisano and Upton (1996, p.687) state that most firms focus

on the mechanics of the initiatives rather than on their substance, the skills and capabilities that are required to achieve the desired results. What is lacking is the strategy behind the technological initiatives. Technological strategy must be aligned to the firm's strategy. The firm's strategy may be to improve the firm's growth and profitability. This can be accomplished in a number of ways. One way could include improvements in manufacturing mix criteria. Boyer Ward and Leong (1996, p.311) say that there are numerous conceptual studies that suggest that infrastructure issues such as worker empowerment, managerial support and commitment to improvement programs like JIT, TQM or concurrent engineering are critical for successful AMT implementation. For example, the firm could implement technologies [3.1.1] that will improve manufacturing mix criteria [k]. These technologies could exist in design, manufacturing and business planning or administration. Having aligned the technological strategy [a] to the firm strategy, technological investment [b] will be required. Technological investment [b] looks at the costs, benefits and risks associated with technological change [c] and technological implementation [d].

Rosenthal (1984, p. 213) lists risks that limit the adoption of technological investment. The main reasons are:

- Inability to quantify strategic benefits.
- Lack of understanding of the potential benefits to be gained from technological adoption.
- Newness of the area of technology.
- Concern over the lack of skills necessary to achieve the potential benefits.

Other reasons provided include self-assessment needs of the firm to understand the requirements that are needed from the investment, benefits to be achieved from the technology, and limitations as a result of the fear by managers' of failure (i.e. bounded rationality and opportunism). Systems that may be used to alleviate the risks of technological investment include reward systems. The risks associated with technological investment are significant. Managers must be aware of costs, benefits and risks before they embark on technological investment.

Having noted the technological risks associated with technological investment, the effects of technology change [c] need to be considered. As firms invest in newer technologies, older technologies become obsolete. Management must be aware that technologies evolve over time and that investment in newer technologies could either destroy or enhance existing systems and competencies.

Successful technological implementation requires that associated technological risks be minimised. Technological implementation [d] together with technological resource skills [3.1.2] may open avenues for firm competencies [3.1.3] in technology management. The

benefits follow in terms of improvements in manufacturing mix criteria, which may lead to competitive advantages. Competitive advantages may lead to the firm's profit and growth.

3.1.2 Technological resource skills

Technological resource skills [3.1.2] are affected in terms of competence enhancing [e] and competence destroying [f] technologies. Competence destroying effects may affect employees, as employee skills may become redundant and further training may be necessary. Competence enhancing technologies on the other hand, improve upon the current employee skills. To sustain employee motivation, firms may opt for performance and reward systems for employees to improve their resource skills, which may result in competence enhancing rather than competence destroying effects. Developing employee skills and learning is part of firm competencies [3.1.3], which leads to knowledge management [3.1.5] and improved organisational learning [3.1.7].

As technologies evolve, the required skills are either enhanced or destroyed. To minimise the risks and increase the benefits associated with technological implementation, firms must be able to match technologies [3.1.1] with technological resource skills [3.1.2]. Technological resource skills are required to manage technologies. This is necessary as new technologies create competence enhancing and competence destroying effects. Firm competencies [3.1.3] are required to match the right technologies with the right technological resource skills [3.1.2]. There are many ways to create firm competencies as the following, authors shows. Williamson (1981, p.1546) refers to 'human asset specificity', which arises from learning-by-doing. Other authors like Pisano (1994, p.86) identify two strategies for learning: learning-by-doing and learning-before-doing. In technological evolving environments, firms must be able to be competent in both types of learning to sustain competitive advantage. These competencies may be created through core competencies and general competencies [h]. Hence firm competencies [3.1.2] may be used to match technologies [3.1.1] and technological resource skills [3.1.3].

Firm competencies [3.1.3] are necessary to create a foundation for knowledge management [3.1.5]. Knowledge management [3.1.5] may improve information flow [l] and knowledge transfer [m]. The integration of information through the firm may create opportunities to improve firm competences. The improvements in firm competencies may lead to improvements in manufacturing mix criteria [k]. The improvements in manufacturing mix criteria [k] may be linked to a firm's profit and growth. Therefore it may be concluded that technological investments in newer technologies should be linked to technological resource skills. This linkage may be provided through firm competencies. Firm competencies [3.1.3] may improve information flow [l] and knowledge transfer [m] with resulting benefits in manufacturing mix criteria [k]. The improvements in manufacturing mix criteria may allow the firm to grow at a different rate to other firms. That goes back to the original premise, H2:

Firms that adopt new technologies grow at different rates to other firms that maintain older technologies.

3.1.3 Firm competencies

Stonehouse et al (2000, p.126) assert that core competencies consist of resources and general competencies. Firm competencies create sustainable competitive advantage, and general competencies may or may not be core, but they are specific skills, organisational knowledge and reputation. Firm competencies [3.1.3] may leverage skills necessary for knowledge management [3.1.5]. Knowledge management [3.1.5] may therefore be necessary to extend the resource barriers of the firm to incorporate new knowledge from other firms.

Tangible and Intangible technological resources [g] are necessary for technological resource skills [3.1.2] and transaction processes [3.1.4]. Such technological resource skills [3.1.2] are dependent on employees within the firm. However, technologies exist within firms in design, manufacturing and business planning or administration. Employees within firms master such technologies so that technological risks are minimised and the benefits increased. The benefits of technological investment [b] may relate to improvements in manufacturing mix [k] criteria through firm competencies [3.1.3]. In carrying out these tasks, managers and employees in firms develop methods and routines called 'transaction processes' that embody the benefits to be obtained from technological use. Such transaction processes may create competitive advantages for the firm. The benefits are indicated in Table 3.1.

The following are some of the authors who suggest links between technologies and firm competencies:

- Burgelman, Madique and Wheelright (1988, p.1) view the integration of technology into a firm's strategy as a competitive advantage. In terms of Figure 3.1, competitive advantage may include factors influencing market share through technological implementation. Such factors could include improvements in manufacturing mix criteria.
- Teece et al (1997) points out that in terms of dynamic capabilities approach, competitive advantages rests on firm idiosyncratic and difficult to imitate resources. In terms of Figure 3.1, this may signify the linkage between technologies [3.1.1] and technological resource skills [3.1.2] that is required for competitive advantage.
- Mauri and Michaels (1998, p. 214) suggest that technology and marketing resources are variables for core strategies. In terms of Figure 3.1, technology and marketing resources may be related to tangible and intangible technological resources [g].
- Mahoney and Pandian (1992, p.370) postulate that successful firms in most industries possess one or more types of intangible assets like technological

know-how, patented process or design, know-how shared among individuals in the firm and marketing assets. These intangible assets are often subject to market (transaction) failure.

- Porter (1991, p.109) suggests that the utilisation of technology to improve manufacturing mix criteria so as to create economies of scope, depends on resource skills and organisational routines.

As technology evolves, the focus for competitive advantages will increase. Technological resource skills [3.1.2] are required to develop firm competencies [3.1.3], which are required to develop knowledge management [3.1.5].

3.1.4 Transaction processes

Transactions occur within and between firms. Managers implement newer technologies to obtain benefits in either transactional cost reduction or transactional value-adding (i.e. transaction certainty, transaction frequency, transaction durability and transaction-specific interests) activities. Through the integration of technologies across the value chain from product design, manufacturing and business planning or management, managers try to improve transaction processes [3.1.4]. These improvements may lead to benefits in manufacturing mix criteria [k] as managers try to obtain competitive advantages for their firms through newer technologies. Transaction processes [3.1.4] may create improvements in knowledge management [3.1.5] through improvements in information flow [l] and knowledge transfer [m]. Better information flow [l] and knowledge transfer [m] may enable managers to react faster to the competitive environment [3.1.9]. Firms possess competitive advantage as a result of faster reaction times.

3.1.5 Knowledge Management

In terms of Figure 3.1 knowledge management [3.1.5] is dependant upon having firm competencies [3.1.3]. The firm competencies that are required may be dependant upon core and general competencies [h] that may lead to improvements in transaction processes [3.1.4]. Transaction processes [3.1.4] may be further improved through the subsets of knowledge management, i.e. information flow [l], knowledge transfer [m] and new or emerging technologies [n]. Knowledge management may be further improved through technological sourcing [3.1.6]. Technological sourcing [3.1.6] will be discussed later in section 3.1.6.

In terms of Figure 3.1 knowledge management [3.1.5] encompasses the areas of information flow [l] and knowledge transfer [m], and new and emerging technologies [n]. Information flow [l], knowledge transfer [m] and new and emerging technologies [n] may lead to better communication within and between firms. This improved communication may help managers make decisions. The decisions managers make may be based on the latest available information and managers may react faster than competitors to market threats and opportunities. The competitive environment [3.1.9] comprises many factors including market

threats [v], market opportunities [w] and external factors [x]. Being able to react faster than competitors to the competitive environment [3.1.9] may create competitive advantages. Therefore managers in firms should have access to the latest available information, knowledge and technologies, which may facilitate the flow of information. Stonehouse (2000, p.365) argues that responsiveness and pro-activity are dependent upon individuals and organisations learning more quickly than competitors. The quick reaction to market threats and opportunities may provide opportunities for competitive advantage. Therefore better communication within and between firms may lead to competitive advantages. Managers in firms should seek more information and knowledge about the competitive environment [3.1.9]. In this way they may be able to stay ahead of their competitors and capitalise on market threats [v] and opportunities [w]. Day and Schoemaker (2000, p.42) say that "Senior managers must wander outside their offices and comfort zones, and start having conversations with informed insiders, outside experts, and customers. They must study competitive moves, float ideas, and seek collaborations." These initiatives may ensure that managers keep abreast with the latest available information and knowledge.

Hoopes and Postrel (1999, p.838) introduce the concept of 'shared knowledge', defined as the knowledge that is held by two or more individuals. This definition, however, does not assume that the communication of that knowledge from one person to the other has occurred. This means that knowledge may be possessed by two parties but each party may be unaware of the other party's intentions regarding the knowledge. In addition each party may possess the knowledge but may be unaware of its potential use. This may occur as parties may have communicated the knowledge between themselves but knowledge transfer may have not occurred. In this thesis knowledge in this context is called 'information'. Hoopes and Postrel (1999, p.838) argue that superior firm capabilities in product design, customer service, manufacturing, market positioning, etc., either depend upon, or can be identified with, shared knowledge. In other words knowledge has to be shared through group networking to improve the chances of finding uses that may lead to competitive advantages. Knowledge cannot merely be communicated. This means that knowledge sharing involves knowledge communication, eg. passing documentation and knowledge transferability, i.e. understanding. To understand knowledge transfer, it is necessary that the components of knowledge be defined. The following authors provide some understanding of this:

- Stonehouse (2000, p.365) notes that knowledge management includes knowledge generation, the formalisation of knowledge, storage of knowledge, diffusion of knowledge and the co-ordination and control of knowledge.
- Hamel, Doz and Prahalad (1996, p.595) say that knowledge transfer depends on how easily knowledge can be transported, interpreted and absorbed.

Figure 3.2 below gives a graphical representation of the different steps involved in the knowledge management process.

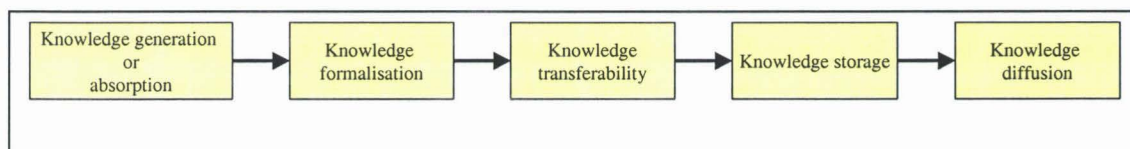


Figure 3.2: Knowledge management processes

Figure 3.2 shows that it is necessary that knowledge first be generated or absorbed either from the market or a technological partner. In terms of Figure 3.1, technological sourcing [3.1.6] through joint ventures, strategic alliances and technology partnering may provide opportunities for knowledge absorption from markets and technology partners. To accomplish this, technological gate-keeping may provide the answer (Robert and Fusfeld (1988, p.313)). Firms must protect the flow of information and knowledge entering and leaving the firm. This may be accomplished through technological gate-keeping. Technological gate-keeping may be used to control and monitor the flow of information between partners. Savioz and Blum (2002, p.93) define gatekeepers as those individuals who frequently contact people outside their firm, and show above-the-average communication skills and pass on their information to certain individuals inside the firm, thereby creating a communication network. Hamel, Doz and Prahalad (1996, p.596) point out that a gatekeeper can be effective only if there are a limited number of gateways through, which a partner can access people and facilities. In this way information or knowledge leaving or entering the firm may be controlled and monitored.

Having generated or absorbed knowledge the next step is to formalise that knowledge. To formalise knowledge one has to consider two forms: of tacit knowledge and explicit knowledge. Tacit knowledge is related to intangible technologies and explicit knowledge is related to tangible technologies. Lane and Lubatkin (1998, p.462) say that a firm's knowledge includes easily communicated observable knowledge, which is explicit knowledge and tacit knowledge, which has interfaces with other sections of the firm and is therefore difficult to define.

Other authors like Simonin (1999, p.599) use the terms 'tacit knowledge' and 'explicit knowledge' or 'experimental knowledge'. At least the following authors define tacit knowledge:

- Reed and DeFillipini (1990, p.89) define tacit knowledge as the implicit and noncodifiable accumulation of skills that results from learning-by-doing.
- Simonin (1999, p.598) cites Nonaka (1994) who defines tacit knowledge, as knowledge which can easily be communicated and shared, is highly personal, and is deeply rooted in action and in an individual's involvement within a specific context.

Lane and Lubtakin (1998, p.462) cites ((Barney 1991, 1995) and Spender (1996)) in support of these views, saying that a firm's capability builds on tacit knowledge, which is rare,

imperfectly trade-able and costly to imitate, and is therefore the basis for competitiveness or superior performance. However, as technology develops, a firm's capability will be loosened as a result of substitute products, competitors and suppliers who try to loosen the network structure. From Figure 3.1 it can be seen that the competitive environment [3.1.9] includes market threats [v], market opportunities [w] and external factors [x] which may affect firm competencies [3.1.3], knowledge management [3.1.5] and technological sourcing [3.1.6]. Firms can look for other partners to improve their capabilities or build on existing knowledge to reinforce the links through knowledge management [3.1.5] and technological sourcing [3.1.6]. Explicit knowledge is knowledge that exists in systems, procedures, methods and routines, which can easily be transferable. Tacit knowledge, on the other hand, is not easily transferable and depends upon the firm's prior experience with a particular technology. This view is also supported by Wolff (1997, p.5) he says that accumulation of specialized knowledge is acquired only by being in an industry. This specialized knowledge may include detailed steps of production, as well as specialized skills that are mainly acquired through learning-by-doing.

Having looked at knowledge transferability, the next step is to consider the storage and diffusion of knowledge. Knowledge acquired from a competitor or partner is only valuable after it is diffused through the organisation. This step involves the co-ordination and cooperation of individuals within firms. Hoopes and Postrel (1999, p.839) define coordination as the synchronization of activities within firms, and cooperation as the behaviour of individuals within firms as they balance personal interests with the interests of the firm. For knowledge and information to be diffused it must be shared. Individuals in firms should firstly cooperate and share knowledge where necessary. Secondly, knowledge should be coordinated so that information overload may not occur. Several mechanisms exist for the dispersion of knowledge. Some firms use software systems for knowledge management while other firms use more routine mechanisms like holding meetings to collect and disseminate information.

The absorption of information involves developing the firm's absorptive capacity, i.e. the ability to learn. Several mechanisms exist for developing a firm's absorptive capacity. These mechanisms will be discussed under organisational learning in section 3.1.7. Knowledge acquisition may occur via technological sourcing through strategic alliances and technology partnering. Other mechanisms that may enhance knowledge management are new and emerging technologies. New and emerging technologies facilitate knowledge management. New technologies in information technology, communication and e-commerce may help manage information better. This may occur as firms interact in a more collaborative manner. Collaboration is possible as managers find lower costs for transactional interaction. Aldrich (1999, p.137) notes that firms that manage information effectively, have the ability to re-deploy the money they save in transaction costs on other activities that create more value for

customers and shareholders. The real value of knowledge management does not lie in transactional cost savings but in the ability of the firm to be able to react quicker as a result of more timely information. Therefore the ability to integrate information and transfer knowledge within and between firms quickly, is becoming a core resource needed for a firm to be competitive.

Knowledge management is a key resource for a firm's competitiveness. New technologies change the way people work. Horibe (1999, p.xi) provides an example of such change through the concept of the knowledge worker, defined as those "workers who use their heads more than their hands to produce value." Horbie (2000, p.1) notes that firms that are able to capture/harness the intellectual capital of knowledge workers will be successful in the information age. Stonehouse (2000, p. 5) refers to this age as the era of the 'intelligent' organisation. The effects of globalisation, further compound the problem of knowledge management and intellectual capital. The effects of globalisation have fundamentally affected and will continue to affect the way business is conducted. The focus on knowledge management and intellectual capital is a cornerstone for competitive advantage.

It is therefore necessary that firms understand and develop the concepts of knowledge management and organisational learning. Knowledge management [3.1.5] may be improved through better technological sourcing [3.1.6]

3.1.6 Technological sourcing

Through competence destroying [e] and competence enhancing technologies [f] firms may be forced to build in-house competence or seek alternative means of technological sourcing. This may involve forming strategic alliances with other firms. Some authors use a similar term 'strategic technology alliances'. At least the following authors have a common understanding on the matter.

- Hagedoorn (1993, p.375) defines strategic technology alliances as 'inter-firm co-operative agreements', which are aimed at improving long-term product market combinations of the companies involved.
- Gulati (1998, p. 293) defines strategic alliances "as voluntary arrangements between firms involving exchange, sharing, or co-development of products, technologies, or services".

According to these views 'strategic alliances' may have benefits for firm competitiveness and some benefits are shown in Table 3.4. Benefits include product market combinations, which may be achieved through the exchange, sharing or co-development of products, technologies or services. Further benefits for global strategies also exist. Porter (1998, p.66) says that for global strategies, companies enter into strategic alliances to gain a number of benefits.

Table 3.4: SWOT Analysis of Strategic Technology Alliances

Strategic Technology alliances	
Strengths	Weakness
1. Hagedoorn (1993, p.373) says that agreed technology transfer from one partner to another can also be a motive for inter-firm co-operation. This technology transfer can equip one partner or both partners to leap-frog their competitors. 2. Gulati's (1998) response is that there is evidence that alliances with embedded ties perform better or last longer than others, and such embedded ties include non-recoverable investments, which can enhance the performance of the alliance. 3. Hamel, Doz and Prahalad (1996, p.592) say a strategic alliance can strengthen both firms against outsiders even as it weakens one partner against the other.	1. Khanna, Gulati and Nohria (1998, p.201) note that for firms in learning alliances to absorb skills from their partners, requires continual allocation of resources to the learning process. 2. Gulati (1998, p.300) says that a partner may either free-ride by limiting its contributions or simply behave opportunistically.
Opportunities	Threats
1. Hamel (1991) also provides evidence that suggests that partners in competitive alliances may sometimes be more likely to view collaboration as a race to the future first, rather than a truly co-operative effort to create the future together. 2. Hagedoorn (1993, p.372) argues that large and diversified firms might still lack some competence in certain areas of scientific and technological fields. Therefore co-operation creates the necessary complementary technology inputs enabling these companies to capitalise on economies of scope through joint efforts. 3. Gulati (1998, p.303) says that each partner's awareness that the other has much to lose from behaving opportunistically enhances its confidence in the other partner. He says that potential hazards could include loss of repeated business with the same partner, loss of other intangible benefits, loss of reputation	1. Hamel (1991) in a research study on international strategic alliances, provides evidence that partners in strategic alliances regarded their alliances as transitional devices where the primary objective was the internalisation of partner skills. 2. Hagedoorn (1993, p.373) argues that such joint activities are merely a cover-up to quickly absorb some capabilities from others. This could also include market access through the joint agreement.

- One is economy of scale or learning, achieved by joining forces in marketing, component production or assembly of particular models. Economies of scale through learning may be achieved through learning-by-doing. Learning-by-doing is also supported by Day and Schoemaker (2000, p.43) who say that the best way to learn is through continuous experimentation, which requires a willingness to experiment and an openness to learn from inevitable failures and setbacks. Examples of learning-by-doing exist in this context and evidence from the CIM industry may be drawn upon. This is expanded upon in section 3.2.4 i.e. manufacturing mix processes and 3.2.5 i.e. technology implementation
- A second benefit is access to local markets, needed technologies, or meeting government requirements for local ownership.

Hagedoorn (1993, p.372) also adds economies of scope. He says that even large diversified firms may still lack some competence in a number of scientific and technological fields, and that the competence that is lacking can be supplied through co-operative joint efforts. To achieve benefits in economies of scale and scope or learning, market access, needed technologies, etc., managers in firms may opt for different tactics to sustain or improve competitiveness. This view is also supported by Madhavan, Koka and Prescott (1998, p.440) who say that network structures have a key influence on performance and industry evolution, and therefore managers engage in strategic manoeuvring to secure positions in their industry's network. Such manoeuvring includes entering into strategic alliances to ensure access to key technologies or other resources. Simonin (1999, p.595) says that strategic alliances are best to expand the knowledge barriers of the firm.

Gulati (1998, p.297) adds that strategic alliances constitute a strategic action and the accumulation thereof can also become a social network. Embedded ties may result from social networks. Gulati (1998, p.298) argues that embedded ties promote greater frequency of information exchange between partners, which can affect the success of the alliance as well as the performance of firms entering them. The benefits of embedded ties include:

- Information access as a result of a larger number of alliances.
- Better partners as a result of the firm's reputation, which may result from the social network structures.
- Superior terms of trade as a result of possible control benefits that may have developed from other relationships.

Embedded ties may also assist firms in forming strategic networks with other firms. Strong embedded ties may pose barriers to firms that initiate structural loosening events, which are typical in network structures. Hence strong network ties may reinforce structural reinforcing events as firms act to protect their own interests.

Gulati (1998, p.300) says that firms entering into alliances face considerable moral hazard concerns because of the unpredictability of the behaviour of partners and the likely costs the firm may encounter from a partner's opportunistic behaviour should it occur. Therefore organisations which want to build ties that effectively address their needs while minimizing the risks, must be aware of the existence of potential partners and have an idea of their needs and requirements. Hagedoorn (1993, p.375) points out that these 'strategic technology partnerships' are different from other partnerships such as cost-economising agreements, which are more closely associated with control of either transaction costs or operating costs, Table 3.3 shows the assumed relationships between the different modes of technology co-operation. Khanna, Gulati and Nohria (1998, p.195) note that alliances have private and common, benefits viz.:

- Private benefits are those that a firm can earn by picking up skills from its partner and applying them to its own operations in areas that are unrelated to the alliance activities.
- Common benefits are those that are incurred by the partners through the alliance. Common benefits are therefore related to what each partner can learn from the other. The life of an alliance can be hampered by common benefits as soon as one partner has absorbed the knowledge from the other partner, the incentives to remain in the alliance are reduced.

Therefore it may occur that partners are in a race to learn from each other. Alliances are based on a combination of private and common benefits. Co-operative relationships arise from private benefits and competitive aspects arise from common benefits. Strong embedded ties based on trust may be crucial to protect firms in a network structure. The formation of clans and cliques may be used to enhance embedded ties. For firms to sustain or improve their position in a network structure, it may be necessary for firms to exist in a symbiotic relationship to the mutual benefit of each partner. Several reasons exist for alliance formations, for instance those provided by Kogut (1988, p.321-322):

- Transaction costs resulting from small numbers bargaining.
- Strategic behaviour that leads firms to enhance their competitive position or market.
- The quest for organisational knowledge or learning that results, when firms want to acquire critical knowledge from the other partner, or one partner wants to maintain its capability while seeking another firm's knowledge. This may be viewed as opportunistic behaviour as discussed by Williamson (1975).

From Figure 3.1 it can be seen that transactional improvements may be achieved through technological sourcing [3.1.5] namely strategic alliances/joint ventures [o], technology partnering [p] and knowledge management [3.1.5] namely information flow [l], knowledge transfer [m] and new and emerging technologies [n]. Cost optimisation may be achieved through economies of scale from a small base of networking firms. Results are improvements

in the firm's competitive position through competence enhancement and the acquisition of knowledge. In addition, firms may diversify into other avenues as a result of the market being penetrated by competitors or forward integration as firms enter into strategic partnerships with other firms to sustain competitiveness. It follows that strategic alliances consisting of joint ventures and technology partnering may provide opportunities for firms to capitalize on economies of scope through joint and co-operative efforts. These joint and co-operative efforts engender both threats and opportunities.

Gulati (1998, p.299) points out that a firm's choice to enter into an alliance depends upon the firm's decision to enter into an alliance and the availability of a partner. In addition, Gulati (1998, p.299) concludes that researchers have linked the formation of alliances to various kinds of capabilities including production, marketing, distribution, regulatory approval and access to new technologies. Gulati (1998, p.306) says that researchers predict that the success of alliances will lie in the following: flexibility in management of the alliance, building trust with the partners, regular information exchange with partners, constructive management of conflict, interface personnel between the partners, etc. Therefore in terms of this thesis, the links to manufacturing mix criteria, technology management, organisational determinants, competitor analysis, external factors, transaction processes and governance structures substantiate Gulati's views. Gulati (1998, p.310) says that there is ample evidence in the automotive industry that suggests significant differences in cost, quality and new product development that is driven by the extent to which firms outsource and the nature of such relationships.

Technology is a strategic asset and firms do not always possess all the technologies that are necessary for competitive advantage. Firms therefore form alliances with other firms to source technological advantages, especially for intangible technologies. In such cases firms form networks with other firms, thereby acquiring the ability to obtain additional resources to sustain or improve competitiveness. Strategic alliances, however, have some disadvantages that result from the opportunistic behaviour of alliance partners. Firms must therefore be cautious about the alliance partners they select. Alternative means of technological sourcing [3.1.6] through strategic alliances/joint ventures [o] and technology partnering [p] coupled with knowledge management [3.1.5] may create opportunities for organisational learning.

3.1.7 Organisational Learning

From Figure 3.1 organisational learning [3.1.7] may be dependent upon knowledge management [3.1.5]. The subsections of knowledge management are prerequisite if organizational learning is to occur. Organisational learning looks at the absorption of knowledge from outside the firm its diffusion within the firm. Information flow [l], knowledge transfer [m] and new and emerging technologies [n] may assist the firm to learn and develop

firm competencies [3.1.3] faster than their competitors. In this way firms may be able to create competitive advantages over competitors. Hamel, Doz and Prahalad (1996, p.598) say that knowledge acquired from a competitor-partner is valuable only after it is diffused through the firm. It is therefore necessary that firms develop the ability to assimilate knowledge and learn from their partners. This, however, is dependent upon the firms' absorptive capacity i.e. their ability to learn. Before discussing absorptive capacity it is necessary to gain an understanding of the different ways of learning. Pisano (1994, p.86) says that there are many ways of learning, such as learning-by-doing and learning-before-doing.

Pisano (1994, p.87) says that the basic idea behind learning-by-doing is that only through actual production experience can an organisation discover process problems. It is these process problems that cause the gap between actual and potential performance to open up. Therefore through learning-by-doing firms can identify opportunities for improvement. Evidence of learning-by-doing is provided by Rosenthal (1984, p.203) who says that leading edge users in CAM processes believe in learning-by-doing. He says that these users rely heavily on outside suppliers for technical assistance and they also regard the reliability factors to be more important than the price of selecting a technology partner. The ability of a firm to learn from its partner and assimilate such knowledge within the firm is key for competitive advantage. Therefore it is necessary that firms develop mechanisms that are needed for organisational learning.

Pisano (1994, p.86) says that one of the major challenges facing innovation lies not in designing the process, but also implementing and replicating it within the firm's operating environment. The ability of firms to recognise knowledge and diffuse it within the firm may create competitive advantages. In order for the firm to be able to recognise knowledge and diffuse knowledge within the firm, certain conditions are necessary. Cohen and Levinthal (1989, 1990, p.128) propose a theory of absorptive capacity which they define as a firm's ability to recognise the value of new external knowledge, assimilate it and apply this knowledge to commercial ends. Lane and Lubatkin (1998, p.462) propose that a firm's ability to value, assimilate and apply new knowledge from a learning strategic partner depends upon the following three activities:

- The specific type of new knowledge offered by the teacher firm (resource owner).
- The similarity between the teacher firm and student firm's organisational structure and compensation practices.
- The host firm's familiarity with the teacher firm's set of organisational problems.

Lane and Lubatkin (1998, p.465) argue that a student firm's ability to internalise knowledge is greater when its knowledge-processing systems are similar. A student firm must have some prior knowledge and similar knowledge to the teacher firm in order for learning to be

successful. This, however, suggests one-way learning between firms, because firms form alliances with other firms to improve competitiveness. In addition there would be no benefit in forming alliances if information transfer from one firm to the other firm did not add value. However, this does not mean that two-way learning does not occur between firms in alliances.

Moreover the rewards for learning in both firms should be similar. For example, if the reward system in the student firm is one of paying for skills improvement, the employees will be receptive to learning. However if the reward system is one of paying for output, the employees may not be so receptive to learning. Therefore the rewards systems in both firms should be similar. The following authors provide some evidence of this:

- Day and Schoemaker (2000, p.44) state that organisations that reward those who play it safe and blame risk takers for 'well-intentioned' failures will discourage learning. This means that learning-by-doing should be supported and there should be an acceptable level of tolerance to failure, which would be conducive to learning. However payment and reward systems also have an impact on the absorptive capacity of firms, as mentioned previously. If employees are rewarded for newly acquired skills they will tend to acquire them. Payment and reward systems have been summarised by Schonberger and Knod (1994, p. 537).
- Rosenthal (1984, p.204) also supports the theory that reward systems encourage risk-taking for long-term strategic gains in CIM implementation. The author says that the failure of firms to provide such reward systems contributes to the issues relating to a firm's failure to achieve for successful factory automation.

Hamel, Doz and Prahalad (1996, p.597) argue that 'to learn one must want to learn'. Payment and reward systems constitute one way of ensuring that employees are motivated to learn. Lane and Lubtakin (1998, p.462) say that there are three methods of learning, namely passive, active and interactive learning.

- Passive learning occurs when firms acquire observable knowledge about technical and managerial processes through journals, seminars and consultants. This is similar to technological gate keeping. Information gate keeping can be focused on developments in the market or world of technology (Roberts and Fusfeld (1988)). Gate keeping is a way of collecting and channelling information about important changes in the internal and external environments.
- More active forms of learning include benchmarking and competitor analysis, which provide a broader view of other firm's capabilities. This type of learning has much in common with Roberts and Fusfeld's view on idea generating, entrepreneurship and championing roles in technological management, where idea generating is the ability to synthesise or analyse information about markets, technologies, approaches, or procedures. Thereafter an idea is generated for a new improved product or service. Entrepreneurship or championing is the ability to recognise, propose, push and demonstrate a new technical idea or process for formal management approval.

- Interactive learning is a means of face-to-face interaction between the student firm and teacher firm. A similarity between interactive learning and project leading, and sponsoring and coaching can be drawn. The roles of project leading, sponsoring and coaching, as proposed by Roberts and Fusfeld (1988), are viewed in the context of the firm. However, we can expand this to include the scenario between firms where project leading could be planning and co-ordinating the set of activities and people involved between the teacher firm and the student firm. In addition, sponsoring and coaching roles could be the guiding and developing of less experienced personnel in their critical roles.

Some authors like Lane and Lubatkin (1998) and Roberts and Fusfeld (1988) have proposed different methods of organizational learning. The comparison of these organizational learning modes is summarised in the Table 3.5.

Table 3.5: Comparison of different modes of organisational learning

Area of focus	Lane and Lubatkin (1998)	Roberts and Fusfeld (1988)
Mainly within firms	Passive learning	Gate keeping
Within and between firms	Active learning	Idea generating entrepreneurial or championing
Within and between firms	Interactive learning	Project leading Sponsoring and coaching

The different modes of learning proposed by the authors are dependent on the firm's ability to absorb information. Lane and Lubatkin (1998, p.462) call this 'absorptive capacity', which was a term coined by Cohen and Levinthal (1990, p.542). They defined it as a firm's general ability to value, assimilate and commercialise new, external knowledge. The different methods of learning are a means of developing the capacity for learning but absorptive capacity is a means of developing the ability to learn. A firm must first create means for developing the capacity for learning before they can develop absorptive capacity. Lane and Lubatkin (1998, p.463) say that demand, appropriability and technology are the drivers for firms to invest in absorptive capacity. Some authors have found a relationship between absorptive capacity and a firm's investment in technology, alliance utilisation and managed communications between alliances.

In firms individuals interact and communicate with other individuals as they perform different roles and functions. The firm's organisational structure regarding the standardisation and centralisation of tasks affects the way individuals interact and communicate with each other. These views are also shared by Hoopes and Postrel (1999, p.1) who say that organisational

integration across functional and disciplinary specialties drives superior firm capabilities. This may be achieved through flatter hierarchies, cross-functional teams, electronic groupware, and similar current management preoccupations, all aimed at improving communication among different individuals and departments. Therefore the firm's organisational structure may affect knowledge transfer and organisational learning. Rosenthal (1984, p. 204) regards resistance to communication across sections of the firm as one of the reasons for failures to establish successful factory automation. Some authors have found a relationship between a firm's standardisation and centralisation of tasks with respect to firm's absorptive capacity. Table 3.6 below shows the relationships that some authors have found between organisational learning concepts such as absorptive capacity and methods of learning, etc. and the drivers thereof.

Table 3.6: Relationships between organisational learning and the drivers thereof

Organisational learning concepts	Drivers	Comments
Absorptive capacity	Payment and reward systems	Different payment and reward systems offer means for the creation of absorptive capacity. Day and Schoemaker (2000, p.44) say that organisations that reward those who play it safe and blame risk takers for 'well-intentioned' failures will discourage learning.
	Technological discontinuities	In order to improve information flow and information transfer between firms during periods of technological discontinuities some firms would opt for improved absorptive capacity. The incentive here is to provide a possible means of job security for the individuals of the firm.
	Technological investment	That is an improvement in technological investment to support improved alliance management. This could include administration systems as discussed in AMTs. Other examples could include the interface of CAD and CAM between firms where one firm produces the CAD drawing and the other firm uses the same CAD drawing in its CAM system.
	Organisational structure	Here similarities between the teacher firm and student firm regarding decision making and centralisation of tasks will influence absorptive capacity.

The intent of a firm to commercially apply knowledge learned depends on the firm's strategic goals. The following are some examples of strategic goals:

- If one of the firm's strategic goals is to form an alliance or joint venture with another firm to improve its competitive edge, the firm may consider technological investment for improved communications to create better alliance management.

- If another strategic goal is organisational restructuring in the form of staff training for centralisation of decisions and standardisation of tasks, the firm may consider investment options pertaining to organizational restructuring.

The strategic goals of the firm therefore also have an influence on the firm's organisational learning intentions.

Figure 3.1 shows that the inputs to organisational learning [3.1.7] are knowledge management [3.1.5] and relationship management [3.1.8]. Knowledge management [3.1.5] has already been discussed and section (3.1.8) is devoted to relationship management. Relationships formed with other firms may be conducive to developing organisational learning capabilities. Therefore relationships that are built between firms may be a means of creating competitive advantages. Such relationships may become barriers to entry for other firms, especially if both firms benefit from the alliance. Relationship management is discussed next.

3.1.8 Relationship Management

The process of relationship management encompasses all aspects of managing business relationships with suppliers, alliance partners, sales channels, employees, customers and investors. Gulati (1998, p.297) says firms can be interconnected with other firms through a wide variety of social and economic relationships. These relationships include supplier relationships, resource flows, trade association memberships, interlocking directorates, relationships among individual employees and prior strategic alliances. Hanson (1995, p.14) states that management of business relationships across collaborating organisations should be critical to achieving a competitive edge. He maintains that procurement practices that fail to tap into the intellectual capital of the supplier are increasingly a potential source of competitive disadvantage. This means that firms should form relationships with other firms to improve knowledge management [3.1.5] through information flow [l] and knowledge transfer [m]. Such relationships may provide added competitive advantages. Such relationships may be formed through social networks and embedded ties [q]. These social networks and embedded ties may be further enhanced through technology sourcing [3.1.6]. Through technology sourcing [3.1.6] firms form network structures with other firms. Through these network structures buyer and seller relationships develop.

Hamel (1991, p.84) quotes a research study in which managers voiced the concern that when collaborating with a potential competitor, failure to out-learn one's partner could render a firm dependent and then redundant within the partnership. This would then lead to competitive vulnerability. Therefore it may be argued that competition for competence also exists between buyer and seller. The partnership may then be exhausted and the firms concerned may dissolve such a partnership. In such cases supplier closeness, communications, trust and goodwill [r] may provide opportunities to extend the relationship. The role of trust as a function of transactions or business exchanges has been emphasised in supplier

relationships. Several authors, including Dyer (1997), Barney and Hansen (1994), Choi and Hartley (1996), Jarillo (1988) and others, mention that supplier closeness, communications, trust and goodwill are important for long-term supplier relationships. Gulati (1998, p.300) says that the 'embedded-ness' of firms in social networks can both restrict and facilitate the alliances a firm enters into. The author further postulates that when faced with uncertainty about a potential partner, firms resort to existing networks to discover information and this leads to lower transaction costs, more specifically as regards search costs, and hence this reduces the risk associated with opportunism. Barney and Hansen (1994, p.177) discuss the competitive advantages of trust, distinguishing between weak form trust, semi-strong trust and strong form trust.

- Barney and Hansen maintain that weak form trust will not be a source of competitive advantage. The very nature of the market in which weak form trust exists means that there will be no significant vulnerabilities for opportunistic behaviour. In this market the benefits to be gained by violating weak form trust will not justify the cost of establishing governance structures to create semi-strong trust. Those firms that invest in semi-strong trust will be at a disadvantage compared with those firms that rely on weak form trust. This kind of trust exists in highly competitive commodity markets.
- The creation of semi-strong trust depends on the ability of the partners to identify sources and levels of opportunistic threat in the transactions/exchanges which they anticipate. Only when partners can accomplish these tasks with the right types of governance to create semi-strong form trust, will the value of the semi-strong form trust be realised. However, the partners may be able to create a competitive advantage over other firms should they be able to establish governance structures to create semi-strong trust. This semi-strong trust would not be shared by other firms and would thus result in cost advantages. However, should competitors be equally skilled, there will be no significant cost advantages and therefore this form of competitive advantage will be minimal. However, if firms are able to manage intermediate market governance structures such as strategic alliances/joint ventures [o], and technology partnering [p] they can create semi-strong form trust using these intermediate market forms of governance, where less skilled firms (in creating such intermediate market governance) use hierarchical forms of governance. Therefore if intermediate market forms of governance are less costly than hierarchical forms of governance, those forms opting for intermediate forms of governance will create a competitive advantage.
- Semi-strong form trust can be used in conjunction with structure enforcing events, (Madhavan, Koka and Prescott (1998, p.444)) to create a network of firms, thus sustaining competitive advantage. Therefore if a competing firm tries to imitate such means for creating semi-strong form trust, it will be more costly to create

embedded ties in the network structure, which has the broader social network of relations. Gulati (1998, p.300) argues that there is ample evidence suggesting that the proclivity of firms to enter alliances is influenced not only by their financial and technological attributes, but also how they are embedded in social network structures between firms. In addition Barney and Hansen (1994, p.179) say that firms opting for social governance to create semi-strong form trust will have a cost-competitive advantage over firms that must rely on economic governance to create semi-strong-form trust.

- Barney and Hansen (1994, p.184) say that for strong form trustworthiness to be economically valuable, all partners with a significant stake in the transaction/exchange must be strong form trustworthy. Should this be the case, then valuable economic opportunities exist. These opportunities include costs of not establishing semi-strong governance mechanisms, which have to be established by other firms that have to use semi-strong-form trust instead of strong form trust. Even more important than the cost of governance structures is the potential for other exchange opportunities such as joint technological investment and development. Semi-strong form firms will opt for expensive governance mechanisms before such knowledge transfer can take place, whereas the firm opting for strong form trust will not be hampered by this hurdle.

Several authors have pointed out that hierarchical governance does not create strong form trust exchange ((Ouchi (1980) as cited by Hamel (1991)). It simply shifts those problems from a market or intermediary to inside the boundaries of the firm. However, in dealing with trust, firms have to weigh the benefits, costs and risks associated with each transaction. The risks associated with each relationship must also be considered. Ring and Van de Ven (1992, p.488) assert that in dealing with risk, parties to a transaction will select a governance structure that will provide appropriate safeguards against risk. In addition, safeguards will become more complex as the level of risk increases. However, they say that risk and trustworthiness are related and considering the need to work over long sustained periods, managers must concern themselves with the trustworthiness of other parties. Ring and Van de Ven (1992, p.490) propose relationships between governance structure, trust and risk. Ring and Van de Ven (1992, p. 489) say that risk and trust are related as follows:

- A history of successful transactions between parties reduces risks in terms of information asymmetry as parties will share information more freely with each other.
- Repeated transactions and adherence to norms of equity and reciprocity will reduce opportunistic behaviour when given access to proprietary information.
- Transaction frequency occurs for different reasons. However, it will increase the likelihood that parties will be able to exercise greater autonomy without fearing a loss of control in subsequent transactions.

- More frequent transactions with different organisations may result in the accumulation of stock information regarding the predictability or reliability of parties.
- Diversity in transactions is also likely to increase the store of information regarding efficacy of contractual safeguards.
- Transaction history with different parties is likely to reduce the time taken to make decisions.

Gulati (1998, p.301) points out that firms do not form alliances as symbolic social affirmations but base alliances on concrete strategic complementarities that they have to offer each other. However, the benefits of buyer seller relationships can only be maintained if each partner has something to offer. The strength of the relationship can be improved through creating barriers to entry. These barriers to entry may exist in the form of network structures. However, network structures must be protected through structural reinforcing events created by firms central in the network structure. Firms must continually improve to strengthen their position in the network structure, be this through structural loosening events created by those firms that are peripheral in the network structure. A firm's position in a network structure may be improved through strategic alliances/joint ventures [o] and technology partnering [p], which may lead to social networks and embedded ties [q] and supplier closeness, communications, trust and goodwill [r] and thereby reduce risk [s].

From Figure 3.1 it may be noted that social networks and embedded ties [q] are a key part of relationship management [3.1.8]. Therefore firms should form networks with other firms to leverage advantages in terms of supplier closeness, communications, trust and goodwill [r]. These social networks and embedded ties [q] may be utilised in reducing the risk [s] associated with network structures. In addition, Madhavan, Koka and Prescott (1998, p.440) say that external relationships provide access to key resources. The structure of the relationship network describes the asymmetric access that competitors have to raw materials, information, technology, markets, or other performance requirements. In view of these arguments firms may use social networks and embedded ties [q] to gain competitive advantages. Furthermore Lorenzoni and Lipparini (1999, p.320) suggest that inter-firm networks could provide an effective way to organise knowledge transfer or access in competitive environments. It also follows from Figure 3.1 that knowledge management [3.1.5] is linked to relationship management [3.1.8], leading to opportunities in the competitive environment [3.1.9].

3.1.9 Integration of linkages

On the basis of Figure 3.1, one can see that linkages between technology management, transaction processes and governance structures could include technologies [3.1.1], technological resources skills [3.1.2], firm competencies [3.1.3], transaction processes [3.1.4], knowledge management [3.1.5], technological sourcing [3.1.6], organisational learning [3.1.7]

and relationship management [3.1.8]. The technologies firms adopt and implement may provide opportunities in terms of the competitive environment [3.1.9]. The competitive environment [3.1.9] may be affected in terms of market threats [v], market opportunities [w] and external factors [x]. For example:

- In the face of market threats by competitors or substitute products, firms may create social networks and embedded ties [q] to form structural enforcing events. These structural enforcing events protect the firm's position in the network. This will enable the firm to create barriers to entry by potential competitors.
- In terms of market opportunities, benefits in terms of improvements in transaction processes may provide competitive advantages over other firms.
- As regards external factors, benefits in terms of globalisation may exist. Globalization may bring benefits in terms of knowledge management [3.1.5] in respect of new or emerging technologies [n]. Benefits may be seen as firms' open avenues for knowledge absorption in terms of technological gate-keeping. In this way managers may keep abreast with the latest available information and knowledge. Such information and knowledge may enable managers to react quicker to market threats [v] and opportunities [w]. The quicker reaction to market threats and opportunities may provide competitive advantages.

However, the extent of such competitive advantages is determined by technological resource skills [3.1.2] and firm competencies [3.1.3]. The ability of managers in firms to select the right technologies for the right tasks is essential to establish interfaces with tasks and technological resource skills [3.1.2]. The resources in terms of employee skills and other technologies are necessary to improve firm competencies. Firm competencies [3.1.3] may also be enhanced through knowledge management [3.1.5] and technological sourcing [3.1.6].

Firms may not always possess all the technologies that are necessary to sustain competitive advantage, in which case they might opt for technology sourcing [3.1.6] from other firms to obtain such technologies. Technological sourcing [3.1.6] includes strategic alliances/joint ventures [o] and technology partnering [n]. In technological sourcing firms may have opportunistic reasons for joining alliances. For instance, firms may form alliances with other firms purely for the sake of absorbing skills from the alliance partner and once such objectives have been accomplished, they leave the alliance. Firms forming alliances should be wary of such partners and should have monitoring and control systems in place to manage information flow. Monitoring and control mechanisms allow firms to enhance relationships with alliance partners based on trust, which would lead to long-term alliances. Developing firm relationships based on trust may be key in alliances leading to sustained competitive advantages.

Having established the possible associations for the linkages between technology management (technologies, technological resource skills and firm competencies) transaction processes and governance structures (knowledge management, technological sourcing organisational learning and relationship management) the investigative framework may be constructed. According to Figure 3.1,

- Technology management links technologies, technological resource skills and firm competences. Firm competencies [3.1.3] may be further enhanced through technological sourcing [3.1.6] by improving technologies [3.1.1]. Firm competences [3.1.3] may provide opportunities in terms of transaction processes [3.1.4]. Improvements in transaction processes [3.1.4] may provide advantages in the competitive environment [3.1.9].
- Transaction processes [3.1.4] are linked to firm competences [3.1.3] and knowledge management [3.1.5]. Technological sourcing [3.1.6] may affect knowledge management [3.1.5] i.e. information flow [l] and knowledge transfer [m], and new and emerging technologies [n]. Benefits may be obtained in transaction processes [3.1.4] through firm competencies [3.1.3] i.e. transactional cost reduction [i], transactional value added [j] and manufacturing mix criteria [k].

The transactional benefits can be related to the following:

- Transactional frequency, transactional certainty/uncertainty and transaction- specific interests. Transaction-specific interests may be achieved through asset specificity (site, physical and human asset specificity). Asset specificity (site, physical and human) may include technological resources skills [3.1.2], firm competencies [3.1.3], knowledge management [3.1.5] technological sourcing [3.1.6], organisational learning [3.1.7] and relationship management [3.1.8].
- In terms of governance structures, organisational learning [3.1.7] and relationship management [3.1.8] can improve knowledge management [3.1.5] together with better technological sourcing [3.1.6]. Better technological sourcing [3.1.6] may lead to better technology partnering relationships based on trust, goodwill, etc. These improved networks may lead to better relationship management and organisational learning. Relationships based on a partnering approach may be more conducive to creating a climate for organisational learning. Continuous organisational learning may lead to competitive advantages.

Following from the links in Figure 3.1 the investigative framework will be discussed.

3.2 Investigative Framework

Having discussed the linkages between technology management, transaction processes and governance structures, the investigative framework for this thesis can be constructed. The investigative framework includes the links formed through technology management,

transaction processes and governance structures. Examples of some links may be explained as follows:

- In technology management there are possible links between technologies [3.1.1], and firm competences [3.1.3]. Managers in firms make decisions that affect technologies [3.1.1]. These decisions cover the subsections of [3.1.1]. Technological decisions affect firm competencies [3.1.3]. The effects may be felt in terms of core and general competencies [h] and transaction processes [3.1.4]. As newer technologies are implemented, improvements in transaction processes [3.1.4] may result in competitive advantages like market opportunities [w]. These market opportunities create barriers to entry for other firms.
- In terms of the competitive environment [3.1.9] other firms also introduce newer technologies. As a result, other firms may also improve firm competences. Improvements in core and general competencies [h] and transaction processes [3.1.4] therefore continually force the firm into the adoption of newer technologies. Firms also opt for alternative methods of technological sourcing through strategic alliances/joint ventures [o] and technology partnering [p]. In these partnerships firms must absorb knowledge from their partners to create competitive advantages. The objective is to improve the firm's technological resource skills [3.1.2], which will lead it into gaining firm competencies [3.1.3] and eventually sustained competitive advantage. Improvements in technologies may improve firm competencies. In the light of this discussion the following subproblems arise.
 - How does technological change [c] affect manufacturing mix criteria [k]? Technological change [c] may involve competence enhancing [e] and competence destroying technologies [f]. Competence enhancing and competence destroying technologies may affect core and general competencies [h]. In addition, Improvements in manufacturing mix criteria [k] may be felt through improvements in information flow [l]. These improvements may then affect the transaction process.
- In transaction processes [3.1.4] there may be possible links between technological resource skills [3.1.2], firm competencies [3.1.3], knowledge management [3.1.5] and technological sourcing [3.1.6]. Technological sourcing [3.1.6] may improve technologies [3.1.1]. Improvements in technologies [3.1.1] may be accomplished as technological sourcing [3.1.6] affects knowledge management [3.1.5].

Improvements may be felt in information flow [l] and knowledge transfer [m]. As a result improvements in firm competencies may also be achieved. The following subproblems then arise:

- What is the effect of information flow and knowledge transfer on transaction processes?
- What is the effect of organisational learning on transaction processes?
- How long does it take changes in technology to affect transaction processes?

This leads to the first central question, i.e. How do changes in technology affect transaction processes?

- In governance structures there may be possible links between knowledge management [3.1.5], technological sourcing [3.1.6], organisational learning [3.1.7] and relationship management [3.1.8]. Relationship management [3.1.8] involves developing relations based on social networks and embedded ties [q], supplier closeness, communications trust and goodwill [r] with technology partners. These relationships may be conducive to long-term alliance partners that may create barriers to entry for other competitors. However, in such relationships both firms must benefit from the alliance for long term sustainability. The sustainability of alliances may be improved through supplier closeness, communications, trust and goodwill [r]. Having strong relationship management [3.1.8] may affect knowledge management [3.1.5]. However, obtaining information from a partner is only valuable once such knowledge can be absorbed and embedded within the firm to create competitive advantages. Such knowledge is complex and spans the areas of employee training, integration with suppliers, employee involvement, design, manufacturing, and administration. Firms should develop the tools necessary for knowledge management [3.1.5] to improve information flow [l], knowledge transfer [m] and new and emerging technologies [n].

Hence the second central question viz:

- How do changes in technology affect governance structures?

The areas of technological sourcing, knowledge management, organizational learning and relationship management provide further insights into the linkages between changes in technology , transaction processes and governance structures. The effects of these areas on technology management enables an investigative framework to be drawn up.

This section is focused on an investigative framework that incorporates the linkages from Figure 3.1. In Figure 3.3 the effects of organisational determinants [3.2.1], competitors [3.2.2], external factors [3.2.3], manufacturing mix processes [3.2.4], technology management [3.2.5], transaction processes [3.2.6] and governance structures [3.2.7] are discussed. Thereafter the effects of technology management on transaction processes and governance structures provide the foundation for the central questions. Figure 3.3 is linked to Figure 3.1.

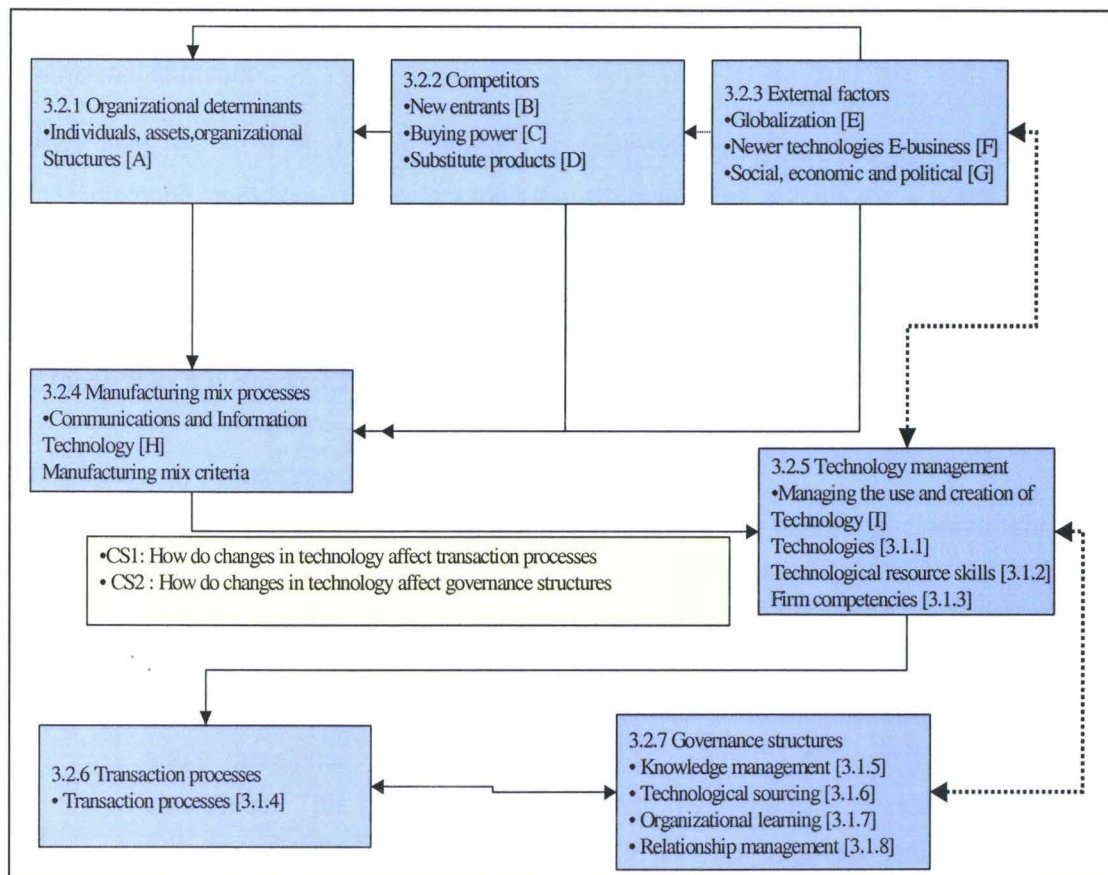


Figure 3.3: The investigative framework

3.2.1 Organisational Determinants

Organisational determinants are rooted in the resource-based view of the firm. In terms of this thesis, organisational determinants [3.2.1] include individuals, assets and organisational structures. Using organisational determinants the firm may be viewed from an organisational and economic viewpoint. Organisational determinants, include many facets (individuals, assets and organisational structures [A]). It is the relationship and networking of these facets that gives rise to all-round improvement, i.e. the whole is greater than the sum of its parts. Hansen and Wernerfelt (1989, p.409) make the following comparisons about the organisational and economic view of the firm:

- Industry selection and positioning within an industry are important contributors to performance.

- Good administrative practices are more important contributors to performance than industry selection and positioning.
- The organisational and economic effects are roughly independent of each other.

In summary they argue that top management teams who demonstrate excellence in both areas, i.e. competitive positioning in the market and building a strong organisational structures, will have better competitive advantages than other firms that opt for a more one-dimensional approach.

Further evidence in support of organizational determinants is provided by Porter's (1991, p.111) diamond paradigm, which incorporates attributes that influences a firm's ability to innovate and upgrade. These attributes are the information available to firms to identify opportunities, the pool of inputs, skills and knowledge, the goals that govern investment, and the pressure on firms to act. Figures 3.1 and 3.3 can be linked using the diamond paradigm and these links are shown in figure 3.4.

These links may be explained as follows:

- Technologies [3.1.1] may be linked to Porter's goals that govern investment, thus explaining the link from Organisational determinants [3.2.1] to technologies [3.1.1].

In terms of organisational determinants, managers are individuals in firms who make decisions. They influence the behaviour of other individuals, namely employees. This view is also supported by Hansen and Wernerfelt (1989, p.401) who say that the organisational theory of the firm suggests that managers can influence the behaviour of employees. Therefore they can affect the performance of the firm. The behaviour patterns of individuals can be changed by the decisions that managers make with regard to technologies. Managers make decisions relating to the firm's technological requirements and these requirements affect firm competencies and technological resource skills.

- Technological resource skills [3.1.2] may be linked to Porter's pool of inputs, skills and knowledge. These pool of inputs can be provided through individuals and therefore organisational determinants [3.2.1] are linked to technological resource skills [3.1.2]. Linking organizational determinants [3.2.1] and technological resources [3.1.2] may create firm competencies [3.1.3] and therefore organisational determinants [3.2.1] is linked to firm competencies [3.1.3] in Figure 3.4.

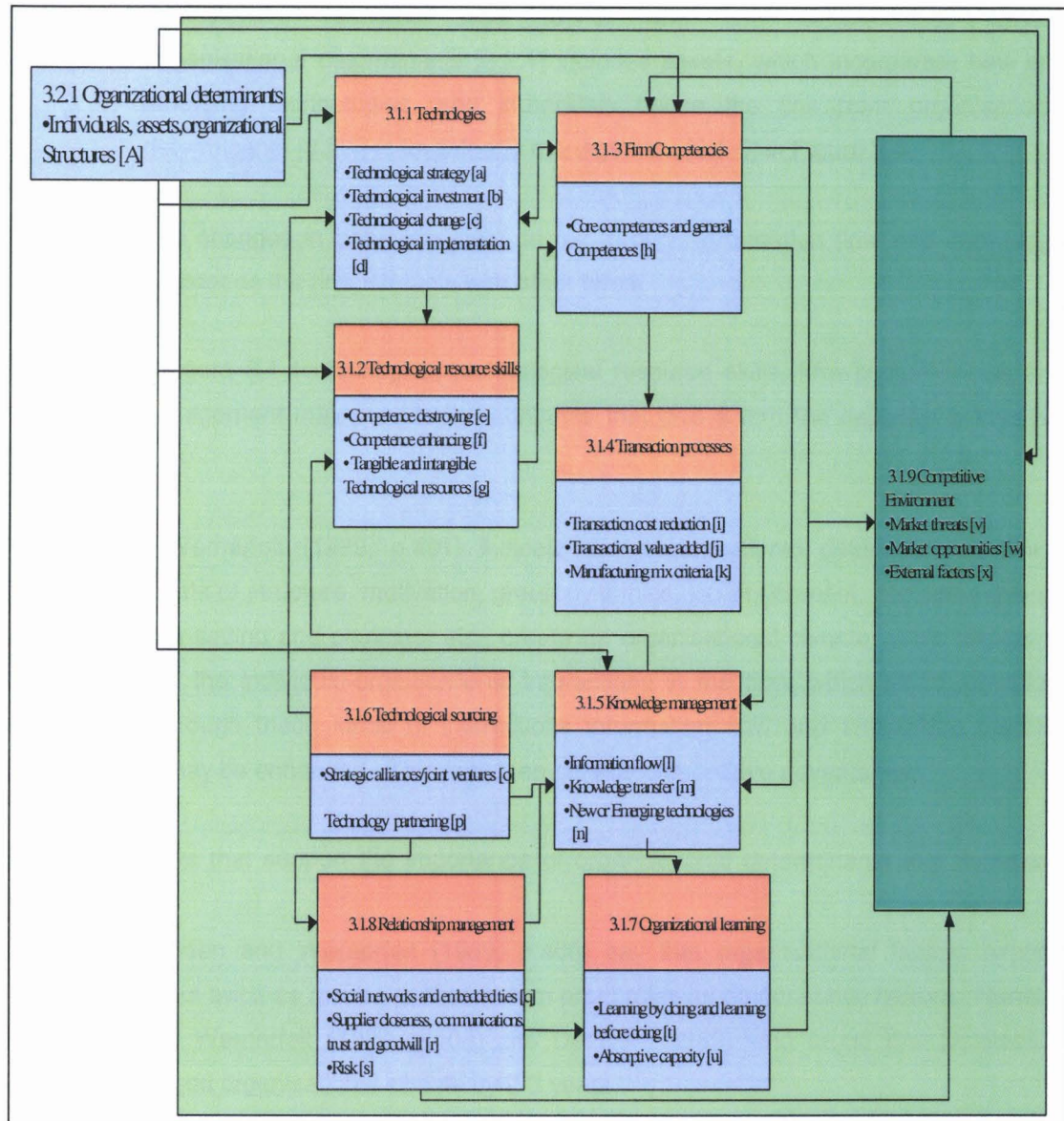


Figure 3.4: Linking Organisational determinants

- Technological resource skills may create competence enhancing or competence destroying technological opportunities. These technological opportunities may require highly skilled individuals to manage the firms technologies. Porter (1991, p.113)) says that mobile factors like ideas and highly skilled individuals are becoming more important for international competitiveness. By influencing the behaviour of individuals managers influence the formal/informal structures, planning, reward, control, information systems, people skills and personalities, which may lead to knowledge management.
- Therefore knowledge management [3.1.5] may be linked to Porter's goals relating to information available to firms to identify opportunities for competitive

advantage. Knowledge can be provided through technologies [3.1.1], technological resource skills [3.1.2] and firm competencies [3.1.3]. Organisational determinants [3.2.1] includes assets, which incorporate new and emerging technologies, and individuals hence the link from organisational determinants [3.2.1] to knowledge management [3.1.5] in Figure 3.4.

- The changes in behaviour may be felt through information flow and knowledge transfer as the firm interacts with other firms.

As shown in Figure 3.1 technologies, technological resource skills, firm competencies and knowledge management may provide the attributes that give a firm the capacity to improve competitiveness.

Hansen and Wernerfelt (1989, p.401) indicate that organisational determinants¹, which include the effects of structure, motivation, group dynamics, job enrichment, decision-making, leadership, goal setting and planning, etc., create an organisational climate. This climate is an indication of the individual-organisational interactions in the firm, which affect individual behaviour. Through these kinds of interactions information flow and knowledge transfer within the firm may be enhanced. This may then provide competitive advantages.

Some arguments that support the importance of organisational determinants are discussed next, viz:

- Hansen and Wernerfelt (1989, p.406) say that organisational factors explain about twice as much variance in firm profit rates as do economic factors. Hansen and Wernerfelt (1989, p.408) cite Dension (1982) who found that profitability lagged organisational climate by 2-3 years.
- Mauri and Michaels (1998, p.212) say that good administrative practices, i.e. processes are more important than industry selection and positioning. Firms' effects dominate over time.
- The asset specificity (human, physical and site) of the firm will create or reduce the barriers to entry from potential competitors. High asset specificity can be said to raise barriers to entry.

In view of these supporting arguments, this research takes organisational determinants to be important. Therefore organisational determinants will be considered in the questionnaire.

¹ The authors use the word organizational phenomena

3.2.2 Competitors

During the 1980s the competitive forces model developed by Porter was the model that was used to analyse the competitive environment [3.1.9]. It emphasised the actions firms could take to protect themselves against competitors [3.2.2]. In terms of this thesis, competitors may be limited to new entrants [B], buying power [C] and substitute products [D]. Later in the 1980s Shapiro (1989) proposed the strategic conflict approach. This approach focused on product market imperfections, entry deterrence and strategic integration. In the strategic conflict approach, firms keep competitors away through strategic investments, pricing strategies, signalling and control of information. The competitive forces model and the strategic conflict model are used to link Figure 3.1 and Figure 3.3. The links are shown in Figure 3.5. These links are explained next.

Competitors [3.2.2] may be linked to the competitive environment [3.1.9], technologies [3.1.1], knowledge management [3.1.5] and organizational learning [3.1.7]. In terms of the strategic conflict model, strategic integration may occur when firms try to improve knowledge management [3.1.5] through technological sourcing [3.1.6] i.e. strategic alliances/joint ventures [o] and technology partnering [p]. Through this kind of partnering, new entrants [B] may be prevented from entering the competitive environment [3.1.9]. By introducing such restrictions market threats [v] may be reduced. Through the mechanisms of technological sourcing [3.1.6], relationship management [3.1.8], knowledge management [3.1.5] and organisational learning [3.1.7] may be improved. Through relationship management [3.1.8] knowledge management [3.1.5] may be facilitated. This may be achieved through information flow [l], knowledge transfer [m] and new or emerging technologies [n], which may be introduced by technology partners. Through knowledge management [3.1.5], barriers to entry may be created, therefore improving the buying power [C] of the firm. The firm may also protect itself by controlling the flow of information out of the firm through technology gate-keeping.

- Relationship management [3.1.8] may be linked to competitors [3.2.2]. Through social networks and embedded ties [q], supplier closeness, communications, trust and goodwill [r] firms form cliques. Through these cliques firms may improve their buying power [C] against other competitors. Cliques may also prevent other firms that are outside the clique network from introducing substitute products. In so doing social networks and embedded ties [q] help in creating barriers to entry. By creating barriers to entry, firms may also control information flow [l], knowledge transfer [m] and new and emerging technologies [n] from getting into the competitive environment. Through the restriction and control of information firms may improve networks formed with other firms and thereby improve market opportunities [w].

It follows from Figure 3.5 that technological sourcing [3.1.6], knowledge management [3.1.5], relationship management [3.1.8] and organisational learning [3.1.7] may help firms with

restricting new entrants [B], improving their buying power [C] and restricting substitute products [D].

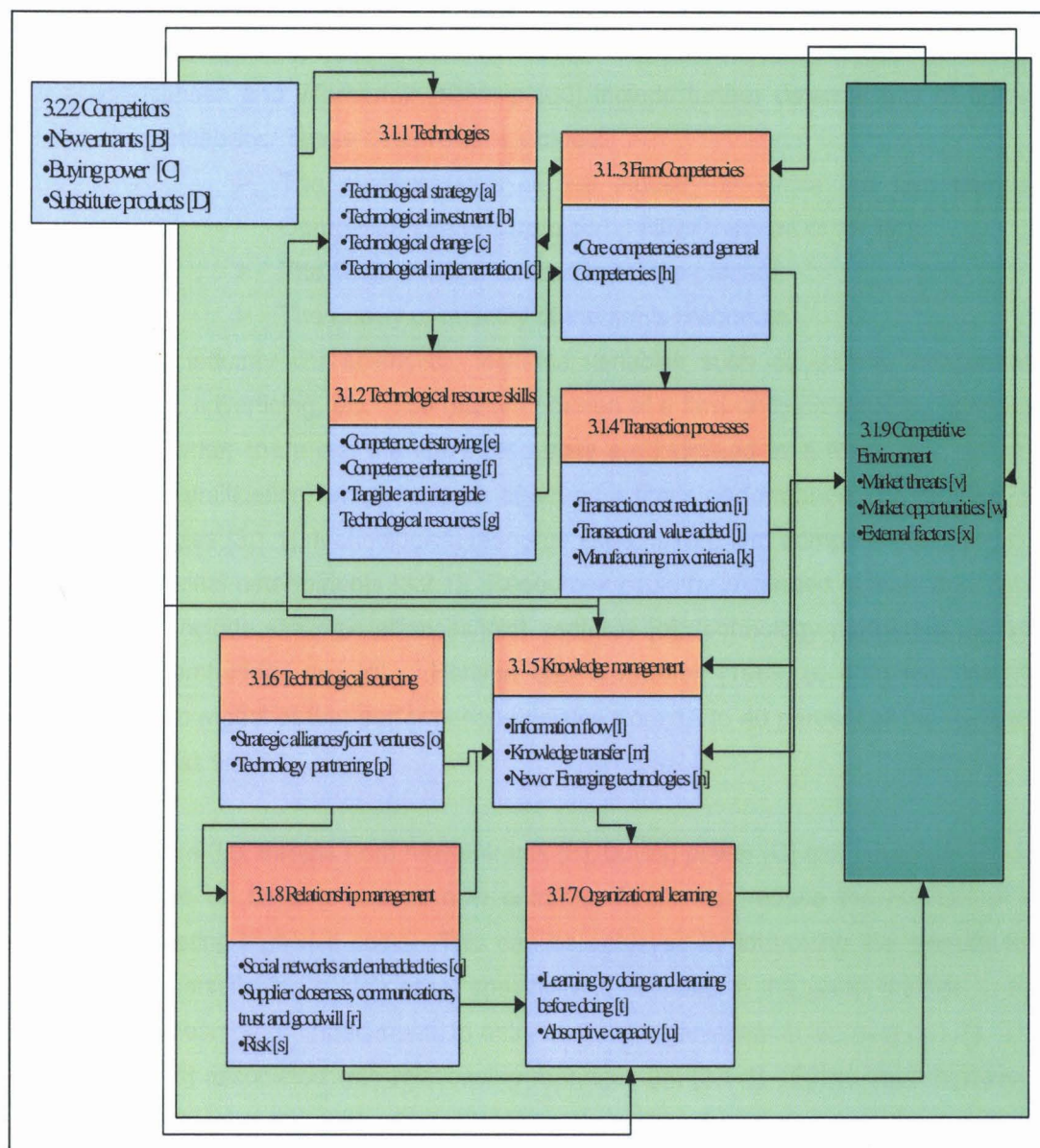


Figure 3.5: Linking competitors

The approach taken here is in conflict with the approach taken by Dyer (1997) in a research study between Japanese and US automakers, in which information sharing was amongst the attributes.

Some arguments that support the importance of competitors are discussed next:

- Teece, Pisano and Sheun (1997) propose the dynamic capabilities approach, which approach looks at internal and external firm-specific competencies to address changing environments. This approach emphasises the development of management capabilities, and combinations of organisational, functional and

technological skills. Several other authors refer to this approach as the extension of the resource-based approach with an extra component of firm-specific capabilities to explain how combinations of competencies and resources can be developed, deployed and protected.

- Hansen and Wernerfelt (1989, p.400) include further determinants of firm-level profitability. These determinants include:
 - The characteristics of the industry in which the firm competes. Competitor analysis from competitive theories of the firm.
 - The firm's position relative to its competitors.
 - The quality or quantity of the firm's resources.

The first item, industry characteristics, includes variables such as growth, concentration, capital intensity, advertising, etc. The relative position of a firm to its competitors is indicated by the firm's market share and the firm's resources are indicated by a firm's size, which are indicators of diversification, which have an effect on a firm's performance. Resources could mean technologies [3.1.1], technological resource skills [3.1.2], firm competencies [3.1.3] and other organisational determinants [3.2.1]. Resources could be extended outside the firm and therefore also include strategic alliances/joint ventures [o], technology partnering [p], social networks and embedded ties [q]. Hansen and Wernerfelt (1989, p. 400) say that: "The typical economic model of firm performance explains from 15 to 40 percent of the variance in profit rates across firms."

As seen in Figure 3.3, threats from new entrants [B], buying power [C] and substitute products [D] put pressure on firms to reduce new entrants. Firms can reduce the number of new entrants by creating high exit costs. This can be achieved by improving the manufacturing mix [3.2.4] by establishing a high asset specificity to succeed in the given market. From Figure 3.5 we glean other impediments to entry such as organisational learning [3.1.7]. There are also risks [s] associated with relationship management [3.1.8]. Firms must however be aware of the risks [s] associated with relationship management.

Hamel (1991) and Hagedoorn (1993) provide evidence of the dangers of technological sourcing [3.1.6]. An instance is partnering where firms use this type of partnering relationship as a cover-up merely to capture the capabilities, knowledge and technologies of their partners. Firms must be aware of this kind of opportunism as this is one of the areas that competitors could use for the creation of structure loosening events and thereby enter the market and create new network structures. In addition, contracts with suppliers and customers can be used to reduce new entrants. This can be done through the mechanisms of high asset specificity and transaction-specific interests, where both partners jointly enter into technological investment and therefore depend on each other for their mutual benefit.

Of major importance recently is the fact that economists are beginning to view firms not as black boxes with inputs and outputs but instead are taking a more operational look at them. This view is supported by Figures 3.1 and 3.3. Figure 3.5 links Figures 3.1 and 3.3 in relation to competitors. Firms consist of complex structures of processes, which link sections of firms, markets and suppliers to produce goods and services from the available resources of capital, labour and material. Nelson (1991, p.65) says that this view looks at technology as a variable in the black box and therefore scholars are looking inside the black box rather than only at the inputs and outputs. Nelson (1991, p.65) also argues that given the same choices and circumstances, all firms will react in the same way. The differences in technology or organisation can only be related to differences in history or initial conditions.

In view of the supporting arguments, the author of this thesis considers competitors to be important. Therefore competitors will form an important part of the research questionnaire.

3.2.3 External factors

There are many external factors that affect firms. In this thesis the focus is on globalisation, e-business and social, economic and political factors. These external factors affect firms in complex ways. Some examples of such effects are:

- Firstly globalisation allows international firms into local markets. This allows industries as well as markets to become global. The advantage of globalisation is that it allows firms to pool resources from across the world. Pooling of resources allows firms to form best practices. These best practices may then be transferred to localised competitive environments [3.1.9]. Transferring of resources may allow competitive advantages.
- Secondly the electronic business world has created virtual markets through which firms may interact. Firms can transact with each other electronically across the globe. Buyer and seller relationships are affected by this technology. There are four models emerging for doing business on the Web, viz. automated purchasing, the anonymous exchange, the content site and the consumer exchange. Each model is focused on the buyer. Each model helps buyers establish a marketplace for goods and services, where buyers and sellers transact at the lowest possible price. This kind of linkage is a structural reinforcing event because both firms are technological tied into the relationship.

Competitor firms will try to break into such a network structure and in doing so they will create structural loosening events. Such structure loosening events will then place the firm at risk as competitor firms will try to enter the market by breaking down the barriers to entry and creating new barriers to entry. The electronic market place has lowered the barriers to entry.

- Thirdly the social, economic and political situation of world economies, as well as the localised market economies, affect the competitive environment [3.1.9]. Trade barriers, restrictions, international sanctions, wars, etc., may force economies into downturns, thus creating competitive advantages or disadvantages for the local economy. These factors will affect imports and exports, which in turn will affect the firm's ability to improve competitive advantages.

From Figure 3.3 it can be seen that the effects of external factors [3.2.3] may be felt in organisational determinants [3.2.1], competitors [3.2.2], manufacturing mix processes [3.2.4] and technology management [3.2.5]. Porter (1998, p.70) says that firms gain and sustain competitive advantage in international competition through improvement, innovation and upgrading. In terms of the framework in Figure 3.3, improvements, innovation and upgrading may lie in organisational determinants [3.2.1], competitors [3.2.2], manufacturing mix processes [3.2.4] and technology management [3.2.5]. The entry of global players in markets continually puts pressure on firms to improve competitive advantages.

Some arguments that support the importance of external factors are discussed next, viz:

- Fagerberg *et al* (1997, p.6) discuss the product life cycle model. The central argument is that new industries usually require high start-up costs, development of specialised processes, the training of labour for new skills, etc. However, once the technology is in place, the pressure is to simplify the technology so that it becomes cheaper to use. Once this is accomplished, the firm may not have to rely on expensive labour or specialised production processes. Firms may then be able to transfer such benefits to other countries to gain competitive advantages over other firms in the same industry. Hence multi-national firms possess competitive advantages over other firms, which do not have access to such additional resources. These firms possess generic technologies and systems which may be transferred. Therefore there are benefits in terms of globalisation.
- Porter (1998, p.103) also says that competitive advantages emerge from close working relationships with world-class suppliers and the industry. Close working relationships with suppliers help firms develop new methods and opportunities to apply new technologies. Firms may then gain quick access to information, new ideas and supplier innovations. These benefits may be further enhanced if suppliers are located in close proximity to firms, thereby shortening the communication lines. Hence related benefits may be achieved through relationship management [3.1.8].
- Hamel (1991) says that global competition is a function of the firm's pace, efficiency and extent of knowledge accumulation. In terms of Figure 3.1, pace and efficiency may be linked to manufacturing mix criteria [k]. Pace and efficiency are then linked with firm competencies [3.1.3]. Knowledge

accumulation may be related to technological sourcing [3.1.6] and knowledge management [3.1.5].

Taking these views into consideration, the links shown in Figure 3.6 between external factors [3.2.3], the competitive environment [3.1.9], technologies [3.1.1], knowledge management [3.1.5] and organizational learning [3.1.7] may be established.

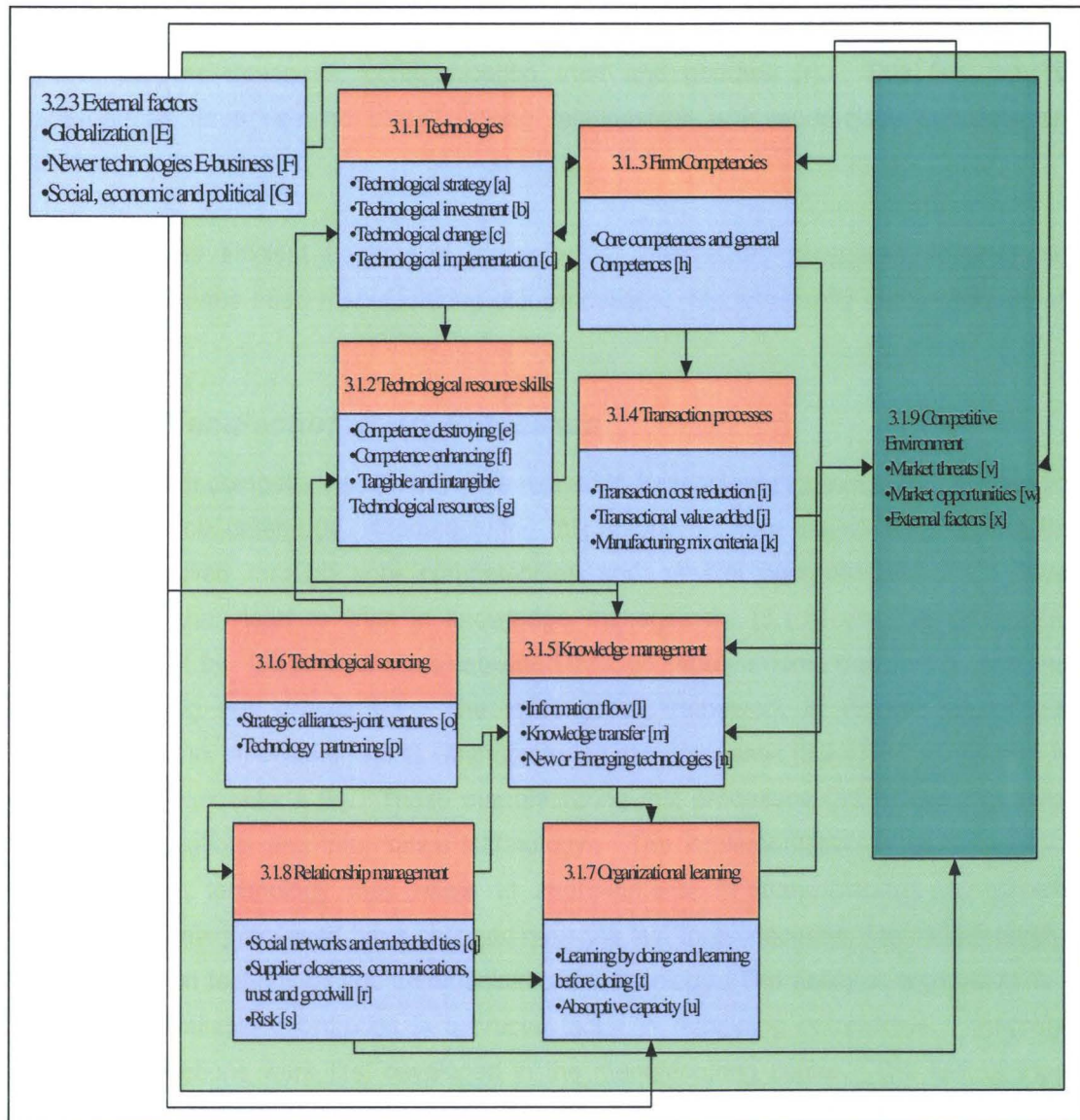


Figure 3.6: Linking external factors

As can be seen in Figure 3.6, Globalisation [E] may be linked to information flow [l] and knowledge transfer [m]. This link may be possible as firms transfer specialised training, production processes, newer technologies, etc., from one country to another.

Competitive advantages lie in newer technologies like e-commerce. This link is shown as newer technologies (E-business) [f] and new and emerging technologies [n]. Such technologies expand the barriers of the firm internationally, putting customers and suppliers in

close proximity to each other and thereby shortening the information value chain. Firms therefore have to keep abreast of the latest technologies that are available to improve customer and supplier contact. The benefits associated with the value chain using these technologies will certainly give competitive advantages relating to the manufacturing mix processes.

Social, economic and political factors [G] may be linked to social networks and embedded ties [q], and supplier closeness, communication trust and goodwill [r]. This link may be established as firms develop close working relationships with world-class suppliers and industries.

To ascertain the efficient transfer of technologies, information, processes, routines and methodologies, firms need manufacturing mix processes. Manufacturing mix processes are discussed next.

3.2.4 Manufacturing Mix Processes

In Figure 3.1 firm competencies [3.1.3] were related to transaction processes [3.1.4] including manufacturing mix criteria [k]. Manufacturing mix criteria [k] were identified as criteria that could be improved through core competencies and general competencies [h]. These improvements then lead to links in knowledge management [3.1.5] and the competitive environment [3.1.9]. These links are established through improvements that may be achieved in manufacturing mix criteria [k]. The investigative framework in Figure 3.3 includes manufacturing mix processes [3.2.4]. Manufacturing mix processes [3.2.4] are the drivers for manufacturing mix criteria [k]. These manufacturing mix processes [3.2.4] are dependent upon communications and information technology. The implementation of communication and information technology may relate to improvements in manufacturing mix criteria. Manufacturing mix processes have changed over the last three decades, the critical catalyst being information technology and communications technology. The ability of organisations to have readily available information is a crucial factor in remaining competitive. Integrated business applications were first developed in the manufacturing sector. The first of these applications was MRP, a materials availability tool. MRP evolved into MRP II to include the entire production processes. Upton (1995) provides evidence in terms of manufacturing flexibility as a result of CIM. During the late 80s CIM came to the fore as the first case of improvements in communications and information technology.

In Figure 3.3 organisational determinants [3.2.1] such as individuals, assets and organisational structures affect the manner in which the manufacturing mix processes [3.2.4] are implemented. Managers influence employee behaviour through competence enhancing and competence destroying technologies. These behavioural changes affect the firm competences in terms of core and general competences. As a result of these changes,

benefits in manufacturing mix criteria may be felt. Managers influence manufacturing mix criteria [3.2.4] through the use of newer technologies like information and processing within the firm and between suppliers and customers. For example, electronic commerce will facilitate communications between suppliers and customers. This may improve the reliability of information, which would in turn influence cost, quality, speed, dependability and flexibility. Benefits may be felt in the transaction process [3.2.6] i.e. transactional cost reduction [i] or transactional value added [j].

In Figure 3.1, manufacturing mix criteria is a subset of transaction processes [3.1.4]. The variables of manufacturing mix criteria are cost, quality, speed, dependability and flexibility. Manufacturing mix criteria [k] give rise to core competences and general competences [h]. At least firm competences [3.1.3] are linked to knowledge management [3.1.5] and organisational learning [3.1.7], which may provide benefits in the competitive environment [3.1.9]. Manufacturing mix criteria, however, require certain manufacturing mix processes. These manufacturing mix processes [3.2.4] are shown in Figure 3.3. Manufacturing mix processes [3.2.4] may consist of communications and information technology [H]. Communications and information flow [H] may influence responses to the competitive environment.

This may be enhanced by the introduction of rapidly changing technologies, for example using information technology to offer new services. These new services may assist managers in responding more rapidly to market threats [v], market opportunities [w] and external factors [x], thereby creating competitive advantages. Therefore management must ensure that they have market penetration before the competitors. Manufacturing must be quick and responsive in assuring timely deliveries, responsive service and adequate capacity. In addition, there is the challenge of managing highly skilled technologists to create new technologies. These new technologies create world class standards for manufacturing mix and firms become more competitive because of their ability to improve on cost, quality, speed, dependability and flexibility, i.e. manufacturing mix criteria. Firms therefore have to manage the most cost-effective and efficient use of technology to stay competitive.

Technology management [3.2.5] in turn affects transaction processes [3.2.6] because the cost of the transaction process is reduced by the introduction of new technologies and the cost-effective and efficient use of older technologies. Transactional value has also improved with regard to transactional reliability, efficiency, accuracy, etc. The information age has reduced transaction costs over wide geographical locations and has also improved communications and information flow.

Technological implementation can create competence enhancing or competence destroying events in firms. Managers in firms must be aware of the effects of such events in their adoption and use of technologies. However, technologies [3.1.1] are linked to firm

competencies [3.1.3], which may lead to improvements in transaction processes [3.1.4]. Transaction processes [3.1.4] consists of subsets of which manufacturing mix criteria [k] is one. Manufacturing mix criteria [k] require manufacturing mix processes [3.2.4], which in turn require technology management [3.2.5], more specifically managing the use and creation of technology [l]. Some arguments that support the importance of manufacturing mix processes are next discussed, viz:

- Bower and Christensen (1995, p.43) support the stance that before managers decide to launch a technology, develop a product, build a plant, or establish new channels of distribution, they should first look at their customers. They should establish whether or not the customers require this new technology. How big will the market be? Will the investment be profitable? etc. The stance taken by Bower and Christensen (1995) suggest that technologies should fit market requirements. If this is achieved, benefits may be realised.
- Skinner (1969) originally pointed out that management must be aware of the danger of looking for economies of scale when the market demands a different strategy. In essence, will the improvements in the manufacturing mix criteria be beneficial. Skinner (1969, p.144) proposes a list (Table 3.7) of constraints or limitations. This list includes criteria for economies of the industry and technology of the industry.
- Skinner (1969, p.139) points out that most managers look at a firm with reasonably modern equipment, up-to-date methods and procedures, co-operative workforce, computerised information systems and an enlightened management. He points out that managers envisage that such a firm performs efficiently. However, the author makes us aware of the misunderstandings associated with a good firm. He points out that there are differences in interpreting efficient performance and the capabilities and expectancies of computer systems. Skinner (1969, p.140) realises that the purpose of manufacturing is to serve the firm, i.e. to meet its needs for survival, profit and growth.
- Abernathy and Clark (1984, p.20) suggest that every opportunity should be taken to improve quality, improve product features, break bottlenecks in production and make process improvements that reduce scrap and increase yields. This may mean that changes in process technology may require new manufacturing mix processes and new technologies.
- Meredith (1987, p.249.) provides evidence concerning the factory of the future, high technology and computerised automation. He says that firms have invested billions in CAM, flexible manufacturing systems, robot intense factories and other

such advanced manufacturing technologies. The author goes on to say that these technologies provide small and large firms with benefits in terms of flexibility, quality, lead-time reductions and other benefits like manufacturing mix criteria. However, the important point to remember is the order in which a company's manufacturing capabilities should be developed.

Table 3.7: Constraints or Limitations adapted from Skinner (1969, p.144)

Economies of the Industry	Technology of the Industry
Labour, material and depreciation costs	Rate of technological change
Flexibility of production	Scale of processes
Return on investment, prices, margins	Span of processes
Number and location of firms	Degree of Mechanisation
Critical control variables	Technological sophistication
Critical sections of firms (maintenance, production control, etc.)	Time requirements for making changes
Financial structures	
Costs and cost relationships	
Operating problems	
Barriers to entry	
Pricing policies	
Maturity of industry	
Importance of economies of scale	
Balance of different types of equipment and equipment capacities	
Nature and type of production control	
Government influences	

- Boyer, Ward and Leong (1996) also confirm the benefits associated with manufacturing mix criteria. As early as 1969 Skinner realised that the purpose of improvements in manufacturing mix criteria is to serve the firm, i.e. to meet its needs for survival, profit and growth.

Following from the discussion above it may be noted that manufacturing mix processes and technology management are important contributors to competitive advantages. However, the priorities associated with manufacturing mix criteria are equally important and firms should focus on these priorities.

Having discussed the link between manufacturing mix processes and manufacturing mix criteria, how technology management and its implementation link with the framework proposed are discussed next.

3.2.5 Technology Management and its implementation

In Figure 3.1 it is shown that technology management includes technologies [3.1.1], technology resource skills [3.1.2] and firm competencies [3.1.3]. It is also shown that the links in technology management lead to improvements in manufacturing mix criteria [k] that may create improvements in the competitive environment. Figure 3.3 then shows the link between

manufacturing mix processes [3.2.4] and technology management [3.2.5]. Figure 3.3 shows how technology management [3.2.5] focuses on managing the use and creation of technology. Manufacturing mix processes [3.2.4] and technology management [3.2.5] are linked. Communications and information technology are implemented to create manufacturing mix processes [3.2.4]. Technology management [3.2.5] focuses on technologies that are required for manufacturing mix processes [3.2.4]. Through better processes, better manufacturing mix criteria are achieved. Manufacturing mix processes [3.2.4] and technology management [3.2.5] work together as a push and pull system. This push and pull system may lead to competitive advantages.

Technology management [3.2.5] is linked to transaction processes [3.2.6] and governance structures [3.2.7]. It follows from Figure 3.1 that technology management is linked to technological sourcing [3.1.6]. As a result of technological sourcing links to relationship management [3.1.8] may be achieved. Through technological sourcing [3.1.6] and relationship management [3.1.8] technology management [3.2.5] is linked to governance structures [3.2.7]. The link is made up through relationships that are created by strategic alliances, joint ventures and technology partnering. Through these relationships social networks and embedded ties may also be created. Lorenzoni and Lipparini (1999, p.329) say that key industry events such as technology advancement, entry of prominent competitors, and a radical shift in consumer preferences are some of the reasons that shape network restructuring. These links will be discussed in more detail in section 3.2.6.

Following on from manufacturing mix processes, some evidence in support of the management and use of technology is discussed next, viz.:

- Boyer, Ward and Leong (1996, p.298) say that the primary benefits achieved from the adoption of AMTs is the capability to combine traditional economies of scale with economies of scope to achieve both flexibility and efficiency. They say that specific benefits from the adoption of AMTs include extreme flexibility, rapid response to changes in demand and product design, greater control and repeatability of processes, reduced waste, faster throughput and distributed processing capability.
- Goldhar and Jelinek (1983,p.142) separate economies of scale as the association with greater production volumes lowers unit costs and greater volumes allow for the use of more expensive special purpose equipment. Economies of scope, on the other hand, can be achieved through efficiencies brought about by variety rather than volume. In other words, leading edge computer knowledge provide the abilities to achieve small production runs.
- Rumelt, Schendel and Teece (1991, p.23) argue that heavy and technologically complex industries are characterised by abundant technical economies of scale and scope. However, the ability of firms to benefit from these economies is limited

by their ability to guide complementary investments and the administrative skill required for the co-ordination of such economies.

These views show that technology management is required to achieve better manufacturing mix processes that will lead to improvements in manufacturing mix criteria and hence lead to competitive benefits.

The emergence of new technologies affects the way people work. New technologies are either competence enhancing or competence destroying. Technology management integrates computers, work and relationships between all stakeholders. As technology grows it increasingly has the capacity to change how the firm should function. Achievements brought about by the use of technology will allow firms to create competitive advantages. There will a strong shift from stand-alone functions to dependent processes. Implementation and use of technology will occur across the value chain, rather than in individual sections of the firm. This will cause a change in the traditional hierarchical organisational structure towards one that gives employees responsibility for customer satisfaction, authority to make decisions about work and information for decision making. This would result in looser or tighter controls, interactions with the environment, information sharing between sections of firms, highly cohesive work groups, less rigid boundaries with competitors, suppliers and customers. This situation creates an environment that incorporates computing (hardware, software, services), communications (telephonic, cable, satellite, wireless) and content (entertainment, publishing, information providers). This convergence of people and technology will affect the way business is conducted and structured. Therefore we formulate two central questions, viz.:

- How do changes in technology affect transaction processes?

And

- How do changes in technology affect governance structures?

To consider these central questions, the influences on technology management need to be explored.

Influences on Technology Management

Recent work by various authors on the resource-based theory of the firm has focused attention on the capabilities and competencies of firms. This is of significance because, from a strategic perspective, industry structure is viewed as a determinant of competitive advantage. Henderson and Cockburn (1994, p.64) cite at least three authors, Barney (1986), Wernerfelt (1984) and Perteraf (1993), who argue that if organisational competence is to be a source of competitive advantage, it should meet the following three conditions:

- It must be heterogeneously distributed within an industry.
- It must be impossible to buy or sell competence lower than its true marginal value in the available factor markets.

- It must be difficult or costly to replicate.

In a research study on pharmaceutical research, Henderson and Cockburn (1994, p.65) differentiate between two types of capabilities, namely component competence and architectural competence. They define component competence as fundamental day-to-day problem solving and architectural competence as the ability to use component competencies and integrate them effectively and to develop new component competencies when required. Other authors use different terms such as 'resource', 'knowledge' and 'skills', etc. for component competence, capabilities and dynamic capabilities for architectural competence. The skills that are mastered in day-to-day activities by employees in processes become strategically important capabilities or competencies.

Henderson and Cockburn (1994, p.66) refer to prior research in the pharmaceutical industry which showed that if architectural competence is to have a competitive advantage, the firm should have the ability to access information from outside the boundaries of the organisation and have the means to integrate this knowledge throughout the organisation. The authors say that the research implies that firms that nurture the development of gatekeepers are likely to outperform those firm's that do not. This also supports Von Hippel's research (1988). In conclusion Henderson and Cockburn (1994, p.80) state that the results of the research extend beyond the boundaries of the pharmaceutical industry and support the view that integration of knowledge both across the boundaries of the firm and across disciplines and product areas within the firm is an important strategic advantage. This research draws our attention to the manufacturing mix processes in firms.

Manufacturing mix criteria of cost, quality, speed, dependability and flexibility may be used to make valid comparisons. Manufacturing mix criteria are described as criteria passing between sections in firms that affect, directly and indirectly, the final product/service offered to the market. The criteria should be:

- Consistent with economic profit,
- clear in meaning,
- limited in number
- independent of each other.

Using the criteria of the manufacturing mix, the chief decision maker can evaluate sections of the firm to make decisions on relational contracting or technological investment within the firm to reduce internal transaction costs.

Boyer, Ward and Leong (1996, p.313) indicate that there is a great deal of literature supporting benefits such as increased flexibility, greater control of processes and faster throughput, but the end goal is to improve performance at plant level. Technological trends concerning products the firm manufactures or sells and technological investments within the firm have an impact on the transaction costs. Such investments will allow the firm to expand.

By escaping transaction costs, the firm may increase profits but at the same time also reduce the risk of employing opportunistic people. Fewer people need to be employed because of technology, which allows work to be performed more accurately, at a faster rate and more reliably, with computers replacing the tasks once performed by people. Technological changes affect transaction processes and influence governance structures. Before discussing the links to transaction processes and governance structures, factors affecting technological investment will be discussed.

Factors affecting technological investment

Rosenthal (1984, p.204) proposes the concepts of 'technology push' and 'technology pull'. He regards technology push as the adoption and use of technology as a result of technological availability and its falling price, (i.e. demand-push relationship). On the other hand, technology pull (i.e. demand-pull relationship) is poorly understood. The reasons why firms adopt and implement technologies are poorly understood and constitute a complex process.

Boyer, Ward and Leong (1996, p.310) suggest that excellent performance requires more than solitary investment in AMTs. In a research study on AMTs, the authors examine two outcomes from investments in technology, namely integration and business performance. They say that that technology by itself is not linked with improved performance. To understand the other inputs to technology it is necessary to explore the definitions by which the authors categorise firms. The authors classify firms (they use companies) as design-based, manufacturing-based and administrative-based, which they further divide into categories or clusters, viz.:

- Traditionalists, who do not have high investments in design, manufacturing or administrative and rely on more conventional business methods that do not use computers.
- Designers, who invest highly in design-related AMTs.
- Generalists, with a high degree of investment in manufacturing and Administrative.
- High investors, who rank first in design, manufacturing and administration.

Boyer Ward and Leong (1996, p.310) conclude that the more technology-intensive firms have more employees and a higher degree of integration but there are no significant differences in terms of performance. Meredith (1987, p.252) differentiates between large firms and small firms. Meredith (1987) supports this view by Boyer Ward and Leong arguing that AMT technologies offer much the same benefits to all firms, whether large or small. However some of these technologies offer more value to large firms (e.g. the ability to customise) and other technologies offer more value to small firms. Meredith (1987, p.249) says that the large firms seem to have more difficulty in capitalising on the new benefits than the small firms do. These new benefits include flexibility, quality and lead-time reductions amongst others.

Meredith (1987, p.253) argues that small firms often compete through new products. They introduce highly profitable products and therefore are able to capitalise on the high margins that are achievable. When the product reaches maturity phase, follower firms enter the market aggressively thereby reducing the margin for smaller firms. Small firms, however, are then constrained by the start-up costs and so cannot compete effectively. This competition between large firms and smaller firms for market share sometimes drives the start-up firm out of the market. The author says that technology offers the small firm benefits of innovating faster, and producing faster and more cheaply. This leaves less time for the follower firm to compete. However, Meredith (1987, p.255) points out that large firms have the additional advantage of being able to afford the often-expensive computerised technologies and the cost of failure should the investment fail. Furthermore they are more likely to have the skill and manpower it takes to understand, implement and manage these technologies. Having discussed the links between manufacturing mix processes and technology management implementations, the links with transaction processes and governance structures are discussed next.

3.2.6 Transaction Processes and Governance Structures

Having defined the components of transaction processes in Figure 3.1, [3.1.4]. It follows from the discussion in section 3.1 that firms are focused on knowledge management issues, i.e. information flow [l], knowledge transfer [m] and the use of new and emerging technologies [n] to achieve their objectives. This view of knowledge management [3.1.5] is used to improve organisational learning [3.1.7]. Through organisational learning firms may achieve competitive advantages in the competitive environment [3.1.9]. This view of transaction processes expands the traditional black box view of the firm to include other firms, which are linked through strategic alliances/joint ventures [o] and technological partnering [p], i.e. the subsets of technological sourcing [3.1.6]. Through technological sourcing, networks are formed with other firms leading up to relationship management [3.1.8]. Figure 3.1 provides some evidence supporting the expansion boundaries of the firm that are discussed next, viz.:

- Core competencies and general competencies [h] may be improved through external resources from technological partners.
- Tangible and intangible technological resource skills [g] expand the barriers of the firm to include technological partners.
- Strategic alliances/joint ventures [o] and technological partnering [p] involves transactions between firms. These transactions may develop social networks and embedded ties [q] with other firms. These networks may lead to supplier closeness, communications, trust and goodwill [r] and risks [s].

The focus is on governance structures which include supplier networks and embedded ties [q] that facilitate a partnership approach, through supplier closeness, communications, trust and goodwill [r], which may minimise risks [s].

Governance structures focus on mechanisms that may facilitate relationship management [3.1.8] and organisational learning [3.1.7]. From Figure 3.3 it is shown that technology management [3.2.5] leads to transaction processes [3.2.6] and governance structures [3.2.7]. An example of such a link is proposed by the WBS model and the IEM model in which technology is utilised to integrate communications within and between firms. Electronic communication is used to improve information flow using new and emerging technologies. New and emerging technologies are then used to link suppliers and customers. Through this linkage, improvements in critical success factors for transaction processes may be achieved.

A typical process may be described as follows. Traditionally a firm will place orders with a supplier by means of a purchase order after inquiries have been made regarding price, deliveries or other customer requirements. Order change requests were and still are a means by which customers can make modifications to orders with suppliers. There are interactions between suppliers and customers regarding the status of deliveries, ad-hoc emergency deliveries, etc. The supplier responds by means of executing planned or unplanned deliveries or by means of formal replies and responses in cases where certain customer requirements could or could not be met. The typical process would be that the customer will prepare a purchase order on the customer's purchasing system. This purchase order will then be communicated via fax to the supplier and/or also telephonically communicated to confirm receipt and accelerate the processing, etc. The customer would then recapture this purchase order to his order management system, which would then allow for processing within the supplier's organisation.

This black box concept of the customer and supplier system's results in duplication of tasks, which is also prone to error. The recapturing of orders by human operators is a potential area where errors could occur as data capture staff incorrectly capture a part number, resulting in a different item being manufactured. Moreover the duplicate processing of orders by suppliers and customers adds further time to the processing of the customer order, thus resulting in longer product lead-times. These problems are further compounded by changing delivery dates or quantities, arranging transportation, managing a large flow of paper work resulting in large filing systems keeping purchasing and data capture staff busy.

The effective management of the order conveyance system can lead to a streamlined process between supplier and customer. The WBS model proposed by Love and Barton (1996), and IEM supports this view. The implementation of technologies such as EDI enables an efficient and effective means of order conveyance to be established. The concept of EDI is a partnership approach between customer and supplier, which tries to eliminate or simplify paperwork. In addition to EDI, bar-coding systems allow for unique part identification for tracking of deliveries and quantities. The implementation and use of such technologies

between customers and suppliers require a relationship of openness. Evidence in support of these types of relationships is given by the following authors:

- Schonberger and Knod (1994) says that this type of partnering approach requires the customer to have the facility to visit the supplier's facility. This will make the customer aware of the supplier's culture, skills, processes, problems and sources of misunderstanding, which in turn would lead to a process of learning and mutual benefit to supplier and customer.
- Upton (1995) also suggests contrary to CIM implementation an example from the pulp and paper industry in which mill managers opted for the purchase of system building blocks from different vendors, which the mill thereafter designed the interfaces between the different vendors. The reason for this was that they wanted to develop the competence within the firm rather than rely on the suppliers.
- Lorenzoni and Lipparini (1999) provide evidence based on the experience from the pharmaceutical or food and processing firms, which now opt for a single supplier for constituent parts of a packaging line rather than different suppliers. These firms opt to deal with a single source and this type of strategy gives justification for models such as the WBS and IEM. In addition the authors say that buyer experience lowers the costs of governing market contracting, and leads to the decision to access external knowledge and complementary assets.
- Lorenzoni and Lipparini (1999) also suggest that the firms in the packaging industry realised benefits in co-makership and they also involved their suppliers as part of the design team. This is a good example of information flow and knowledge transfer. The authors propose that by adhering to a learning-by-co-operating logic, firms create the conditions for the exchange of goods and knowledge on a day-to-day basis, which facilitate and develop supplier's capabilities.

If the customer understands the purchasing policies and practices, the supplier can effectively streamline its processes to accommodate the customer. This could include blanket orders for frequently placed items, interfacing into MRP systems where the supplier determines the frequency and quantity of customer orders based on customer demands and forecasts, and barriers to backward integration, which enables the supplier to stay in business.

Figure 3.7 summarises the links between technology management, transaction processes, governance structures (Figure 3.1) and the investigative framework (Figure 3.3).

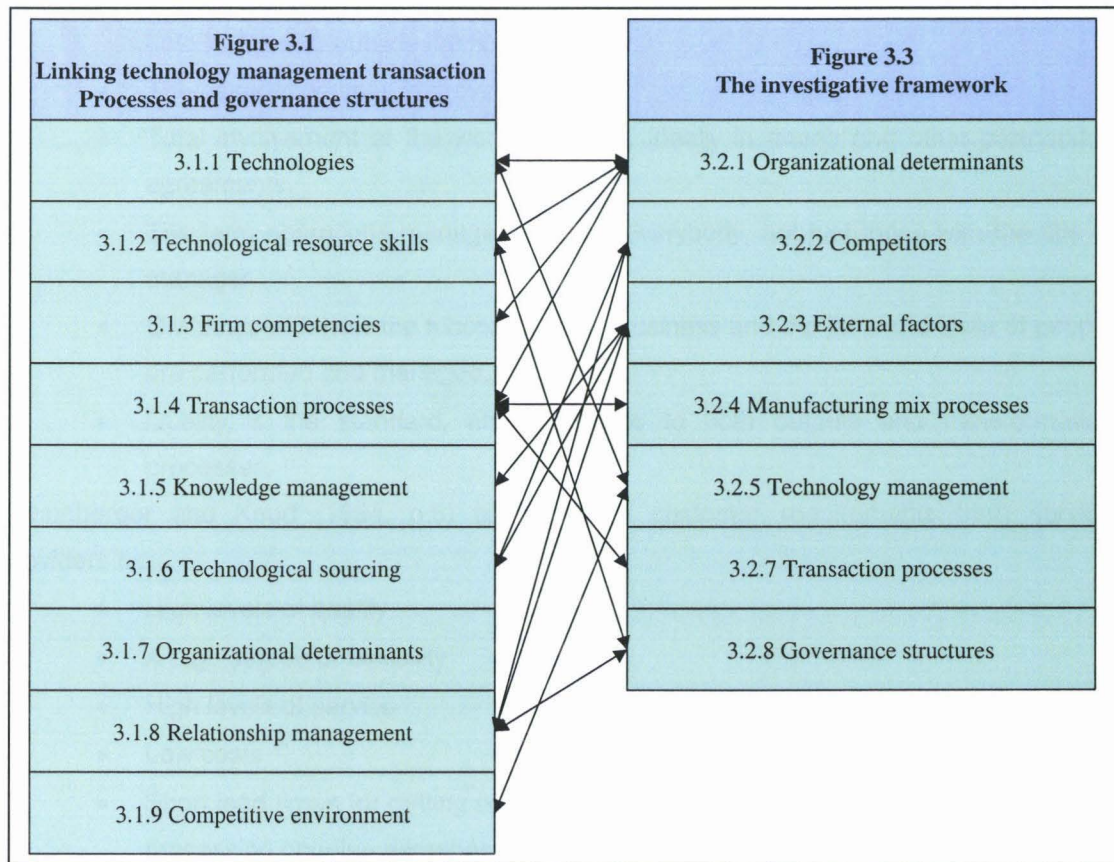


Figure 3.7: Linking technology management, transaction processes, governance structures and the investigative framework.

Having described the links between the technology management framework Figure (3.1) and the investigative framework Figure (3.3), the transformation process is discussed.

3.3 The Transformation Process

This section is focused on understanding the transformation process in firms. It forms the framework for the concepts that will be used for the research objectives, mainly a better understanding of the RBV and TCE views of the firm. Hayes, Pisano and Upton (1996, p.3) assert that most firms providing products or services have the bulk of their human and financial resources invested in operations. OM is the process whereby technological use, transaction cost economics, governance structures and organisational learning come together in a transformation process so that the firm can produce the goods and services that are required for competitive advantage.

Schonberger and Knod (1994, p.3) maintain that all organisations have operations. However, the focus is on the transformation of resources into goods and services. In operations, inputs, i.e. knowledge and skills of people, capital, natural resources, materials and technology are transformed into outputs, i.e. goods and services. The author lists the following drivers of operations management:

- Continually improving service to customers, where 'customers' means customers both inside and outside the firm.
- The path of continual improvement.
- Total involvement of the work force, i.e. ideally in teams and other partnership agreements.
- The term operations manager includes everybody, not just those with the title of manager.
- OM deals with how the functions of the business and the jobs and skills of people are performed and managed.
- Quality is the standard, and it applies to both outputs and transformation processes.

Schonberger and Knod (1994, p.6) elaborate on customer requirements from service providers as:

- High levels of quality
- A high degree of flexibility
- High levels of service
- Low costs
- Short lead times for getting new and better improvements to market in addition to processing ongoing demands.
- Little or no variability (deviation from target).

Other evidence in support of these views is discussed next.

- Skinner (1969, p.139) provides the following definition of strategy: "Strategy is a set of plans and policies by which a company aims to gain advantages over its competitors". Skinner (1969, p.140) adds that operations² is part of the strategic concept that relates a firm's strength and resources to opportunities in the market and that OM's task is to create a unique operations task for each strategy.
- Schonberger and Knod (1994, p.8) state that OM strategies should be consistent with the business plan but with a narrower focus on capacity (operating resources), products, processes, methods, systems and outputs such as quality, cost, lead time, flexibility, variation and service. In terms of this thesis, these criteria may be likened to manufacturing mix criteria.
- Hayes, Pisano and Upton (1996, p.8) say that once competitive differentiation has been set, then the operations organisation is configured and managed in such a way that it can provide the form of differentiation most effectively.

Recognizing these views on the transformation process it may be noted that RBV and TCE views of the firm and organisational learning all offer different advantages and disadvantages to the field of operations management.

² Skinner uses the words 'manufacturing' instead of 'operations' and 'manufacturing manager' instead of 'operations manager'.

Transaction cost economics has been used to explain why organisations exist, i.e. why transactions are carried out within organisations rather than only in markets initially it was used to explain the existence and location of firm boundaries. The make or buy decision was reinforced by means of economic analysis of transaction costs. Recently, however, TCEs has been expanded to other areas including distribution strategies, international organisation, strategic analysis, etc. Other authors like Ghoshal and Moran (1996, p.15) tackle this area of research. The fundamental basis of TCE is that organisations exist to control opportunism. This theory is in conflict with other operations management areas such as quality management, where the co-operation and behaviour of people is required to improve. Secondly transaction cost economics rests on the assumption that efficiency is the dominant criterion for organisation economics. Amundson (1998, p.349) suggests the following comparison of techniques from a TCEs perspective and indicates how the techniques may be viewed from an operations management perspective (Table 3.8).

Table 3.8: Comparison of techniques from Transaction Cost Economics and Operations Management adapted from Amundson (1998, p.349)

Transaction Cost Economics Concepts	Operations Management Concepts
Asset Specificity	Dedicated Equipment Focused factory
Opportunism	Operations management does not have a direct match for this concept. However operations management addresses concepts such as supplier partnerships or reducing the number of suppliers and raising the volume per supplier
Integration	Supplier partnerships Kanban, just-in-time manufacturing Design for manufacture Cross-functional teams
Efficiency	Cost Quality Dependability of delivery Flexibility (Transaction cost economics would argue that all these concepts could be explained by efficiency in the long term. However, operations management would argue that these concepts should be achieved in the short term to ensure long-term efficiency).

TCE focuses on how to integrate various tasks to lower transaction costs. The RBV, on the other hand, focuses on efficient utilisation resources as a means of competitive advantage. Lorenzoni and Lipparini (1999, p.319) say that RBV sees the firm improving its competitive advantage by the possession of unique, inimitable resources and capabilities and the ability to process resource accumulation and deployment. Lorenzoni and Lipparini (1999, p.319) identify the common weakness of the TCE and RBV, i.e. it focuses on a single firm and on single transactions thereby limiting insight into the process by which multiple firms, working collaboratively, develop individual and common capabilities.

The RBV of the firm arose from the field of strategic management and provides an explanation of firms' performance that competes with other explanations such as transaction cost economics. According to the RBV, the firm consists of resources and these resources have the potential to provide and sustain competitive advantage. Amundson (1998, p349.) says that the resource-based view is attractive to operations management researchers because it focuses on capabilities that reside within the firm and are also consistent with the general definition of operations management. Amundson (1998, p.350) maintains that the relationship between strategic management, RBV and operations management is that the latter can provide a more detailed understanding of how competitive advantage is provided through the resources generated by operations, for example the potential that lies in the manufacturing mix criteria.

The integration of organisational learning into operations management exists in several areas such as knowledge-based competencies, quality management, which includes learning, and benchmarking, amongst others, and etc. The field of operations management has not directly focused on organisational learning but these concepts lie within the areas of manufacturing mix, quality management, teamwork, and etc. Recent studies in operations management on aspects such as manufacturing-engineering interface, the use of cross-functional teams, just-in-time, quality management, new product development, computer-integrated manufacture, supply chain management and etc., involve a substantial integration of organisational learning concepts into operations management. Several researchers agree that the theme of information integration provides new insight into operations management. The role of information technology in supporting the exchange of information between organisational sections of firms provides avenues for research. Philosophies and practices such as quality management, process engineering, concurrent engineering teamwork and the emphasis on customer focus encourage the integration of organisational learning and operations management.

Amundson (1998, p.354) poses the following questions as a means of gauging whether or not integration into operations management is taking place.

- Are the location of firm boundaries important to operations management?
- Is the recent emphasis on supply chain management an indication that locations of firm boundaries are more or less important than the past?
- Are the make-or-buy decisions important for operations management researchers?
- How frequently are make-or-buy decisions made?
- Are the majority of supply chain decisions of a make-or-buy nature or are they concerned with issues such as selecting the best supplier, the nature, of the relationship between a firm and its supplier (adversary or partner?) or problem solving over the term of the supplier relationship?

- How does the nature of the customer/supplier relationship affect transaction costs, and how do changes in the level of transaction costs ultimately affect governance structures across firms?

These questions posed by Amundson (1998) suggest that operations management is closely linked to the RBV and TCE views of the firm. Operations management draws significantly on the research and theories developed in other disciplines, which is mainly due to the fact that the research base in operations management is small. However, the operations perspective is very relevant and attractive to practising managers because of the applied nature of operations management. Moreover operations management provides an interdisciplinary link between business and engineering. Amundson (1998, p.357) says that it is important for researchers in operations management to encourage integration with various outside disciplines including but not limited to strategic management, organisational studies economics, industrial engineering education, sociology etc. Having discussed the relevance of the RBV and TCE views of the firm, the research objectives are discussed next.

3.4 Research Objectives

3.4.1 Technology management, transaction process and Governance structures

The first objective of this thesis is to understand the links between technology management, transaction processes and governance structures as shown in Figures 3.1 and 3.3. The areas that may contribute towards the links are technologies [3.1.1], technological resource skills [3.1.2], firm competencies [3.1.3], transaction processes [3.1.4], knowledge management [3.1.5], technological sourcing [3.1.6], organisational learning [3.1.7] and relationship management [3.1.8]. Figure 3.1 and Figure 3.3 are linked in Figure 3.7. Figure 3.7 summarizes the links between the technological and the investigative framework.

From Figure 3.3 it follows that firms react to competitors [3.2.2] and external factors [3.2.3] and are therefore forced to initiate. Firms are affected in terms of organisational determinants [3.2.1]. Managers in firms react by making decisions that affect organisational determinants [3.2.1], which affect manufacturing mix processes [3.2.4]. Competitors [3.2.2] and external factors [3.2.3] therefore affect manufacturing mix processes [3.2.4]. As a result, firms are forced to adopt technologies [3.2.5] to influence transaction processes [3.2.6] and governance structures [3.2.7]. These links propose relationships between technology management transaction processes and governance structures, these links can be depicted in a cyclic model (Figure 3.8).

Figure 3.8 depicts a cyclic approach to understanding the links. The competitive environment [3.4.1] includes competitors [a] and external factors [b]. Competitors [a] and external factors [b] push the firm into improving competitive advantages. As a result, new entrants, competitor buying power and substitute products are introduced into the market. In addition, external factors resulting from globalisation, newer technologies, social, economic and political issues further influence strategy [3.4.2]. Therefore strategy [3.4.2] has to be changed to cope with the changing competitive environment [3.4.1]. Strategy [3.4.2] is formulated by managers to drive firm's competitive advantages, improve market share and improve. Strategy from a RBV looks at FSRs to counter the threats from the competitive environment [3.4.1]. Threats from the competitive environment [3.4.1] force the firm to adapt to rapidly changing environments. Strategy [3.4.2] affects organizational determinants [3.4.3] and technology management [3.4.4].

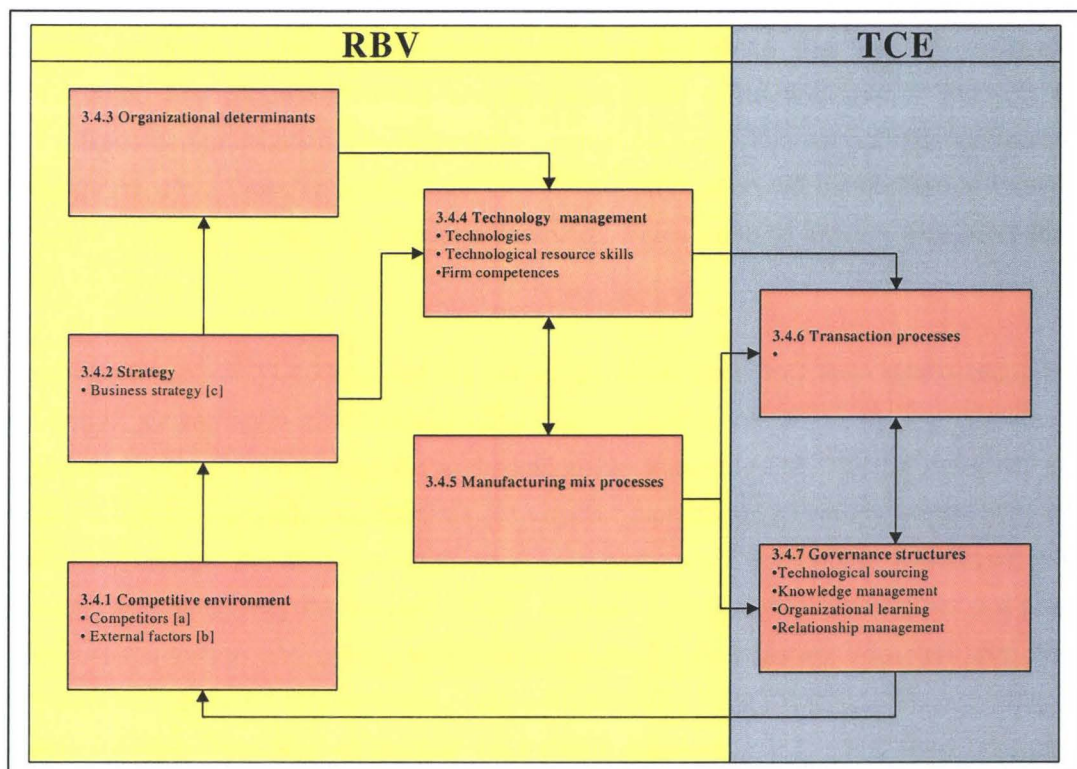


Figure 3.8: A cyclic model Linking technology management, transaction processes and governance structures

Due to the competitive environment [3.4.1], strategy [3.4.2] is affected. As a result organizational determinants [3.4.3] are affected. Managers in firms have to develop technologies, technological resource skills and firm competencies. Through technology management, firms may be able to implement manufacturing mix processes [3.4.5]. Manufacturing mix processes improve transaction processes [3.4.6] i.e. transaction cost reduction, transaction value added, and manufacturing mix criteria.

Therefore the business strategy [3.4.2] should be re-aligned to cope with the competitive environment [3.4.1]. Strategy [3.4.2] and organizational determinants [3.4.3] affect technology management [3.4.4]. Technology management [3.4.4] improves manufacturing mix processes [3.4.5]. These manufacturing mix processes [3.4.4] affect transaction processes [3.4.6] and governance structures [3.4.7].

Manufacturing mix processes [3.4.5] affect technology management [3.4.4] in terms of the automation of data transactions. This may lead to improvements in the transaction process [3.4.6]. Improvements in transaction processes may be effected as firms opt for alternative means of technological sourcing. This is linked to technology partnering, which may require improvements in knowledge management, especially information flow and knowledge transfer. The level of automation in a firm may influence the way information is passed within the firm, i.e. between different sections of the firm and outside the firm i.e. between technology partners. The level of automation may influence the way information is communicated and processed within and between firms. The first part of the process encompasses communication, i.e. relating to information flow. The second part consists of knowledge transfer. Only firms which are able to use information will benefit from the efforts involved in trying to develop organizational learning. Firms need to interact with other firms through technology partnering.

Governance structures [3.4.7] provide the means by which firms may form relationships with other firms. Governance structures [3.4.7] encompass technological sourcing, knowledge management, organisational learning and relationship management. Social networks and embedded ties may provide opportunities for supplier closeness, communications, trust and goodwill. Through these social networks and embedded ties, risks associated with technology partnering may be reduced. Firms operating within network structures are prone to structure-reinforcing and structure-loosening events. It is therefore important that firms build relationships based on closeness, trust and goodwill. Relationships, however, may be infiltrated by other firms wishing to enter the network structure. As a result firms may often have to be wary of such changes in the competitive environment. Therefore better relationship management will lead to improved technology partnering. In this way the firm may be able to raise barriers to entry to fend off competitors. Madhavan, Koka and Prescott (1998, p.442) say that being a well-connected partner in a network can be a strategic advantage. Each contact is a potential source of relevant information, resources or influence. Therefore network structures based on supplier closeness, communications, trust and goodwill may be an added advantage.

The effects of technological management [3.4.4] are likely to be felt in transaction processes [3.4.6]. Structure-reinforcing events enforce stronger network structures and as a result, the frequency of transactions with technology partners is likely to increase. In addition, there is

likely to be an upward trend in transaction certainty. This is largely due to the closeness of the relationship. The effects of a good relationship will be shown in the accuracy of forecasts in terms of purchase orders on strategic partners. In a close relationship all firms are aware of the advantages and disadvantages of inadequate information and therefore firms will pay more attention to the accuracy of transactions, thereby increasing the certainty of data transactions. Transaction-specific interests in terms of site specificity, physical asset specificity and human asset specificity are also likely to increase. As transaction frequency and certainty increase, firms will be more likely to invest in transaction-specific interests. Physical asset specificity relates to new state-of-the-art technologies and human asset specificity could be in terms of specialised personnel required to maintain, manage and use such technologies.

The effects of transaction processes [3.4.6] are also likely to be felt on governance structures [3.4.7]. Transactional process benefits are likely to be felt in terms of supplier relationship management. Supplier relationship management is measured by means of technological knowledge acquisition, i.e. developing the ability to learn and economies of scope with benefits like improvement in market access through technology partnering and improvements in communication and information sharing with technology partners. Improvements in supplier relationships often put pressure on manufacturing mix criteria. Effective relationships demand improvements in manufacturing mix criteria mainly because as firms become closer and understand how the others operate, they can react faster and therefore require information more frequently. Close relationships constitute a resource that can create barriers to entry and hence provide competitive advantage. Figure 3.8 also depicts the links between the RBV and TCE views of the firm. These links occur in competitive environments in Figure 4.2 the technological impacts on firm structures are considered. The S-curve phenomenon is used to explain how firms cope with technological impacts.

The RBV and TCE views of the firm are discussed next.

3.4.2 Comparison of the RBV and TCE views³ of the firm

As shown in Figure 3.8, the RBV of a firm is concerned with the effects of the competitive environment [3.4.1], strategy [3.4.2], organizational determinants [3.4.3], technology management [3.4.4] and manufacturing mix processes [3.4.5]. TCE, however, is concerned with transaction processes [3.4.6] and governance structures [3.4.7].

The TCE view of the firm focuses on transaction cost reduction processes. The primary objective is to remove cost from the transaction process. The focus is on cost reduction. The RBV is concerned with the optimisation of a firm's resources, i.e. human, physical, technological, etc. Both theories focus on the improvement in firm performance. In

³ RBV and TCE views are also referred to as RBT and TCE theories

transaction cost theory, however there is a strong focus on network structures and supplier relationships. From the literature survey it follows that TCE allows the firm to specialise in those activities that are needed for competitive advantage. Some authors share the following views.

- Williamson (1991, p.79) says the main hypotheses which TCE is based “align transactions, which differ in attributes, with governance structures, which differ in their costs and competences, in a discriminating (mainly transaction cost economizing) way.”
- Rumelt, Schendel and Teece (1991, p.14) state that TCE rests primarily on the conjunction of bounded rationality, asset specificity and opportunism. The authors add that of all the new sub-fields of economics, TCE has the greatest affinity with strategic management.
- Mahoney and Pandian (1992, p.364) assert that the RBV stimulates conversation within mainstream strategy research, organizational economics and industrial organisation and also provides a framework for discussion between these research perspectives.
- Dyer (1997, p.535) says that a central premise of TCE theory is that transaction costs increase as firms (the authors uses the word ‘transactors’) make greater asset-specific investments.
- Mauri and Michaels (1998, p.212) maintain that the proponents of the RBV concentrates on unique resources from which firms (the author uses the word ‘companies’) may derive sustainable competitive advantage.

These views suggest that no theory is superior but both theories are interrelated. Figure 3.8 shows possible links between the RBV and TCE views of the firm. Some comparisons derived from the literature survey are discussed in Table 3.9. These comparisons are categorised into either the RBV or TCE view of the firm. These categorisations are based on the arguments posed in the literature survey. Statistical tests may provide insight concerning the applicability of the RBV and TCE views to this model

Having compared the RBV and TCE views of the firm the next section explores the effects of technology management on the organisational and environmental evolution.

Table 3.9: Comparisons on the RBV and TCE views of the firm

Evaluation criteria	RBT	TCE	Some comments
1. Co-ordination and integration	X	X	Both the RBT and TCE prescribe the co-ordination and integration within and between firms. RBT looks at the collective advantage of all resources. TCE requires, amongst other things transaction frequency, certainty/uncertainty and asset specificity, which require an underlying foundation of co-ordination and integration
2. Transformation/change management	X	X	RBT also requires that firm resources be extended outside to incorporate all resources. This will involve transformation processes and change management in adopting new technologies, network structures and supplier relationships. For TCE the area of supplier relationships looks at governance mechanisms, supplier networks, etc. which are required for successful transformation/change management.
3. Technological discontinuities	X		The integration of technologies between sections of firms requires the effective utilisation of technological and human resources, which will lead to lower periods of discontinuity. This will allow firms to obtain higher levels of integration and therefore improvements in manufacturing mix criteria and performance of the firm.
4. Technological investment	X		Technological investment is a resource that firms could leverage more in order to obtain improvements in other firm-specific resources. The RBT requires the collective advantage of all resources.
5. Technological importance	X	X	In terms of improvements in manufacturing mix criteria for competitive advantages is required by the RBT and TCE
6. Manufacturing mix	X	X	Both the RBT and TCE of the firm subscribe to improvements in manufacturing mix criteria.
7. Knowledge transfer and integration	X	X	Both the RBT and TCE of the firm subscribe to improvements in manufacturing mix criteria.
8. Organisational learning	X		This ingredient is essential for the RBT in terms of knowledge transfer and integration, which is the foundation for co-ordination and integration, transformation/change management, etc.
9. Economies of scale and scope	X	X	Flexibility in terms of Scale and lower unit costs in terms of scope in order to improve value added are required by the RBT and TCE.
10. Network structure		X	Link between governance structures, technological use and system ownership, administration, planning and control Network, structures, transaction certainty/uncertainty Supplier relationships
11. Behaviour patterns	X	X	In terms of network structures in Competence enhancing and destroying events are subscribed by both the RBT and TCE.
12. Transaction costs		X	Technology directly links to transaction cost reduction for example by using fewer people to perform the same tasks.

13. Transactional frequency with major suppliers	X	X	Both RBT and TCE require a relationship with key suppliers that will mutually benefit both firms. From a RBT point of view transactional frequency will lead to the collective advantage of the suppliers resources as well as the firm's resources. From a TCE view transactional frequency will lead to improved transactional value because, as firms communicate with each other, there will be a relationship of trust leading to improvements in forecast orders etc. , which would lead to better planning through more readily available information
14. Transaction specific interests	X	X	Asset specificity is essential in terms of dedicated equipment and hence the RBV. This also leads to transactions that are pertained in terms of investment levels by both firms
15. Information flow	X		From a RBV this is essential for knowledge transfer and integration
16. Transactional frequency	X	X	Both the RBV and TCE subscribe to this criterion. Transactional frequency leads to more frequent communication, which builds upon a relationship of openness and trust. Moreover more frequent transactions leads to lower transaction cos.
17. Information sharing	X	X	Both theories require this criterion as a foundation to build upon
18. Goodwill or trust	X	X	A relationship of trust and openness is required in order that best benefits be obtained from both theories
19. Relation specific investments	X	X	This is similar to transaction-specific interests above but the focus is more on a clan-type relationship.
20. Supplier selection	X	X	Supplier roles responsibility and selection is likely to influence both the RBT and TCE

3.4.3 The technological effects of the organisational and environmental evolution on firms competitive advantage

In Figure 3.3 a link is shown between organisational determinants [3.2.1] and external factors [3.2.3]. Figure 3.4 shows that organisational determinants are linked to firm competencies [3.1.3]. Firm competencies [3.1.3] are linked to technologies [3.1.1]. Technologies in turn affect technological resource skills [3.1.2] and firm competencies [3.1.3]. Figure 3.3 shows the impact of external factors [3.2.3] such as of globalisation, new technologies like e-business and the social, economic and political factors on organizational determinants and manufacturing mix processes. Evidence of the impact of these external factors is given by the following authors amongst others.

- Porter (1998, p.124) uses chance events to explain occurrences, that have little to do with the circumstances of the nation and are also outside the control of firms (and often the national government). Some of his examples which are important because they influence competitive advantage are the following: discontinuities in input costs like oil costs, significant shifts in world financial

markets or exchange rates, political decisions by foreign governments, wars, and etc. The author argues that chance events are important because they create discontinuities that allow changes in the competitive position.

- Stonehouse *et al* (2000, p.239) maintains that technological change notably the development of information and communications technology (ICT), has been among the most important drivers behind globalisation. The effects of ICT have implications for firms especially in the management of knowledge and co-ordination activities, as these increase flexibility and responsiveness.

In Figure 3.3 technology management [3.2.5] is linked to transaction processes [3.2.6], which in turn is linked to governance structures [3.2.7]. In terms of ICT, improved connectivity may exist between firms both nationally and internationally. As a result of ICT, transaction processes and governance structures between firms may be affected. Figure 3.8 shows a link between governance structures [3.4.7] and the competitive environment [3.4.1]. Some other examples of the effects of the organisational environment include the following:

- To improve manufacturing mix criteria and remain competitive, firms implement technologies that influence transaction processes and governance structures. To gain greater benefit from technological integration, firms reorganise within the firm and outside the firm to sustain manufacturing mix criteria and the firm's growth rates. It is expected that firms will make changes in terms of number of suppliers and focus on core tasks, outsourcing non-core activities (as suggested by TCE, i.e. the firm will opt to buy services outside the firm should these services be cheaper to obtain in the market). In doing so, contracting of services from the market become an alternative to providing the service within the firm. Contracting includes strategic alliances, joint ventures, mergers and acquisitions.
- To improve their competitiveness, firms have to capitalise on the collectives of all resources. These include resources within the firm and outside it. Firms have to move constraints to improve competitiveness. Firms' competitive strategies include suppliers and competitors. By knowing competitors firms can position themselves advantageously within network structures. Technological pull technologies such as the WWW will fundamentally alter the way firms interact with each other. The roles and responsibilities of firms are altered as such technologies pull firms together in a common market place.

It may therefore be concluded that links exist between the external environment and technology management.

The next chapter is focused on forming the research question and developing metrics for the central questions, subproblems and hypothesis.

4 The Research Question

4.1 Metrics for Central Questions

4.1.1 Metrics for technology management

From the literature survey in Chapter 2 (Hay and Morris' model) and Appendix M links are established when managers in firms make decisions that affect efficiency, investment in R&D and technology. These links are further reinforced in Chapter 3. Figure 3.1 shows the links between technology management, transaction processes and governance structures. In addition, in Figure 3.3 the investigative framework is mapped. Figure 3.3 depicts an investigative framework for linking technology management, transaction processes and governance structures in a competitive environment.

The investigative framework introduces organisational determinants [3.2.1], competitors [3.2.2], external factors [3.2.3], and manufacturing mix processes [3.2.4]. These three factors introduce different effects on technology management, transaction processes and governance structures. For example, manufacturing mix processes are influenced by technologies like ICT, e-mail, EDI, MIS, ERP, inter-net technologies, etc. These technologies affect processes. In this thesis the processes are referred to as 'manufacturing mix processes'. These manufacturing mix processes affect manufacturing mix criteria like cost, quality, speed, dependability and flexibility. In addition, manufacturing mix processes influence relationships within and between firms. Figure 4.1 shows the associated relations.

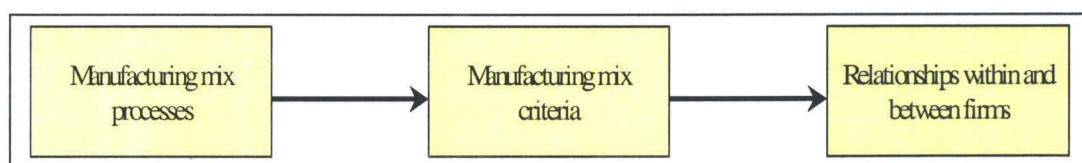


Figure 4.1: Relations between manufacturing mix processes and manufacturing mix criteria

The literature survey shows that co-operation between firms is cost economising for technology exchanges (i.e. technological sourcing). Technological sourcing may enhance knowledge management, relationship management and organisational learning. Cost economisation may be achieved by at least the following means:

- A reduction in risk cost may be associated with developing in-house technologies rather than adopting from a technological partner.
- Access to markets that would not be possible without a technology partner.
- Creating barriers to entry by networking with key technology partners. Market entry costs may be high as a result of asset specificity that may have been developed by technology partners.

In Figure 3.3 technology management is linked to manufacturing mix processes. Technology management is also linked to transaction processes and governance structures. Rapid technological changes, impact on firm resources affecting the way managers group or pool resources to obtain competitive advantages. The flow of information within and between firms may leverage strategic advantages over competitors, making the firm more adaptable to the competitive environment.

Figure 4.2 gives a graphical representation of the changing technological environment. Included are benefits from the implementation of AMT typologies. Some benefits are supported by the following authors amongst others:

- Meredith (1987, p.252) points out benefits in flexibility, quality, lead time, cycle time, reduced labour, reduced inventory, less space, image, capacity, safety, cost and risk.
- White (1996, p.316) models links between manufacturing capabilities and business performance. White (1996, p.327) concludes that a key aspect of strategy involves the manufacturing capabilities of quality, delivery speed, delivery dependability, flexibility and cost.
- Amundson (1998, p.349) shows relationships in terms of asset specificity, opportunism, integration and efficiency.

These benefits show that as technology grows, it has the power to change the way firms function.

Some arguments that support the importance of technology management are discussed next:

- Long term positioning of firms may be influenced by strategic technological alliances/joint ventures, joint R&D, direct investment and to a lesser degree customer supplier relationships.
- Researchers such as White (1996), (already discussed in Chapter 2 and Appendix N)), underline the importance of support relationships between manufacturing capabilities and business performance. In this thesis manufacturing capabilities refer to manufacturing mix criteria and business performance means competitive advantage. This reinforces the model proposed by Hay and Morris. Some of the links shown in the model proposed by White are as follows:
 - Efficiencies in delivery speed can be realised from conformance to quality as a result of reduced scrap, rework and liability costs, which also results in delivery dependability.
 - Delivery dependability reduces penalty costs, which in turn reduces manufacturing costs. Therefore profitability is improved, which

increases business performance. As a result cost competitiveness is achieved.

- Product flexibility is improved through quicker response times as a result of faster set-up and changeover times. This contributes to dependability competitiveness and speed competitiveness.
- Speed competitiveness, dependability competitiveness, flexibility competitiveness and cost competitiveness influence market share and price, which results in better profitability and improved business performance.

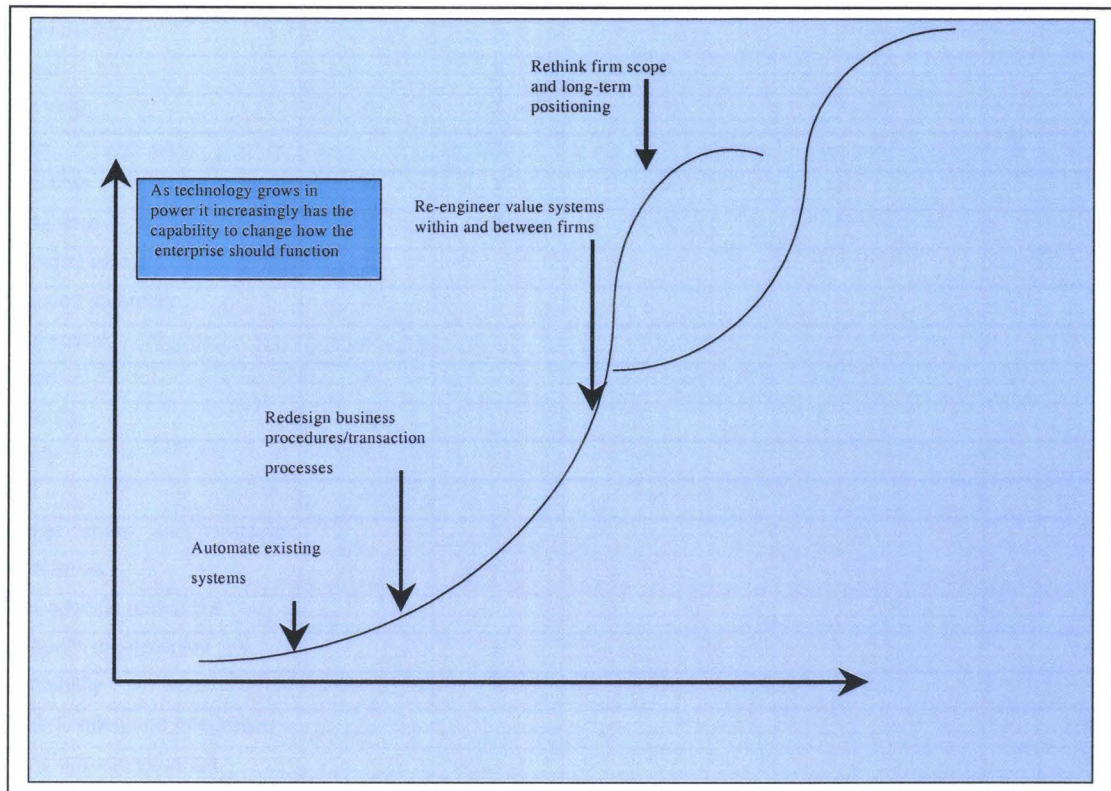


Figure 4.2: Technology impacts on firm structures

These benefits may be likened to manufacturing mix criteria, which may also be driven by technology management. Parallels between the Hay and Morris model and the model proposed by White can thus be drawn.

Following from the relationships listed by Amundson (1998, p.349) in terms of asset specificity, opportunism, integration and efficiency, it can be postulated that efficiency is related to the concepts of cost, quality, dependability of delivery and flexibility. On the other hand, integration is affected by supplier relationships, communication through cross-functional teams, etc. These models show linkages between technology, transaction processes and governance structures. The benefits and risks of manufacturing technologies as proposed by Meredith also support this stance. Technology benefits clearly support manufacturing mix

criteria, but also include the following: flexibility, quality, lead time, cycle time, reduced labour, reduced inventory, less space, image, capacity, safety, cost and risk.

Table 4.1 below compares the manufacturing mix criteria as proposed by various researchers.

Table 4.1: Comparison of technological benefits

Technological benefits	Meredith (1987)	White (1996)	Hay & Morris (1991)	Slack (1991) Ferdows and De Meyer (1989)	Teece, Pisano and Sheun (1997)
Quality	X	X		X	
Dependability		X		X	
Speed		X	X	X	
Flexibility	X	X	X	X	
Cost		X	X	X	
Lead time	X	X	X		
Cycle time	X	X	X		
Reduced labour	X				
Reduced inventory	X				
Less space	X				
Image	X				
Capacity	X				
Safety	X				
Risk	X				
Market share and strategic capabilities		X			X
Firm-specific resources					X
Competitive strategies					X
Profitability		X	X		
Co-ordination and Integration					X
Transformation/change management					X
Organisational learning					X

Following on from the above discussion, Table 4.2 shows metrics for technology management and manufacturing mix processes that may support the hypothesis.

Managers make decisions regarding technological implementation. Technological implementation offers benefits in manufacturing mix criteria. Managers experience pressure from competitors, external factors and organisational determinants to remain competitive. This forces managers to improve manufacturing mix criteria. For example:

- Threats from competitors include new products, more buying power and substitute products, which threaten the firm.
- External factors of an economic, social and political nature together with the firms' organisational structures, assets and individuals, further increase the pressures on managers to improve the output of their firms.

Table 4.2: Metrics for Technology management

Technology management	Metrics for technological implementation	Scale	References or comparisons
Technological strategy	- Alignment of business strategy and technological strategy. - The effect of technological strategy on a firm's competitive advantage. - Categorize firms into technological approaches	7-point Likert scale 7-point Likert scale 5 interval categorization i.e. innovators, early adopters, early majority, late majority and laggards	Burgelman, Madique and Wheelright (1988, p.1). Day and Schoemaker (2000, p.135).
Technological investment	- Percentage of firm's technological investment as a percentage of total investments. - Proportion of a firm's technological investments that are made in the latest available technologies - The extent to which technological implementations are restricted by certain risks - Matching technological implementations to staff training	6 point forced ranking 6-point forced ranking 7-point Likert scale 7-point Likert scale	Risks as identified by Rosenthal (1984, p.213).
Technological change	Extent to which technological implementations have affected transaction processes within and between firms	7-point Likert scale	
Technological integration	- Extent to which data transactions are conducted in the firm through the use of computers or computerized equipment - Extent to which firms have integrated technologies across the AMT classification - How long it takes firms to integrate technological implementations across the AMT classification. - Rate the competence of managers in firms with	7-point Likert scale 7-point Likert scale 5-point forced ranking 7-point Likert scale	Boyer, Ward and Leong (1996, p312).

	regard to their ability to identify the firms technological needs.		
Technological importance	- To what extent are the following criteria important: technologies, cost, quality, speed, dependability and flexibility? - Measure the influence of certain factors on technological implementations. - Will measure time periods between integration in design, manufacturing and administration. - Firms' ratings in terms of technological adoption.	7-point Likert scale 7-point Likert scale	Boyer, Ward and Leong (1996, p.312). Day and Schoemaker (2000, p.135).
Technological resource skills	Extent to which firms have been affected by competence destroying technologies and competence enhancing technologies.	7-point Likert scale	
Firm competencies	- Extent to which tangible and intangible technological resource skills are matched. - Extent to which firms have implemented technologies to improve core competencies and general competencies. - Measure the importance of certain factors in the firm	7-point Likert scale 7-point Likert scale 7-point Likert scale	Factors as determined by Mahoney and Pandian (1992, p.370).

The effects of technological implementation on transaction processes and governance structures are evident in value chains. The different technologies that are implemented in the value chain from suppliers to customers support technology sourcing, knowledge management, relationship management and organisational learning. Evidence of this is evident in the WBS model, which supports the integration of information within and between firms. The transactions that occur within and between firms are improved through the integration of information, thus providing benefits from suppliers to customers in terms of

manufacturing mix criteria, knowledge management, relationship management and organisational learning. Knowledge transfer and integration leads to improved relationship management and organisational learning as firms interact with one another. Benefits in joint decision making for improved competitiveness are realised. As firms can learn from one another faster than their competitors, benefits in transaction processes follow. These benefits assist in developing competitive advantages.

4.1.2 Metrics for transaction processes

Transaction processes in firms consist of criteria that support strategic networks in which firms transact with other firms. In these network structures the firm's position in the network needs to be considered. The relative position of a firm in a network reinforces that firm's stability when technological changes occur in the market place. Structural reinforcing and structural loosening events would typically either strengthen a firm's position and make it more competitive or weaken its position and make it vulnerable to competitor firms. Structural reinforcing and structural loosening events may be reinforced by different mechanisms. Some of these mechanisms may relate to:

- High asset specificity with technology partners creating barriers to entry.
- Access to markets through technology partners.
- Transaction cost reduction across the value chain from suppliers to customers via improvements in manufacturing mix criteria.

These mechanisms may be affected by different types of relationships. Some of these relationships may include opportunism as proposed by Williamson, fairness as proposed by Ouchi (1980)(cited by Hamel (1991), collaboration as proposed by Hamel and Prahalad (1996) and strategic networks as proposed by Madavan, Koka and Prescott (1998).

Transaction cost reduction may be achieved when the firm opts for alternative means of sourcing resources. These alternative means may include technology sourcing through technology partnering with suppliers, competitors or customers. When opting for alternative sourcing, many factors need to be considered. The following are some of these factors:

- Cost or risk avoidance by adopting the resource from a technology partner who has already achieved some competence in this area.
- Cheaper to acquire the resource from a partner as compared to in house development.
- Integrating key partners into the network structure hereby creating structural reinforcing events.

Factors that need to be considered in improving transaction value include knowledge management, relationship management and organisational learning. This includes the management of horizontal integration (backward and forward) and vertical integration. Management of the value chain would support benefits in cost, quality, speed, dependability and flexibility, i.e. manufacturing mix criteria.

To achieve transaction cost reduction and improvements in transaction value key metrics need to be considered. In designing the metrics the following should be considered: transaction frequency, transaction certainty/uncertainty and transaction-specific interests, asset specificity (site specificity, physical asset specificity and human asset specificity).

Table 4.3 shows the metrics for transaction processes.

Table 4.3: Metrics for transaction processes

Transaction processes	Metrics for transaction processes	Scale	References or comparisons
Transaction processes	Extent to which transaction processes are aimed at improving manufacturing mix criteria.	7-point Likert scale	Deduced from White (1996, p.324) i.e. model of manufacturing capabilities and business performance.
	Extent to which information flow and knowledge transfer have affected manufacturing mix criteria.	7-point Likert scale	Deduced from the dynamic capabilities model by Teece, Pisano and Sheun (1997, p.518).
	Extent to which organizational learning has affected manufacturing mix criteria.	7-point Likert scale	Deduced from the dynamic capabilities model by Teece, Pisano and Sheun (1997, p.520).
	Extent to which technological implementations have affected transaction cost reduction and transactional value added.	7-point Likert scale	Deduced from the Sandone model by Ferdows and de Meyer (1989) and the model proposed by White (1996).
	How long has it taken technological implementations to affect transaction processes with regard to transactional cost reduction and transactional value added?	5-point forced ranking	The Model proposed by White (1996, p.324) does not cater for the missing time dimension therefore it has been incorporated as a metric.

Having determined the metrics for transaction processes we have to establish the metrics for the place where transactions occur, i.e. in governance structures. The extent of governance structures is determined by the level of asset specificity. As asset specificity increases the strength of governance structures is increased.

4.1.3 Metrics for governance structures

In Figure 3.1 technology management includes technologies, technological resource skills and firm competencies. Technology management is linked to transaction processes and governance structures. Technological implementation results in technological change, which

forces managers to change business processes, i.e. transaction processes in firms and between firms. In doing so, managers manipulate governance structures to match the transaction process. Governance structures facilitate relationship management and organisational learning within and between firms. Better knowledge management as a result of improved information flow, knowledge transfer through new and emerging technologies may result in timely and accurate reaction to threats from competitors, external factors and organisational determinants. The factors of effective governance may consist of:

- Economies of scale by transacting with a small group of suppliers, which results in lower transactions costs.
- Frequency of transactions; repeated transactions also result in lower transaction costs.
- Information sharing where benefits lie in the reduction of contracting and monitoring costs.
- Use of goodwill or trust, which lowers maintenance costs in terms of contract renewal (transaction costs).
- The effect of relation-specific investments, which serve to improve co-operative long-term relationships.
- Supplier relationships from an adversarial approach to a partnership approach, i.e. joint problem resolution and a philosophy of openness that goes beyond a price comparison.
- The focus on supplier selection based on closeness of the relationship and continuous improvement. Issues such as frequency of communication, content and means of communication play an important role. For example, electronic means of communication such as EDI, the Internet, e-commerce, etc., render effective near-real-time communication possible.
- Linkages to manufacturing mix criteria for supplier selection include supplier financial situation, consistency (relating to quality), relationship, flexibility, technological capability, service, reliability and price (cost).

Metrics for effective governance are shown in table 4.4.

Table 4.4: Metrics for effective governance

Governance structures	Metrics for governance structures	Scale	References or comparisons
Technological sourcing	- How firms view strategic partnerships, either adversarial or partnership - Extent to which adversarial or partnership approach is used. - Extent to which strategic alliances are a source of competitive advantage.	2-point forced ranking 7-point Likert scale	Schonberger and Knod (1994, p.276). Hamel, Doz and Prahalad (1996, p.592).
Knowledge management	- Effect of information flow and knowledge transfer on transactional cost reduction and transactional value added. - Extent to which firms have identified the benefits of information flow to improve technological resource skills. - Extent to which firms have identified the benefits of knowledge transfer to improve technological resource skills. - Extent to which firms have identified the benefits of new and emerging technologies to improve technological resource skills. - Extent to which firms have used control and monitoring systems to control the flow of critical skills and technologies to technology partners. - Extent to which firms possess the necessary resources to cope with the effects of globalisation.	7-point Likert scale 7-point Likert scale 7-point Likert scale 7-point Likert scale 7-point Likert scale	Lorenzoni and Lipparini (1999, p.320). Hamel (1991, p.83). Madhavan, Koka and Prescott (1998, p.440). Hamel, Doz and Prahalad (1996, p.596).
Relationship management	Extent to which technology management has improved the social networks and embedded ties, supplier closeness, communications, trust and	7-point Likert scale	Dyer (1997, p.540) using asset specificity to develop relationship management.

	good will, and improved market opportunities through partnering. • Extent to which trust and goodwill have led to increased transactional history. • Extent to which increased transactional history has led to certain factors. • Extent to which firms have adopted effective governance mechanisms. • Extent to which technological implementations have led to improved network structures.	7-point Likert scale 7-point Likert scale 7-point Likert scale 7-point Likert scale	Dyer (1997, p.547). Factors as determined by Ring and Van De Ven (1992, p.489). Effective governance mechanisms as determined by Hagedoorn (1993, p.376). Deduced from Madhavan, Koka and Prescott (1998, p.443), only key industry events are the cause of network restructuring.
Organizational learning	• Extent to which organizational learning has affected transactional cost reduction and transactional value added. • Extent to which information flow and knowledge transfer have affected learning-by-doing and learning-before-doing. • Extent to which new and emerging technologies have affected learning-by-doing and learning-before-doing. • Extent to which organizational learning has affected information flow, knowledge transfer and new and emerging technologies. • Extent to which organizational learning has affected market threats, market opportunities and external factors. • Extent to which information flow and knowledge transfer has affected the firm's absorptive capacity.	7-point Likert scale 7-point Likert scale 7-point Likert scale 7-point Likert scale 7-point Likert scale 7-point Likert scale	Deduced from Jarillo (1988, p.38), establishing an efficient network is a means of improving transactions. Deduced from Madhavan, Koka and Prescott (1998, p.443), only key industry events are the cause of network restructuring. Cohen and Levinthal (1989, 1990).

From the discussion and above the literature survey and metrics that have been discussed, the central questions can be determined, viz.:

- How do changes in technology affect transaction processes?

And

- How do changes in technology influence governance structures?

The first central question will enable us to link manufacturing mix criteria to transaction processes. The focus of the central questions will be to determine whether changes in technology do indeed affect transaction processes and governance structures. The central questions suggest the link between technology management and transaction processes. The benefits of technology management should show improvements in transaction processes and governance structures. The links are effected by managers in firms that create new technologies to cope with organisational determinants, competitors and other external factors of an economic, social and political nature. To understand the effects of these factors, it is necessary to determine additional metrics. Table 4.3 gives the additional metrics that are required.

Table 4.5: Metrics for the investigative framework, i.e. organisational determinants, competitors and external factors

Investigative framework	Metrics for investigative framework	Scale	References or comparisons
Organizational determinants	• Extent to which industry positioning and selection, organizational processes and administrative practices and managerial capabilities are important to a firm's performance.	7- point Likert scale	Criteria determined by Hansen and Wernerfelt (1989, p.409).
	• Comparing a firm's performance relative to key competitors.	7-point Likert scale	Boyer, Ward and Leong (1996, p.312).
	• Comparing firms relative to key competitors with regard to ability to adapt to rapidly changing technologies.	7-point Likert scale	
	• Extent to which firms will be affected by the following: new entrants, buying power of competitors, substitute products	7-point Likert scale	Porter (1991, p.101) , to hold an attractive relative position a firm should posses sustainable competitive advantage.

External factors	Extent to which firms will be affected by globalisation, E-business, social, economic and political factors	7-point Likert scale	Deduced from Stonehouse (2000, p.31), extent to which world wide competition will affect firms
Manufacturing mix	- Extent to which technological implementations have affected manufacturing mix criteria. - Extent to which manufacturing mix criteria have affected organizational determinants, competitors, and external factors	7-point Likert scale 7-point Likert scale	Goldhar and Jelinek (1983, p.144), benefits of information systems with regard to manufacturing mix criteria.

Table 4.6: Metrics for the RBV and organizational and environmental evolution

RBT and TCE	Metrics for RBT and TCE	Scale	References or comparisons
RBV	- Extent to which firms are affected by Firm resources, industry selection and positioning and transactional cost reduction and transactional value added. - Extent to which firms have developed a diversification strategy.	7-point Likert scale 7-point Likert scale	Deduced from Tallman (1991, p.71) and Porter (1991, p.100) with regard to firm and industry effects. Criteria for diversification as determined by Wernerfelt (1984, p.172).
Organizational and environmental evolution	Extent to which firms possess competitive advantage.	7-point Likert scale	Criteria for competitive advantage as determined by Porter (1991, p.111).

In summary the links between technology management, transaction processes and governance structures focus attention on the following:

- Technology management
 - Technologies
 - Technological resource skills
 - Firm competencies
- Transaction processes
 - Transaction cost reduction
 - Transaction value added
 - Manufacturing mix criteria
- Governance structures
 - Knowledge management

- Technological sourcing
- Organizational learning
- Relationship management

The central questions set the framework for the thesis and also pose subproblems that need to be answered to support the central questions. These subproblems are discussed next.

4.2. Metrics for sub Problems

There are four subproblems, which have been identified:

4.2.1 How long does it take changes in technology to affect transaction processes?

- Subproblem 4.2.1 enables us to establish trends in technological integrations that may lead to effects in transaction processes. These trends can be measured using periods of integration between the different technological categories like design, administration and manufacturing. These trends in integration may allow us to determine windows of technological discontinuities. These technological discontinuities may, for instance be correlated to a firm's growth rates. In addition, further links may be established to other subproblems such as the effects of organisational learning, information flow and knowledge transfer. The effects of newer technologies such as electronic commerce can also be determined.
- Trends can be measured by classifying firms into the categories of innovators, early adopters, laggards, etc. These categorisations will be used as criteria to determine the time span between technological changes or integrations and the associated effects on transaction processes.

4.2.2 What is the effect of organisational learning on transaction processes as a result of newer technologies?

- Subproblem 4.2.2 enables us to establish the effects of organisational learning and newer technologies on transaction processes. As managers in firms adopt newer technologies to improve manufacturing mix criteria, firms are forced through a knowledge management process. This knowledge management process triggers an organisational learning process. This organisational learning process is driven by the subsets of technology management and transaction processes. Newer technologies force the firm to develop or improve technological resource skills. These technological resource skills drive firm competencies. Firm competencies drive knowledge management and knowledge management drives organisational learning. Therefore newer technologies affect transaction processes (i.e. technological resource skills, which affect firm competencies and knowledge management). Knowledge management in turn affects organisational learning.

Some evidence that supports the effects of organisational learning as a result of newer technologies on transaction processes, is discussed next:

- A large amount of research has focused on supplier relationships, strategic alliances, etc., which firms form with other firms to improve their competitive edge. However, the effectiveness of these networks relies on the ability of firms to learn from each other. The knowledge that each firm contributes to the relationship strengthens the network, thus creating a competitive edge.
- From the literature survey it is evident that there are different modes of learning that facilitate the transfer of knowledge from one firm to another or between firms. However, firms must have a certain level of absorptive capacity to facilitate learning. A firm must create a means of learning before it can develop absorptive capacity. The literature survey shows that some authors have proposed the following drivers for absorptive capacity: Payment and reward systems, technological discontinuities, technological investment and organisational structure.
- As technology develops and is implemented in firms in a race to improve manufacturing mix criteria, a firm's position is threatened as other firms create structure-loosening events. Therefore firms will continually try to seek alliances with other firms to improve their capabilities or build on existing organisational knowledge so that they can remain competitive. For example, decisions are made regarding a firm's position in network structures, behavioural patterns (opportunistic or fairness), transaction costs, transactional frequency, transactional certainty/uncertainty and transaction- specific interests. These are the drivers for information flow and knowledge transfer within and between firms, which influence manufacturing mix criteria.

In accomplishing such tasks, firms affect the way transactions are carried out; hence transaction processes are changed.

4.2.3 What is the effect of information flow and knowledge transfer on transaction processes?

- Subproblem 4.2.3 enables us to link the effects of information flow and knowledge transfer to transaction processes. The effects of information flow and knowledge transfer lie in the ability of the firm to develop absorptive capacity. Different methods of learning create the means for developing the capacity to learn. On the other hand it is also necessary to develop the ability to learn, i.e. absorptive capacity. Some authors

have found technological discontinuities to be an incentive for firms to create absorptive capacity. This is because of linkages which firms develop with other firms to improve information flow and knowledge transfer. Information flow and knowledge transfer contribute to added benefits in manufacturing mix criteria, which affect transaction cost economics.

4.2.4 How do changes in technology, e.g. electronic commerce, affect manufacturing mix criteria?

- Subproblem 4.2.4 relates to benefits in technological implementation. These benefits may lie in the improvement in communications and information processing, which results in improvements in manufacturing mix criteria, i.e. cost, quality, speed, dependability and flexibility. Firms, however, must manage the most cost-effective and efficient use of technology to create competitive advantages. Efficient and effective use of technology also lies in the integration of technologies through the different AMT classifications, i.e. design, manufacturing, or administration. The integration of the different sections of the firms and other firms into an ERP system will provide additional benefits in terms of manufacturing mix, as firms are integrated horizontally and vertically. The major driver evident from the literature survey is clearly competition from competitors. The emergence of newer technologies also affects the transformation processes in firms with regard to the ability to create goods and services. The use of such technologies contributes to improvements in manufacturing mix criteria.

Newer technologies can create high asset specificity with strategic suppliers, thus creating barriers to entry and at the same time improving manufacturing mix criteria e.g. CIM systems between firms and their key suppliers. Such systems could include CAD drawings being transferred automatically to a supplier's CAM system. For such systems to operate efficiently, both firms must be knowledgeable about how they function between themselves and their standardised operating processes must be active. This kind of relationship management around automated technologies results in improvements in manufacturing mix and creates barriers to entry for competitors.

- Managers of firms strive to improve manufacturing mix criteria to sustain competitive advantage. However, newer technologies drive manufacturing mix criteria as well when other firms introduce

technologies, that threaten the firm as a result of improvements in manufacturing mix criteria. Therefore, trying to create high asset specificity with strategic suppliers secures the network structure while at the same time providing benefits in terms of manufacturing mix criteria.

The two relevant hypotheses are discussed next.

4.3. Metrics for hypothesis

Hypothesis 1

Firms that adopt new technologies grow at different rates to other firms that maintain older technologies.

- Firms must understand how technologies mature. Technological discontinuities between old and new technologies often create structure-loosening or structure-reinforcing events. These events either enable the firm to develop competitive advantage or reduce their existing competitive advantage. Firms need to take the necessary steps to anticipate and manage the transition between old and new technologies. The first step lies in distinguishing old technology from new. Authors like Foster have proposed the technical potential as a measure of old and new technologies. This is the difference between the current state-of-the-art technology and the technical limit. The higher the technical potential, the newer the technology. From the literature survey it is evident (Foster (1988)) that the essence of technological management is the ability to make smooth and timely transitions to new technologies with superior performance improvement in manufacturing mix criteria, which will benefit the growth rates of firms.
- Knowing when to invest in new technologies is certainly important. In a symmetrical S-curve at midpoint it may seem counterproductive to invest in a newer technology when there is still a lot of improvement in the old technology. However, from the literature survey it is evident that it takes five or ten years to develop a new technology. Bearing this in mind, it is probably more realistic to obtain further benefits from the current technology by making other process improvements in terms of transaction processes and governance structures rather than investing in another technology. It must be noted that it is not new technologies that create a winning company.
- The technology with the greatest potential will dominate the market as more firms opt for its use in an endeavour to improve return on investment. Sometimes other market factors influence the return ratios.

Such factors are usually a function of the competitive nature of the industry and include: supply/demand conditions, relative power of customers and suppliers, company strategies, substitute products, external factors, etc. This is referred to as 'investment yield'. To establish which technologies to invest in, firms should consider both manufacturing mix benefits (return on investment in financial terms) and investment yield.

- The underlying assumption is that new technologies provide greater benefits in terms of firms growth rates than older technologies do. Firms' growth rates are measured in terms of the following variables: sales growth, return on sales and earnings growth.
- Technology should be viewed as a corporate asset because technology is critical to competitiveness in terms of manufacturing mix criteria. The firm should, however, focus on the drivers for improvement in manufacturing mix criteria rather than a technology investment. Technological investment is a means to improve the profitability of firms.

Hypothesis 2

Managers rate manufacturing mix criteria (cost, quality, speed, dependability and flexibility) as more important than technological leadership.

- The technological importance is the relative importance that a particular technology plays in a given business segment (as defined by Pappas, p. 231). Technological leadership therefore could mean the level of a firm's investment in certain technologies as compared to its major competitors. To determine technological leadership, the importance of each technology to the firm in terms of AMT classifications of design, manufacturing or administration should be determined. When establishing priorities for technological investment, each classification needs to be measured so that an investment profile can be determined. In other words, are technological investments based on value added returns as in the case of manufacturing mix criteria? Or are technological investments based on the relative importance of the technology as compared to major competitors. Technological strategy is a means whereby a firm can most effectively invest its technological resources to achieve sustainable competitive advantage.
- On the other hand, early adopters of new technologies have a longer time period to master the knowledge and skill necessary to obtain the full benefit of the technology. Such firms will have overcome problems due to learning effects, resistance to change, etc., which other late adopters of the technology will have to contend with. In contrast, however, as the

technology develops most of the bugs and problems associated with the state-of-the-art technology will be eliminated and hence late adopters of the technology will not have to contend with such issues as early adopters. The late adoption of technology may have benefits in terms of lower scrap and rework costs as compared to the early adopters.

- The models proposed by Hay and Morris, White, Meredith and the sand cone all rate manufacturing mix criteria as very important. Schonberger and Knod also provide evidence in support of customer service levels, which include manufacturing mix criteria. It is therefore clearly evident from the literature survey that it is the continuous endeavour to improve manufacturing mix criteria that drives technological investment.
- The literature survey, however, also shows that technological investment by other firms also forces managers to improve manufacturing mix criteria. Therefore technological investment can be seen as one of the drivers for improvement in manufacturing mix criteria.

The metrics have been developed through literature surveys and references are made. These metrics are used in the questionnaires for the user and system integrator firms. The questionnaires are then structured into different scales to cater for the different metrics. Cronbach Alpha tests are utilised to check the reliability for each of the scales. The following methodology was utilised to test the reliability and validity of the questionnaires.:

- Firstly an interview process was used to check the language, questionnaire style, format, clarity, etc. Recommendations from this processes was used to further streamline the questionnaire.
- Secondly the questionnaire was circulated to a pilot group, which underwent another interview process. Statistical tests were used at this stage to give an indication of the questionnaire reliability. The CITC and Cronbach Alpha tests gave high results due to the sample size of the pilot group. No questions were modified at this stage
- Thirdly the questionnaire was sent out to the main group. Cronbach Alpha tests was utilised to check reliability. Multiple Cronbach Alpha tests was performed to check reliability of the different scales (section 6.4).
- Fourthly the results was tested through an expert panel.

More detail on these testing methods is described in Chapter 5 and Chapter 6. Chapter 5 focuses on the research methodology and Chapter 6 focuses on the research results.

5 The Research Methodology

The research methodology used in this thesis is shown in Figure 5.1. A cross-sectional approach was utilised for the research. The research methodology consisted of 8 steps.

- Step 1 consists of a literature survey to determine the content of the questionnaire. The content of the questionnaire is aimed at meeting the requirements of the investigative framework, and dealing with central questions, subproblems, hypothesis and research objectives. Therefore an extensive literature survey was conducted prior to the questionnaire design. A three-step approach was utilised involving two questionnaires, namely a user questionnaire and system integrator questionnaire. The user questionnaire was aimed at technology users and the system integrator questionnaire was aimed at technology application specialists. This two-step process will provide an understanding of technological perspectives in firms from two different perspectives i.e. users and system integrators. Rosenthal (1984, p.203) used a three-step process. The third step in this thesis consists of an expert panel, through which some of the final results are substantiated.
- Step 2 consists of an interview process to check the language, questionnaire style, format, clarity, etc. The respondents include 10 technology specialists and 3 academics. Each of the respondents was interviewed on an individual basis.
- Step 3 consists of revising the questionnaire in line with the recommendations from the pre-test.
- Step 4: The questionnaire was circulated to a pilot group, which underwent another interview process. The pilot study was conducted using respondents similar to the target group. The questionnaire was sent to 15 managers including managing directors, general managers, and other specialists involved with technology strategy and/or implementation.
- Step 5: The correlated item total correlation method (CITC) was used together with Cronbach's Alpha.
- Step 6: Due to the small sample size, statistical tests were performed but none of the questions were dropped because the CITC and Cronbach Alpha gave a very high reliability at this stage. Cronbach Alpha for retained items was in the region of 0.9. As a result of the small sample size and many items in the questionnaire (122) it was decided to divide the questionnaire into scales, 6 scales were chosen. Thus fewer items per scale solves the item-sample size ratio problem. No items were dropped at this stage.
- Step 7: Thereafter the questionnaire was circulated to the main group. The questionnaire was circulated to 50 firms from the user group and 34 firms from the system integrator group. The firms involved covered the electronics and electrical engineering industry and the information technology industry (hardware

and software firms). The scale method for Cronbach Alpha, together with the CITC method, was used for data reliability.

- Step 8: Thereafter the results were analysed statistically and tested with an expert panel.

In this thesis two questionnaires are used, one aimed at user firms and the other aimed at system integrator firms. User firms are firms that utilise technologies, system integrator firms are firms that are involved in the implementation of technologies. These two divisions have been made so that comparisons between the two groups could be determined. These comparisons will then be utilised to identify gaps between the two groups. Figure 5.2 shows a graphical relationship between customers, system integrators and technology providers. In terms of the graphical representation user firms can be likened to customers.

Figure 5.3 shows the relationship between the two questionnaires. Each of the questions is encoded with an alpha-numeric character shown after the question number. These codes describe the area of questioning and the question number relative to that area, e.g. TC 1 refers to technological change question 1 of that section, TINV 4 refers to technological investment question 4 of that section, STP 1 refers to system integrator questionnaire, question 1 on transaction processes, etc. These codes are used in the tables and figures that follow.

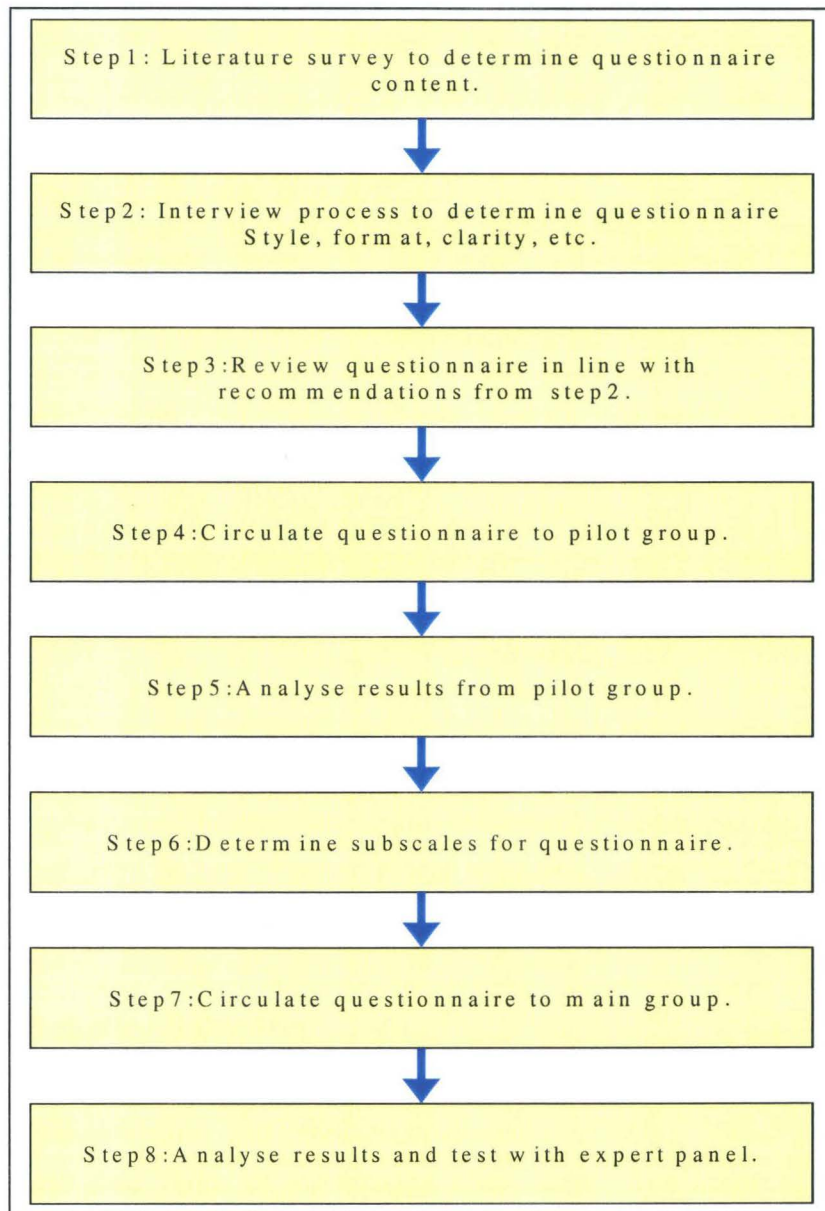


Figure 5.1: Research methodology

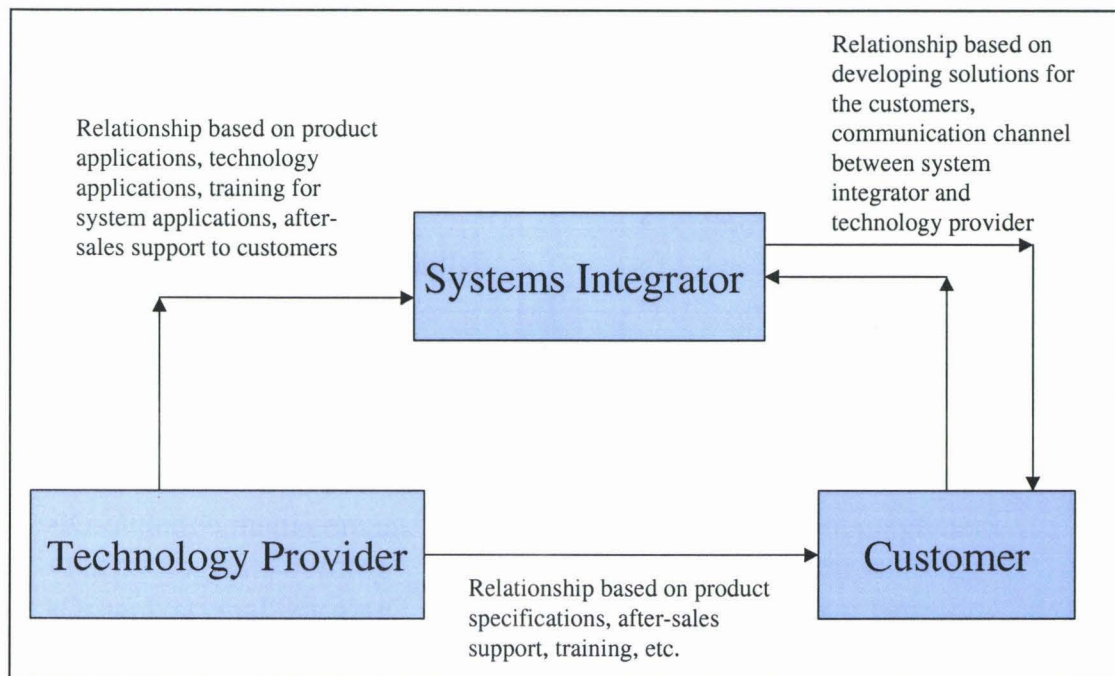


Figure 5.2: Relationships between customers, system integrators and technology providers.

Having discussed the steps involved in the research methodology and the three approaches adopted in this research, the next section is focused on selecting the industries in which the research was to be carried out.

5.1 Industry Selection

The industries selected for the research were limited to the electronics and electrical engineering industry and information technology industries. These industries were selected because most forms of technologies affect them. The scope of technologies in these industries range from design and manufacturing to business planning. This covers all the AMT classification areas. Therefore this selection will give a holistic picture of technology management and its effect on transaction processes and governance structures, which could then be applied to other industries. The AMT classification for market segments will be used. The market will be segmented into the categories: traditionalists, designers, generalists and high investors. Considerations and links to innovators, early adopter, early majority, late majority and laggards will also be used.

Previous research in AMT was categorised in a similar manner. This method also provides a holistic view of the organisational effects on technological implementations, which is why it was followed in this thesis. By using this method, comparisons could be drawn between this research and other research in the area of AMTs.

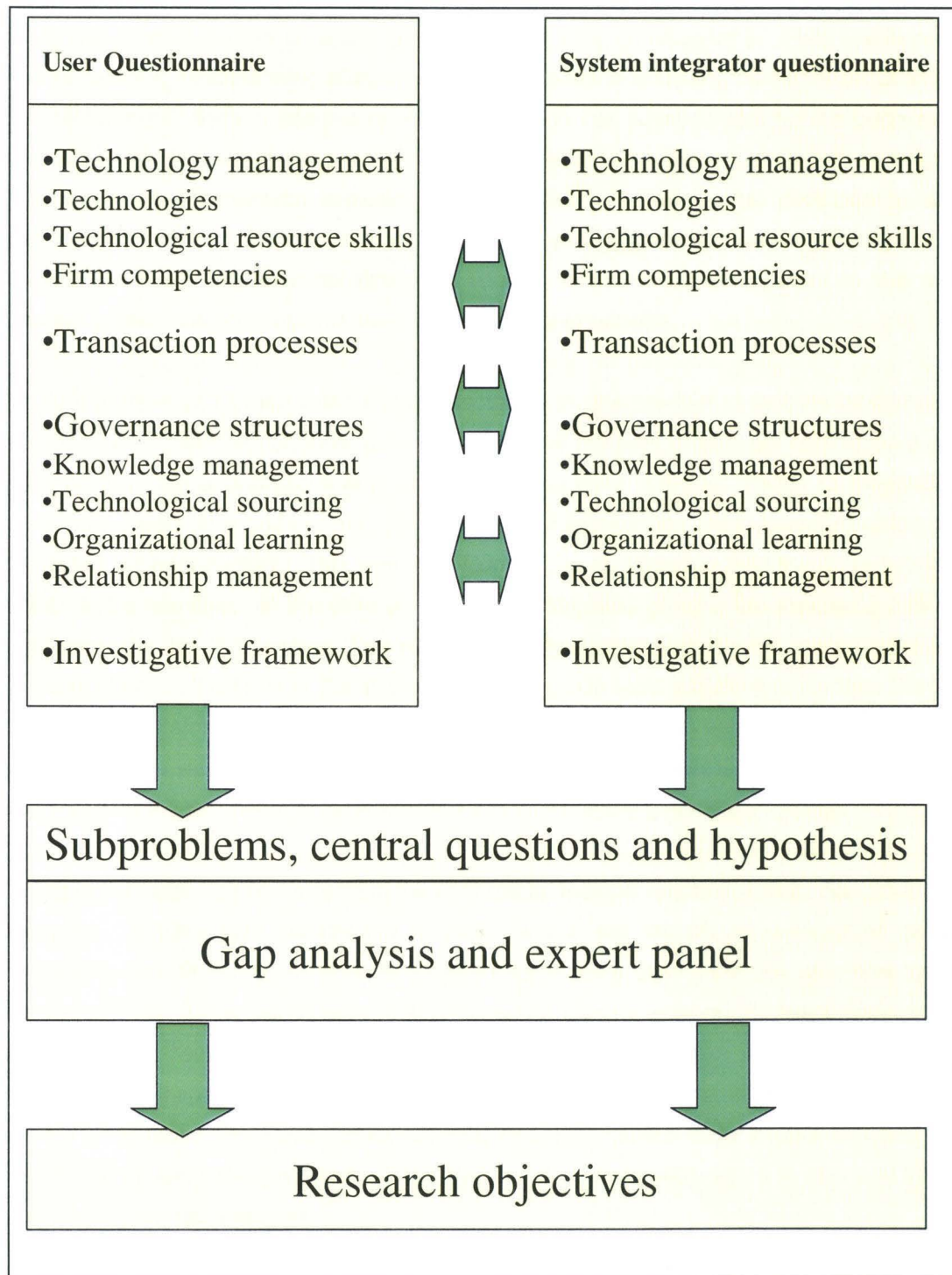


Figure 5.3: Relationships between questionnaires, subproblems, central questions, hypotheses and research objectives

5.2 Circulation of questionnaire

Since more than one person from each firm could participate in the responses, it was necessary, first of all, to gain the active interest and support of top management in these firms. This was essential to achieve an acceptable response rate for the questionnaires. The research consisted of two questionnaires, viz. the user questionnaire (Appendix D) and the

system integrator questionnaire (Appendix E). The system integrator questionnaire was designed to reinforce the links formed through the user questionnaire. This questionnaire was targeted at systems integrators who are the experts in matching customer requirements with technology. System integrators were included in this questionnaire for the purposes of evaluating whether or not firms were competent in assessing their technological needs, and thus establishing successful implementations. Research reveals that decisions to adopt technologies in firms were often made by managers who lacked the necessary background to assess the firm's technological options. These reasons were contributory to the firm's success in technological implementation and associated benefits.

Firstly a sample of 13 respondents was selected to for the pre-test to test the design of the questionnaire. Four respondents were selected from the user group, Six respondents were selected from the expert group and three academics were selected. These 13 respondents were interviewed on a one-on-one. As regards user groups, the chief executive officer was contacted for an interview. This was then followed by an interview with the chief executive officer or his nominee. In the case of the system integrator groups, the managing directors were contacted for an interview. This was followed by an interview with the managing director or his nominee. The firms in the system integrator group were usually smaller than the user groups and therefore for such firms the managing director was an appropriate contact. The initial circulation was used to determine whether or not the questionnaire was sufficiently well-structured for the respondents to understand and interpret the questions correctly.

Owing to the large size of the firms in the user group, multiple responses from this group were accepted. A t-test was constructed to verify bias in the sample as a result of multiple responses from firms. For the t-test selected items were used from the user and system integrator firms. These items were then checked for bias by categorizing responses into two categories, i.e. responses equal to one or responses greater than one. This method is discussed in Chapter 6, section 6.5. In addition, some user firms operated as users and system integrators. In these cases different decision makers were interviewed and both results were taken into consideration. Differences within firms with regard to user and system integrators were not analysed.

The majority of the firms were international and multinational and therefore it often occurred that the areas of responsibility of executive management and senior management covered more product ranges than middle management did. Middle management was often restricted to either one or two product ranges. This research was focused across the total range of product groupings and therefore the questionnaire was aimed mainly at executive or senior management level. Therefore it was necessary to modify the questionnaire to include the person's position in the company. The positions were divided into four categories, namely Chairman/CEO/COO, executive directors, non executive directors/general managers and

others, including technology specialists, strategists, business development managers, sales managers and marketing managers. All the responses were taken into consideration.

The firms that were to participate in the research were selected from the following registered authorities:

- The Financial Mail survey of the top 100 companies in South Africa. The June 2001 publication was used. From this survey the firms competing in the electronics and electrical engineering industry, and information technology industries were selected. This list was then pruned. This resulted in a final list of 40 top companies in South Africa.
- The list of Fortune 500 companies competing in South Africa was also used. The August 1999 publication was used. This list was then pruned. This resulted in a list of 10 firms.
- The South African Institute of Instrumentation and Control, covers the areas of the general electrical engineering category. Its list was pruned, resulting in a list of 19 firms.
- Top ICT companies within South Africa. This list was pruned and resulted in a list of 15 firms.

This resulted in a total sample size of 84 firms (response rates are discussed in Chapter 6, section 6.5), with 50 user firms and 34 system integrator firms. The list of user firms is shown in Appendix H, and the list of system integrator firms is shown in Appendix I. Samples sizes and response rates differ in operations management. Some other researchers have used the following sample sizes and response rates:

- Rosenthal (1984, p.203) used a three step research process involving 57 users, 38 system integrators⁴ and 64 experts with response rates of 78%, 86% and 48% respectively.
- Swamidass and Kotha (1999, p.27) used 160 firms across 7 industry sectors. The response rates per industry were as follows: Fabricated metal products 7.4%, industrial machinery and equipment 36%, electronic and other electric equipment 25.9%, transportation equipment 7%, instruments and related products 25.2%, miscellaneous manufacturing industries, 4.7% and others⁵, where no indication of sample size was given.
- Boyer, Ward Leong (1996, p.306) used 92 traditionalists, 25 designers, 64 generalists and 21 high investors. A 41.1% response rate was achieved.
- Choi and Hartley (1996, p.333) used 156 surveys. The response rates were 21% distributed as follows: 41% from plants, 24% from divisions, 33% from corporate

⁴ The author used the term supplier.

⁵ In this case respondents failed to disclose the identity of their firms and hence the response rate for this category could not be determined.

levels and a further 60% from divisions that were business units had more than \$50 million in annual sales.

In view of the different sample sizes used by the various authors, the sample size for this thesis of 84 and a response rate of 79% is deemed to be acceptable.

These are the two reasons for the high response rate. Firstly multiple responses from firms were accepted. Secondly the processes used in identifying each person and contacting them directly also led to the high response rate. The methodology for multiple responses was adopted from Dyer (1997, p.544). Non-respondents were followed up using a second letter of encouragement, after which no further follow-up was done. A test for non-response bias was conducted. This will be discussed in Chapter 6, section 6.5.

These bodies covered the spectrum of the product groupings and industries that were to be included in this research. These registered bodies are leading authorities on the relevant fields in South Africa and therefore the source is regarded as germane amongst experts in the field. These sources were used to identify firms and contact persons. Each person was contacted telephonically, thereafter a document giving an overview of the research was e-mailed. A follow-up telephonic conversation was held to set up interviews with the initial contact person. In some instances the person contacted referred the researcher to an individual within the organization who was more competent to add value to the research. In such cases the nominee was contacted and an alternative interview was set up. In other instances persons asked to see the questionnaire before the interview. The questionnaire was e-mailed to them, with a reminder that the questionnaire should not be filled as it was expected that this would be done during the interview process. This request was honoured by all respondents. Each questionnaire was addressed specifically to each person and then e-mailed to each of them.

To create a body of knowledge drawn from the experience of leading firms that were represented, a two-part survey method was adopted. The user survey was designed to address firms that were leaders and to check possible links that were related to technology management. The system integrator survey was aimed at the major system integrators in the market, and their observations and opinions were sought to determine possible links for the success/failures and potential benefits for technology management. A one-to-one mapping between the user and the system integrator questionnaire was used. A gap analysis was done based on the two questionnaires. An expert panel was used to test some of the preliminary findings obtained from the users and system integrators.

5.3 Questionnaire design

To incorporate the aspects depicted in Figures 3.1, the questionnaire was categorized into different sections viz. technologies, technological resource skills, firm competencies,

transaction processes, technological sourcing, knowledge management, organizational learning, relationship management, organizational determinants, competitors, external factors, manufacturing mix, RBV and TCE and the organisational and environmental evolution. This information was used to structure the questionnaire to obtain the relevant information from the respondents and for ease of coding and data capture. The benefits of using this method were the following:

- Parallels could be drawn between this thesis and other research.
- It facilitated responses from the respondents.
- It rendered possible the construction and testing of the framework for the research.
- It enabled the researcher to compare benefits of the resource based view and the transactions cost view, in relation to each firm and then determine the superior view.
- It ensured that all the inputs and outputs of technology management, transaction processes and governance structures were considered.

Using this as a basis and the metrics for each category, a discussion for the questionnaire follows:

- Technologies encompassed the extent to which firms have identified technological strategy and linked technological strategy into firm strategy. Thereafter consideration was given to technological investment decisions, and the effects of technological change where considered. Then technological implementation was addressed. Some examples included technological integration, which determines the level to which data transactions are integrated within firms. Technological integration covers the areas of design, manufacturing and business planning sections of the firm. Firms are rated as either being technology innovators, early adopters, early majority, late majority or laggards. Time periods were to be measured for integration of technologies between the design, manufacturing and business planning sections of the firm. Here firms could opt for islands of automation in terms of, say, design systems like CAD with no integration into manufacturing or little integration into manufacturing systems. Whether or not firms opted for islands of automation, there would be effects on transaction processes, governance structures and manufacturing mix criteria. The metrics in Table 4.2 were used.
- Technological resource skills focus on the implementation of technologies and its effects, which create competence destroying and competence enhancing skills. Tangible and intangible technological assets are considered to be a source of competitive advantage. The matching of the right tangible technological resource with the intangible technological resource was also considered.

- Firm competencies focus on core competencies and general competencies. Core competencies and general competencies are viewed as either improving or not improving competitive advantage. In addition, technological implementation is seen to be either improving or not improving competitive advantage.
- Firm competencies are related to transaction processes. Improvements in firm competencies lead to improvements in transaction processes like transaction cost reduction, transaction value added and manufacturing mix criteria.
- Knowledge management focuses on information flow and knowledge transfer within and between firms. Knowledge management could be facilitated with the use of new and emerging technologies. In addition the resources that are necessary to cope with new technologies are also considered. Technological sourcing is used as inputs to improve technological resource skills. Strategic alliances and joint ventures are considered as a means of either acquiring the technologies or technological resource skills as a means to benefit both partners in competitive advantage or as a means to merely acquire the skills of the other partner. Managers were asked to categorise their firm into either of these categories. In addition managers were asked to whether alliances are a source of competitive advantage.
- Organisational learning focuses upon the benefits of information flow and knowledge transfer with regard to learning-by-doing and learning-before-doing. In addition the effects of newer technologies on learning-by-doing and learning-before-doing were also considered. Lastly the effects of information flow and knowledge transfer on the firms absorptive capacity were also measured.
- Relationship management focuses attention on the following:
 - Social networks and embedded ties,
 - Supplier closeness, communications, trust and goodwill and
 - Risks.
- Organisational determinants focus upon industry selection and positioning, administrative practices and processes, the firms' core resources with regard to:
 - Individuals, assets and organisational structures,
 - Technological acquisition through tangible technologies,
 - Patented process or design
 - Intangible technologies like know-how shared among individuals in the firm
 - The firms selection and positioning with the industry.

- Competitors focused upon the firm's performance measured against its competitors over the last three years with regard to sales growth, return on sales and earnings growth. Other considerations were the firm's ability to transform itself in rapidly changing environments relative to its competitors. Finally the firm's defence against new entrants, buying power and substitute products were measured.
- External factors measured the effects of globalisation, e-business and social and economic factors on firms.
- Manufacturing mix process benefits as a result of technological implementation were measured with regard to cost, quality, speed, dependability and flexibility. Furthermore the effects of organisational determinants, competitors and external factors were also measured. Finally the effects of information flow and knowledge transfer and organisational learning on manufacturing mix criteria were also considered.
- Organisational and environmental evolution focuses upon firm competencies as a result of generalised factors like generic technologies, specialised factors like skilled resources and other related products, related and supporting industries, demand in South Africa, firms' strategy, structure and rivalry, and government intervention.

Having established a framework for the questionnaire the next step was to determine the questions. The metrics developed in Chapter 4 were used as a basis for the questionnaire design. The questions are shown in Appendix D, and E.

Seven-point Likert scales were used in majority of the cases, some questions also consisted of 5-point rankings. Responses range from 1 to 7 and in each question 1 to 7 was defined. The response X= Not relevant/Do not know was also made available. The questionnaire was sent to a pilot group as discussed in detail in Chapter 6.

5.4 Data Analysis

Figure 5.3 gave an overview of the problem integration. Having defined the questionnaire a more detailed description of the problem integration could be given as depicted in Figure 5.2. Referring to the questionnaire in Appendix D and E, each of the questions was coded with an alpha numeric character shown after the question number. These codes describe the area of questioning and the question number relative to that area, e.g. TC 1 refers to technological change question 1 of that section, TINV 4 refers to technological investment question 4 of that section, etc. These codes are used in Figures 5.4 to 5.12 to describe the questions that relate to the sub problems (SP1, subproblem 1, etc.), central questions (CQ1, central

question 1, etc.) and hypothesis (H1, hypothesis 1, etc.). Having discussed the bias for the questionnaire design, the subproblems are discussed next.

- SP1: Figure 5.4 shows the relationship between SP1 and the individual questions. For SP1: **How long does it take changes in technology to affect transaction processes?**

- Time periods after technological implementations to the realised benefits on transaction processes with regard to transactional cost reduction and transactional value added are measured.
- In addition time periods for integration between design, manufacturing and administration sections of a firm are measured.

These are measured from a user perspective and a system integrator perspective.

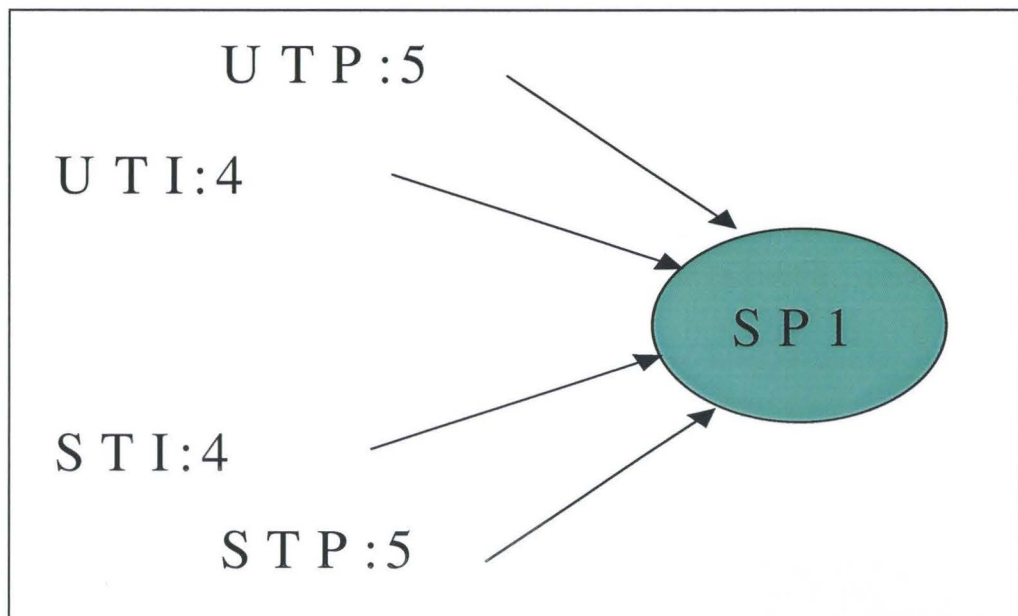


Figure 5.4: Subproblem 1 analysis

- SP2: Figure 5.5 shows the relationship between SP2 and the individual questions. For SP2: **What is the effect of organizational learning on transaction processes?**
 - The effects of organizational learning on transaction cost reduction and transaction value added are determined.

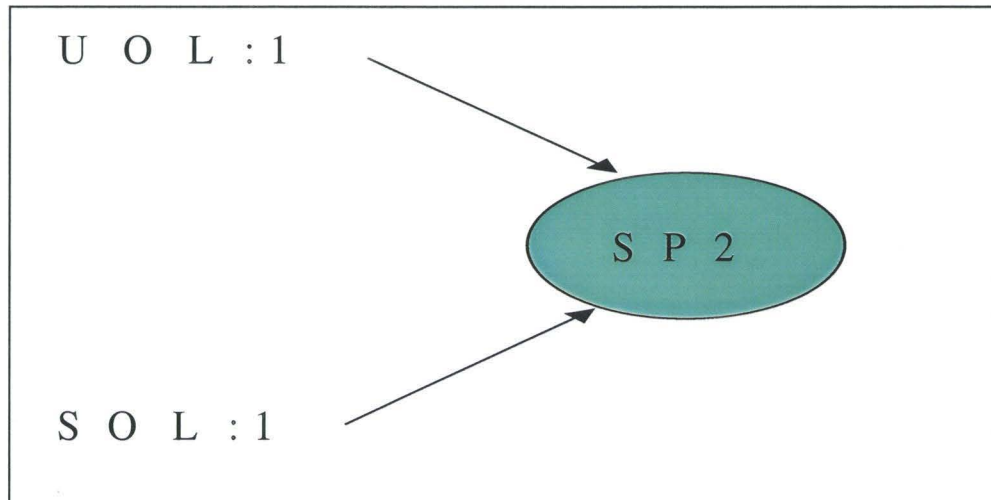


Figure 5.5: Subproblem 2 analysis

- SP3: Figure 5.6 shows the relationship between SP3 and the individual questions. For SP3: **What is the effect of information flow and knowledge transfer on transaction processes?**
 - The effects of information flow and knowledge transfer on transaction cost reduction and transactional value added activities are considered.

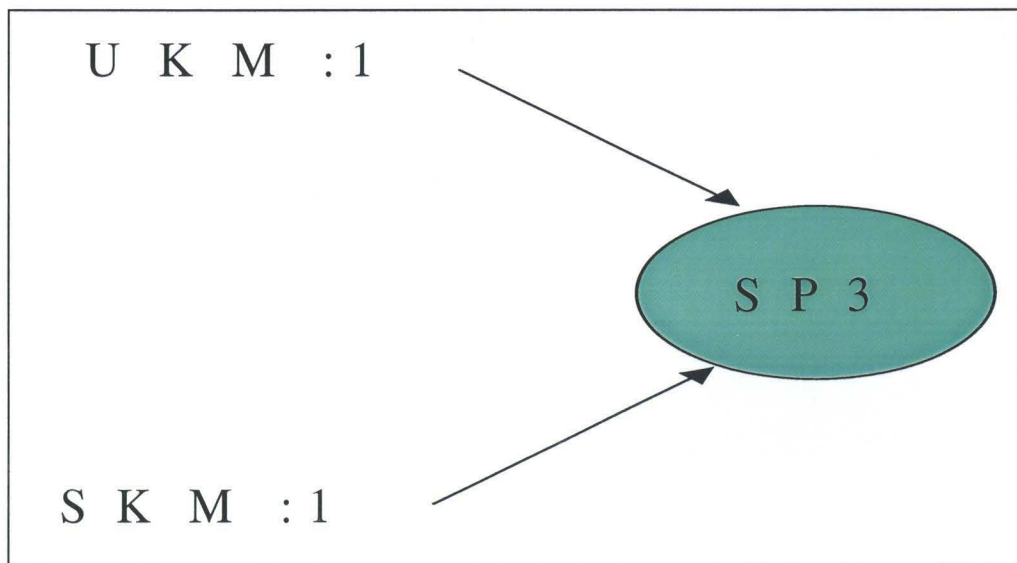


Figure 5.6: Subproblem 3 analysis

- SP4: Figure 5.7 shows the relationship between SP4 and the individual questions. For SP 4: **How do changes in technology, e.g. electronic commerce, affect manufacturing mix criteria?**
 - The benefits in terms of technological implementations are rated with regard to the manufacturing mix criteria.

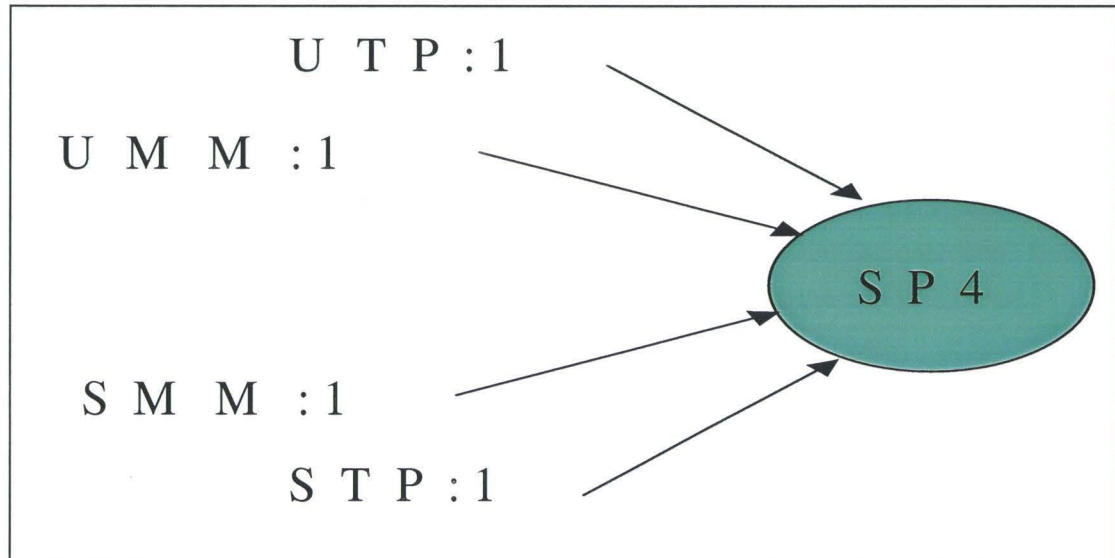


Figure 5.7: Subproblem 4 analysis

Having discussed the four subproblems the central questions are discussed next:

- For CQ1, Figure 5.8 shows the relationship between CQ1 and the individual questions. For CQ1: **How do changes in technology affect transaction processes?**
 - The benefits in terms of technological implementations in respect of transaction processes, i.e. transaction costs and transactional value added are considered.

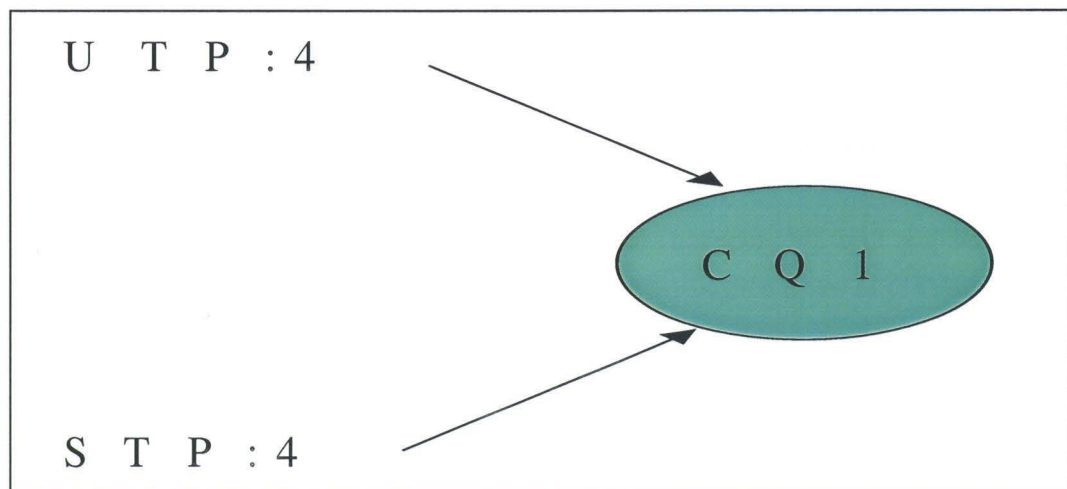


Figure 5.8 :Central question 1 analysis

- For CQ2, Figure 5.9 shows the relationship between CQ2 and the individual questions. For CQ2: **How do changes in technology affect governance structures?**
 - The extent to which technology management has improved: social networks and embedded ties, supplier closeness,

communications trust and goodwill and improved market opportunities through partnering IS considered.

- The extent to which firms have adopted effective governance in terms of joint ventures and strategic alliances, two-way technology exchanges, one-way technology exchange, direct investment and customer and supplier relations is considered.
- The extent to which technological implementations have improved network structures with key partners is considered.

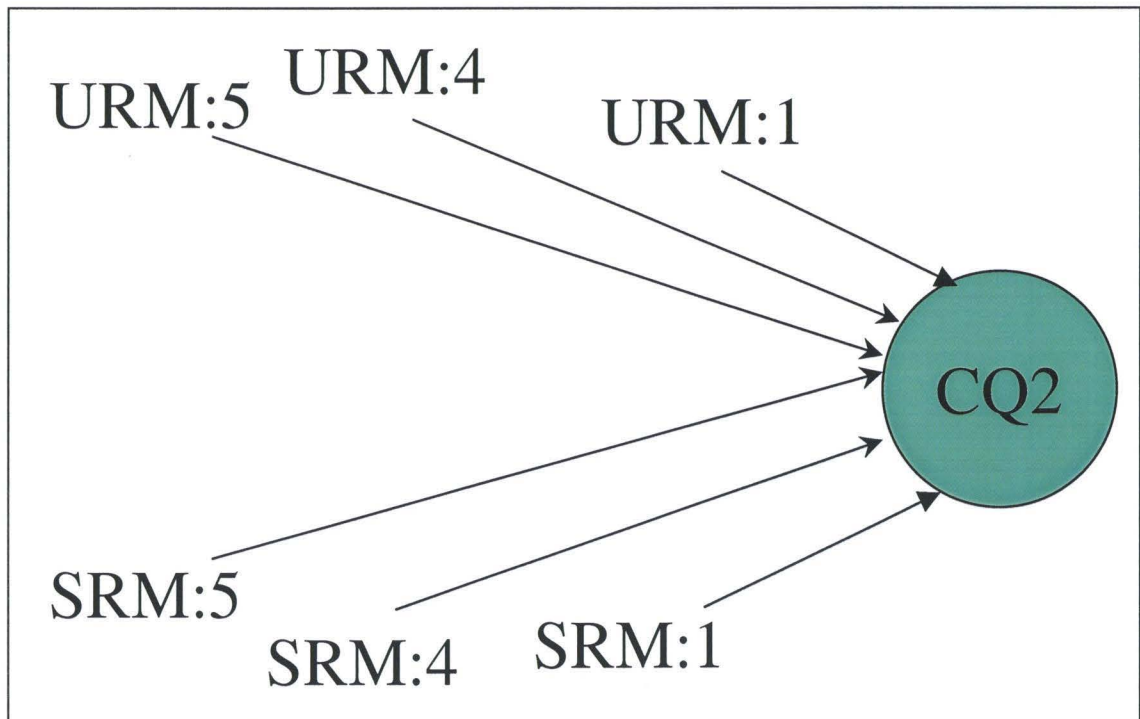


Figure 5.9: Central question 2 analysis

Having discussed the central questions the hypotheses are discussed next.

- For H1, Figure 5.10 shows the relationship between H1 and the individual questions. For H1: **Firms that adopt new technologies grow at different rates to other firms that maintain older technologies.**
 - Proportion of investments allocated to technological related activities is considered.
 - Proportion of technological investments allocated to the latest state of the art technologies is considered.
 - Firms' growth rates with regard to key competitors are considered. Growth is measured in terms of sales growth, return on sales and earnings growth.

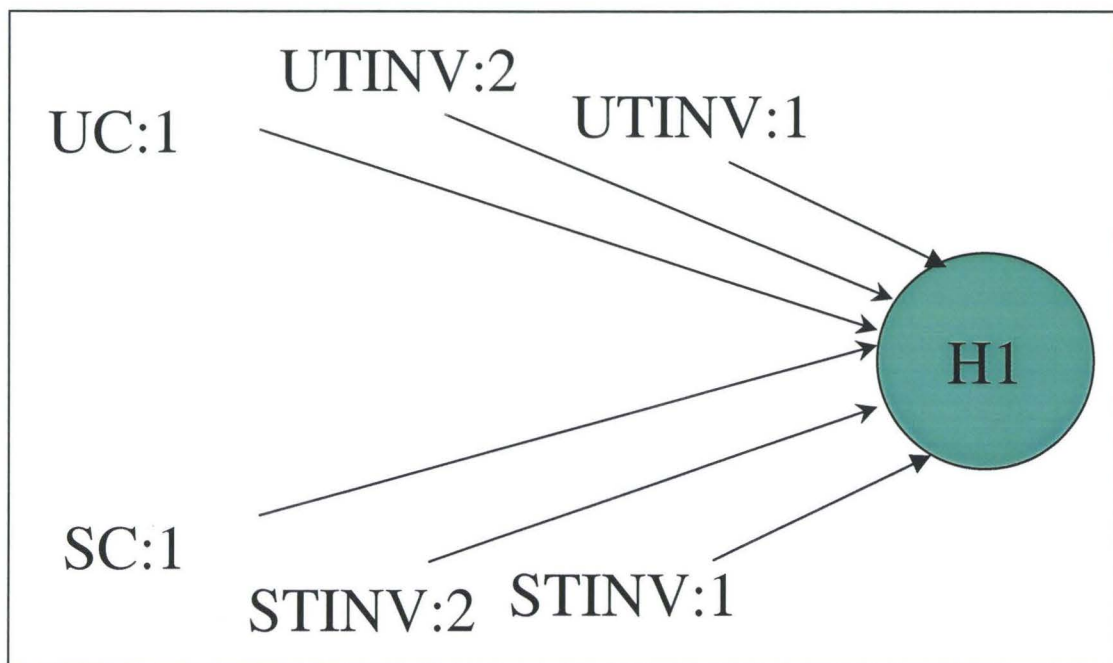


Figure 5.10: Hypothesis 1 analysis

- For H2, Figure 5.11 shows the relationship between H2 and the individual questions. For H2: **Managers rate manufacturing mix criteria as being more important than technological leadership.**
 - The importance of technologies in respect of the manufacturing mix criteria are considered.

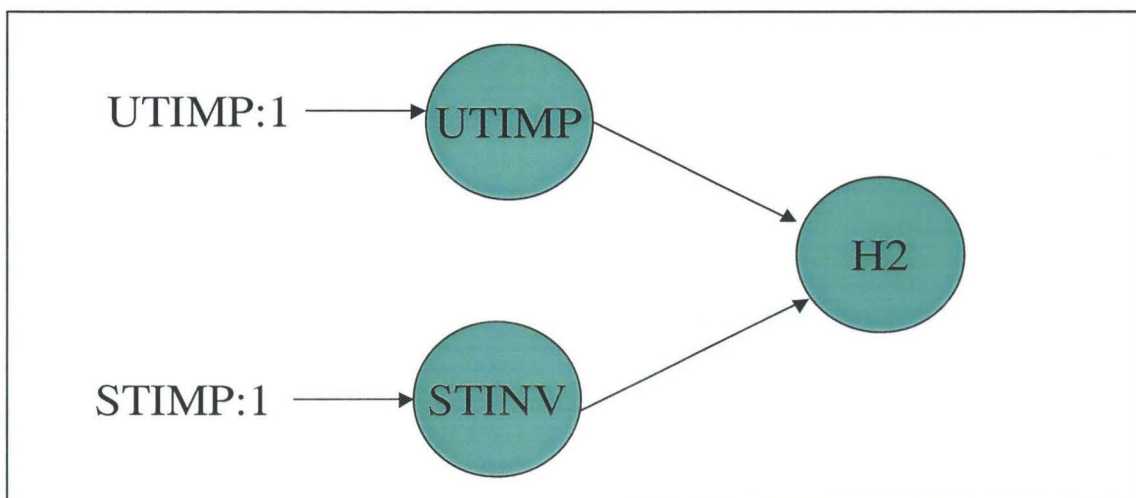


Figure 5.11: Hypothesis 2 analysis

Figure 5.12 shows the interrelationships between the subproblems, central questions and hypothesis.

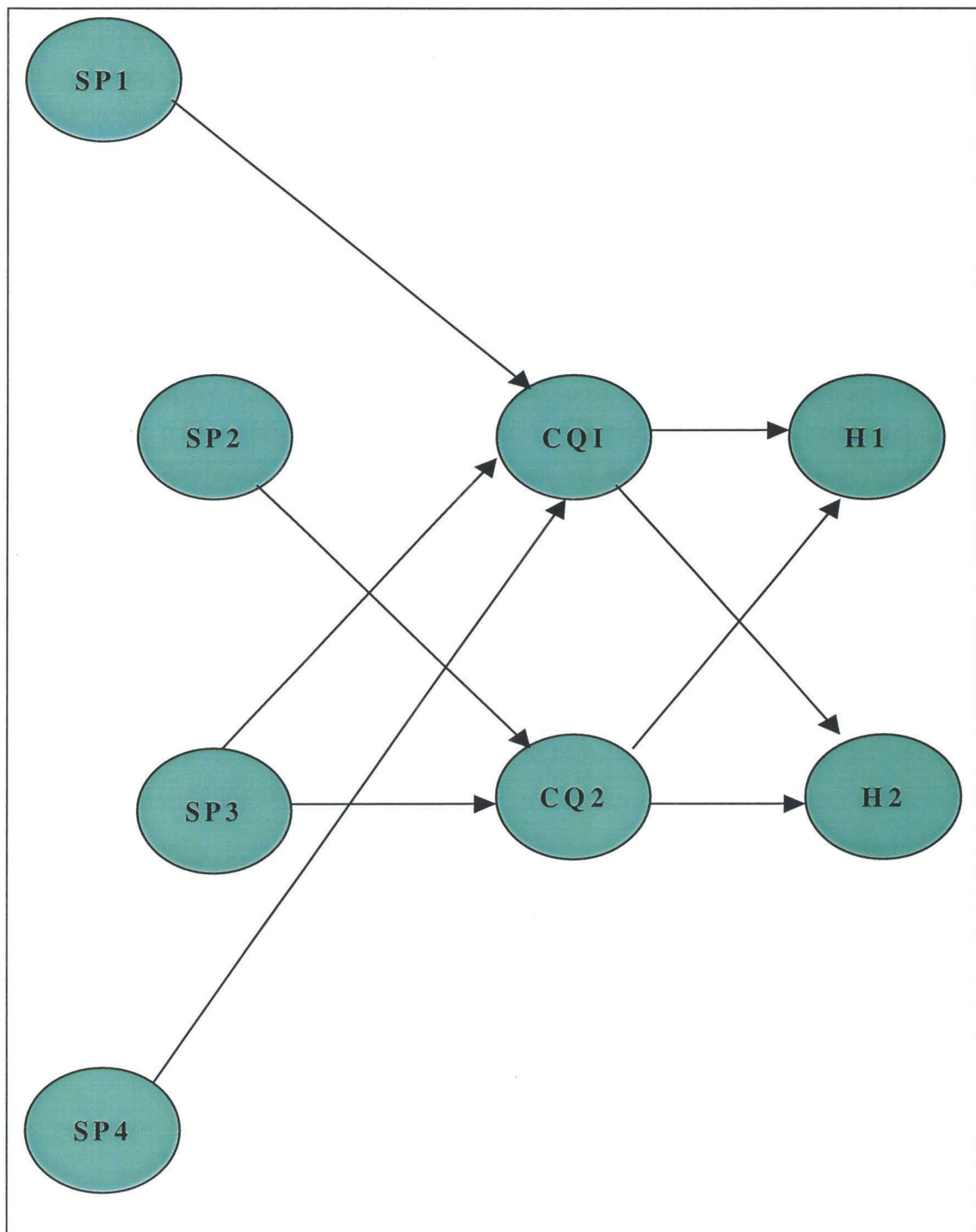


Figure 5.12: Linking of the subproblems, central questions and hypothesis

Figure 5.12 shows the links between the hypothesis, central questions and subproblems. The above discussion lays the framework for understanding the research objectives.

5.5 Reliability and Validity

A correlation method was used to study relationships between the various questions. Owing to the large number of items in the instrument (122) and the relative small population size of 84, two methods for testing reliability would be used: firstly the correlated-item total

correlations and secondly the Cronbach Alpha method was used. The questions were developed from the literature. To ensure that the questions were relevant it was necessary, after examining the correlated-item total correlations (CITC), for items with CITC less than 0.5 to be dropped to purify the questions. This method, however, could only be utilised at the final sample stage, because of the sample size of 84 and the number of items (122) in the instrument. The difference between the sample size and number of items posed an item-sample size problem. To alleviate this problem the 122 items were divided into 6 scales, this gave a number of items under each scale, which together with the CITC method was used to evaluate the adequacy of the items. It was expected that there would be a high degree of inter-correlation among the variables and therefore internal consistency is an appropriate measure for reliability. Cronbach's Alpha method was to be used to test internal consistency. Krause (1999, p.213) cites De Villis (1991) who noted that alpha values below 0.6 are unacceptable. Therefore it was decided that alpha values above 0.6 would be deemed acceptable for the items that remained. The Cronbach Alpha method was therefore utilised to make the final decision.

Validity, however, was to be tested by means of the literature survey and expert opinion, i.e. content validity, and for this an expert panel shall be used. For the expert method an expert panel would be set-up to test the statistical results. The questionnaire for the expert panel is shown in Appendix G. The questionnaire would be completed through a panel process to obtain opinions on certain issues.

5.6 Expected results

To answer the central questions and hypothesis, answers had to be obtained for the four subproblems. Each subproblem was considered individually. The first subproblem is:

SP1: How long does it take changes in technology to affect transaction processes?

- Transaction processes occur within and between firms. Within firms, time periods for integration between design, manufacturing and administrative functions of the firm were to be measured for a user group. This would give an indication of the firm's ability to integrate across its different sections. From a system integrators point of view, the time periods for integration were also to be measured. A strong correlation for periods of technological discontinuities was anticipated.
- A strong correlation between users and system integrators in respect of technological implementations and the associated benefits in transaction processes was also expected. Time periods for realised benefits after technological implementations was also expected to coincide for users and system integrators.

This problem measures the extent of competence enhancement in the form of level of technological integration. The literature survey indicates that highly integrated firms will be

highly competent in the technologies adopted in that firm. The reason for this is that if firms have not mastered the islands of automation as in AMT classifications, they will not opt for a high degree of integration between AMT typologies. It was therefore proposed that the level of integration would be a fair measure of competence enhancement. This is the case because if the results revealed a low level of competence enhancement this would mean that new technologies create technological discontinuities that destroy competence and therefore such firms would not be in a position to integrate technology across the AMT classifications adequately.

The second subproblem is:

SP2: What is the effect of organisational learning on transaction processes?

- The effects of organisational learning on transaction processes are measured with metrics namely transaction costs and transactional value added activities.

The third subproblem is:

SP3: What is the effect of information flow and knowledge transfer on transaction processes?

- The relationship between technological investment, information flow and knowledge transfer within and between firms was expected to be strongly correlated. Resultant benefits in transaction frequency, transaction certainty/uncertainty and transaction specific interests were expected.

The fourth sub problem is:

SP4: How do changes in technology, e.g. electronic commerce affect manufacturing mix criteria?

- Rapid technological change is expected to be met with high technological investment, together with improvements in manufacturing mix criteria. Other relationships are expected in supplier relationships, joint ventures and mergers in terms of technological knowledge acquisition, economies of scope, improvements in market access through partnering and improvements in communication and information sharing with key partners. Technological change is also expected to influence strategic partnerships with firms entering into new partnerships for technological knowledge acquisition.
- The influences of the manufacturing mix criteria were expected to be in firms' growth rates, technological investments, and transaction processes including standardisation of processes and procedures. Possible linkages exist for technological management in terms of correlations relating to automation of data transactions, information flow and knowledge transfer within and between firms and supplier relationships.

These possible linkages provide the feedback from technological management into the manufacturing mix criteria, which eventually could result in the proposed impact on transaction processes and governance structures. The investigative framework initially does not show the feedback loop between manufacturing mix and technology management, but this loop is inevitable as will be evident from this thesis. In addition, further supporting arguments include the investments of other firms in technology that influence competition thereby forcing firms to improve manufacturing mix criteria, which in turn affect technological management. It is envisaged that relationships between technological integration and improvements in terms of communication and information processing create competence enhancing effects as a result of the timing of technological transitions, which in turn affect manufacturing mix criteria. This argument in turn supports the two central questions because manufacturing mix criteria affect technological management.

We now turn to the central questions. The first central question is:

CQ1: How do changes in technology affect transaction processes?

- Through technological integration benefits can be realised in transaction processes. Technological integration will have improvements in automation of data transactions within and between firms. Competence enhancing and competence destroying effects will be felt. Time periods for technological discontinuities and information flow and knowledge transfer will also be influenced.

The second central question is:

CQ2: How do changes in technology affect governance structures?

- Governance structures for supplier relationships are expected to be strongly influenced by technological change. The future supply forces changes in supplier roles, responsibilities and selection. Technological change is expected to bring about improvements in knowledge management, technological sourcing, organizational learning and relationship management. It is also expected that firms will often change suppliers to keep up with the latest market trends in terms of technology to meet market benchmarks for competitiveness in manufacturing mix criteria. Technological change is also expected to have marked improvements in technological integration.

Having developed answers to the subproblems and central questions for this thesis, we have the foundation for the hypothesis. The hypothesis rests on the links established thorough the central questions and subproblems. The first hypothesis is:

H1: firms that adopt new technologies grow at different rates to other firms that maintain older technologies.

- It was expected that this hypothesis would prove to be true. Firms' growth in terms of sales growth, return on sales and earnings per growth were expected to correlate to technological investment. Technological investment in the latest available technologies is expected to be more strongly correlated to firm growth. However, technological investment is not the only ingredient for firm growth. Other ingredients are expected to be found in knowledge transfer and information flow, organisational learning, firm diversification and supplier relationships.

The second hypothesis is:

H2: Managers rate manufacturing mix criteria more important than technological leadership.

- It was expected that this hypothesis would prove to be true. Firms' competitiveness is driven through the benefits from technological investment and not from the investment itself. Other facets include knowledge transfer and information flow, technological integration, organisational learning, supplier relationships, and manufacturing mix, will lead to growth in firms. Simply investing in technology is not the only ingredient that managers rate important.

5.7 Research objectives

The research objectives were three-fold:

- Firstly to understand the links between technological management, transaction processes and governance structures,
- secondly to investigate parts of core competence (RBV) and transaction cost economies (TCE) views and to determine the superior theory or link parts of both theories and
- thirdly to investigate the technological effects of the organizational and environmental evolution on firm's competitive advantage.

It was expected that the linkages between technology management, transaction processes and governance structures as depicted in Figure 3.1 and the investigative framework in Figure 3.3 would be validated. It was also expected that in respect of the three objectives the findings will be as follows:

- Not all the links would found, but links in the model were expected.
- It was also expected that enough evidence is provided to categorize the relative advantages and disadvantages of the RBV and TCE views.
- It was expected that organizational and environmental evolution drives firms, i.e. push relationships, and these relationships force firms to develop competitive advantages.

6 The Research Results

6.1 *Pre-test*

For the pre-test a data pack was sent to a small group. This group consisted of specialists in the areas of technology management, both in the user firms and system integrator firms. The group was made up of senior and middle management functions, which included CEOs, executive directors, strategy managers, managing directors, business development managers and other functional specialists involved in technology management. The data pack consisted of the following documents, viz.:

- Overview of research, appendix A.
- Interviewer instructions, appendix B.
- Definition of terms, appendix C.
- Questionnaires
 - Appendix D, user questionnaire and
 - Appendix E, system integrator questionnaire.

They were given a few weeks to examine the data pack. Individual interviews were then set up. During the interview process, they were asked to review the questionnaire and comment on the language and clarity of each question, as well as the overall format. Their input was gained through interactive, structured interviews and was a helpful way to improve the instrument in respect of its wording, clarity and relevance. This group was too small to perform any CITC or Cronbach alpha tests. Some of the comments received from the pilot group are discussed next (the question numbers refer to the modified questionnaires):

- For ease of understanding the questionnaire format was changed from a point numbering system to a tabular system. The initial user questionnaire is shown in Appendix F.
- Using the Likert scale, 1 signified little or no effect and 7 signified a good effect. Some respondents felt that a better word to use would be 'large' instead of 'good'.
- For question 4 an even scale interval was used. It was suggested that this scale might not be appropriate because the scale was too large and all responses could typically fall into the first category. The scale was accordingly modified to an unequal scale.
- Question 18, 24, 33 and 38 was changed from a forced ranking system to 7-point Likert scales.
- In Question 38 the term 'transactional history' was used it was recommended that this be clarified by using an additional explanatory phrase. The following extension to the question was added: "an increased number of transactions over a long period of time".
- Question 10 used the terms 'design', 'manufacturing' and 'administration'. Some respondents felt that the word administration was misleading as it could mean to reflect only financial or commercially related activities, so the questionnaire was

modified to include the words 'ERP' (enterprise resource planning) and 'MIS' (management information systems).

The above list does not include all recommendations. For reference the questionnaires before the pre-test are also included in Appendix F. After each interview the questionnaire was accordingly modified before any further interviews were conducted. Having completed the pre-test round, the pilot group interviews were conducted next.

6.2 Pilot test

For the pilot group, 15 firms were selected in total. The firms were selected from each category shown in table 6.1 below.

- User firms - Electronics and electrical engineering industry.
- User firms - Information technology industry.
- System integrator firms - Electronics and electrical engineering industry.
- System integrator firms - Information technology industry.

The size of the pilot sample may seem small, but other authors working in this area have used smaller sample sizes for pilot projects for example Swamidass and Kotha (1998, p.28). The instrument used by Swamidass and Kotha (1998, p.28) consisted of 19 items, in which 17 firms were used to test reliability. Simonin (1999, p.605) used 12 interviews for a pre-test and respondents consisted of doctoral students, and faculty and business contacts. This questionnaire consists of 15 respondents and an instrument of 122 items. In terms of the evidence provided this is deemed to be acceptable.

Table 6.1: Firms selected for the pilot group

	Electronics and electrical engineering industries	Information technology industry
User firms	Siemens Ltd. Spescom Datavoice Delta ABB Alstom Electrical	Siemens Business Services Software Features Setpoint Technology
System integrators	Keopps Isis AST Siemens A&D Siemens Technical Services	Data Tech Faritec Strategic Services Compatible Information Systems

The spread of firms across the industries was also deemed acceptable. The interview process is discussed next.

6.3 The interview process

For the final run, three different methodologies were considered, viz.:

- Option 1: Questionnaire distribution through mail survey.
- Option 2: Personalised interviews using an external company to perform field work.
- Option3: Personalised interviews conducted by the author.

The advantages and disadvantages of each option are discussed next.

- Option 1: Questionnaire through mail survey.
 - Firstly, during the pre-test and pilot stage, it took approximately 60 minutes to complete a questionnaire. In addition, being a cross-sectional study across the disciplines of technology management, strategic management, organizational and TCEs, and operations management not all respondents were au fait with all aspects of these areas. Real examples often had to be quoted so as to clarify the terms and definitions
 - Secondly the mail survey had the advantage that the questionnaires would not require a large time commitment from the author. With a sample size of 84 and an expected response rate of 65%, it would require approximately 78 hours of interviewing time. Taking travel time and availability of respondents into account, it was estimated that the interview process would last approximately 3 to 4 months.
 - In view of the possible misinterpretation of the definitions by respondents this option was not favoured.
- Option 2: Personalised interviews using an external company to perform field work
 - Firstly, being a cross-sectional study the time span from the start of the interviewing process to its completion was identified as being important. The time span should be as small as possible. In view of the fact that many firms would be involved in the interview process it was calculated that this would take the author approximately 3 to 4 months to complete. This time span was acceptable but taking other commitments of the respondents into account this period might have to be extended by at least another month. This time period would also be acceptable. However, option 2 could reduce the time period to within 1 to 2 months by using multiple interviewers.
 - Secondly, the firms that were identified for the research focused on a limited population, split as follows:
 - User firms: electronics and electrical engineering, 20 firms and information technology industry, 11 firms.
 - System integrator firms: electronics and electrical engineering industries, 14 firms and information technology industry, 16 firms, and others 3.

As can be seen the population is fairly limited and should a mail survey be utilised it was envisaged that not enough responses would be received to draw meaningful results from the research. Therefore option 2 was better than option 1 in this regard. In addition, the

geographical distances between firms meant that a fair amount of travel would be required and by using multiple interviewers this problem could be reduced.

- Thirdly, using personalised interviews was envisaged to have an estimated market response rate of approximately 75-80%. In view of this high response rate, the sample size would achieve the required sample size for meaningful statistics, i.e. 25-30 in terms of the “magic number”.

However, the use of an external company still raised a few concerns, viz.:

- Firstly, three individuals together with a supervisor were involved in the interview process. To ensure that the questions were not interpreted differently by each of the interviewers, it was necessary for interview instructions to be drawn up. These interviewer instructions are shown in Appendix B. The interviewers were trained by the author and this training was conducted during the pre-test phase.
 - Secondly to ensure that the results were not fabricated or misrepresented, the author would be required to conduct additional interviews to validate the results.
 - Thirdly a trial run was performed with the external company. The following problems were encountered: in two occasions the external company cancelled meetings with the author at the last minute. In addition the external company had over-committed itself with regard to other activities and therefore had problems keeping to a strict deadline. Furthermore the cost involved in using the external company was in the region of R50 000, which deviated significantly from their initial quotation.
 - In view of the advantages, disadvantages and problems encountered with the external company, this option was abandoned.
- Option3: Personalised interviews conducted by the author.
 - Firstly, this option had the advantage that any misconceptions or misunderstandings during the interview process could be cleared up immediately.
 - The disadvantage was that the author is well known in the industry and therefore some firms would not be willing to be interviewed as this might pose a conflict of interests since the author is employed by a competitor firm. However, the structure of the research is an original contribution to knowledge and therefore even though this was a possible hurdle, the author believed it could be overcome. An additional letter from the University of the Witwatersrand stating that

the author was conducting research for a Ph.D thesis would also be presented during the interviewing process.

Having compared the three options in terms of their advantages and disadvantages, option 3 was selected as the best one.

Having discussed the interview process, the analyses of results are discussed next.

6.4 Analysis of results

The results of the pilot test were included in the final results. The Cronbach alpha analysis was used to explore the instrument with several objectives in mind: purification, reliability, conciseness as well as constructive and predictive validity. Previous researchers in operations management have deferred in their selection of Cronbach Alpha. Some authors share the following views.

- Flynn et al (1990, p.266) suggests a Cronbach alpha value of 0.70 as the minimum acceptable alpha value.
- Tracey, Vonerembse and Lim (1999, p.417) have suggested that CITC (Correlated item total correlation) values below 0.5 are unacceptable and that alpha values below 0.6 are unacceptable. The authors have also used a scale technique hence the lower alpha value.
- Krause (1999, p.213) citing DeVellis (1991) says that alpha values below 0.6 are unacceptable.

In view of the evidence provided it was decided that an alpha value of 0.60 would be utilised. Items which did not contribute strongly to Cronbach Alpha, would be dropped in the final stage. Items where the content of which was considered important to the research, were modified during the pilot stage. Cronbach alpha was also calculated after the final run. At this stage items that did not contribute to Cronbach alpha were dropped. In this thesis the CITC methodology was used to test the 'positive-ness' or 'negative-ness' of responses. The numerical value of the responses for the CITC methodology was not utilised owing to the large number of items in the questionnaire (122), in comparison to the small sample size of 33, for the user and system integrator firms respectively.

The Cronbach Alpha reliability tests are discussed next. The Cronbach Alpha tests are given in Appendix K. The final questionnaire consisted of 122 items and 66 responses, 33 responses from the user firms and 33 responses from the system integrator firms. To obtain meaningful Cronbach Alpha results multiple Cronbach Alpha tests were performed. This consisted of dividing the items into scales, six scales were used in the final interpretation. The scales consisted of a number of items in each scale, this resulted in a greater reliability for the Cronbach Alpha tests. The six scales that were used are: technology management, transaction processes, governance structures, the investigative framework, the RBV and TCE views and the organizational and environmental evolution. The tests were as follows:

- Cronbach Alpha tests for the whole group, Appendix K, section K1. The following results were obtained:
 - Reliability for user group - 0.922.
 - Reliability for system integrator group - 0.9272.
- Cronbach alpha tests for the combined user and system group, Appendix K, section K2. The following results were obtained:
 - Reliability for user and system integrator groups - 0.9229.

The Cronbach alpha values were considered to be high. This was due to the large number of items in the questionnaire, i.e. 122, compared to the low number of responses 33. In view of this situation, a scale method for the Cronbach Alpha tests was next performed.

- Cronbach Alpha tests scale method, Appendix K, section K3. The questionnaire was categorized into six groups, i.e. Technology management, transaction processes, governance structures, investigative framework, RBV and TCE view and organizational and environmental evolution. Each of these categories was then tested for Cronbach Alpha. The following results were obtained (Table 6.2):

Table 6.2: Cronbach Alpha tests utilizing scales

Cronbach Alpha 6 scales combined	Cronbach Alpha 6 scales split for user and system integrators		Cronbach Alpha 6 scales reported independently		
Combined (user & system integrators) Cronbach Alpha	User firm	System integrator	Scales	User firm	System Integrator
0.7923 Appendix K4	0.7975 Appendix K3	0.8124 Appendix K3	Technology management Appendix K5, K5.1	0.6995	0.6952
			Transaction processes Appendix K5, K5.2	0.8223	0.8305
			Governance structures Appendix K5, K5.3	0.7338	0.8175
			Investigative framework Appendix K5, K5.4	0.8238	0.7644
			RBV & TCE view Appendix K5, K5.5	0.744	0.6022
			Organizational & environmental evolution Appendix K5, K5.6	0.507	0.5332

The Cronbach alpha tests were deemed acceptable and all items were utilized. The Cronbach alpha scales for the subscale organizational and environmental evolution

for the user and system integrator groups are low at 0.507 and 0.5332 respectively. However, the Cronbach alpha for the interval method combined user and system group, section K4, is 0.7923, and hence the use of this subscale for the user group is justified. Non-response and industry bias are discussed next.

6.5 Non-response and Industry bias

There are different opinions on testing for non-response bias. Some authors have used the following:

- Swamidass and Kotha (1998, p. 28) used a chi-square test to determine non-response and industry bias. They used certain criteria like number of employees, 5-year income growth and 5-year sales growth for respondents and non-respondents. These two groups were tested for bias.
- Krause (1999, p.212) used late respondents to determine typical responses of non respondents. They say“(a)lthough these results do not rule out the possibility of non response bias, they suggest that non response may not be a problem to the extent that late responders represent the opinions of non respondents.”

In this thesis information like number of employees, income growth and sales growth relating to non-respondents could not be obtained and therefore the method suggested by Swamidass and Kotha (1998) could not be used. The researcher decided to use the method suggested by Krause (1999) instead. Table 6.3 shows the distribution of industries in the 84 firms receiving the questionnaires and the distribution of industries among the respondents. In Tables 6.5 and 6.6 variables (selected at random) between responding and non-responding firms are compared. The *t*-statistic in Tables 6.5 and 6.6 is interpreted to mean that non-response is either a factor or not a factor i.e. where there are significant differences between means, then non-response who have introduced bias alternatively where there are no significant differences between means non-response would not have introduced bias into the study.

Table 6.3: Industries and respondents

Categories		No. of responses	% of responses	Questionnaires mailed to	% of total mailed
User firms	Electronics and electrical	20	61%	17	20%
	Information technology	11	33%	32	38%
	Other	2	6%	1	1%
Total		33	100%	50	60%
System integrators	Electronics and electrical	14	43%	23	27%
	Information technology	16	48%	11	13%
	Other	3	9%	0	0%
Total		33	100%	34	40%
Grand total		66	100%	84	79%

Table 6.4: Respondents

	Respondent category	No. of responses	% of responses
1.	Chairman/CEO/COO	7	11%
2.	Executive directors	20	30%
3.	Non-executive directors/General managers	21	32%
4.	Others	18	27%
Total		66	100%

Tables 6.5 and 6.6 below depict a test for non-response bias for user and system integrator firms respectively. The interviews were categorised into early responses and late responses. For early responses 18 firms were selected and for late responses 15 firms were selected. The responses from these firms were then compared using *t*-tests. It was found that for selected variables there are differences between early responses and late responses. The responses from the latter 15 could be viewed as being the same as non-respondents. Hence it may be concluded that there are no bias as a result of non-response.

Tables 6.7 and table 6.8 shows that there is no bias for multiple responses from user and system integrator firms. Responses were categorized into responses of 1 or more than one and these two categories were then compared using *t*-tests. It was found that firms that responded more than once did not introduce bias into the results. This is true for both the user and system integrator firms.

Table 6.5: A test for non-response bias in user firms

Question nos.	Category	User and System integrators	Mean	Standard deviation	F test for equality of variances	t-test for equality of means	Significance 2- tailed	Degrees of freedom
1	To what extent do you believe that your firm's business strategy and technology strategy are aligned?	First 18 Second 15	4.75 4.78	1.67 1.30	0.710 Sig. 0.413	-0.038 ⁺	0.970	64
2	To what extent do you believe that your firm's business strategy has a positive effect on its firms competitive strategy?	First 18 Second 15	5.63 5.00	1.30 1.50	0.027 Sig. 0.873	0.919 ⁺	0.372	64
3	Pick the technological approach that is adopted by your firm most of the time.	First 18 Second 15	2.00 2.56	1.07 0.88	0.001 Sig.0.9 0.974	-1.160 ⁺	0.266	64
7	In relation to technological investment, do you believe that your firm invests adequately in staff training?	First 18 Second 15	4.00 4.11	1.51 1.17	1.430 Sig. 0.250	-0.168 ⁺	0.869	64
14	How would you rate the competence of managers in your firm with regard to assessing the firm's technological needs?	First 18 Second 15	4.63 4.22	1.69 1.30	0.102 Sig. 0.754	0.547 ⁺	0.594	64
18	To what extent do you believe that your firm's tangible and intangible technological resources are matched?	First 18 Second 15	4.88 4.67	1.25 1.73	0.942 Sig. 0.347	0.287 ⁺	0.778	64
29	To what extent does your firm view strategic alliances as a source of competitive advantage?	First 18 Second 15	6.00 5.22	0.53 1.30	2.876 Sig. 0.111	1.643 ⁺	0.129	64
40	To what extent has technological implementation in your firm led to improved network structures with key partners over the last 5 years?	First 18 Second 15	5.38 5.11	1.06 0.60	4.525 Sig. 0.050	0.621 ⁺	0.548	64

⁺ Equal variances not assumed

Table 6.6: A test for non-response bias in system integrator firms

Question nos.	Category	User and System integrators	Mean	Standard deviation	F test for equality of variances	t-test for equality of means	Significance 2- tailed	Degrees of freedom
1	To what extent do you believe that your firm's business strategy and technology strategy are aligned?	First 18 Second 15	3.90 3.43	1.10 1.27	0.005 Sig. 0.947	0.794 ⁺	0.471	64
2	To what extent do you believe that your firm's business strategy has a positive effect on its competitive strategy?	First 18 Second 15	5.30 5.86	0.67 0.69	0.142 Sig. 0.711	-1.653 ⁺	-0.557	64
3	Pick the technological approach that is adopted by your firm most of the time.	First 18 Second 15	2.40 2.43	0.97 0.79	0.167 Sig. 0.689	-0.067 ⁺	0.029	64
7	In relation to technological investment, do you believe that your firm invests adequately in staff training?	First 18 Second 15	3.30 2.43	1.25 0.79	4.755 Sig. 0.046	1.623 ⁻	0.125	64
14	How would you rate the competence of managers in your firm with regard to assessing the firm's technological needs?	First 18 Second 15	3.10 3.00	1.10 1.00	0.074 Sig. 0.789	0.195 ⁺	0.849	64
18	To what extent do you believe that your firm's tangible and intangible technological resources are matched?	First 18 Second 15	3.90 3.43	1.20 0.79	1.059 Sig. 0.320	0.979 ⁺	0.343	64
29	To what extent does your firm view strategic alliances as a source of competitive advantage?	First 18 Second 15	5.30 5.43	0.67 0.79	0.316 Sig. 0.582	-0.351 ⁺	0.732	64
40	To what extent has technological implementation in your firm led to improved network structures with key partners over the last 5 years?	First 18 Second 15	5.00 4.86	1.15 1.35	0.047 Sig. 0.832	0.228 ⁺	0.823	64

Table 6.7: Test for bias from multiple responses from User firms

Question nos.	Category	User and System integrators	Mean	Standard deviation	F test for equality of variances	t-test for equality of means	Significance 2- tailed	Degrees of freedom
1	To what extent do you believe that your firms business strategy and technology strategy are aligned.	1 >1	5.13 4.89	1.19 1.27	0.032 Sig. 0.858	0.484 ⁺	0.636	64
2	To what extent do you believe that your firms business strategy has a positive effect on your firms competitive strategy	1 >1	5.50 5.78	1.22 1.30	0.00 Sig. 0.987	-0.556 ⁺	0.587	64
3	Pick the technological approach that is adopted by your firm most of the time	1 >1	2.17 2.56	1.05 0.88	0.444 Sig. 0.510	-1.069 ⁺	0.300	64
7	In relation to technological investment do you believe that your firm invests adequately in staff training	1 >1	4.33 4.78	1.43 1.48	0.04 Sig. 0.953	-0.774 ⁺	0.452	64
14	How would you rate the competence of managers in your firm with respect to assessing the firm's technological needs.	1 >1	4.71 4.22	1.27 1.72	0.670 Sig. 0.419	0.774 ⁺	0.454	64
18	To what extent do you believe that your firms tangible and intangible technological resources are matched.	1 >1	4.63 5.00	1.24 1.22	0.121 Sig. 0.730	-0.780 ⁺	0.448	64
29	To what extent does your firm view strategic alliances as a source of competitive advantage	1 >1	5.54 5.67	1.28 0.50	3.024 Sig. 0.092	-0.402 ⁺	0.690	64
40	To what extent has technological implementation in your firm lead to improved network structures with key partners over the last 5 years	1 >1	5.00 4.78	1.38 0.67	2.226 Sig. 0.146	0.618 ⁺	0.541	64

⁺ Equal variances not assumed, - Equal variances assumed

Table 6.8: Test for bias from multiple responses from system Integrator firms

Question nos.	Category	User and System integrators	Mean	Standard deviation	F test for equality of variances	t-test for equality of means	Significance 2 tailed	Degrees of freedom
1	To what extent do you believe that your firms business strategy and technology strategy are aligned.	1 >1	3.57 3.83	1.54 1.19	0.969 Sig. 0.332	-0.545 ⁺	0.590	64
2	To what extent do you believe that your firms business strategy has a positive effect on your firms competitive strategy	1 >1	5.33 5.67	1.11 0.79	0.570 Sig. 0.452	-1.009 ⁺	0.321	64
3	Pick the technological approach that is adopted by your firm most of the time	1 >1	2.43 2.08	0.75 1.16	0.443 Sig. 0.510	0.924 ⁺	0.369	64
7	In relation to technological investment do you believe that your firm invests adequately in staff training	1 >1	3.29 3.08	1.38 1.08	1.332 Sig. 0.257	0.466 ⁺	0.645	64
14	How would you rate the competence of managers in your firm with respect to assessing the firm's technological needs.	1 >1	3.48 3.17	1.12 1.03	0.113 Sig. 0.739	0.803 ⁺	0.429	64
18	To what extent do you believe that your firms tangible and intangible technological resources are matched.	1 >1	3.81 3.67	0.81 1.15	2.10 Sig. 0.158	0.378 ⁺	0.710	64
29	To what extent does your firm view strategic alliances as a source of competitive advantage	1 >1	5.52 5.33	0.81 1.07	0.646 Sig. 0.428	0.533 ⁺	0.600	64
40	To what extent has technological implementation in your firm lead to improved network structures with key partners over the last 5 years	1 >1	5.14 5.08	1.11 1.00	0.074 Sig. 0.788	0.158 ⁺	0.875	64

In this thesis non-response did not introduce any bias into the study in addition multiple responses also did not introduce any bias into the study.

Having completed the tests for multiple responses the research objectives are discussed next.

⁺ Equal variances not assumed

6.6 Research objectives

Owing to the small sample size of 66 basic statistics, Pearson's, Spearman's and Kendall's tests are used to evaluate links. In some instances Pearson's or Spearman's or Kendall's tests are used, this is the case so as to ensure that problems encountered as a result of the small sample size, scale used being not ordinal, etc is minimised (Siriram and Snaddon (2003b)). For larger sample sizes path analysis would be more appropriate, but due to the small size and extensive number of links explored a conceptual approach using statistical correlations is more appropriate. For a treatment of path analysis refer to Hair et al (1998, p.577). Statistical correlations are depicted as $r_{\alpha,\beta}$, where α refers to correlations with respect to the user firm and β refers to correlations with respect to the system integrator firms.

Forming links

The first objective of the research is to link technology management, transaction processes and governance structures. Appendix J, Tables J1, J2 and J3 is constructed to show the correlations between the technological framework (i.e. technology management, transaction processes and governance structures), the investigative framework and links between the technological and investigative framework. These links are shown in Figure 6.1 to Figure 6.5. In addition the scatter plots for correlations are shown in appendix L, discussions on the scatter plots are not provided.

Figure 6.1 is next discussed next. The following links have been established:

- Technologies [3.1.1] and technological resource skills [3.1.2] are linked. System integrator firms believe that that this is so. Using Pearson's correlation it is found that $r_{\beta}=0.345$ at 0.05 level of significance. This linkage is supported by links through the subsets of technologies and technological resource skills, viz.
 - User firms believe that technology change [c] and competence enhancing [e] effects are linked, and technological implementation [d] and tangible and intangible technological resources [g] are linked.
 - System integrator firms believe that technological implementation [d] and competence destroying [e] effects are linked and technological change [c] and competence enhancing effects [f] are linked.

These links were discussed with the expert panel. Which viewed this linkage as follows: user firms believe that competence enhancing effects increases a result of technological change. This is mainly because firms believe that they are keeping abreast with the latest technologies and when they upgrade they are again using the latest technologies. It is only when firms are not using the latest technologies that they do not enjoy the benefits of competence enhancing technologies. In addition, user firms saw technological implementations as closing the gap between tangible and intangible technologies. This is mainly due to the fact that firms that are faced with technological change regularly train and upgrade their employees to maintain newer technologies.

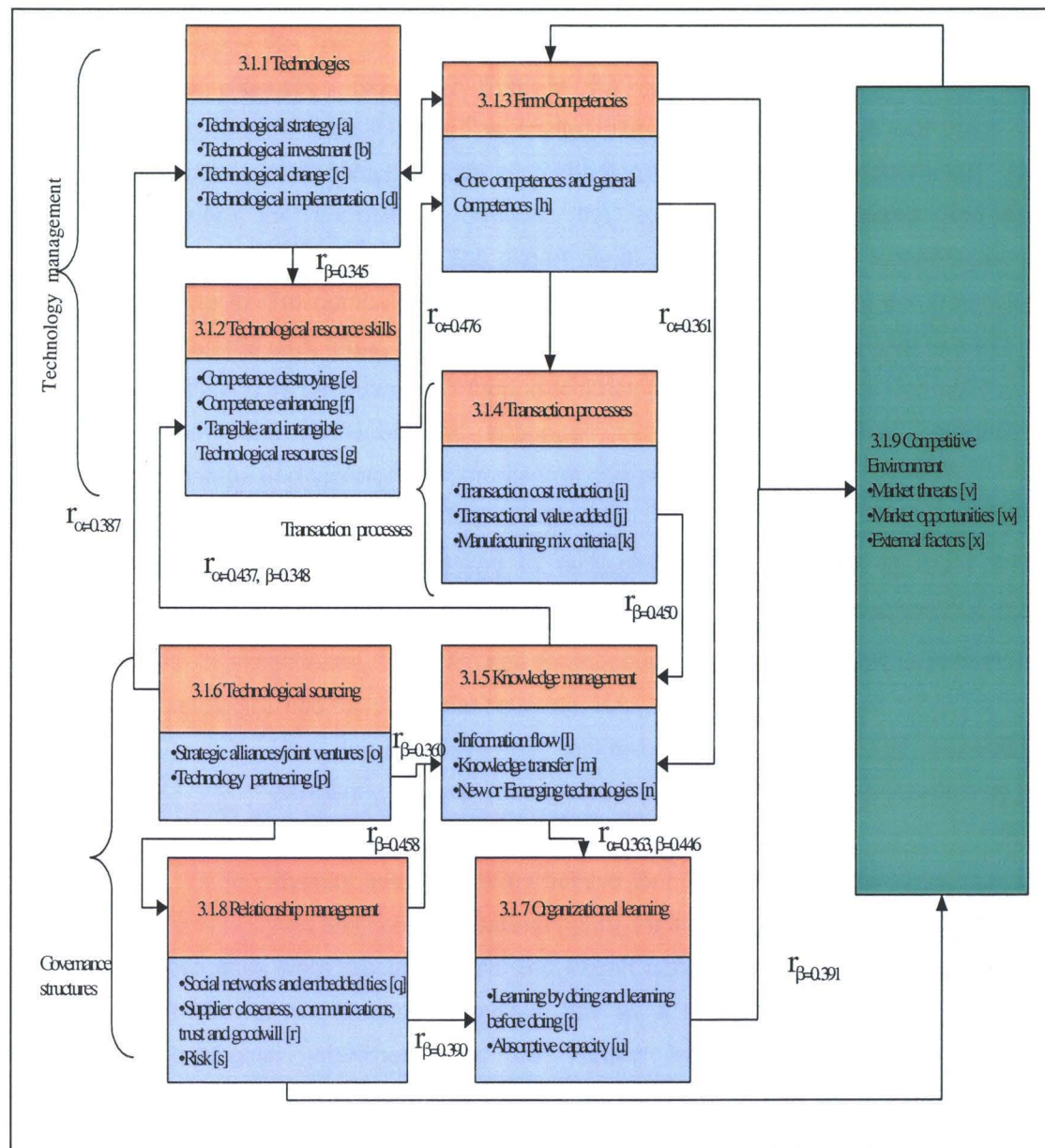


Figure 6.1: Linking technology management, transaction processes and governance structures

Therefore the technological implementations are linked to tangible and intangible technological resources. System integrator firms believe that technological implementation is linked to competence destroying effects and competence enhancing effects. They see firms keeping abreast with the latest technologies as linked to competence enhancing effects and firms not keeping abreast with the latest technologies as linked to competence destroying effects. The discussions with the expert panel substantiate this linkage. The scatter plot for technologies and technological resource skills is shown in Appendix L, Figure L1. The scatter plots show that there are linear relationships between technologies and technological resource skills.

- Technologies [3.1.1] and firm competencies [3.1.3] are linked. User firms believe that this is so. Using Pearson's correlation it is found that $r\alpha=0.400$ at 0.05 level of significance. No other links in the subsets of technologies and firm competencies were found. The scatter plot in Figure L2 shows that there are spherical relationships between technologies and firm competencies, and therefore the correlations between the subsets of technologies and firm competencies cancel out. The expert panel, however, did view technologies as leading to firm competencies in core competencies and general competencies. As regards user firms, the expert panel argued that technologies give rise to firm competencies because even though technology is available to the competition, it is how one manages and integrates technology that creates competitive advantage and therefore can create firm competencies.
- Technologies [3.1.1] are linked to technological sourcing [3.1.6]. User firms believe this is so. Using Spearman's correlation, it is found $r\alpha=0.387$ at 0.05 level of significance. This linkage is supported by links through the subsets of technologies and technological sourcing, viz:
 - User firms believe that technological strategy [a] and technology partnering [n] are linked, and that technological implementation [d] and technological partnering [n] are linked.
 - System integrator firms believe that technological implementation [d] and technological partnering [d] are linked.

These links were discussed with the expert panel and the expert panel viewed them as follows: user firms believe that as a result of technological strategy, technological implementations do indeed lead to technology partnering relationships. User firms also agreed that this needs to be agreed upon upfront during the strategy phase in a structured approach. System integrator firms saw technological implementations as leading to technology partnering relationships but they saw this as an ad hoc approach rather than a strategic one on the part of user firms. The main reason given by the system integrator firms is that user firms tend to attempt technological implementations by themselves only when these implementations are found to be less effective than when partnerships with system integrators are formed. The scatter plot is shown in Figure L3.

- Technological resource skills [3.1.2] and firm competencies [3.1.3] are linked. User firms believe that this is so. Using Pearson's correlation it is found that $r\alpha=0.476$ at 0.01 level of significance. This linkage is supported by links through the subsets of technological resource skills and firm competencies, viz.:
 - User firms believe that competence enhancing [f] and core competencies and general competencies [h] are linked, and that

tangible and intangible technological resource skills [g] and core competencies and general competencies [h] are linked.

- System integrator firms believe that competence enhancing [f] and core competencies and general competencies [h] are linked but they do not see a link to tangible and intangible technological resource skills.

These links were discussed with the expert panel who viewed this linkage as follows: competence enhancing effects are achieved in both core competencies and general competencies. Both user firms and system integrator firms believe that competence enhancing effects are not biased towards either core competencies or general competencies. However, system integrator firms do not believe that tangible and intangible technological resource skills are linked to core competencies and general competencies. They feel that firms tend to neglect investment in general competencies and hence have bigger gaps in tangible and intangible technological resource skills as compared to the gaps in core competencies. The scatter plot is shown in Figure L4.

- Technological resource skills [3.1.2] and knowledge management [3.1.5] are linked. Both user firms and system integrator firms believe this link exists. Using Pearson's correlation it is found that for user firms $r\alpha=0.437$ and for system integrator firms $r\beta=0.348$, at 0.05 level of significance. This linkage is supported by links through the subsets of technological resource skills and knowledge management, viz.:
 - User firms believe competence destroying [e] and competence enhancing effects [f] are linked to information flow [l]. In addition, they believe that competence destroying effects [e] is also linked to knowledge transfer [m] and new and emerging technologies [n].
 - System integrator firms believe that only competence destroying [e] effects are linked to information flow [l].

These links were discussed with the expert panel who viewed this linkage as follows: user firms believe that competence destroying effects lead to better information flow, knowledge transfer and use of new and emerging technologies. System integrator firms, however, only saw competence destroying effects linked to better information flow; they did not see a link to knowledge transfer and new and emerging technologies. The scatter plot is shown in Figure L5.

- Firm competencies [3.1.3] and transaction processes [3.1.4]. Neither user firms nor system integrator firms saw links between these. The expert panel viewed this linkage as follows: in the case of both users and system integrators, the expert panel argued that firm competencies will lead to better transaction

processes. However, this will only occur if the process is correct. Competence in poor processes will not lead to benefits in transaction processes. The scatter plot is shown in Figure L6.

- Firm competencies [3.1.3] and knowledge management [3.1.5] are linked. User firms believe that this is so but system integrator firms do not. Using Pearson's correlation it is found that for user firms $r\alpha=0.361$, at 0.05 level of significance. This link is supported by the links through the subsets of firm competencies and knowledge management, viz.:

- User firms see core competencies and general competencies [h] linking to knowledge transfer [m].

These links were discussed with the expert panel who viewed this linkage as follows: user firms see benefits in knowledge transfer as a result of in-house training schemes, committees, quality improvement programmes, and etc. These initiatives are not visible to system integrators and hence they do not see the link to core competencies and general competencies or to knowledge transfer. The scatter plot is shown in Figure L7.

- Firm competencies [3.1.3] and the competitive environment [3.1.9] are not linked. However, links through the subsets of firm competencies and the competitive environment were found for system integrator firms. System integrator firms see core competencies and general competencies [h] as being linked to external factors [x]. These links were discussed with the expert panel who viewed this linkage as follows: system integrator firms see market threats and other external factors as driving manufacturing mix criteria, and core and general competencies. User firms, however, do not believe that these are driving factors, they see improvement in manufacturing mix criteria and core and general competencies as the processes of continuous improvement within their firms. The scatter plot is shown in Figure L8.

- Transaction processes [3.1.4] and knowledge management [3.1.5] are linked. System integrator firms believe that this is so, but user firms do not see this link. Using Pearson's correlation it is found that for system integrator firms $r\beta=0.450$, at 0.01 level of significance. This linkage is supported by the links through the subsets of transaction processes and knowledge management, viz:

- User firms believe manufacturing mix criteria [k] are linked to information flow [l] and knowledge transfer [m].
- System integrator firms believe manufacturing mix criteria are only linked to information flow. They do not see a link to knowledge

transfer. In addition, they see transaction value added [j] as linked to knowledge transfer [m] and new and emerging technologies [n].

The expert panel viewed this linkage as follows: user firms see manufacturing mix criteria linked to information flow and knowledge transfer because to obtain benefits in manufacturing mix criteria, technologies exist throughout the firm involving different sections of the firm and other firms. Therefore, to obtain benefits in manufacturing mix criteria, information flow and knowledge transfer have to take place. System integrator firms only see a link to information flow. This is because system integrator firms are generally not integrated within firms when implementing technologies. They are often seen as outside parties with a defined scope and deliverables and they are therefore not aware of the other activities within the firm. However, system integrator firms agree that transaction value added is achieved through knowledge transfer and this can be supported by additional new and emerging technologies. The scatter plot is shown in Figure L9.

- Knowledge management [3.1.5] and organizational learning [3.1.7] are linked. Both user firms and system integrator firms believe that this is so. This linkage is supported through the subsets of knowledge management and organizational learning by both user firms and system integrator firms. Using Spearman's correlation $r_{\alpha}=0.363, \beta=0.446$, at 0.05 level of significance. This link is supported by the following links through the subsets of knowledge management and organizational learning, viz:
 - User firms believe information flow [l] and knowledge transfer [m] are both linked to learning-by-doing and learning-before-doing [t], at 0.05 level of significance. User firms also believe that new and emerging technologies [n] are linked to learning-by-doing and learning-before-doing.
 - System integrator firms believe that information flow [l] and knowledge transfer [m] are both linked to learning-by-doing and learning-before-doing [t] and information flow [l] and knowledge transfer [m] are linked to absorptive capacity [u].

The expert panel viewed this linkage as follows: both user firms and system integrator firms see information flow and knowledge transfer as being linked to learning-by-doing and learning-before-doing. However, only user firms link new and emerging technologies to learning-by-doing and learning-before-doing. System integrator firms do not see this link. User firms believe that new and emerging technologies like simulation tools can be used to improve learning-by-doing and learning-before-doing. The scatter plot is shown in Figure L10.

- Technological sourcing [3.1.6] and knowledge management [3.1.5] are linked. Using Pearson's correlation $r\beta=0.360$, at 0.05 level of significance. System integrator firms believe that this is so, but user firms do not. None of the subsets of technological sourcing or knowledge management support this link. The expert panel viewed this linkage as follows: both user firms and system integrator firms believed that technological sourcing would lead to knowledge management provided that partnerships were based on a partnering approach. However, these links could not be verified by statistical analysis. The scatter plot is shown in Figure L11.
- Technological sourcing [3.1.6] and relationship management [3.1.8] are not linked for user firms and system integrator firms. However, through the subsets of technological sourcing and relationship management, system integrator firms believe that technology partnering is linked to supplier closeness, communications, trust and goodwill. The expert panel viewed this linkage as follows: technology partnering does lead to supplier closeness, communications, trust and goodwill but user firms said that they had not had much experience with such relationships. The scatter plot is shown in Figure L12.
- Organizational learning [3.1.8] and the competitive environment [3.1.9] are linked. System integrator firms believe that this is so but user firms do not. Using Pearson's correlation $r\beta=0.391$, at 0.05 level of significance. This link is supported by the following links through the subsets of organizational learning and the competitive environment, viz.:
 - User firms believe that absorptive capacity [u] and market threats are [v] are linked.
 - System integrator firms believe that absorptive capacity [u] and market opportunities [w] are linked.The expert panel viewed this linkage as follows: user firms see market threats as providing potential for absorptive capacity. However, system integrator firms see market opportunities as providing potential for absorptive capacity. The scatter plot is shown in Figure L13.
- Relationship management [3.1.8] and knowledge management [3.1.5] are linked. System integrator firms believe that this is so but user firms do not. Using Pearson's correlation $r\beta=0.458$, at 0.01 level of significance. This link is supported by the following links through the subsets of relationship management and knowledge management, viz.:

- User firms believe that supplier closeness, communications, trust and goodwill [r] are linked to information flow [l] and knowledge transfer [m].
- System integrator firms believe that social networks and embedded ties [q] are linked to information flow [l] and new and emerging technologies [n].

The expert panel viewed this linkage as follows: user firms see supplier closeness, communications, trust and goodwill as sufficient for information flow and knowledge transfer. System integrator firms say that social networks and embedded ties are necessary for information flow, which also leads to new and emerging technologies. System integrator firms believe that firms should form networks with other firms. In this way firms form cliques, which would further support, supplier closeness, communications, trust and goodwill. The scatter plot is shown in Figure L14.

- Relationship management [3.1.8] and organizational learning [3.1.7] are linked. System integrator firms believe that this is so but user firms do not see this link. Using Pearson's correlation $r\beta=0.390$, at 0.05 level of significance. This link is supported by the following links through the subsets of relationship management and organizational learning, viz.:
 - Both user firms and system integrator firms believe that supplier closeness, communications, trust and goodwill [r] are linked to learning-by-doing and learning-before-doing [t].
 - System integrator firms believe that risks [s] is linked to learning-by-doing and learning-before-doing [t].

The expert panel viewed this linkage as follows: both user and system integrator firms link supplier closeness, communications, trust and goodwill to learning-by-doing and learning-before-doing. However, system integrator firms believe that there are risks associated with learning-by-doing and learning-before-doing. Therefore the expert panel believed that these risks associated with learning-by-doing and learning-before-doing can be minimised through supplier, closeness, communications, trust and goodwill. The scatter plot is shown in Figure L15.

- Relationship management [3.1.8] and the competitive environment [3.1.9] are not linked, according both user firms and system integrator firms. However, some links through the subsets of relationship management and the competitive environment have been found: User firms believe that social networks and embedded ties [q] are linked to market opportunities [w] and external factors [x]. The expert panel viewed this linkage as follows: user firms see social networks and embedded ties giving rise to market opportunities that may be arise as a

result of external factors. These external factors could be structural loosening and structural reinforcing events. Firms central to the network structure benefit from these events that lead to market opportunities. The scatter plot is shown in Figure L16.

Having discussed the links in the technological framework, the links in the investigative framework Figure 6.2 is discussed next.

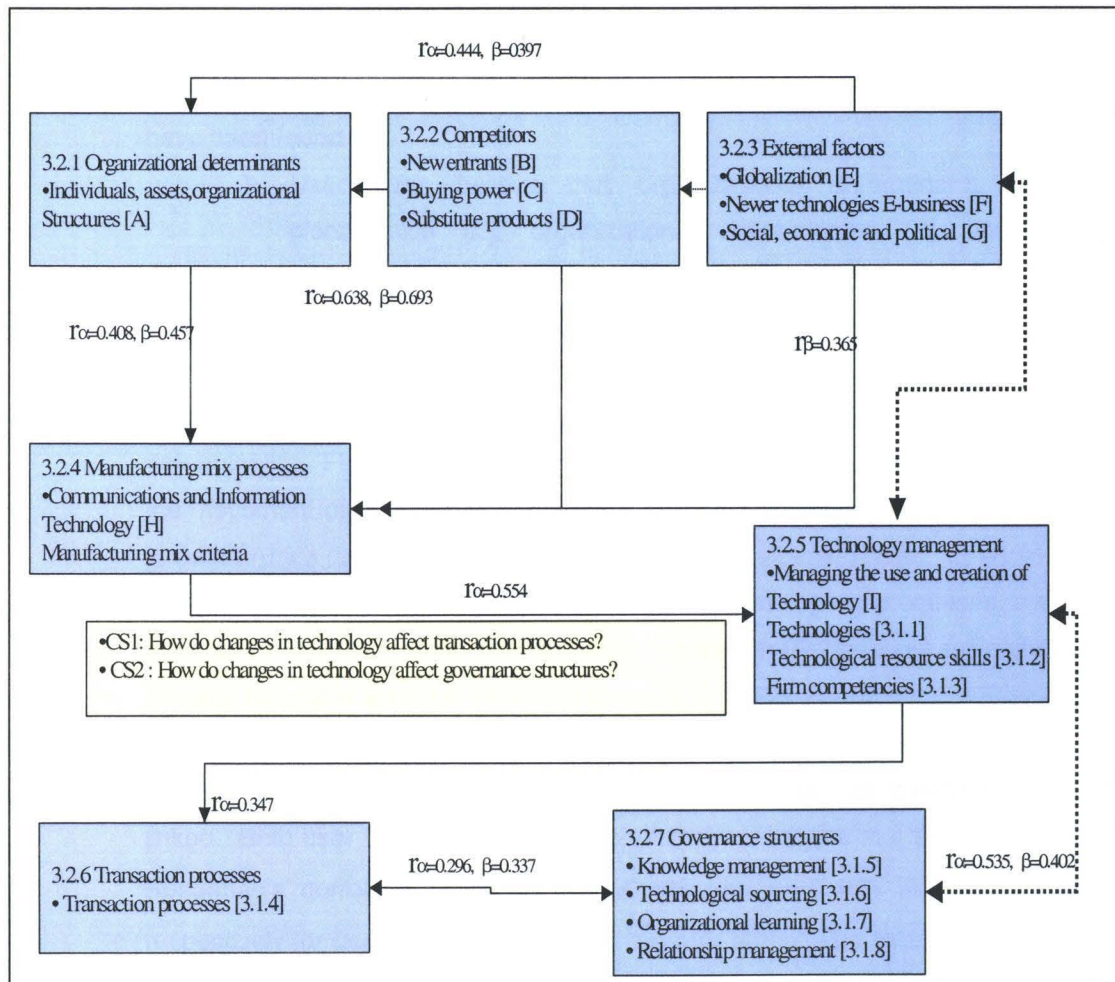


Figure 6.2: Linking the investigative framework

- Organizational determinants [3.2.1] and competitors [3.2.2] are linked. Both user firms and system integrator firms believe that this is so. Using Spearman's correlation coefficient, $r=0.638$ and $\beta=0.693$, at 0.05 level of significance. Through the subsets of organizational determinants and competitors the following links have been found viz.
 - Both user and system integrator firms believe individuals, assets and organizational structures [A] and new entrants [B], buying power [C] and substitute products [D] is linked.

The expert panel viewed this linkage as follows: both users and system integrators felt that organizational determinants were affected by competitors, i.e. new entrants [B], buying power [C] and substitute products. The scatter plot is shown in Figure L17.

- Organizational determinants [3.2.1] and external factors [3.2.3] are linked. Both user and system integrator firms believe organizational determinants and external factors are linked. Using Spearman's correlation coefficient $r\alpha=0.444$ and $r\beta=0.397$, at 0.01 and 0.05 level of significance respectively. Through the subsets of organizational determinants and external factors the following links have been found viz.
 - User firms believe that organizational determinants [A] and globalisation [E], organizational determinants [A] and Newer technologies [F], and organizational determinants [A] and social, economic and political factors [G] is linked. System integrator firms did not see this linkage.

The expert panel: felt that external factors did indeed impact on organizational determinants. Firms are faced with globalisation and this has affected pricing and the movement of people within the industry. The political and economic situation in South Africa has resulted in people leaving, thus affecting firms. In addition, E-business has required that firms upgrade their technologies, processes, systems and people. System integrator firms did not see these reasons are significant. The scatter plot is shown in Figure L18.

- Organisational determinants [3.2.1] and Manufacturing mix criteria [3.2.4] are linked. Both user firms and system integrator firms believe that this is so. Using Spearman's correlation coefficient, $r\alpha=0.408$ and $r\beta=0.457$, at 0.05 and 0.01 respectively for user firms and system integrator firms. The expert panel viewed this linkage as follows: individuals within firms make decisions regarding technology, processes and systems. These decisions involve communication and IT technology, and they affect manufacturing mix criteria. Examples could include the placing of purchase orders via systems such as the EDI, inter-net, e-commerce, etc. Other examples include the interface of design systems such as CAD into manufacturing systems such as CAM. In such instances the CAD drawing can automatically be downloaded into the supplier's manufacturing CAM system, thus making the data transaction fairly routine. This, coupled with automatic purchasing systems, will further support the trend towards more frequent data transactions. Transaction certainty is also likely to increase as automated systems of data transfer and transactional communication will make data available more timely and thus more reliable. This will assist in developing

more accurate forecasts for production planning and thus more accurate forecasts will be made available to suppliers, which would further increase transaction certainty. The ability to perform transactions frequently and with certainty is a motivator towards improving network relationships with strategic partners. However, this ability is provided by technological integration within and between firms. The scatter plot is shown in Figure L19.

- Manufacturing mix processes [3.2.4] and competitors [3.2.2] could not be linked. However, through the subsets of manufacturing mix processes and competitors it was found that communications and information technology [H] linked to new entrants [B] and buying power [C]. The expert panel viewed this linkage as follows: new entrants often enter the market with new technologies, which provide additional benefits in terms of improvements in manufacturing mix processes especially communications and IT technology. This causes existing firms to follow suit in upgrading their technologies, etc. The scatter plot is shown in Figure L20.
- Manufacturing mix processes [3.2.4] and external factors [3.2.3] are linked. System integrator firms believe that this is so. Using Spearman's correlation coefficient, $r\beta=0.365$, at 0.05 level of significance. Through the subset of manufacturing mix processes and external factors, user firms felt that communications and IT technology [H] are linked to social, economic and political factors [G]. The expert panel viewed this linkage as follows: the social, economic and political climate in South Africa is affecting the use of technology. Firms have to invest in technology, people and systems to cope with the effects of globalisation. The scatter plot is shown in Figure L21.
- Manufacturing mix processes [3.2.4] and technology management [3.2.5] are linked. User firms believe that this is so. Using Spearman's correlation coefficient $r\alpha=0.554$, at 0.01 level of significance. Through the subsets of manufacturing mix processes and technology management, the following links were found viz.:
 - Manufacturing mix processes [3.2.4] and technologies [3.1.1] for user firms, at $r\alpha=0.433$, at 0.05 level of significance.
 - Manufacturing mix processes [3.2.4] and technological resource skills [3.1.2] were linked, at $r\alpha=0.589$ and $r\beta=0.471$, at 0.05 level of significance.
 - Manufacturing mix processes [3.2.4] and firm competencies [3.1.3] were, at $r\alpha=0.359$, at 0.05 level of significance.

The expert panel viewed these linkages as follows: they saw communications and IT technology as being affected by all the facets of technology management and concurred with the results found. The scatter plot is shown in Figures L2,L23,L24 and L25.

- Technology management [3.2.5] and transaction processes [3.2.6] are linked. User firms believe this is so. Using Kendall's correlation coefficient, $r\alpha=0.347$, at 0.01 level of significance. The expert panel viewed this linkage as follows: Technologies [3.1.1] and transaction processes are linked. The scatter plot shown in Figure L26.
- Technology management [3.2.5] and external factors [3.2.3] could not be linked. However through the subsets of technology management and external factors it was found that technological resource skills [3.1.2] and social, economic and political factors [G] were linked for user firms. The expert panel viewed this linkage as follows: they saw technological resource skills being affected by the social, economic and political factors as a result of people leaving the economy for different reasons, which included crime, economical situation, etc. System integrator firms however felt that there is an equal inflow of people to compensate. The scatter plot is shown in Figure L27.
- Technology management [3.2.5] and Governance structures [3.2.7] is linked. Both user firms and system integrator firms believe technology management and governance structures is linked, $r\alpha=0.535$, and $r\beta=0.402$, at 0.01 and 0.05 level of significance respectively. Through the subsets of technology management and governance structures the following links were found viz.
 - User firms see technological resource skills [3.1.2] and organizational learning [3.1.7] linked.
 - System integrator firms see technologies [3.1.1] and knowledge management [3.1.5] and technological resource skills [3.1.2] and knowledge management [3.1.5] linked.

The expert panel viewed this linkage as follows: Technologies give rise to information, flow and knowledge transfer. Firms use new and emerging technologies to assist with information flow. Continuous improvement teams share this knowledge thus knowledge transfer occurs. Therefore technologies and knowledge management are linked. Technological resource skills is also linked to organizational learning. Technologies involve learning-by-doing and learning-before-doing to improve technological implementations. This learning-by-doing and learning-before-doing increases the firm's absorptive capacity. Firm

competencies and knowledge management have already discussed in figure 6.1. The scatter plot is shown in Figure L 28.

- Transaction processes [3.2.6] and Governance structures [3.2.7] are linked for user and system integrator firms. Using Kendall's correlation coefficient $r\alpha=0.296$ and $r\beta=0.337$, at 0.05 and 0.01 levels of significance for users and system integrators respectively. Through the subsets of transaction processes and governance structures the following links were also found viz.
 - Transaction processes [3.1.4] and Knowledge management [3.1.5], for system integrator firms, $r\beta=0.338$ at 0.01 level of significance
 - Transaction processes [3.1.4] and technological sourcing [3.1.6], for user firms, $r\alpha=0.265$, at 0.05 level of significance.
 - Transaction processes [3.1.4] and organizational learning [3.1.7], for system integrator firms, $r\beta=0.279$, at 0.05 level of significance.
 - Transaction processes [3.1.4] and relationship management [3.1.8], for user firms, $r\alpha=0.323$, at 0.05 level of significance.

The expert panel felt that transaction processes and governance structures is linked as all technological implementations is focused towards either transaction cost reduction, transactional value added or improvements in manufacturing mix criteria. However in order that the improvements made be sustained links to knowledge management for continuous improvement, alternative suppliers through technological sourcing for technological advancement, organizational learning for continuous improvement and relationship management with key stake-holders is necessary. The scatter plot is shown in Figure L 29.

Having discussed linkages in the investigative, the links between the investigative framework and technological framework is discussed. Three links are proposed i.e. Organizational determinants, competitors and external factors. Firstly organizational determinants are discussed. Figure 6.3 focuses on the links between organizational determinants and the technological framework.

- Organizational determinants [3.2.1] and technologies [3.1.1] are linked for user firms. Using Spearman's correlation it was found that $r\alpha=0.390$, at 0.05 level of significance for user firms. Through the subsets of organizational determinants and technologies the following links were found, viz.:
 - User firms believe that organizational determinants [3.2.1] are linked to technological strategy [a] and technological implementation [d]. System integrator firms did not see this link.

The expert panel viewed this linkage as follows: user firms saw individuals as managers in firms who make decisions regarding technologies and technological implementations. The scatter plot is shown in Figure L30.

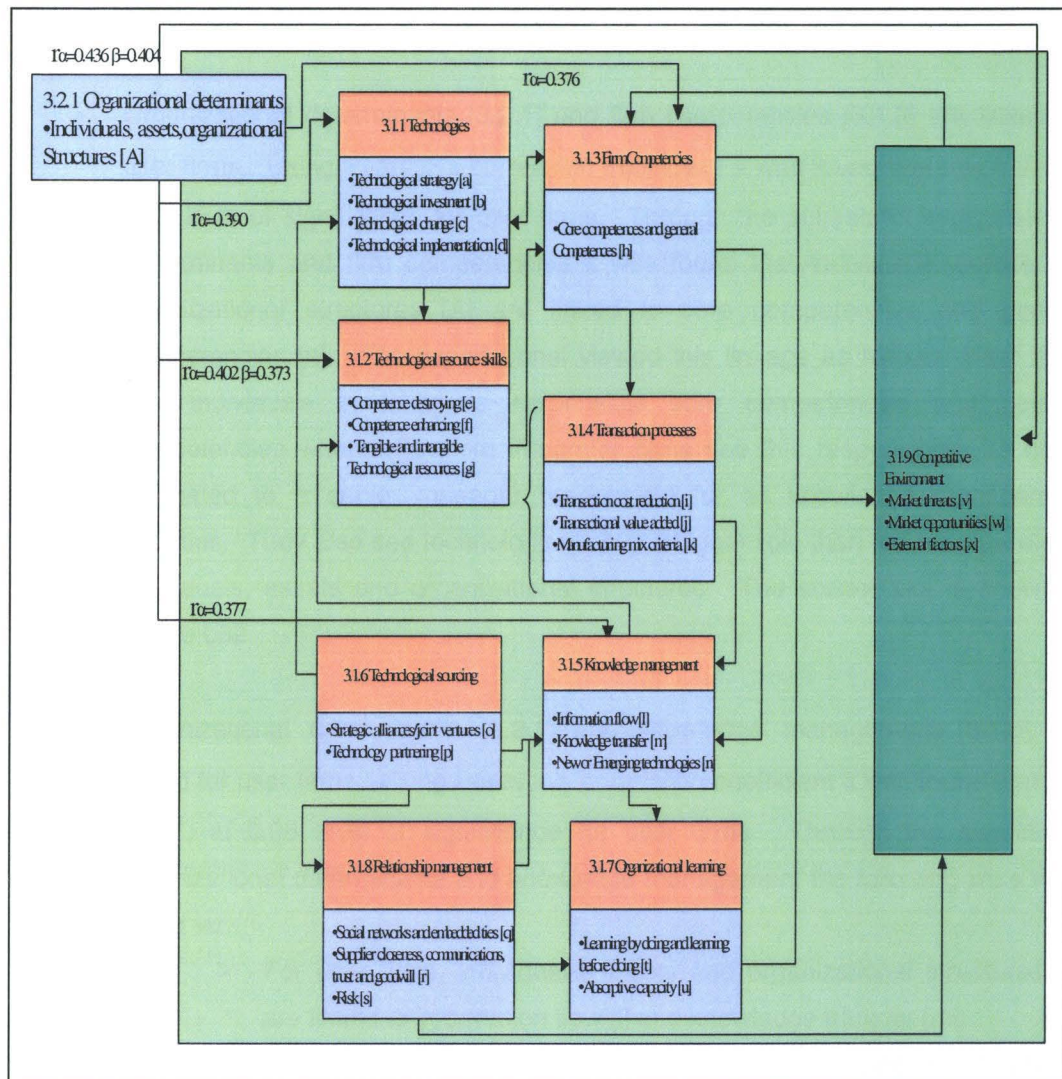


Figure 6.3: Linking organizational determinants

- Organizational determinants [3.2.1] and technological resource skills [3.1.2] are linked for both user firms and system integrator firms. Using Pearson's correlation it was found that $r\alpha = 0.402$ and $r\beta=0.373$, at 0.05 level of significance for user firms and system integrator firms respectively. Through the subsets of organizational determinants and technological resource skills the following links were found viz.
 - User firms see organizational determinants linked to tangible and intangible technological resources, system integrator firms do not see this link.

The expert panel viewed this linkage as follows: Individuals within firms manage and use technologies, and it is therefore expected that these individuals are

responsible for tangible and intangible technological resources. However system integrator firms believe that tangible and intangible resources are not the responsibility of all individuals in the firm, but that this responsibility should be delegated to a senior manager. The scatter plot is shown in Figure L31.

- Organizational determinants [3.2.1] and firm competencies [3.1.3] are linked for user firms. Using Pearson's correlation coefficient it was found that $r_{\alpha} = 0.376$ at 0.05 level of significance for user firms. Through the subsets of organizational determinants and firm competencies it was found that individuals, assets and organizational structures [A] are linked to core competencies and general competencies [h]. The expert panel viewed this linkage as follows: User firms saw individuals in firms as responsible core competencies and general competencies whereas system integrator firms see this responsibility as being delegated to a senior manager responsible for all knowledge management activities. They also see technology playing a bigger role than focusing purely on individuals, assets and organizational structures. The scatter plot is shown in Figure L32.
- Organizational determinants [3.2.1] and knowledge management [3.1.5] are linked for user firms. Using Pearson's correlation coefficient it was found that $r_{\alpha} = 0.377$, at 0.05 level of significance for user firms. Through the subsets of organizational determinants and knowledge management the following links were found viz.:
 - For user firms, individuals, assets and organizational structures [A] are linked to information flow [I] and knowledge transfer [m].
 - For system integrator firms individuals, assets and organizational structures [A] are only linked to information flow [I]. They do not see a link to knowledge transfer.

The expert panel viewed this linkage as follows: system integrator firms were not aware of in-house training schemes, continuous improvement programmes, etc. Therefore system integrator firms did not see that individuals, assets and organizational structures are linked to information flow. In addition system integrator firms were not aware of all the technologies within their firm since their experience was often concentrated within certain sections of the firm. The scatter plot is shown in Figure L33.

- Organizational determinants [3.2.1] and technological sourcing [3.1.6] could not be linked. Through the subsets of organizational determinants and technological sourcing the following links were found viz.

- User firms believe individuals, assets and organizational structures [A] and strategic alliances/joint ventures [o], and individuals, assets and organizational structures [A] and technology partnering [p] is linked. System integrator firms do not see this link.

The expert panel viewed this linkage as follows: user firms believe that individuals, work within certain structures and resources and when this is correctly understood this leads to forming of good alliances and partnerships. However these structures and resources can be misused to ones own benefit and thereafter detrimental to alliances and partnering. System integrators also concurred with this response. The scatter plot is shown in figure L34.

- Organizational determinants and [3.2.1] and the competitive environment [3.1.9] are linked. Both user and system integrator firms believe organizational determinants [3.2.1] and the competitive environment [3.19] is linked, using Pearson's correlation coefficient $r_{\alpha}=0.436$ and $\beta=0.404$, at 0.05 level of significance. Through the subsets of organizational determinants and the competitive environment, the following links were found viz.

- User firms and system integrator firms believe individuals, assets and organizational structures [A] and market opportunities [w] is linked.

The expert panel viewed this link as follows: they saw firms being more aware of market opportunities, than market risks. Managers in firms should also be forecasting and collecting marketing information on market risks and other external factors. The scatter plot is shown in Figure L35.

Secondly competitors are discussed Figure 6.4 focuses on the links between competitors and the technological framework.

- No links could be found between competitors [3.2.2] and the technological framework. However through the subsets of competitors and the technological framework the following links were found viz.
 - For system integrator firm's new entrants [B] could be linked to technological investment [b] and technology partnering [p]. In addition buying power [C] could be linked to transaction value [j], risks [s] and market opportunities [W].
 - For user firms buying power [C] could be linked to core competencies and general competencies [h]. In addition new entrants [B] could be linked to technology partnering [p] and risks [s]. In addition substitute products [D] could be linked to transaction value added [j]

The expert panel viewed this linkage as follows: user firms see new entrants as investors in new technologies and posing risks on technology partnering

relationships. These risks with regard to penetrating the network structure, could be achieved by introducing disruptive technologies. In addition, the additional buying power of new entrants put pressure on transaction value added activities, as competitors could create more value in their value chains, thereby increasing risks for other firms and creating more market opportunities for themselves. System integrators saw competitors as possessing more buying power, which put risks on other potential buyers. As a result of additional investment firms core competencies and general competencies could be weakened, and firms would have to continually upgrade and develop core and general competencies, to sustain competitive advantage. New entrants also threatened existing technology partnerships through their buying power and substitute products. The scatter plots are shown in Figures L36 and L37 respectively.

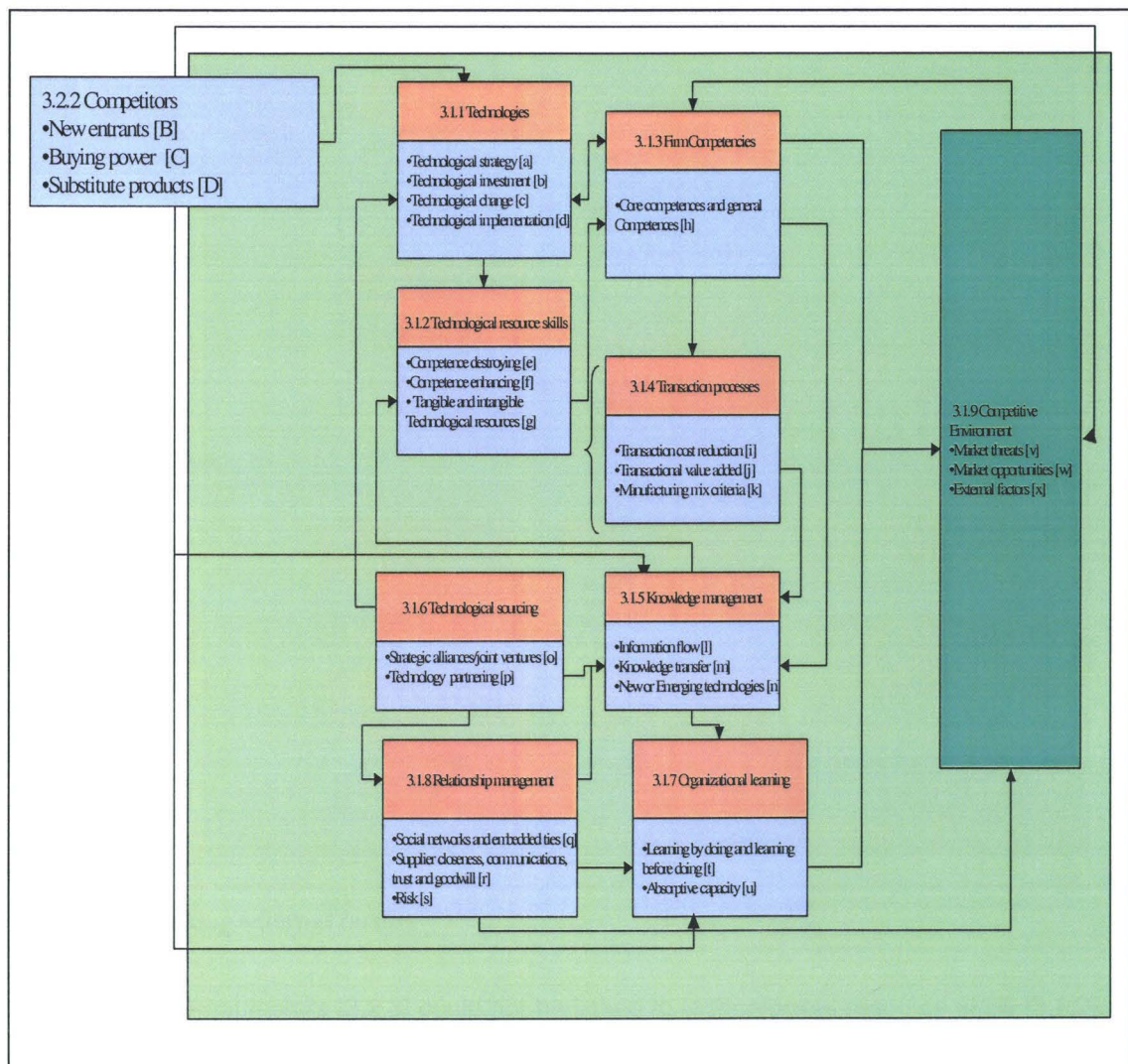


Figure 6.4: Linking competitors

Thirdly external factors are discussed figure 6.5 focuses on the links between external factors and the technological framework.

- External factors [3.2.3] and technologies [3.1.1] are linked. System integrator firms believe external factors and technologies is linked. Using Pearson's correlation coefficient $r\beta=0.419$, at 0.05 level of significance. Through the subsets of external factors and technologies the following links could be found viz.:

- System integrator firms believe new technologies [F] and technological strategy [a] are linked, globalisation [E] and technological investment [b] are linked.

System integrator firms argued new technologies and globalisation have forced firms to rethink technology strategies, which have resulted in additional technological investment, hence the development of competence enhancing skills. The scatter plot are shown in Figures L38.

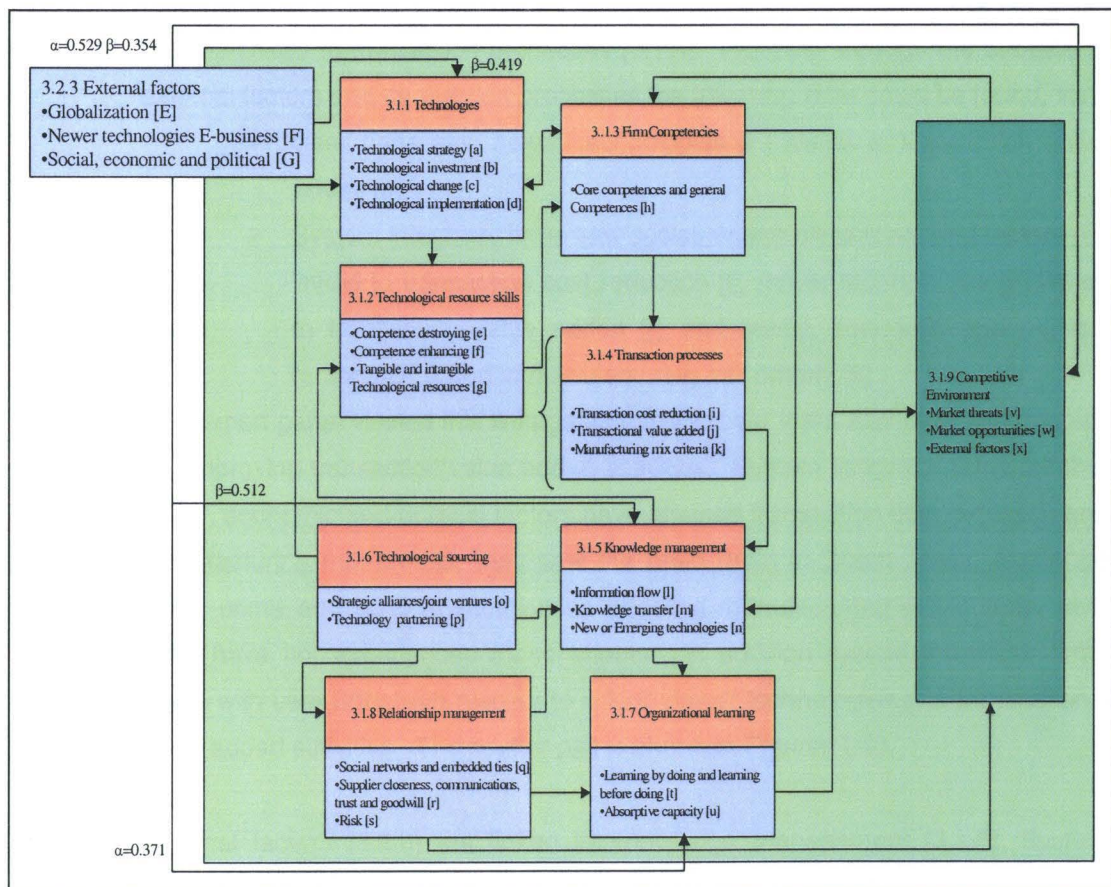


Figure 6.5: Linking external factors

- External factors [3.2.3] could not be linked to technological resource skills [3.1.2]. However through the subsets of external factors and technological resource skills the following links could be found viz.:
- User firms believe social, economic and political factors [G] are linked to competence enhancing [f].

- System integrator firms believe newer technologies [F] are linked to competence enhancing [f], and social, economic and political factors [G] is linked to competence enhancing [f].

The expert panel viewed this linkage as follows: Both user and system integrator firms saw social, economic and political factors as competence enhancing. They argued that the social, economic and political factors have benefited firms in developing new competencies that have resulted in competitive advantage. Some of these benefits include development of small business through outsourcing, partnering relationships, etc. System integrator firms also felt newer technologies resulted in retraining of individuals, which resulted in competence enhancing effects. The scatter plot is shown in Figure L39.

- External factors [3.2.3] could not be linked to firm competencies [3.1.3] nor could they be linked to transaction processes [3.1.4]. However through the subsets of external factors and transaction processes the following links could be found, viz.:
 - User firms saw newer technologies [F] linked to transaction value added [j].
 - System integrator firms saw social, economic and political factors [G] linked to transaction cost reduction [l], newer technologies [F] linked to transaction value added [j], and social, economic and political factors [G] linked to manufacturing mix criteria [k].

The expert panel viewed this linkage as follows: user firms saw new technologies as improving transaction value added activities. System integrator firms felt that social, economic and political factors have affected transaction cost reduction and manufacturing mix criteria, they saw the brain drain in South Africa, exchange rates, crime and political situation as affecting manufacturing mix criteria, user firms have not experienced these effects. In addition system integrator firms agree with user firms with respect to linking newer technologies and transactional value added activities. The scatter plot is shown in Figures L40.

- External factors [3.2.3] are linked to knowledge management [3.1.5]. System integrator firms believe that external factors are linked to knowledge management. Using Spearman's correlation $r\beta=0.512$, at 0.01 level of significance. This linkage is supported by the subsets of external factors and knowledge management, viz.:
 - User firms believe that newer technologies [F] are linked to new and emerging technologies [n].
 - System integrator firms believe that newer technologies [F] are linked to knowledge transfer [m].

The expert panel viewed this linkage as follows: newer technologies like e-business improve the potential for knowledge transfer and can also add to existing technologies. The scatter plot is shown in Figure L41.

- External factors [3.2.3] and technological sourcing [3.1.6] could not be linked. The expert panel viewed this linkage as follows: evidence provided by the expert panel was contrary to the statistical findings. Both user and system integrator firms provided examples where for example globalisation led to the formation of strategic alliances and joint ventures and technology partnering relationships. The scatter plot is shown in Figures L42.
- External factors [3.2.3] and organizational learning [3.1.7] are linked. User firms believe external factors and organizational learning is linked. Using Spearman's correlation coefficient $r_{\alpha} = 0.371$, at 0.05 level of significance. Through the subsets of external factors and organizational learning the following links could be found, viz.:
 - User firms believe social, economic and political factors [G] is linked to absorptive capacity [u].The expert panel viewed this link as follows, they felt the social, economic and political factors have forced firms into a process of continuous improvement with many initiatives in improving and sustaining competitive advantage. This therefore led to firms improving absorptive capacity. The scatter plot is shown in Figure L43.
- External factors [3.2.3] and relationship management [3.1.8] could not be linked. The expert panel viewed this linkage as follows: evidence provided by the expert panel was contrary to the statistical findings. Both user and system integrator firms provided examples where for example globalisation led to the formation of strategic alliances and joint ventures and technology partnering relationships. The scatter plots are shown in figures L44.
- External factors [3.2.3] and the competitive environment [3.1.9] could be linked. Both user firms and system integrator firms believe external factors and the competitive environment are linked. Using Pearson's correlation coefficient $r_{\alpha} = 0.529$ and $r_{\beta} = 0.354$, at 0.05 level of significance. Through the subsets of external factors and the competitive environment the following links were found, viz.:
 - User firms see the following links globalisation [E] and market threats [v], newer technologies [F] and market threats [v], globalisation [E] and market opportunities [w], newer technologies [F] and market opportunities, and globalisation [E] and external factors [x].
 - System integrator firms see social, economic and political factors [G] linked to external factors [X].

The expert panel viewed this linkage as follows: user firms felt that globalisation and newer technologies have affected firms in terms of both market threats and market opportunities and these were also influenced by other external factors. System integrator firms saw social, economic and political factors linking to external factors, they saw these external factors as crime, inflation, etc. The scatter plot is shown in Figure L45.

Having discussed the first objective viz. links between the technological framework (i.e. technology management, transaction processes, governance structures (Figure 6.1)) and the investigative framework (Figures 6.2), and the links for organizational determinants (Figure 6.3), competitors (Figure 6.4) and external factors (Figure 6.5), the second objective is next discussed.

Investigating parts of the RBT and TCE theories

The second objective of the research is to investigate parts of core competence theory (RBV) and transaction cost economic (TCE) views and to determine the superior theory or link parts of both theories. In meeting this objective, a comparison is first drawn between firms' competitive advantage with regard to firm resources, industry selection and positioning and transactional benefits in respect of cost reduction and value added activities. Table 6.9 shows the comparisons.

Table 6.9: Comparing resource factors and transactional benefits

Question nos.	Category	User and system integrators	Mean	Standard deviation	F test for equality of variances	t-test for equality of means	Significance 2 tailed	Degrees of freedom
54.1	Firm resources	User	5.12	1.34	0.816 Sig. 0.370	-1.269 ⁺	0.209	64
		System integrators	5.52	1.18				
54.2	Industry selection and positioning	User	5.15	1.15	0.058 Sig. 0.811	0.676 ⁺	0.502	64
		System integrators	4.94	1.39				
54.3	Transactional benefits	User	4.76	1.37	1.310 Sig. 0.257	-0.196 ⁺	0.845	64
		System integrators	4.82	1.13				

As seen in Table 6.9, both user firms and system integrator firms see firm resources, industry selection and positioning as important. It may therefore be argued that for competitive advantage, firms need to have competencies in firm resources, industry selection and

⁺ Equal variances not assumed

transactional benefits. These variables (firm resources, industry selection and transactional benefits) are used to categorise other factors in either the RBT or TCE theory. Thereafter factors that contribute to the RBT and TCE theory are used to determine the superior theory or link both theories. As a basis for comparison, firms resources and industry selection and positioning are categorized into the RBT and transactional benefits are categorised into the TCE theory. Table 3.9 in Chapter 3, section 3.4.2 shows the different views of the RBTs and TCE theories. Table 3.9 is modified to include the categories from Table 6.9, which are then compared to the evaluation criteria. This is shown in Appendix J, Table J4. Table 6.10 below summarises the correlations for the RBT and TCE theories. Spearman's correlation was used for these tests because it gave the most correlations when compared to Pearson's and Kendall's correlation tests. In total 71 correlations were found. It may be concluded from the results that both the RBT and TCE theories of the firm are linked, and therefore managers in firms should concentrate on both theories as neither theory is superior to the other.

Table 6.10: Summarizing correlations for the RBT and TCE views of the firm

Firm category	RBT	TCE
User	12	29
System integrator	14	16
Total	26	45
In total 71 correlations were found		

From Table 6.10 it can be seen that for selected criteria both the RBV and TCE are considered as important. Managers therefore have to consider both aspects in managing and implementing technologies.

The technological effects of the organizational and environmental evolution on firms competitive advantage

The third objective is to investigate the technological effects of organisational and environmental evolution on firms competitive advantage. Table 6.11 shows the technological effects of the organisational and environmental evolution on firms' competitive advantage.

These effects are discussed next viz.:

- Generalized factors: these are easy to source through global networks like generic technologies from distant sources but transfer of knowledge benefits from proximity.
 - Both user and system integrator firms agree on this factor and there are no significant differences between means for either. Generalized factors may therefore be seen as having the same effect on user and system integrators, bringing some competitive advantages to both users and system integrators.
- Skilled labour and natural resources

- Both user firms and system integrators agree on this factor and there are no significant differences between means for either. Skilled labour and natural resources may therefore be seen as having the same effect on users and system integrators, and there are significant competitive advantages that can be derived from this factor.
- Related and supporting industries like home-based suppliers and other related industries
 - Both users and system integrators agree on this factor and there are no significant differences between means for either. Both users and system integrators see this factor as important for competitive advantage.
- Demand in your country
 - Both users and system integrators agree on this factor and there are no significant differences between means for either. There are significant advantages that can be derived from this factor.
- Firms strategy structure and rivalry
 - Both user and system integrators agree on this factor and there are no significant differences between means for either. There are significant competitive advantages that can be derived from this factor.
- Government intervention, through its competition policies, can create an environment in which firms can gain competitive advantage, through the creation of large projects etc.
 - Both user firms and system integrator firms agree on this factor and there are no significant differences between means for either. Government intervention has lead to competitive advantages.

It may therefore be argued that technology management and a firms environmental and organizational evolution are linked for the factors selected above. These factors are specialized factors like skilled labour and natural resources and, firms strategy, structure and rivalry. In some cases a contribution to a firm's competitive advantage has been achieved. The question can then be posed: has a firm's competitive advantage led to environmental and organizational evolution.

Table 6.11: The effects of technology management on firm's organisational and environmental evolution

Question nos.	Category	User and System integrators	Mean	Standard deviation	F test for equality of variances	t-test for equality of means	Significance 2- tailed	Degrees of freedom
56.1	Generalised factors which are easy to source through global networks like generic technologies from distant sources but transfer of know-how benefits from proximity	User	4.45	1.54	0.573	1.097 ⁺	0.277	64
		System integrator	4.06	1.37	Sig. 0.452			
56.2	Specialised factors like skilled labour and natural resources	User	4.88	1.11	0.118	-1.834 ⁺	0.071	64
		System integrator	5.33	0.89	Sig. 0.732			
56.3	Related and supporting industries like home based suppliers and related industries	User	3.72	1.42	3.541	-1.839 ⁺	0.071	64
		System integrator	4.30	1.10	Sig. 0.064			
56.4	Demand in your country	User	4.36	1.37	0.003	-0.554 ⁺	0.582	64
		System integrator	4.55	1.31	Sig. 0.957			
56.5	Firms strategy, structure and rivalry	User	4.97	0.88	5.772	-1.082 ⁺	0.283	64
		System integrator	5.24	1.15	Sig. 0.019			
56.6	Government intervention e.g. by its competition policies, creating an environment in which firms can gain competitive advantage, creation of large projects etc.	User	4.00	1.95	1.245	-1.542 ⁺	0.128	64
		System integrator	4.67	1.53	Sig. 0.269			

Having met the objectives of the research, possible answers to the sub-problems are proposed next.

⁺ Equal variances not assumed

Sub Problems

Considering SP1viz.

Table 6.12: A test for subproblem 1

Question nos.	SP1: How long does it take changes to technology to affect transaction processes?	User or system integrators	Mean	Standard deviation	F test for equality of variances	t-test for equality of means	Significance 2-tailed	Degrees of freedom
26.1	Transactional cost reduction	User	2.67	1.14	0.003 Sig.	-0.323 ⁺	0.747	64
		System integrators	2.75	1.14	0.956			
26.2	Transactional value added	User	2.70	1.38	6.635 Sig.	-0.935 ⁺	0.354	64
		System integrators	2.97	0.95	0.012			
13	Integrate between technologies in design, process/manufacturing and/or management	User	2.69	1.34	0.561 Sig.	-2.566 ⁺	0.013	64
		System integrators	3.58	1.15	0.457			

The effects of technological change on transaction processes were measured in two ways. Firstly the effect on transactional cost reduction was measured and secondly the effect on transactional value-added activities was measured. These effects are discussed next viz.:

- Transactional cost reduction
 - Both users and system integrators agree that there are no significant differences between means for either of them. The results reveal that the effects of technological change are likely to be felt in transactional cost reduction 6 months to one year after successful implementation.
- Transactional value added
 - Both users and system integrators agree that there are no significant differences between means for either of them. The results reveal that the effects of technological change is likely to be felt in transactional value-added activities 6 months to one year after successful implementation.
- Length of time to integrate between technologies
 - There are significant differences between users and system integrators in respect of time periods for integration between technologies. The results reveal that integration between technologies is likely to take place as follows: for user firms, integration is likely to take place within 6 months to one year, whereas system integrator firms believe that technological

⁺ Equal variances not assumed

integration is likely to take place one to two years after technological implementation.

In conclusion it may be said that after successful technological implementation, the effects in respect of transactional cost reduction and transactional value-added activities will be realised within 6 months to one year thereafter. The effect of organizational learning on transaction processes is considered next, leading to SP2.

The associated relationships are shown in Table 6.13 below. SP2 is considered next viz.:

Table 6.13: A test for subproblem 2

Question nos.	SP2: What is the effect of organizational learning on transaction processes?	User or system integrators	Mean	Standard deviation	F test for equality of variances	t-test for equality of means	Significance 2 tailed	Degrees of freedom
41.1	Transactional cost reduction	User	4.79	1.05	1.029 Sig. 0.314	1.805 ⁺	0.076	64
		System integrators	4.27	1.26				
41.2	Transactional value added	User	4.82	1.24	0.023 Sig. 0.879	1.225 ⁺	0.225	64
		System integrators	4.45	1.17				

The effects of organizational learning on transaction processes were measured in two ways. Firstly the effect on transactional cost reduction was measured and secondly the effect on transactional value-added activities was measured. These effects are discussed next viz.:

- Transactional cost reduction
 - Both users and system integrators agree that there are no significant differences between means for either of them. The results reveal that the effects of organizational learning on transactional cost reduction are important, with the means at 4.79 and 4.27 for users and system integrators respectively.
- Transactional value added
 - Both users and system integrators agree that there are no significant differences between means for either of them. The results reveal that the effects of organizational learning on transactional value-added activities are important, with the means at 4.82 and 4.45 for users and system integrators respectively

In conclusion it may be said that the benefits of organizational learning, in respect of transactional cost reduction and transactional value-added activities is slightly above average

⁺ Equal variances not assumed

on a 7-point Likert scale. Next the effect of information flow and knowledge transfer on transaction processes are considered, leading to SP3.

The associated relationships are shown in Table 6.14 below. SP3 is considered next viz.:

Table 6.14: A test for subproblem 3

Question nos.	SP3: What is the effect of information flow and knowledge transfer on transaction processes?	User or system integrators	Mean	Standard deviation	F test for equality of variances	t-test for equality of means	Significance 2 tailed	Degrees of freedom
30.1	Transactional cost reduction	User	4.82	1.33	0.037	1.853 ⁺	0.069	64
		System integrators	4.27	1.04	0.848			
30.2	Transactional value added	User	5.36	0.96	0.838	1.466 ⁺	0.148	64
		System integrators	5.03	0.88	0.363			

The effects of information flow and knowledge transfer on transaction processes were measured two ways. Firstly the effect on transactional cost reduction was measured and secondly the effect on transactional value-added activities was measured. These effects are discussed next viz.:

- Transactional cost reduction
 - Both users and system integrators agree that there are no significant differences between means for either of them. The results reveal that the effects of information flow and knowledge transfer on transactional cost reduction is important, with the means at 4.82 and 4.27 for users and system integrators respectively.
- Transactional value added
 - Both users and system integrators agree that there are no significant differences between means for either of them. The results reveal that the effects of information flow and knowledge transfer on transactional value-added activities are important, with the means at 5.36 and 5.03 for users and system integrators respectively.

In conclusion it may be said that the benefits of information flow and knowledge transfer, in respect of transactional cost reduction and transactional value-added activities are slightly above average on a 7-point Likert scale. Next the effects of technology management on manufacturing mix criteria are considered, leading to SP4. The associated relationships are shown in Table 6.15 below. SP4 is considered next viz.:

⁺ Equal variances not assumed

Table 6.15: A test for subproblem 4

Question nos.	SP4: How does technology management affect manufacturing mix criteria?	User or system integrators	Mean	Standard deviation	F test for equality of variances	t-test for equality of means	Significance 2 tailed	Degrees of freedom
22.	To what extent do you believe that firms' technological strategies are aimed at improving manufacturing mix criteria?	User System integrators	5.55 5.18	1.12 1.07	0.001 Sig. 0.973	1.346 ⁺	0.183	64
52.	For leading firms: to what extent do you believe that technological implementations have affected the following manufacturing mix criteria?							
52.1	Cost	User System integrators	5.06 4.88	0.998 1.111	0.338 Sig. 0.563	0.699 ⁺	0.487	64
52.2	Quality	User System integrators	5.36 4.88	1.17 1.11	0.005 Sig. 0.941	1.728 ⁺	0.089	64
52.3	Speed	User System Integrators	5.24 5.18	0.969 0.808	0.049 Sig. 0.826	0.276 ⁺	0.784	64
52.4	Dependability	User System integrators	5.42 4.67	0.83 1.22	5.082 Sig. 0.028	2.955 ⁻	0.004	64
52.5	Flexibility	User System integrators	5.15 4.76	1.034 1.37	0.628 Sig. 0.431	1.318 ⁺	0.192	

For SP4, the effects of technology management on manufacturing mix criteria were measured in two ways. Firstly the alignment of a firms' technological strategy towards improving manufacturing mix criteria was considered and secondly the effects of technological implementations on each of the manufacturing mix criteria. These two approaches are discussed next viz.:

- Alignment of a firm's technological strategies towards improving manufacturing mix criteria

⁺ Equal variances not assumed

⁻ Equal variances assumed

- Both users and system integrators agree on this, and there are no significant differences between means for either of them. The results reveal that firms have aimed their technological strategies at improving manufacturing mix criteria, with means at 5.55 and 5.18 for users and system integrators respectively.
- Technological implementations have affected manufacturing mix criteria.
 - Both users and system integrators agree on these criteria, and there are no significant differences between means for either of them. Each of the manufacturing mix criteria is discussed next viz.:
 - Cost: user and system integrators see no major differences on cost as a result of technological implementation, with means at 5.06 and 4.88 respectively.
 - Quality: user and system integrators see no major differences on quality as a result of technological implementation, with means at 5.36 and 4.88 respectively.
 - Speed: user and system integrators see no major differences on speed as a result of technological implementation, with means at 5.24 and 5.18 respectively.
 - Dependability: user and system integrators differ on the effects on dependability as a result of technological implementation, with means at 5.42 and 4.67 respectively.
 - Flexibility: user and system integrators see no major effect on flexibility as a result of technological implementation, with means at 5.17 and 4.76 respectively.

In conclusion it may be said that firms have aligned their technological strategies towards improving manufacturing mix criteria and in addition the effects of technological implementations on each of the manufacturing mix criteria are rated slightly above average on a 7-point Likert scale.

Having discussed the subproblems the central questions are discussed next.

Central questions

The associated relationships are shown in Table 6.16 below. CQ1 is considered next.

The effects of technological implementations on transaction processes are considered for CQ1. The effects of technological implementations on transaction processes were measured in two ways; firstly the effect on transactional cost reduction was measured and secondly the effect on transactional value-added activities was measured. These effects are discussed next:

Table 6.16: A test for Central Question 1

Question nos.	CQ1: How does technological implementations affect transaction processes?	User or system integrators	Mean	Standard deviation	F test for equality of variances	t-test for equality of means	Significance 2 tailed	Degrees of freedom
25.	To what extent do you believe that technological implementations have affected transaction processes with regard to:							
25.1	Transaction cost reduction?	User	4.91	1.07	0.594	0.672 ⁺	0.504	64
		System integrators	4.72	1.13	0.444			
25.2	Transaction value added?	User	5.12	0.96	0.146	2.049 ⁺	0.045	64
		System integrators	4.64	0.96	0.703			

- Transactional cost reduction
 - Both users and system integrators agree that there are no significant differences between means for either of them. The results reveal that the effects of technological implementations on transactional cost reduction are important, with means measured at 4.91 and 4.72 for users and system integrators respectively.
- Transactional value added
 - There are significant differences between users and system integrators. The results reveal that the effects of technological implementations on transactional value-added activities is of more importance to users than system integrators, with means measured at 5.12 and 4.64 for users and system integrators respectively.

In conclusion it may be said that the benefits of technological implementations, in respect of transactional cost reduction and transactional value-added activities, is average at 4 on a 7-point Likert scale. Next the effects of technological implementation on governance structures are considered, leading to CQ2

The associated relationships are shown in Table 6.17 below. CQ2 is considered next:

The effects of technological implementations on governance structures are considered for CQ2. The effects of technological implementations on governance structures were measured in three ways: firstly the effects of technological implementations on relationships and partnering were considered, i.e. social networks and embedded ties, supplier closeness communications, trust and good will, and market opportunities through partnering; secondly

⁺ Equal variances not assumed

Table 6.17: A test for Central Question 2

Question nos.	CQ2: How does technological implementations affect governance structures?	User or system integrators	Mean	Standard deviation	F test for equality of variances	t-test for equality of means	Significance 2 tailed	Degrees of freedom
36.	To what extent do you believe that technological implementations have affected the following:							
36.1	Social networks and embedded ties?	User	4.79	1.14	3.468	2.507 ⁺	0.015	64
		System integrators	3.70	1.49	Sig. 0.067			
36.2	Supplier closeness, communications, trust and goodwill?	User	4.88	1.17	0.150	1.793 ⁺	0.078	64
		System integrators	4.36	1.17	Sig. 0.700			
36.3	Market opportunities through partnering?	User	5.15	1.15	0.019	0.761 ⁺	0.450	64
		System integrators	4.93	1.17	Sig. 0.889			
39.	To what extent do you believe that firms adopt the following approaches which support effective governance:							
39.1	Joint ventures and strategic alliances?	User	4.77	1.26	0.015	0.477 ⁺	0.635	64
		System integrators	4.56	1.32	Sig. 0.903			
39.2	Two way technology exchanges?	User	4.24	1.52	0.576	1.096 ⁺	0.277	64
		System integrators	3.85	1.39	Sig. 0.451			
39.3	One way technology exchanges?	User	3.67	1.51	0.078	-0.798 ⁺	0.428	64
		System integrators	3.97	1.57	Sig. 0.781			
39.4	Direct investment?	User	3.97	1.67	0.329	0.314 ⁺	0.754	64
		System integrators	3.85	1.46	Sig. 0.569			
39.5	Customer and supplier relationships?	User	5.49	1.15	0.824	1.541 ⁺	0.128	64
		System integrators	5.09	0.91	Sig. 0.367			
40.	To what extent do you believe that technological implementations have led to improved network structures with firms and their key partners over the last 5 years?	User	4.94	1.22	0.140	-0.647 ⁺	0.520	64
		System integrators	5.12	1.05	Sig. 0.709			

⁺ Equal variances not assumed

technological approaches were considered; and thirdly network structures were considered. These effects are discussed next:

- Relationships and partnering
 - Both users and system integrators agree that there are differences between means for users and system integrators. Each of the relationship and partnering criteria is discussed next:
 - Social networks and embedded ties: There are significant differences between users and system integrators as a result of technological implementations, with means measured at 4.79 and 3.70 respectively.
 - Supplier closeness, communications, trust and goodwill: both users and system integrators agree on the effects resulting from technological implementations, with means measured at 4.88 and 4.36 respectively.
 - Market opportunities through partnering: both users and system integrators agree on the impact of technological implementations on market opportunities through partnering, with means measured at 5.15 and 4.93 respectively.

In conclusion it may be said that technological implementations have given rise to advantages in terms of relationships and partnering.

- Approaches supporting effective governance
 - Both users and system integrators agree that there are no significant differences between means for users and system integrators. Each of the different approaches supporting effective governance is discussed next, viz.:
 - Joint ventures and strategic alliances: users and system integrators have supported the use of joint ventures and strategic alliances to support effective governance, with means measured at 4.77 and 4.56 respectively.
 - Two-way technology exchanges: users and system integrators have supported the use of two-way technology exchanges for effective governance, with means measured at 4.24 and 3.85 respectively.
 - One-way technology exchanges: users and system integrators have supported the use of one-way technology exchanges for effective governance, with means measured at 3.67 and 3.97 respectively.
 - Direct investment: users and system integrators have supported the use of direct investments for effective governance, with means measured at 3.97 and 3.85 respectively.
 - Customer and supplier relations: both users and system integrators supported the use of customer and supplier relations for effective

governance. They see this criterion as more important than the other criteria, with means measured at 5.49 and 5.09 respectively.

In conclusion supplier and customer relations were seen as being more important than the other factors in favour of effective governance.

- Network structures
 - Both users and system integrators agree that there are no significant differences between means for either of them. The results reveal that technological implementations have led to improved network structures with firms and their key partners over the last five years, with means measured at 4.94 and 5.12 for users and system integrators respectively.

In conclusion it may be said that technological implementations lead to improved network structures with firms and their key partners

Finally it may be said that technological implementations affect governance structures, and that the more important effects are felt through supplier and customer relations, and improved network structures with firms and their key partners as a result of technological implementations. The hypotheses mentioned before are considered next.

Hypothesis

The associated relationships are shown in Table 6.18 below. Hypothesis 1 (H1) is as follows:

- Proportion of investments made in the latest state-of-the-art technologies
 - There are no significant differences between users and system integrators when it comes to investment in the latest state-of-the-art technologies. User firms tend to invest more in these technologies, whilst system integrator firms see this as not being necessary, with means measured at 4.18 and 3.06 for users and system integrators respectively. This means that users invest 25% to 50% in the latest state-of-the-art technologies, whilst system integrators say that leading firms invest 10% to 25% in these technologies.

Having discussed technological investments, firm growth rates are discussed next. Three categories are considered for firm growth rates i.e. sales growth, return on sales and earnings growth.

- Sales growth: both user firms and system integrator firms agree in respect of this factor, that there are no significant differences between means for users and system integrators. Users see benefits in terms of sales growth as a result of technological implementations and system

Table 6.18: Hypothesis 1-firms that adopt new technologies grow at different rates to firms that maintain older technologies

Question nos.	H1: firms that adopt new technologies grow at different rates to other firms that maintain older technologies.	User or system integrators	Mean	Standard deviation	F test for equality of variances	t-test for equality of means	Significance 2-tailed
4.	Indicate your firm's level of technological investment as a percentage of total investments.	User	3.48	1.37	2.332 Sig. 0.132	2.995 ⁺	0.004
	For leading firms, what proportion of investments are allocated to technological related activities.	System integrator	2.53	1.19			
5.	Indicate what proportion of your firm's technological investments are made in the latest available technologies.	User	4.18	1.63	0.072 Sig. 0.789	2.873 ⁺	0.006
	For leading firms, in your opinion what proportion of investments are made in the latest available technologies?	System integrator	3.06	1.94			
48	User firms: For your major product lines, indicate your firm's performance relative to your major competitors as a result of technological implementation. System integrators: For leading firms, how would you rate their performance relative to their competitors as a result of technological implementation?						
48.1	Sales growth	User	5.18	1.45	4.68 Sig. 0.034	1.964 ⁻	0.055
		System integrators	4.60	0.86			
48.2	Return on sales	User	4.88	1.47	1.578 Sig. 0.214	-0.194 ⁺	0.847
		System integrators	4.94	1.02			
48.3	Earnings growth	User	4.79	1.45	0.117 Sig. 0.733	-0.372 ⁺	0.711
		System integrators	4.91	1.18			

⁺ Equal variances not assumed⁻ Equal variances assumed

integrators also see this increase for leading firms, with means measured at 5.18 and 4.60 respectively.

- Return on sales: user firms and system integrator firms agree on this factor and there are no significant differences between users and system integrators as regards return on sales as a result of technological investments, with means measured at 4.88 and 4.94 respectively.
- Earnings growth: users and system integrators that there are no significant differences between users and system integrators on earnings growth as a result of technological investments, with means measured at 4.79 and 4.91 respectively.

For testing of Hypothesis 1 (H1) a one-tailed test may also used to test differences in means. To determine firm performance as a result of technological investment, Question 3 is used. Firms are categorised as innovators, early adopters, early majority, late majority and laggards. For the analysis innovators and early adopters were combined and the early majority and late majority were combined. No firms were categorised as laggards. Using this categorization the two groups were compared to determine whether firms that invested in technology grew at different rates to firms that maintained older technologies. The following decision rule was applied:

- $H_0: \mu_1 = \mu_2$, there are no significant differences between firms.
- $H_1: \mu_1 \neq \mu_2$, there are significant differences between firms.
 - Under hypothesis H_0 , both categories of firms come from the same population. The mean and standard deviation of the difference in means are given by
 - $t = (\bar{x}_1 - \bar{x}_2) / \sigma \sqrt{(1/N_1 + 1/N_2)}$
 - where $\sigma = \sqrt{(N_1 S_1^2 + N_2 S_2^2) / (N_1 + N_2 - 2)}$

For a one-tailed test, at 0.05 level of significance we would reject H_0 if t where greater than t at 0.95 (Murray (1994, p.(230-238))).

Two comparisons are drawn, firstly using a two-way split comparing innovators and early adopters to early majority and late majority firms, this result is shown in Table 6.19, Table J5 gives information relating to the number of items, mean and standard deviation. In addition a four-way split is also done comparing each of the categories, i.e. innovators, early adopters, early majority and late majority, these results are shown in Figure 6.20, Table J6 gives information relating to number of items, mean and standard deviation. Hence the following conclusions for sales growth, return on sales and earnings growth may be drawn:

Table 6.19: Results for Hypothesis 1, two-way split

User firms	H ₀	H ₁	
Innovators and early adopters	Accepted	Rejected	$t_{0.95}$ at 31 degrees of freedom is 1.70 and $t = 0.7664$
Early majority and late majority			
System integrator firms	Accepted	Rejected	$t_{0.95}$ at 29 degrees of freedom is 1.70 and $t = 0.9210$
Innovators and early adopters			
Early majority and late majority			

Therefore it may be concluded that for user and system integrator firms H₀ is Accepted, i.e. firms that invest in newer technologies do not grow at different rates to firms that maintain older technologies when comparing sales growth, return on sales and earnings growth.

Table 6.20: Results for Hypothesis 1, four-way split

Firm categories	User	System integrator	Innovators	Early adopters	Early majority	Late majority
Innovators	*		x	H ₀ true. $t = 0.9210 < t_{0.95}$ (1.73 at 19 degrees of freedom). H ₀ true. $t = 0.76 < t_{0.95}$ (1.75 at 15 degrees of freedom).	H ₀ true. $t = 0.9229 < t_{0.95}$ (1.771 at 13 degrees of freedom). H ₀ true. $t = 1.17 < t_{0.95}$ (1.78 at 12 degrees of freedom).	H ₀ true. $t = 0.9210 < t_{0.95}$ (1.80 at 11 degrees of freedom). H ₀ rejected $t = 4.214 > t_{0.95}$ (2.92 at 2 degrees of freedom).
Early adopters	*		H ₀ true. $t = -0.73 < t_{0.95}$ (1.73 at 19 degrees of freedom). H ₀ true. $t = -0.75 <$	x	H ₀ true. $t = -0.73 < t_{0.95}$ (1.75 at 18 degrees of freedom). H ₀ true. $t = -0.04 <$	H ₀ true. $t = 0.59 < t_{0.95}$ (1.75 at 16 degrees of freedom). H ₀ true. $t = 0.017 <$

			$t_{0.95}$ (1.75 at 15 degrees of freedom).		$t_{0.95}$ (1.71 at 25 degrees of freedom).	$t_{0.95}$ (1.75 at 15 degrees of freedom).
Early majority	*	*	H_0 true. $t = -0.89 < t_{0.95}$ (1.77 at 13 degrees of freedom). H_0 true. $t = -0.57 < t_{0.95}$ (1.78 at 12 degrees of freedom).	H_0 true. $t = 0.07 < t_{0.95}$ (1.73 at 18 degrees of freedom). H_0 true. $t = 0.04 < t_{0.95}$ (1.71 at 25 degrees of freedom).	x	H_0 true. $t = -1.45 < t_{0.95}$ (1.81 at 10 degrees of freedom). H_0 true. $t = 0.03 < t_{0.95}$ (1.81 at 10 degrees of freedom).
Late majority	*	*	H_0 true. $t = -2.08 < t_{0.95}$ (1.79 at 11 degrees of freedom). H_0 true. $t = -0.21 < t_{0.95}$ (2.920 at 2 degrees of freedom).	H_0 true. $t = 0.09 < t_{0.95}$ (1.75 at 16 degrees of freedom). H_0 true. $t = -0.012 < t_{0.95}$ (1.75 at 15 degrees of freedom).	H_0 true. $t = -0.84 < t_{0.95}$ (1.81 at 10 degrees of freedom). H_0 true. $t = -0.034 < t_{0.95}$ (1.78 at 12 degrees of freedom).	x

In conclusion for H1 it may be said that firms that adopt new technologies do not grow at different rates to other firms that maintain older technologies. The only exception where firm growth rates deferred was for system integrator firms who believed that innovator firms grew differently to late majority firms.

Hypothesis Two (H2) is considered next. The associated relationships are shown in Table 6.21 below.

Managers' preference with regard to manufacturing mix criteria or new technologies are considered next.

- Technologies: There are significant differences between users and system integrators in this regard. Users see technologies as being more important than system integrators do, with means measured at 5.64 and 4.72 respectively.

Table 6.21: Hypothesis 2-Managers rate manufacturing mix criteria as more important than technological leadership.

Question nos.	H2:Managers rate manufacturing mix criteria as more important than technological leadership.	User or system integrators	Mean	Standard deviation	F test for equality of variances	t-test for equality of means	Significance 2-tailed
15.	User Firms: To what extent do you believe that your firm views the following criteria as important for competitive advantage? System integrators: To what extent do you believe that firms view the following criteria as important for competitive advantage?						
15.1	Technologies	User	5.64	1.17	0.500	3.341 ⁺	0.001
		System integrators	4.72	1.04	Sig. 0.482		
15.2	Cost	User	5.45	1.44	11.501	-0.734 ⁻	0.088
		System integrators	5.97	0.92	Sig. 0.001		
15.3	Quality	User	6.09	1.04	0.864	2.350 ⁺	0.022
		System integrators	5.55	0.83	Sig. 0.356		
15.4	Speed	User	5.30	1.33	0.976	0.896 ⁺	0.374
		System integrators	5.03	1.13	Sig. 0.327		
15.5	Dependability	User	6.00	1.09	0.064	3.244	0.002
		System integrators	5.15	1.03	Sig. 0.801		
15.6	Flexibility	User	5.36	1.25	0.873	2.028 ⁺	0.047
		System integrators	4.79	1.05	Sig. 0.354		

- Cost: There are no significant differences between users and system integrators, with means measured at 5.45 and 5.97 respectively.
- Quality: There are significant differences between users and systems integrators with regard to quality, with means measured at 6.09 and 5.55 respectively.
- Speed: There are no significant differences between users and system integrators, with means measured at 5.30 and 5.03 respectively.
- Dependability: There are significant differences between users and system integrators, with means measured at 6.00 and 5.15 respectively.

⁺ Equal variances not assumed

⁻ Equal variances assumed

- Flexibility: There are significant differences between users and system integrators, with means measured at 5.36 and 4.79 respectively.

For testing of Hypothesis two (H2) a one-tailed test for testing differences between means may also be used. The associated relationships are shown in Table 6.22 below, Table J7 gives information relating to number of items, mean and standard deviation.

The following decision rule was applied viz.

- $H_0 : \mu_1 = \mu_2$, there are no significant differences between firms.
- $H_1 : \mu_1 \neq \mu_2$, there are significant differences between the importance of technologies and manufacturing mix criteria..
 - Under hypothesis H_0 , both categories of firms come from the same population. The mean and standard deviation of the difference in means are given by.
 - $t = (\bar{x}_1 - \bar{x}_2) / \sigma \sqrt{(1/N_1 + 1/N_2)}$
 - where $\sigma = \sqrt{(N_1 S_1^2 + N_2 S_2^2) / (N_1 + N_2 - 2)}$

For a one-tailed test, at 0.05 level of significance we would reject H_0 if t where greater than t at 0.95.

For a one-tailed test, at 0.05 level of significance we would reject H_0 if t where greater than t at 0.95.

Hence the following conclusions for the importance of technology and manufacturing mix criteria may be drawn viz.

Table 6.22: Testing hypothesis 2

User firms	Ho	H ₁	Results
Importance of technology	Accepted	Rejected	$t_{0.95}$ at 64 degrees of freedom is 1.67 and $t = -0.02$
Importance of manufacturing mix criteria			
System integrators	Ho	H ₁	
Importance of technology	Accepted	Rejected	$t_{0.95}$ at 33 degrees of freedom is 1.71 and $t = -2.71$
Importance of manufacturing mix criteria			

Therefore it may be concluded H_0 is accepted for both user and system integrator firms i.e. there are no significant differences between firms. Managers in firms do not rate manufacturing mix criteria more important than technological leadership.

7 Discussion of results

Chapter 7 deals with a discussion of the research with regard to germane articles that have been used for the construction of the theoretical framework. Firstly the three objectives of the research are discussed in sections 7.1 to section 7.3. Thereafter other factors considered to be important in respect of technology management, (i.e. factors affecting technological risk, technological implementations, strategic partnerships, relationship management and technological sourcing) are discussed. Sections 7.4 to 7.8 are focused on these other factors. The first objective of the research, i.e. establishing links, is discussed next.

7.1 *Forming links*

In the literature survey, Chapter 2 reference is made to the Hay and Morris Model, the manufacturing capabilities and business performance model, and the Sandcone model. Using these models a technological and investigative framework is developed, this is shown in Figure 3.1 and 3.3 respectively. This thesis shows that there are links in the technological framework and investigative framework. Some of these are discussed next.

- In the adapted Hay and Morris model, it is shown that management affects efficiency, investment in R&D and technology. In this thesis we have shown in the investigative framework (Figure 3.3) that organizational determinants [3.2.1] are linked to manufacturing mix processes [3.2.4]. In turn it is argued that manufacturing mix processes [3.2.4] improve transaction processes [3.2.6] in respect of transactional cost and transactional value-added activities. It may therefore be argued that management drives efficiency, which is in line with the Hay and Morris model. In addition it is shown that organizational determinants [3.2.1] (i.e. individuals, assets and organizational structures) are linked to technologies, technological resource skills, firm competencies and knowledge management. It may therefore be argued that with such links, benefits in R&D and technology may be achieved, which is therefore in line with the Hay and Morris model.
- In the Hay and Morris model it is shown that through technology and economies of scale, improvements in firm profit and growth can be achieved. In the technological framework (Figure 3.1) and investigative framework (Figure 3.3) drivers for technology management are considered (i.e. organizational determinants, competitors and external factors). These drivers are shown to be linked to manufacturing mix processes, which in turn drive technology management. Therefore the links found are in agreement with those of the Hay and Morris model.
- The manufacturing capabilities and business performance model (Appendix N) proposes relationships that exist among competitive capabilities (manufacturing mix criteria). In this thesis we have shown the importance to firms of manufacturing mix criteria for competitive advantage. However the

manufacturing capabilities and business model does not cater for factors such as organizational structures or management styles. In this thesis links have been developed to include factors outside the control of manufacturing. These factors are organizational determinants, competitors and external factors. They have then been used to consider factors outside the control of manufacturing for firms' competitive advantages.

- The Sandcone model (Appendix O) allows for the existence of manufacturing mix variables. In this thesis it is proposed that technology be integrated into these variables. There are differences in opinion between user firms and system integrator firms with regard to the importance of technology. In ranking means, user firms rate technology second, whereas system integrator firms rate technology as the least important. In addition, in the manufacturing and business model it is proposed that conformance quality, delivery speed, delivery dependability, product flexibility and cost reductions are directly related to business performance. In this thesis it is shown that technology is also directly related to business performance.
- In addition to drivers like organizational determinants, competitors and external factors, other factors like technological acquisition, patented process or design, know-how shared among individuals in the firm, the firm's selection and positioning within an industry, etc., are also considered to be important.
 - Firstly organizational determinants and managerial practices are considered to be a key factor that was not taken into account in the manufacturing capabilities and business performance model. Authors like Hansen and Wernerfelt (1989, p.409) described three additional criteria, which are considered to be important contributors to firm performance. These criteria are industry selection and positioning within an industry, good administrative practices and the fact that economic and organizational effects are roughly independent. These criteria can be likened to other organizational determinants like individuals, assets and organizational structures. In this thesis the criteria suggested by Hansen and Wernerfelt (1989, p.409) re tested. Table 7.1 gives the findings.
 - Each of these criteria are discussed next:
 - Industry selection and positioning: both users and system integrators agree on this criterion, there are no significant difference between means for users and system integrators, with means measured at 5.55 and 5.64 respectively. Both users and system integrators see industry selection and positioning as important contributors to a firm's performance.

- Organizational processes and administrative practices: There are significant differences between means for users and system integrators, with means measured at 5.52 and 4.97 respectively. Users see organizational processes and administrative practices as being more important than system integrators do.
- Managerial capabilities: Both users and system integrators agree on this criterion, with no significant differences between means for users and system integrators, with means measured at 5.85 and 5.93 respectively.

Table 7.1: Organizational determinants

Question nos.	Category	User or system integrators	Mean	Standard deviation	F test for equality of variances	t-test for equality of means	Significance 2-tailed	Degrees of freedom
47.1	Industry selection and positioning	User	5.55	0.97	0.192 Sig. 0.663	-0.354 ⁺	0.725	64
		System integrators	5.64	1.11				
47.2	Organizational processes and administrative practices	User	5.52	0.87	1.909 Sig. 0.172	2.100 ⁺	0.040	64
		System integrators	4.97	1.21				
47.3	Managerial practices	User	5.85	0.91	0.169 Sig. 0.683	-0.417 ⁺	0.678	64
		System integrators	5.93	0.86				

Table 7.2 shows the ratings of the criteria proposed by Hansen and Wernerfelt (1989, p.409). 1 indicates the most important and 3 indicates the least important. In conclusion it may be said that these criteria are important contributors to a firm's performance.

Table 7.2: Ranking criteria important for a firm's performance

Description of factors	Users	System integrators
Industry selection and positioning	1	1
Organizational processes and administrative practices	2	2
Managerial capabilities	3	3

- There are other tangible and intangible factors considered important for competitive advantage, and these substantiate the importance of organizational determinants and technology. Authors like Mahoney and Pandian (1992, p.370) list different tangible and intangible

⁺ Equal variances not assumed

integrators, with means measured at 5.12 and 5.91 respectively. User firms tend to view know-how shared among individuals in the firm as less important than system integrators do.

- The firm's selection and positioning within an industry: There are significant differences between means for users and system integrators, measured at 5.79 and 5.30 respectively. User firms tend to see industry selection and positioning as more important than system integrators do.

Table 7.4 below shows the ratings between users and system integrators for the factors that are important for competitive advantage. One indicates the most important and five indicates the least important. Both user and system integrator firms regarded technological acquisition to be equally important. They saw this to be of lower importance as access to technology was readily available. This was apparent during discussions with the expert panel

Table 7.4: Ranking factors that are important for competitive advantage

Description of factors	Users	System integrators
Individuals, assets and organizational structures	2	1
Technological acquisition	4	4
Patented process or design	5	5
Know-how shared among individuals in the firms	3	2
The firm's selection and positioning within an industry	1	3

Having discussed the linkages, the RBV and TCE views are discussed next.

7.2 The RBV and TCE views

In the literature survey (Chapter 2) the debate around the RBV and TCE views shows that there are advantages and disadvantages to either theory. However, scholars have not been able to link both theories successfully. Scholars have either argued for or against either theory. In this thesis all the items in the questionnaire are correlated to either the RBV or the TCE view. For the RBV the variables of firm resources and industry selection and positioning are combined as a RBV factor, for the TCE view transactional benefits in either transactional reduction or transactional value added are used. In Chapter 3 section 3.4.2 possible comparisons for the RBV and TCE views are proposed. Using this argument seventy-one correlations were found in total. This suggests that both the RBV and TCE views of the firm provide benefits. Some of these benefits are discussed next, viz.:

- The technological approaches that have been adopted by firms are categorized as innovators, early adopters, early majority, late majority and laggards. These categories are then correlated to the RBV and TCE views. It was found that both user and system integrators correlate to the RBV and TCE views. A possible

explanation could be that the approach that firms take is based on the resources that firms possess and this would lead to transactional benefits. Therefore a correlation for both factors is found.

- Technological investment in firms was further broken down into investment in the latest available technologies. Investment in the latest available technologies is then correlated to the RBV and TCE views. It is found that both user and system integrator firms correlate to the RBV and TCE views. A possible explanation could be that firms invest in resources technology as a resource to obtain transactional benefits.
- Technological implementations as a means to improve core competencies. It was found that both user and system integrator firms correlate to the RBV and TCE views. A possible explanation could be that firms use technological implementations to improve core competencies, core competence being a resource to obtain transactional benefits. Therefore a correlation is found.

The above list is by no means comprehensive but it provides a platform for further discussion to link the RBV and TCE views of the firm.

The RBV and TCE views of the firm could also be used in determining firms' diversification for growth. Diversification could be seen as being based on the resources a firm possesses, and these resources could then be further developed through diversification. In addition, some firms can diversify and thereafter develop their resources. There are different mechanisms of diversification that could be used by firms. The RBV can be seen as a basis for diversification to obtain transactional benefits. In Chapter 2 and Appendix S reference is made to diversification and performance, researchers argue the benefits and concerns around diversification and performance leading to resources and the motivation for growth. Some of these criteria are tested to check if the arguments posed can be supported. Authors like Wernerfelt (1984, p.172) proposed criteria that were important for addressing issues in the formulation of strategy for diversified firms. In this thesis we test usage of these criteria. Table 7.5 shows the results.

A discussion of the criteria follows:

- Current resources as a basis for diversification: both users and system integrators agree on this criterion, with no significant differences between means, means measured at 4.39 and 4.00 respectively. Both users and system integrators see current resources as a basis for diversification as important for diversification.
- Resources to be developed through diversification: both users and system integrators agree on this criterion, with no significant differences between means, means measured at 4.15 and 4.24 respectively. Both users and

system integrators see resources to be developed through diversification as being important for diversification.

Table 7.5: Factors supporting diversification strategy

Question nos.	Category	User and system integrators	Mean	Standard deviation	F test for equality of variances	t-test for equality of means	Significance 2-tailed	Degrees of freedom
55.1	Current resources as a basis for diversification	User System integrators	4.39 4.00	1.39 1.09	2.025 Sig. 0.160	1.281 ⁺	0.205	64
55.2	Resources to be developed through diversification	User System integrators	4.15 4.24	1.35 1.20	0.476 Sig. 0.493	-0.289 ⁺	0.773	64
55.3	Into what markets should diversification take place?	User System integrators	4.88 4.56	1.52 1.15	2.348 Sig. 0.130	0.916 ⁺	0.363	64
55.4	What types of firms have been identified for diversification?	User System integrators	4.15 4.61	1.87 1.12	7.003 Sig. 0.010	-1.198 ⁺	0.235	64

- Into what markets should diversification take place? Both users and system integrators agree on this criterion, with no significant differences between means, means measured at 4.88 and 4.56 respectively. Both users and system integrators see firms having made important progress in identifying into what markets diversification should take place.
- What types of firms have been identified for diversification? Both users and system integrators agree on this criterion, with no significant differences between means, means measured at 4.15 and 4.61 respectively. Both users and system integrators consider that firms have made important progress in identifying what types of firms have been identified for diversification.

In conclusion it may be said that the criteria identified by Wernerfelt (1984, p.172) are taken into account by firms, there is evidence that these criteria are considered important to adopt in diversification strategies. The technological effects of the organizational and environmental evolution are discussed next.

⁺ Equal variances not assumed

7.3 Technological effects of the organizational and environmental evolution on firms competitive advantage

Porter (1991, p.111) lists organizational and environmental criteria that are important in determining a firm's performance. These criteria are used to determine the technological effects of organizational and environmental evolution on a firm's performance. The results are shown in Table 7.6.

Table 7.6: Organizational and environmental evolution (repeated from Chapter 6 for the sake of clarity)

Question nos.	Category	User or system integrators	Mean	Standard deviation	F test for equality of variances	t-test for equality of means	Significance 2-tailed	Degrees of freedom
56.1	Generalized factors like generic technologies, which are easy to source through global networks	User	4.45	1.54	0.573	1.097 ⁺	0.277	64
		System integrators	4.06	1.37	Sig. 0.452			
56.2	Specialised factors like skilled labour and natural resources	User	4.88	1.11	0.118	-1.834 ⁺	0.071	64
		System integrators	5.33	0.89	Sig. 0.732			
56.3	Related and supporting industries like home-based suppliers and others	User	3.73	1.42	3.541	-1.839 ⁺	0.071	64
		System integrators	4.30	1.10	Sig. 0.064			
56.4	Demand in your country	User	4.36	1.36	0.003	-0.554 ⁺	0.582	64
		System integrators	4.55	1.30	Sig. 0.957			
56.5	Firms' strategy, structure and rivalry	User	4.97	0.88	5.772	-1.082 ⁺	0.283	64
		System integrators	5.24	1.15	Sig. 0.019			
56.6	Government intervention e.g. by its competition policies, creating an environment in which firms can gain competitive advantage through the creation of large projects, etc.	User	4.00	1.95	1.245	-1.542 ⁺	0.128	64
		System integrators	4.67	1.53	Sig. 0.269			

⁺ Equal variances not assumed

In addition, these factors are ranked using means to determine the importance, with 1 indicating the most important and 5 the least important. It seems that both users and system integrators agree with the selection of factors. However, there are differences between them with regard to the importance of the factors.

Table 7.7: Ranking organizational and environmental factors important for a firm's performance

Description of factors	Users	System integrators
Generalised factors like generic technologies, which are easy to source through global networks	3	6
Specialised factors like skilled labour and natural resources	2	1
Related and supporting industries like home-based suppliers and others	6	5
Demand in your country	4	4
Firms' strategy structure and rivalry	1	2
Government intervention	5	3

Having discussed the three objectives of the research, other factors that are considered important are as follows:

- Section 7.4: factors affecting technological risk
- Section 7.5: factors affecting technological implementations
- Section 7.6: strategic partnerships
- Section 7.7: relationship management
- Section 7.8: technological sourcing

These factors can be tied back to earlier discussions in the literature survey. For example:

- Factors affecting technological risk, in Chapter 2 technology cycles are discussed, reference is made to technological discontinuities, eras of ferment, dominant designs, era of incremental change, etc. These technological cycles are then used to explain technology with regard to a systems concept. Thereafter the timing of technological transitions is discussed. Managers in firms that are not aware of these technological transitions may place their firms under technological risk. Technological risks may occur as managers may be unable to assess their firms technological strategies, lack of understanding of the benefits resulting from technological adoption, newness of the area of technology, etc. In addition some managers may not have the necessary skills to achieve the potential technological benefits for their firms.
- Factors affecting technological implementations, in Chapter 2 technological implementation with regard to a value chain perspective is proposed. Using the value chain perspective, managers in firms become aware of the different AMT that exist. Managers therefore can use technological implementations to obtain

reduce risks and improve factors like manufacturing mix criteria, information flow and knowledge transfer. Furthermore decisions that managers make can be aligned to the firm's technological policies.

- Strategic partnerships, in Chapter 2 reference is made research conducted by Dyer (1997) on Japanese automakers. In section 7.6 some of these alliances are tested especially those related to alliance development.
- Relationship management, in Chapter 2 reference is made to supplier relationships, supplier roles responsibilities and selection. These activities are tested to determine opportunistic behavior, transactional diversity, time taken to make decisions, accumulation of information regarding the predictability and reliability of suppliers and risks in terms of information asymmetry.
- Through strategic partnerships and relationship management, technological sourcing may develop. In Chapter 2 closeness of relationships depend on communication this has been argued through the different mechanisms of governance. These relationships are used to develop long-term technological sourcing strategic alliances and joint ventures. In section 7.8 these different alliances and joint ventures are tested, ranging from joint ventures and strategic alliances to customer and supplier relationships.

Having discussed the links to early chapters each of the areas from section 7.4 to 7.8 is discussed next.

7.4 Factors affecting technological risk

Rosenthal (1984, p.213) listed perceptions of technological risks and in this thesis these risks were measured to determine their levels of effect. Table 7.8 shows the effects of the associated risks.

In terms of this thesis, risks preventing technological implementations were measured. The following are the factors that were considered:

- Inability to quantify strategic benefits: There are significant differences between user and system integrator firms in that the former do not see inability to quantify strategic benefits as an important risk, whereas the latter do indeed see this as an important risk. Means are measured at 3.30 and 4.90 respectively.
- Lack of understanding of the benefits resulting from the technological adoption: There are significant differences between user and system integrator firms in that the former do not see the lack of understanding of the benefits resulting from the technological adoption as an important risk, whereas the latter do indeed see this as an important risk, with means being measured at 3.30 and 4.88 respectively.
- Newness of the area of technology: There are significant differences between user and system integrator firms in that the former do not see newness of the

area of technology as an important risk, whereas the latter do indeed see this as an important risk, with means being measured at 3.55 and 4.58 respectively.

- Concern about the lack of skills necessary to achieve the potential benefits: There are no significant differences between user and system integrator firms with regard to the lack of skills necessary to achieve the potential benefits, with means being measured at 3.79 and 4.48 respectively.

In conclusion it may be said that user firms do not see the factors listed as posing restrictions for technological implementations. System integrators, on the other hand do indeed see these factors as posing restrictions on technological implementations. Both user and system integrator firms are concerned about the lack of skills necessary to achieve the potential benefits. It may therefore be said that the factors given by Rosenthal (1984, p.213) are important.

Table 7.8: Measuring levels of risks preventing technological adoption

Question nos.	Category	User or System integrators	Mean	Standard deviation	F test for equality of variances	t-test for equality of means	Significance 2 tailed	Degrees of freedom
6.1	Inability to quantify strategic benefits.	User System integrators	3.30 4.90	1.63 1.60	0.137 Sig. 0.713	-0.403 ⁺	0.00	64
6.2	Lack of understanding of the benefits resulting from the technological adoption	User System integrators	3.30 4.88	1.61 1.43	1.100 Sig. 0.298	-4.202 ⁺	0.00	64
6.3	Newness of the area of the technology	User System integrators	3.55 4.58	1.86 1.20	11.083 Sig. 0.001	-2.679 ⁻	0.010	64
6.4	Concern about the lack of skills necessary to achieve the potential benefits	User System integrators	3.79 4.48	1.58 1.39	0.863 Sig. 0.356	-1.902 ⁺	0.062	64

As discussed in Chapter 2 and the frameworks proposed in Chapter 3 especially Figure 3.1 it can be argued that managers in firms should be aware of the building blocks of technology to reduce technological risk. The building blocks pertaining to technology strategy, technological, technological investment, technological change and technological implementation are important. Managers having a better knowledge of these areas could improve the related technological for their firms. These areas could include technologies,

⁺ Equal variances not assumed

⁻ Equal variances assumed

technological resource skills, firm competencies (i.e. the subsets of technology management in Figure 3.1)

Factors affecting technological implementations are considered next.

7.5 Factors affecting technological implementations

Through the literature survey different factors were noted as affecting technological implementations. In this section these factors are tested.

Table 7.9: Factors affecting technological implementations

Question nos.	Category	User or system integrators	Mean	Standard deviation	F test for equality of variances	t-test for equality of means	Significance 2-tailed	Degrees of freedom
16.1	Market threats	User	4.88	1.29	0.004	0.483 ⁺	0.631	64
		System integrators	4.73	1.26	0.949			
16.2	Current technology obsolete	User	4.64	1.17	1.073	-0.894 ⁺	0.375	64
		System integrators	4.91	1.31	0.304			
16.3	To obtain benefits in criteria like cost, quality, speed, dependability and flexibility	User	5.70	0.98	1.37	1.778 ⁺	0.080	64
		System integrators	5.24	1.09	0.247			
16.4	To improve information flow and knowledge transfer	User	5.30	1.16	0.00	2.563 ⁺	0.013	64
		System integrators	4.58	1.15	0.983			
16.5	In line with the firm's technological policy	User	4.70	1.61	1.740	2.468 ⁺	0.016	64
		System integrators	3.82	1.26	0.192			

The following factors were considered:

- Market threats: both user and system integrator firms agree on the effects of market threats, with no significant differences between means (means are measured at 4.88 and 4.73 respectively). Market threats are considered to be a driver for technological implementations, and firms do to them
- Current technology obsolete: both user and system integrator firms see that current technology being obsolete as a basis for technological implementations, with means measured at 4.64 and 4.91 respectively. Current technology being obsolete is considered as a driver for technological implementations, and firms do

⁺ Equal variances not assumed

keep track of obsolete technologies and tend to invest some of their funds in newer state-of-the-art technologies. as can be deduced from H1.

- Obtain benefits in manufacturing mix criteria: both user firms and system integrator firms see improvements in manufacturing mix criteria as a driver for technological implementations, with means measured at 5.70 and 5.24 respectively.
- To improve information flow and knowledge transfer: There are significant differences between users and system integrators, in that the former see improvement in information flow and knowledge transfer as a driver for technological implementations, whilst the latter do not see the same benefits, even though some benefits are achieved. Means are measured at 5.30 and 4.58 respectively.
- In line with the firm's technological policy: Here there are significant differences between users and system integrators in that users see implementation of a firm's technological policy as a driver for technological implementations, whereas system integrators do not see the same benefits. Means measured at 4.70 and 3.82 respectively.

Table 7.10 shows the associated ratings, where 1 is the most important and 5 is the least important. From this Table it can be seen that both users and system integrators agree that obtaining benefits in manufacturing mix criteria is the most important driver for technological implementations.

Table 7.10: Rating factors affecting technological implementations

Description of factors	Users	System integrators
Market threats	3	3
Current technology obsolete	5	2
To obtain benefits in manufacturing mix criteria	1	1
To improve information flow and knowledge transfer	2	4
In line with the firm's technological policy	4	5

Therefore the value perspective of technology management is important, as managers in firms become aware of the different AMT's that exist. Managers therefore can use technological implementations to obtain reduce risks and improve factors like manufacturing mix criteria, information flow and knowledge transfer. Furthermore decisions that managers make can be aligned to the firm's technological policies. Therefore using technological implementations managers may link transaction processes and governance structures in Figure 3.1

The factors that support strategic partnerships are discussed next.

7.6 Strategic partnerships

The effects of strategic partnerships are tested.

For strategic partnerships two approaches are considered: firstly forming strategic alliances for acquiring the capabilities, information and technology of the other firm, thereafter dissolving the partnership and secondly creating a strategic alliance for the benefit of both firms and thereafter developing the partnership further. These approaches are next discussed next viz.:

Table 7.11: Reasons for developing strategic partnerships

Question nos.	Category	User or system integrators	Mean	Standard deviation	F test for equality of variances	t-test for equality of means	Significance 2-tailed	Degrees of freedom
28.1	Acquiring the capabilities, information and technology of the other firm thereafter dissolving the partnership.	User	2.00	1.40	2.950 Sig. 0.091	-4.099 ⁺	0.00	64
		System integrators	3.70	1.93				
28.2	Create a strategic alliance for both firms thereafter developing the partnership further	User	5.91	1.07	4.431 Sig. 0.039	3.884 ⁺	0.00	64
		System integrators	4.67	1.49				

- Acquiring the capabilities, information and technology of the other firm and thereafter dissolving the partnership: There are significant differences between users and system integrators in that the former see the occurrence of this situation as less likely, whereas the latter see it occurring more frequently. Means are measured at 2.00 and 3.70 respectively.
- Creating a strategic alliances for both firms and thereafter developing the partnership further: There are significant differences between users and system integrators in that the former see themselves as adopting a partnership approach whereas the latter see partnerships developing, but to a lesser extent. Means are measured at 5.91 and 4.67 respectively.

In conclusion user firms see themselves as adopting a partnership approach, but system integrators do not share the same view.

Referring to Figure 3.1 it may therefore be argued that through strategic partnerships there are opportunities to develop technological sourcing and knowledge management opportunities. Which would improve relationship management.

⁺ Equal variances not assumed

Relationship management is discussed next.

7.7 Relationship management

Ring and Van De Ven (1992, p.489) proposed different factors as a result of transactional history between parties, these factors include greater autonomy i.e. less opportunistic behaviour, information asymmetry, transactional diversity, reduce the time to make decisions, accumulation of information regarding the predictability and reliability of partners. In this thesis Table 7.12 shows the effect of these factors on partners.

A discussion of these factors follows:

- Opportunistic behaviour: both users and system integrators agree that increased transactional history does not give rise to opportunistic behaviour, although there is some indication of it. There is no difference between the means (3.70 and 3.70) respectively.
- Transactional diversity: both users and system integrators agree that increased transactional history does not contribute significantly to transactional diversity. The means do not differ significantly (4.42 and 4.52 respectively).
- Reduce the time taken to make decisions: both users and system integrators agree on this factor that increased transactional history does not contribute significantly in reducing the time to make decisions between partners. Differences were not significant with the means measured at 4.45 and 4.88 respectively.
- Accumulation of information regarding the predictability and reliability of partners: both users and system integrators agree that this factor is important, with no significant differences between them, means measured at 5.19 and 5.36 respectively.
- Risks in terms of information asymmetry: both users and system integrators agree that increased transactional history does not lead to high risks in terms of information asymmetry between partners. The means were measured at 3.58 and 3.27 respectively, showing no significant difference.

In conclusion, increased transactional history has shown benefits in the accumulation of information regarding the predictability and reliability of partners and risks in terms of information asymmetry. Table 7.13 below shows some rankings in respect of these criteria.

With regard to the factors listed by Ring and Van De Ven (1992, p.489), it has been shown that transactional diversity does indeed give rise to these benefits. In addition the benefits are prioritised for users and system integrators.

Table 7.12: Possible effects of increasing transactional history

Question nos.	Category	User or system integrators	Mean	Standard deviation	F test for equality of variances	t-test for equality of means	Significance 2-tailed	Degrees of freedom
38.1	Opportunistic behaviour	User	3.70	1.42	0.491	0.00 ⁺	1.00	64
		System integrators	3.70	1.31	Sig. 0.486			
38.2	Transactional diversity	User	4.42	1.32	0.447	-0.298 ⁺	0.767	64
		System integrators	4.52	1.15	Sig. 0.506			
38.3	Reduce the time taken to make decisions	User	4.45	1.48	0.273	-1.134 ⁺	0.261	64
		System integrators	4.88	1.56	Sig. 0.603			
38.4	Accumulation of information regarding the predictability and reliability of partners	User	5.19	1.16	1.883	-0.747 ⁺	0.458	64
		System integrators	5.36	0.78	Sig. 0.175			
38.5	Risks in terms of information asymmetry	User	3.58	1.50	1.725	0.875 ⁺	0.385	64
		System integrators	3.27	1.31	Sig. 0.194			

Table 7.13: Ranking factors that are achieved as a result of transactional history

Description of factors	Users	System integrators
Opportunistic behaviour	5	5
Transactional diversity	4	4
Reduce the time taken to make decisions	3	3
Accumulation of information regarding the predictability and reliability of partners	1	1
Risks in terms of information asymmetry	2	2

Referring to relationship management [3.1.8] in Figure 3.1, it may be argued that social networks and embedded ties, supplier closeness, communications, trust and goodwill can be used to reduce risk. The following reasons may be presented: firstly increased transactional history reduces risk. Through increased transactional history parties may be brought closer together. Secondly accumulation regarding the predictability and reliability of partners, though transactional history firms may accumulate information about each other.

Technological sourcing is discussed next.

⁺ Equal variances not assumed

7.8 Technological sourcing

Hagedoorn (1993, p.376) proposed different relationships between joint ventures, technology exchanges, direct investment and customer and supplier relationships. In this thesis these relationships were tested, and Table 7.14 shows the different relationships that are being implemented by user and system integrator firms. These relationships were also discussed in Chapter 6, CS1. Table 7.15 shows the rankings of these relationships, with 1 indicating the most important and 5 the least importance.

Table 7.14: Technology approaches that support effective governance

Question nos.	Category	User or system integrators	Mean	Standard deviation	F test for equality of variances	t-test for equality of means	Significance 2-tailed	Degrees of freedom
39.1	Joint ventures and strategic alliances.	User	4.73	1.26	0.015 Sig.	0.477 ⁺	0.635	64
		System integrators	4.58	1.32	0.903			
39.2	Two-way technology exchanges	User	4.24	1.52	0.576 Sig.	1.096 ⁺	0.277	64
		System integrators	3.85	1.39	0.451			
39.3	One-way technology exchanges	User	3.67	1.51	0.078 Sig.	-0.798 ⁺	0.428	64
		System integrators	3.97	1.57	0.781			
39.4	Direct investment	User	3.97	1.67	0.329 Sig.	0.314 ⁺	0.754	64
		System integrators	3.85	1.46	0.569			
39.5	Customer and supplier relationships	User	5.48	1.15	0.824 Sig.	1.541 ⁺	0.128	64
		System integrators	5.09	0.91	0.367			

Table 7.15: Ranking factors supporting effective governance

Description of factors	Users	System integrators
Joint ventures and strategic alliances	2	2
Two-way technology exchanges	3	4
One-way technology exchanges	5	3
Direct investment	4	4
Customer and supplier relations	1	1

⁺ Equal variances not assumed

In Chapter 2 closeness of relationships depend on communication this has been argued through the different mechanisms of governance. From Chapter 3, Figure 3.1 different mechanisms of governance are related to technological sourcing, knowledge management, relationship management and organizational learning. These governance structures may be used to develop relationships that can be used to develop long-term technological sourcing strategic alliances and joint ventures.

In Chapter 7 the links to Chapter 2 and Chapter 3 are reinforced. The research objectives are supported and other questions pertaining to technological risk, technological implementations, strategic partnerships, relationship management and technological sourcing are also reinforced.

Chapter 8 focuses on the conclusions and further research.

8 Conclusions and further research

8.1 *The Investigation process*

The models developed and hypothesis tested are intended to form a basis for future discussion. They are definitely not meant to be the final word on the subject. It is hoped that this thesis will lead other researchers to collect empirical evidence that will improve our knowledge of technology management, transaction processes and governance structures.

This has also tried to demonstrate that for a fuller understanding of technology management, transaction processes and governance structures, it is necessary that the areas of technology management, strategic management, organizational and TCEs and operations management be understood. Therefore in the thesis a model is constructed, through a literature survey. The body of information gathered is then filtered and concentrated in a technological and investigative framework. These frameworks are then used to study links in technology management, transaction processes and governance structures. Having established the possible associations for the links between technology management (technologies, technological resource skills and firm competencies), transaction processes and governance structures (technological sourcing, knowledge management, organizational learning and relationship management) the research objectives could be discussed.

8.2 *The research objectives*

There are three research objectives. They are as follows:

- To understand the links between technology management, transaction processes and governance structures. These links are discussed in Figure 3.1 and verified in Figure 6.1.
 - Technology management links technologies, technological resource skills and firm competencies. Technologies may be further enhanced through technological sourcing. In this way additional benefits may be realized which may result in improving the firm's technological resource skills. Knowledge management may also improve technological resource skills. Technological resource skills then contribute toward firm competencies.
 - Improvements in transaction processes are either obtained through transaction cost reduction, transaction value added or in manufacturing mix criteria. Transaction processes can be used to improve knowledge management. Information flow can lead to improved manufacturing mix criteria, whilst transactional value-added activities and manufacturing mix criteria can lead to knowledge transfer. In addition greater benefits in transactional

value-added activities can be obtained through the use of new and emerging technologies.

- Governance structures support technological sourcing, knowledge management and organizational learning, through which competitive advantages may be obtained. Knowledge management is linked to organizational learning. Technological sourcing is linked to knowledge management and relationship management is linked to knowledge management.

Further discussion on these links are provided in section 6.6.

- To investigate parts of core competence (RBV) and transaction cost economic (TCE) views and to determine the superior theory or link parts of both theories. In section 3.4.2 a comparison between the RBV and TCE view is done. Furthermore in section 6.6 evidence in terms of investigating the RBV and TCE is provided. The results are as follows
 - In Table 6.10 it is shown that there are 71 possible correlations for linking the RBV and TCE view. It therefore may be concluded that both theories or views are important.
 - Research evidence indicates that both theories are important for competence in firms. Managers in firms should integrate and use both theories.
- To investigate the technological effects of the organizational and environmental evolution on firms' competitive advantage. These technological effects are discussed in section 6.6. More specifically the results are presented in Table 6.11.
 - Six factors (these factors are presented in Table 6.11) were tested and each of them were identified and used by managers but they all concur that no single factor is more important than the others for competitive advantage. It is the interplay of all these factors that leads to competitive advantage. However, ranking means elicited the following priorities:
 - For user firms the priorities are firms' strategy, structure and rivalry, specialized factors like skilled labour and natural resources, generalized factors like generic technologies, which are easy to source through global networks, demand in the country, government intervention and related and supporting industries like home-based suppliers and others.
 - For System integrator firms priorities are as follows: specialized factors like skilled labour and natural resources,

firms' strategy, structure and rivalry, government intervention, demand in the country, related and supporting industries like home-based suppliers and others and generalized factors like generic technologies, which are easy to source through global networks.

The research questions are discussed next.

8.3 Research questions

There were 2 central questions and 4 subproblems that were raised: The research results are discussed in section 6.6.

- CQ1: How do changes in technology affect transaction processes?

These results are presented in Table 6.16.

- *Transaction processes were measured using two criteria, i.e. transactional cost reduction and transactional value-added activities. There were no significant differences between user and system integrator firms with regard to transactional cost reduction. Both believe that there are advantages to be gained technological implementations in respect of transactional cost reduction. However, as regards to transactional value-added activities, user firms and system integrator firms differ. User firms believe that technological implementations have a large impact on technological value-added activities whereas system integrator firms do not see this impact as being so large.*

- CQ2: How do changes in technology affect governance structures?

These results are presented in Table 6.17. Three approaches were investigated, i.e. relationship management activities (i.e. social networks and embedded ties, supplier closeness, communications trust and goodwill and market opportunities through partnering(question 36 in Table 6.17)), approaches supporting effective governance (joint ventures and strategic alliances, two-way technology exchanges, one-way technology exchanges, direct investment, and customer and supplier relationships (question 39 in Table 6.17)) and network structures (question 40 in Table 6.17).

- *Relationship management: Both user and system integrator firms agree that technological implementations do lead to better relationships with partners. The most significant benefit, however, was better market opportunities through partnering. Significant differences between user and system integrators were found for social networks and embedded ties. User felt that technological implementations did lead to better social*

networks and embedded ties. However system integrators however saw a lower impact.

- Approaches supporting effective governance: There were five factors that were considered in favor of effective governance, i.e. joint ventures and strategic alliances, two-way technology exchanges, one-way technology exchanges, direct investment and customer and supplier relations. Customer and supplier relations is the approach that is favored by users and system integrators. However there were no significant differences between users and system integrators.
- Network structures: Both users and system integrators see technological implementations as having improved network structures between firms and their key partners.

In terms of governance structures, the most important benefits from technological implementations have been in the areas of customer and supplier relations and improved network structures with partners.

The subproblems are discussed next:

- SP1: How long does it take changes in technology to affect transaction processes?

These results are presented in Table 6.12.

- Transaction processes were measured with regard to transaction cost reduction and transaction value-added activities. Both users and system integrators agreed that it took six months to one year to see benefits in transactional cost reduction (question 26.1 in Table 6.12) and transactional value-added activities (question 26.2 in Table 6.12) after technological implementation. However, user and system integrator firms differed when it came to time periods between integration of technologies (question 13 in Table 6.12). User firms see integration as occurring six months to one year after implementation, whereas system integrators see integration occurring one year to two years after implementation.

- SP2: What is the effect of organizational learning on transaction processes?

These results are presented in Table 6.13.

- Transaction processes were measured with regard to transaction cost reduction and transaction value-added activities. Both users and system integrators agreed that

organizational learning did lead to improvements in transaction processes with regard to transactional cost reduction and transactional value-added activities.

- SP3: What is the effect of information flow and knowledge transfer with regard to transaction processes?

These results are presented in Table 6.14.

- Transaction processes were measured with regard to transaction cost reduction and transaction value-added activities. Both users and system integrators agreed that information flow and knowledge transfer did lead to improvements in transaction processes with regard to transactional cost reduction and transactional value added.

- SP4: How do changes in technology affect manufacturing mix criteria?

These results are presented in Table 6.15. Technological implementations and their effect on manufacturing mix criteria were measured in two ways. Firstly the focusing of a firm's technological strategies on improving manufacturing mix criteria (question 22 in Table 6.15) is considered and secondly the effect of technological implementations on manufacturing mix criteria (question 52 in Table 6.15).

- Both users and system integrators agreed that firms do focus their technology strategies on improving manufacturing mix criteria.
- Both users and system integrators agreed that technological implementations have provided benefits in terms of cost, quality, speed and flexibility. However, as regards dependability, user firms see a greater benefit than system integrator firms do.

Having discussed the subproblems the hypotheses are discussed next.

8.4 The Hypothesis

There were two hypotheses and each will be discussed.

- H1: Firms that adopt new technologies grow at different rates to firms that maintain older technologies.

The results are presented in Tables 6.18, 6.19 and 6.20. For testing of H1 three different approaches are used. Firstly a conceptual approach using *t*-tests are used (Table 6.18). Secondly a two-way split was used to compare two categories of firms, these two categories are innovators and early adopters compared to early majority and late majority firms

(Table 6.19). Thirdly each of the categories innovators, early adopters, early majority and late majority firms are compared to each other (Table 6.20). For each of the three categories firm growth rates were measured in terms of sales growth, return on sales and earnings growth. The results are as follows:

- Firstly for the conceptual approach there were no significant differences between user firms and system integrator firms with regard to firm growth rates i.e. firms that adopted newer technologies did not grow differently to firms that maintained older technologies.
- Secondly for the two-way split i.e. combining innovators and early adopters, and comparing them to early majority and late majority firms, no significant differences between firms with regard to firm growth rates were found i.e. firms that adopted newer technologies did not grow differently to firms that maintained older technologies.
- Thirdly for the four-way split comparing innovators, early adopters, early majority and late majority firms it was found that other system integrator firms believe that innovators grew differently to late majority firms.

It may therefore be concluded that technological investments alone did not lead to an increase in firm growth rates for users and system integrators. With the exception of a four way split were system integrators saw innovator firms growing differently to late majority firms. In terms of Innovators and late majority firms these may be considered as extremes and further research is necessary to verify the results. The findings of this research can be verified by at least two researchers viz.

- Carr (2003, p.43) says that companies can gain benefits on their competitors by having superior insight into the use of new technology. This may be achieved by adopting a wait and see scenario. Therefore in this thesis it may be argued that firms did not experience improved growth as a result of technological implementations when compared to their competitors because they adopted a wait and see stance. The wait and see stance provide opportunities for firms to develop competencies in terms of other factors like organizational learning and knowledge management. These competencies provide opportunities, which allow firms to learn from other firms and in this way develop other competitive advantages. These other competitive

advantages could be in transaction processes and governance structures.

- Gardner and Ash (2003, p.23) say that successful business models in a complex ICT-enabled context, is determined not by a single variable like technology or people but the management of both planned change and the emergent changes generated at the people/technology interface. This may also be interpreted as that technology alone does not provide business success but the linking of technology people and processes. In terms of this thesis it can be seen as the linking of technology, transaction processes and governance structures.

In conclusion it may be argued that technological implementation alone does not create competitive advantages, it is the linking of technology, transaction processes and governance structures that provides competitive advantages.

- H2: Managers rate manufacturing mix criteria as more important than technological leadership.

The results are presented in Table 6.21 and 6.22. For testing H2 two approaches are used. Firstly a conceptual approach using *t*-tests (Table 6.21). Secondly a two-way split comparing importance of technology and importance of manufacturing mix criteria (Table 6.22). The results are as follows

- Firstly using the conceptual approach. When comparing technologies against the manufacturing mix criteria of cost, quality, speed, dependability and flexibility user firms see technology to be important relative to the other manufacturing mix criteria. System integrator firms however see manufacturing mix criteria as more important and technology the least important. However when ranking means the following priorities arise (Table 8.1). From a user perspective technology is rated 3rd and from a system integrator perspective technology is rated 6th.

Secondly using a two-way split user firms and system integrator firms do not see technology as more important than technological leadership i.e. Managers do not rate manufacturing mix criteria as being more important than technological leadership. For user and system integrator firms H2 is true, managers do not rate manufacturing mix criteria more important than

Table 8.1: Ranking technologies and manufacturing mix criteria

Description of factors	Users	System integrators
Technologies	3	6
Cost	4	1
Quality	1	2
Speed	6	4
Dependability	2	3
Flexibility	5	5

technological leadership. The findings of this research can be verified by at least the following researchers viz.

- Carr (2003) and Gardner (2003) also verify that it is the linking of technology, people and processes that lead to competitive advantage.
- McLaughlin (2003) provides lessons in terms of using IT to improve downstream supply chain operations. He proposes the use of IT in managing complex carrier service and rate structures, as well as outbound shipping scenarios. This can be seen as using technology to link different aspects of the value chain to provide competitive advantages. In terms of this thesis it is the linking of technology, transaction processes and governance structures that provides competitive advantages. i.e. Managers do not rate manufacturing mix criteria more important than technological leadership. Technology and manufacturing mix criteria are linked.

In conclusion it may be argued that technology and manufacturing mix criteria are both linked and it is how a firm links technology and manufacturing mix criteria that leads to competitive advantage.

Having discussed the hypothesis, areas for further research will be discussed next.

8.5 Areas for further research

Where do we go from here? The competitive environment is being influenced by such factors as globalization, E-business and social and economic factors. Firms' competitive advantages are found in their resources i.e. individuals, technologies and processes, industry selection and positioning and managerial capabilities. Further research could be conducted in areas that could improve the match between tangible and intangible technologies. Some of these areas are as follows:

- Use firm resources to improve technological discontinuities, especially in terms of competence destroying effects. There are many technological tools that can be used to overcome the effects of competence destroying technologies.
- Use information flow and knowledge transfer to overcome or improve competence destroying, competence enhancing and tangible and intangible technological resources.
- Use new and emerging technologies to overcome or improve competence destroying, competence enhancing and tangible and intangible technological resources.
- The technological effects of the organizational and environmental evolution needs to be validated with further research. More metrics need to be developed. The reliability using Cronbach Alpha tests could be improved with better metrics.
- Understand the impact of organizational learning on information flow, knowledge transfer and new and emerging technologies.
- Investigating firm growth rates for innovator firms and late majority firms. In this thesis it was found that system integrator firms felt that innovator firms grew differently to late majority firms, however user firms did not see such growth.
- The models built in this thesis are verified by basic statistics using statistical correlations. The main reason for this is that the sample size of 66 is too small to conduct additional statistical tests. It is recommended that the models developed in this thesis be tested in other areas to obtain a larger sample size. In so doing, other researchers may consider testing the models based on structural equation modeling/path analysis. The models developed here can therefore be verified by using more advanced statistical methods.
- The approach taken in this thesis is from a technology management and economic perspective. Approaches from technology management, strategic management, organizational and transactional cost economics and operations management are considered. Other researchers like Moll (1998) have looked at the business transformation process from an industrial engineering perspective. Moll looks at business transformation from three perspectives viz. management of transformation, the transformation process and application of behavioral sciences. Business transformation in terms of this thesis may focus on the aspects of transaction processes and governance structures. Parallels between this thesis and the work done by Moll can provide further benefits in understanding technological implementations.

The above list is by no means comprehensive. It merely gives some avenues for further research.

In this thesis it has been shown that technology management should not only be confined to product technologies. Process technologies are just as important. The following lessons for managers are suggested:

- The links in this thesis are shown in Figure 3.1 (the technological framework), further factors are introduced in Figure 3.3 (the investigative framework). These links are then verified in Figures 6.1 to 6.5. However these links occur in a changing technological environment. This changing technological environment is described in Figure 4.2. Figure 4.2 is reproduced here (Figure 8.1) for further clarity. Managers must be aware of this changing technological environment. Firstly systems exist, managers automate these systems. These systems occur within the firms and between firms. Managers redesign business process and hence business are transformed through new transaction processes and governance structures. Thereafter value systems within and between firms grow. As this occurs newer technologies arise. Managers need to be aware of these new technologies when redesigning business process. As new technology provides advantages that firms could use to leap frog their competitors. However this research indicates that a wait and see stance could be more appropriate as firms learn from other firms. The wait and see approach could be used by firm to learn from other firms. However for such learning to occur firms need relationship management and organizational learning competencies that would improve knowledge management and thereby create competitive advantages.
- Managers need to innovate in processes across the value chain from design, manufacturing to business planning. Different business models adopting strategic alliances, joint ventures and technology partnering relationships with firms and their key partners are a valuable source of competitive advantage. Linking technology management, transaction processes and governance structures has potential for firms to develop and differentiate themselves from competitors.
- Managers need to keep abreast of the latest technologies. Managers in firms believe that they are doing this, but system integrators believe managers in firms are not investing in the latest available technologies. However the latest state-of-the-art technologies are not as important as how one implements and integrates these technologies. It is this that creates competitive advantage. What is important is that managers

should recognize that they are not investing in the latest state-of-the-art technologies.

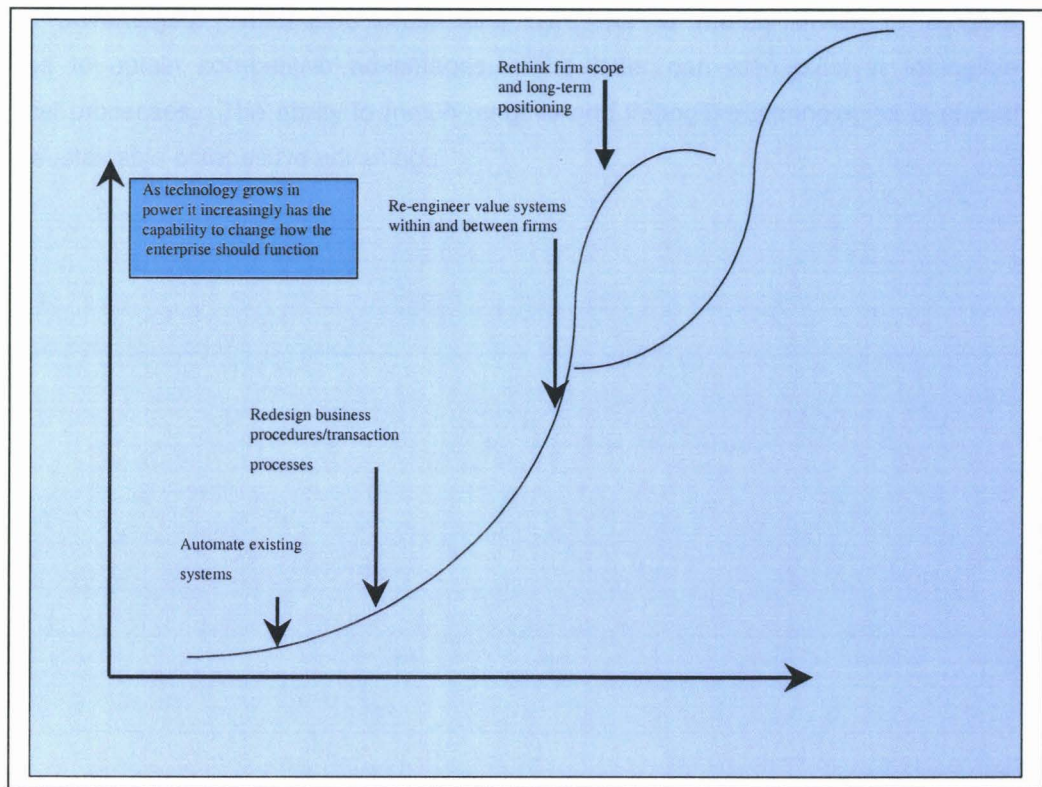


Figure 8.1: Technology impacts on firm structures

- Managers see technological implementations as producing large benefits in dependability, whereas system integrators do not. Managers need to be aware of this gap in understanding.
- Managers in firms see technological integration occurring 6 months to one year after implementation, whereas system integrators see integration taking place one year to two years after implementation. Managers should take cognizance of these differences when evaluating technological implementations as they could have implications for extending beyond the immediate implementation phase.
- Managers must be aware of when to invest in latest technologies in order to obtain maximum benefit for competitive advantage. In this thesis patterns of technological innovation were discussed. Managers must be aware of these patterns to obtain maximum benefit. Interesting lessons and comparisons may be found in Carr (2003) and this thesis. Carr (2003) argues that rapid technology change in the IT industry does not guarantee benefits for first movers.

Finally it may be argued that technological implementation is not a competitive advantage as it is available to the competition as well. It is how a firm applies technology that will make it more competitive than other firms. Technology and processes are linked. It is the link

between the tangible technologies and intangible resources that exist in processes, knowledge, information, organizational learning and relationship management that create competitive advantages. Managers must take care not to merely invest in tangible technologies to obtain competitive advantages. The latter can also exist in intangible technological processes. The ability to match tangible and intangible technologies is crucial to achieve sustainable competitive advantage.

Appendix A

Overview of research

This research investigates the effects of technology management on business (transaction) processes and how it influences making and buying patterns (governance structures). Over the last decade we have been faced with a phenomenal amount of technological development. Technological developments have spanned business across the entire value chain from customers to suppliers. Technology has provided options for integrating networks with suppliers and customers. Through technology management, firms are focusing on value-added activities to optimise transaction processes and governance structures. For example, how does the development of the Internet and electronic commerce affect the way companies trade? Trading by electronic commerce may change the modus operandi of firms from buying to making. Some governance structures and transaction processes may become obsolete as firms trade electronically between each other. Changing governance structures may improve profitability. The objectives of the research are to:

- Understand the links between technology management, transaction processes and governance structures.
- Investigate two theories, i.e. RBT (resource-based theory) and TCE (transaction cost economics theories) and to find the superior one.
- Investigate the technological effects of the environmental and organisational evolution on firms competitive advantage.

In meeting these two objectives, two hypotheses are tested, namely:

- H1: Firms that adopt new technologies grow at different rates to firms that maintain older technologies.
- H2: Managers rate criteria like cost, quality, speed, dependability and flexibility more important than technologies.

This research focuses on technologies that exist in design, manufacturing and management, for instance CAD (computer aided design), CAE (computer aided engineering), FMS (flexible manufacturing systems, ERP (enterprise resource planning), electronic business, etc. Attention is devoted to technological strategy, technological investment, technological change, technological implementation and technological risk, and more explicitly the management and use of technology as opposed to technology development. This research is a cross-sectional study on user firms, i.e. firms that adopt technologies and system integrator firms, i.e. firms that are involved in the implementation of technologies. The user firms are categorized in two industry sectors, namely electronics and the electrical engineering industry and the information technology industry. The user firms were selected from the financial mail survey of top companies and the Fortune 500 companies. In both cases the 2000 and 2001 editions were used. For system integrator firms the Journal for Instrumentation and Control and listings from the 2001 publication of The Top ICT Companies in South Africa were used.

Appendix B

Interviewer instructions

1. Interviewers are to inform the interviewees that this research is being conducted through the University of Witwatersrand, School of Mechanical Engineering, Aeronautical and Industrial Engineering.
2. When interviewing user firms, interviewees are to answer the questions pertaining to their firms unless the question specifically suggests otherwise.
3. When interviewing system integrator firms, interviewees are to answer the questions pertaining to the customers of system integrator firms unless the questions specifically suggest otherwise.
4. The list of definitions provided must be used. Interviewers are not to give their own definition of terms. Where further clarity on definitions is required, the author/researcher is to be consulted.
5. The interviewer is also requested to note any comments or suggestions made by the interviewee during the interview process.

Appendix C

Definition of terms

Question Reference	Question no.	Definition
UTS3/STS3	3	The definitions used for this question are based on Day and Schoemaker (2000, p.135) Innovators - Technology enthusiasts. These people are committed to the possibility that any new technology in their area of interest has promise and are willing to take the time to master it. Early adopters - Visionaries. These adopters see the opportunity presented by the new capability to change the rules of competition in their market. Early majority - Pragmatists. This is a large group that decides to adopt only when the benefits of the technology are well proven and risks are tolerable. Late majority - Conservatives. This group adopts an innovation only after a majority of people have tried it. Laggards - Tradition bound. These people are suspicious of changes and are likely to adopt the innovation only when they have no choice or it takes on a measure of tradition itself.
UTC1/STC1	8/31	Information flow - pertains to knowledge sharing, that is the knowledge that is shared by two or more individuals. This means that knowledge may be possessed by two parties but each party may be unaware of the other party's intentions regarding the knowledge. Knowledge transfer - depends on how easily knowledge can be transported, interpreted and absorbed.
UTI1/STI1	13	CAD, CAE, CAPP – Computer-aided design, computer-aided engineering and computer-aided process planning. CNC, CAM, FMS - Computer numeric control, computer-aided manufacture and flexible manufacturing systems. MRP, EDI - Manufacturing requirements planning and Electronic data inter-change.

UTRS1/STRS1	17	The definitions used for this question are based on Burgelman, Madique, Wheelwright (1996, p.190) Competence destroying technologies - are based on different knowledge or concepts that are required for providing the new services. In acquiring such new knowledge, the existing expertise is regarded as obsolete. For example, mechanical watch-making skills were rendered irrelevant by quartz movements. Competence enhancing technologies - are based on existing know-how. For example, in watch technology, automatic mechanical movements represented a fundamentally different way of providing energy to the spring, but built on prior mechanical competence.
UTP4/STP4	25	The definitions used for this question are based on Williamson (1981, p.1546) Transaction certainty - the uncertainty to which transactions are subject. Transaction-specific interests - the degree to which transactions are supported by durable, transaction-specific interests. Transaction-specific interests pertain to site specificity, physical asset specificity and human asset specificity. Site specificity - when successive stations are locked in a cheek-by-jowl relation to each other so as to economize on inventory and transportation costs. Physical asset specificity - where specialized equipment are required for production. Human asset specificity - arises from a learning-by-doing fashion. Transactional frequency - the frequency with which transactions occur. Transactional durability - the durability with which transactions occur.
UOL1/SOL1	41/24	Organizational learning - Looks at the absorption of knowledge from outside the firm and diffusing it within the firm
UOL2/SOL2	42	Learning-by-doing - only through actual production can an organization discover process problems.
UOL2/SOL2	42	Learning-before-doing - when reliable theoretical models and heuristics exist, laboratory experiments, simulation and other forms of 'learning-before-doing' can be productively harnessed; i.e. the process of learning before actual production can begin.
UOL6/SOL6	46	Absorptive capacity - a firm's ability to recognize the value of new external knowledge, assimilate it and apply this knowledge to commercial ends, i.e. the firm's ability to learn.

Appendix D

User Questionnaire

General questions

Name: _____

Company name: _____

Tel. no. _____

E-mail address: _____

Date. _____

Designation: _____

Screeners questions

S 1: Please indicate your position in the company:

1. Chairman/CEO/COO
2. Executive directors
3. Non-executive directors/General managers
4. Others

S 2: Please place your firm in one of the following categories:

5. National local company
6. Multinational company
7. Joint venture, mergers or strategic alliance
8. Other, e.g. franchises

S3: Would you be interested in participating in further research? Simply answer yes or no.

9. YES/NO

S4: Would you prefer that your firm not be mentioned as one of the firms participating in the research?

10. Prefer not to be mentioned.
11. Prefer to be mentioned.

S5: In which of the following industry categories would you classify your firm?

12. Electronics and Electrical engineering.
13. Information technology industry.
14. Other

S6: Indicate your firm's size in terms of number of employees.

15. _____

Specific Questions

Technology management

Technologies

The Likert scale is used for the questions pertaining to technology management, i.e. Question 1 to Question 16. 1 indicates little or no effect and 7 indicates a large effect.

Technological strategy

References	Questions	Answers	Do not know
UTS1	1. To what extent do you believe that your firm's business strategy and technological strategy are aligned? 1= little or no alignment. 7= Large alignment.	1—2—3—4—5—6—7	—
UTS2	2. To what extent do you believe that your firm's technological strategy has a positive effect on your firm's competitive strategy?	1—2—3—4—5—6—7	—
UTS3	3. Pick the technological approach that is adopted by your firm most of the time.	---Innovators ---Early adopters ---Early majority ---Late majority ---Laggards	—

Technological investment

References	Questions	Answers	Do not know
UTINV1	4. Indicate your firm's level of technological investment as a percentage of total investments.	--- <=5% --- >5% and <=10% --- >10% and <=25% --- >25% and <=50% --- >50% and <=75% --- >75%	—
UTINV2	5. Indicate what proportion of your firm's technological investments is made in the latest available technologies.	--- <= 5% --- >5% and <=10% --- >10% and <=25% --- >25% and <=50% --- >50% and <=75% --- >75%	—

UTINV3	6. To what extent do you believe that technological investment in your firm is restricted by the following risks? 6.1. Inability to quantify strategic benefits. 6.2. Lack of understanding of the benefits resulting from technological adoption. 6.3. Newness of the area of technology. 6.4. Concern about the lack of skills necessary to achieve the potential benefits.	1—2—3—4—5—6—7 1—2—3—4—5—6—7 1—2—3—4—5—6—7 1—2—3—4—5—6—7	— — — —
UTINV4	7. In relation to technological investment, do you believe that your firm invests adequately in staff training? 1= little or no investment 7= Large investment	1—2—3—4—5—6—7	—

Technological change

References	Questions	Answers	Do not know
UTC1	8. To what extent have technological implementations in your firm, as opposed to conventional methods, improved information flow and knowledge transfer between key partners?		
	8.1. Within the firm.	1—2—3—4—5—6—7	—
	8.2. Outside the firm	1—2—3—4—5—6—7	—
	1= little or no improvement 7= Large improvement.		
UTC2	9. To what extent has your firm changed strategic partners because of technological change in your industry and because existing partners were no longer capable of new competence in the technology over the last 5 years?	1—2—3—4—5—6—7	—
	1= Little or no change. 7= Large change.		

Technological integration

References	Questions	Answers	Do not know
UTI1	10. Indicate the extent to which data transactions are conducted in your firm through the use of computers or computerised equipment.		
	10.1. Design, i.e. CAD, CAE, CAPP	1—2—3—4—5—6—7	—
	10.2. Process or manufacturing such as CAD linked to CNC, CAM, robots or FMS, bar coding, real time process systems, automated handling, robotics and group technology, i.e. generalists manufacturing and operations, i.e. warehousing, distribution, process industries.	1—2—3—4—5—6—7	—
	10.3. Management information systems (MIS) such as MRP, office automated, accounting, electronic mail, EDI, decision support systems, knowledge base systems, i.e. Generalists.	1—2—3—4—5—6—7	—
	1= Little or no use 7= Large use.		

UT12	11. Is your firm involved in design, manufacturing and MIS? Tick yes or no. If you answered yes, go to Question 12 If you answered no, go to Question 14.	Yes ____ No ____	____
UT13	12. Indicate your firm's overall level of technology integration in design, manufacturing or administration. 1= little or no integration 2= Large integration	1—2—3—4—5—6—7	—
UT14	13. How long do you believe it takes your firm to integrate between technologies in design, process/manufacturing or management? 1= Within 3 months 2= Within 6 months 3= Within one year 4= Within 2 years 5= More than 2 years	1—2—3—4—5	—
UT15	14. How would you rate the competence of managers in your firm with regard to assessing the firm's technological needs. 1= Little or poor competence. 7= Large competence.	1—2—3—4—5—6—7	—

Technological importance

References	Questions	Answers	Do not know
UTIMP1	15. To what extent do you believe that your firm views the following criteria as important for competitive advantage?		
	15.1. Technologies	1—2—3—4—5—6—7	—
	15.2. Cost	1—2—3—4—5—6—7	—
	15.3. Quality	1—2—3—4—5—6—7	—
	15.4. Speed	1—2—3—4—5—6—7	—
	15.5. Dependability	1—2—3—4—5—6—7	—
	15.6. Flexibility	1—2—3—4—5—6—7	—
	1= indicates the least important 7= indicates the most important		

UTIMP2	16. To what extent do you believe that your firm has been influenced by the following factors for technological implementations?		
	16.1. Market threats	1—2—3—4—5—6—7	—
	16.2. Current technology obsolete	1—2—3—4—5—6—7	—
	16.3. To obtain benefits in criteria like cost, quality, speed, dependability and flexibility.	1—2—3—4—5—6—7	—
	16.4. To improve information flow and knowledge transfer.	1—2—3—4—5—6—7	—
	16.5. In line with the firm's technological policy.	1—2—3—4—5—6—7	—
	1= Least important 5= Most important		

Technology management and transaction processes

Technological resource skills

The Likert scale is used for the questions pertaining to technology management and transaction processes, i.e. Questions 17 to 35. 1 indicates little or no effect and 7 indicates a good effect.

Competence destroying and competence enhancing technologies

References	Questions	Answers	Do not know
UTRS1	17. To what extent has your firm been affected by the following technologies that have altered the way your firm has conducted business over the last 5 years?		
	17.1. Competence destroying technologies.	1—2—3—4—5—6—7	—
	17.2. Competence enhancing technologies.	1—2—3—4—5—6—7	—

Tangible and intangible technological resources

References	Questions	Answers	Do not know
UTRS2	18. To what extent do you believe that your firm's tangible and intangible technological resources are matched i.e. having the right match, between technologies and technological resource skills?	1—2—3—4—5—6—7	—
	1= little or no match 7= Large match		

Firm competencies

Core competencies and general competencies

References	Questions	Answers	Do not know
UFC1	19. To what extent do you believe that your firm views technological implementation as a means to improve core competencies? (Core competence being valuable, sustainable, versatile and difficult to imitate). 1= little or no importance 7= Large importance	1—2—3—4—5—6—7	—
UFC2	20. To what extent do you believe that your firm views technological implementation as a means to improve? general competencies? 1= little or no importance 7= Large importance	1—2—3—4—5—6—7	—

References	Questions	Answers	Do not know
UFC3	21. Indicate the importance of the following in your firm.		
	21.1. Individuals, assets and organisational structures.	1—2—3—4—5—6—7	—
	21.2. Technological acquisition.	1—2—3—4—5—6—7	—
	21.3. Patented process or design.	1—2—3—4—5—6—7	—
	21.4. Know-how shared among individuals in the firm.	1—2—3—4—5—6—7	—
	21.5. The firm's selection and positioning with the industry.	1—2—3—4—5—6—7	—
	1= indicates the least important 7= indicates the most important		

Transaction processes

Process/manufacturing mix criteria=cost, quality, speed, dependability and flexibility.

References	Questions	Answers	Do not know
UTP1	22. To what extent do you believe that your firm's technological strategies are aimed at improving criteria like cost, quality, speed, dependability and flexibility? 1= little or no match. 7= total match.	1—2—3—4—5—6—7	—
UTP2	23. To what extent has information flow and knowledge transfer in your firm led to improvements in manufacturing mix criteria, i.e. cost, quality, speed, dependability and flexibility?	1—2—3—4—5—6—7	—
UTP3	24. To what extent has organisational learning in your firm led to improvements in manufacturing mix criteria i.e. cost, quality, speed, dependability and flexibility.	1—2—3—4—5—6—7	—

UTP4	25. To what extent do you believe that technological implementations in your firm have affected transaction processes with respect to: 25.1. Transactional cost reduction? 25.2. Transactional value added i.e. efficiency, reliability, frequency, durability and transaction specific interests?	1—2—3—4—5—6—7 1—2—3—4—5—6—7	— —
UTP5	26. How long do you believe it takes technology implementations in your firm to affect the following transactional processes with regard to. 26.1. Transaction costs? 26.2. Transactional value added i.e. transactional efficiency, reliability, frequency, durability and transaction-specific interests? 1= Within 3 months. 2= Within 6 months. 3= Within one year 4= Within 2 years 5= More than 2 years.	1—2—3—4—5 1—2—3—4—5	— —

Technological sourcing

Strategic alliances/joint ventures

References	Questions	Answers	Do not know
UTSP1	27. Would you say that technology relationships with your firm's key partners are based on an adversarial or partnership approach? Tick one option	___ Adversarial ___ Partnership	___ ___
UTSP2	28. Does your firm view strategic partnerships as a means to: 28.1. Acquire the capabilities, knowledge and technology of the other firm, thereafter dissolving the partnership? 28.2. Create a strategic alliance for the benefit of both firms, thereafter developing the partnership further? 1=Little or no support 7=Large support	1—2—3—4—5—6—7 1—2—3—4—5—6—7	___ ___
UTSP3	29. To what extent does your firm view strategic alliances as a source of competitive advantage?	1—2—3—4—5—6—7	___

Knowledge management

References	Questions	Answers	Do not know
UKM1	30. What is the effect of information flow and knowledge transfer on the following transactional processes?		
	30.1. Transactional cost reduction	1—2—3—4—5—6—7	—
	30.2. Transactional value added, i.e. transactional efficiency, reliability, frequency, durability and transaction specific interests.	1—2—3—4—5—6—7	—
UKM2	31. To what extent has your firm identified the benefits of information flow to improve technological resource skills in terms of the following criteria?		
	31.1. Competence destroying	1—2—3—4—5—6—7	—
	31.2. Competence enhancing	1—2—3—4—5—6—7	—
	31.3. Tangible and intangible technological resources.	1—2—3—4—5—6—7	—

UKM3	32. To what extent has your firm identified the benefits of knowledge transfer to improve technological resource skills in terms of the following criteria? 32.1. Competence destroying 32.2. Competence enhancing 32.3. Tangible and intangible technological resource skills.	1—2—3—4—5—6—7 1—2—3—4—5—6—7 1—2—3—4—5—6—7	— — —
UKM4	33. To what extent has your firm identified the benefits of new and emerging technologies to improve technological resource skills in terms of the following criteria? 33.1. Competence destroying 33.2. Competence enhancing 33.3. Tangible and intangible technological resource skills.	1—2—3—4—5—6—7 1—2—3—4—5—6—7 1—2—3—4—5—6—7	— — —

Technological gate-keeping

References	Questions	Answers	Do not know
UKM5	34. Indicate the extent to which the following control and monitoring systems are utilised by your firm to control the flow of critical skills and technologies to your technology partner.		
	34.1. Central collaboration office to interface with technology specific partners.	1—2—3—4—5—6—7	—
	34.2. Decentralised control through other divisions.	1—2—3—4—5—6—7	—
	34.3. Flat management and organisational structures for alliance operations.	1—2—3—4—5—6—7	—
	34.4. Limitation and control procedures for the transfer of information to partners through disciplines and procedures.	1—2—3—4—5—6—7	—
	34.5. Transfer of staff across the partnership agreement.	1—2—3—4—5—6—7	—
	1= Least frequently or not at all 7= Most frequently.		

New and emerging technologies

References	Questions	Answers	Do not know
UKM6	35. Do you believe that your firm possesses the necessary technological resources to cope with the effects of globalisation? 1= Little or no technological resources 7= Full technological resources	1—2—3—4—5—6—7	—

Governance structures**Relationship management**

The Likert scale is used for the questions pertaining to governance structures, i.e. Questions 36 to 45. 1 indicates little or no effect and 7 indicates a good effect.

References	Questions	Answers	Do not know
URM1	36. To what extent do you believe that technology management in your firm has improved the following: 36.1. Social networks and embedded ties? 36.2. Supplier closeness, communications, trust and goodwill? 36.3. Improved market opportunities through partnering? 1= Least important 7= Most important	1—2—3—4—5—6—7 1—2—3—4—5—6—7 1—2—3—4—5—6—7	— — —
URM2	37. To what extent do you believe that trust and goodwill have led to increased transactional history between your firm and its key partners?	1—2—3—4—5—6—7	—

References	Questions	Answers	Do not know
URM3	38. To what extent do you believe that increased transactional history (i.e. an increased number of transactions over a long period of time, say 5 years) has led to the following:		
	38.1. Opportunistic behaviour?	1—2—3—4—5—6—7	—
	38.2. Transactional diversity?	1—2—3—4—5—6—7	—
	38.3. Reduced the time taken to make decisions?	1—2—3—4—5—6—7	—
	38.4. Accumulation of information regarding the predictability and reliability of partners?	1—2—3—4—5—6—7	—
	38.5. Risks in terms of information asymmetry?	1—2—3—4—5—6—7	—
	1=Least frequently 7=Most frequently		

URM4	39. To what extent does your firm follow adopt the following approaches which support effective governance?		
	39.1. Joint ventures and strategic alliances.	1—2—3—4—5—6—7	—
	39.2. Two-way technology exchanges.	1—2—3—4—5—6—7	—
	39.3. One-way technology exchanges.	1—2—3—4—5—6—7	—
	39.4. Direct investment, i.e. transaction-specific interests.	1—2—3—4—5—6—7	—
	39.5. Customer and supplier relationships.	1—2—3—4—5—6—7	—
	1= least important 7= Most important.		
URM5	40. To what extent has technological implementation in your firm led to improved network structures with key partners over the last 5 years?	1—2—3—4—5—6—7	—

Organisational learning

Learning-by-doing and learning-before-doing

References	Questions	Answers	Do not know
UOL1	41. To what extent has organisational learning affected the following transactional processes? 41.1. Transactional costs 41.2. Transactional value added, i.e. transactional efficiency, reliability, frequency, durability and transaction-specific interests.	1—2—3—4—5—6—7 1—2—3—4—5—6—7	— —
UOL2	42. To what extent do you believe that information flow and knowledge transfer has benefited your firm in terms of the following: 42.1. Learning-by-doing? 42.2. Learning-before-doing? 1= Little or no benefit 7= Large benefit	1—2—3—4—5—6—7 1—2—3—4—5—6—7	— —
UOL3	43. To what extent do you believe that new and emerging technologies affected your firm in terms of 43.1. Learning-by-doing? 43.2. Learning-before-doing?	1—2—3—4—5—6—7 1—2—3—4—5—6—7	— —

UOL4	44. To what extent has organisational learning affected knowledge management in your firm in terms of the following:		
	44.1. Information flow?	1—2—3—4—5—6—7	—
	44.2. Knowledge transfer?	1—2—3—4—5—6—7	—
	44.3. New and emerging technologies?	1—2—3—4—5—6—7	—
ULO5	45. To what extent has organisational learning affected the firm's competitive environment in terms of the following:		
	45.1. Market threats?	1—2—3—4—5—6—7	—
	45.2. Market opportunities?	1—2—3—4—5—6—7	—
	45.3. External factors, i.e. social, economic and political?	1—2—3—4—5—6—7	—

Absorptive capacity

UOL6	46. To what extent do you believe that information flow and knowledge transfer has affected your firm's absorptive capacity?	1—2—3—4—5—6—7	—
------	--	---------------	---

Investigative framework

The Likert scale is used for the questions pertaining to governance structures, i.e. Questions 47 to 52. 1 indicates little or no effect and 7 indicates a large effect.

Organisational determinants

UOD1	47. To what extent do you believe that the following criteria are important contributors to your firm's performance?		
	47.1. Industry selection and positioning	1—2—3—4—5—6—7	—
	47.2. Organisational processes and administrative practices.	1—2—3—4—5—6—7	—
	47.3. Managerial capabilities.	1—2—3—4—5—6—7	—

Competitors

UC1	48. For your major product lines indicate your firm's performance relative to your major competitors as a result of technological implementation.		
	48.1. Sales growth	1—2—3—4—5—6—7	—
	48.2. Return on sales	1—2—3—4—5—6—7	—
	48.3. Earnings growth.	1—2—3—4—5—6—7	—
	1= little or no performance advantage 7= Large performance advantage		
UC2	49. Rate your firm relative to its competitors in its ability to adapt to rapidly changing technologies.	1—2—3—4—5—6—7	—
	1= little or no adaptability advantage 7= large adaptability advantage		

UC3	50. To what extent do you believe that your firm will be affected by the following within the next 2 years?		
	50.1. New entrants	1—2—3—4—5—6—7	—
	50.2. Buying power of competitors	1—2—3—4—5—6—7	—
	50.3. Substitute products.	1—2—3—4—5—6—7	—

External factors

UEF1	51. To what extent do you believe that your firm will be affected by the following within the next 2 years?		
	51.1. Globalisation	1—2—3—4—5—6—7	—
	51.2. E-business	1—2—3—4—5—6—7	—
	51.3. Social, economic and political factors.	1—2—3—4—5—6—7	—

Manufacturing mix

UMM1	52. To what extent do you believe that technological implementation has affected your firm with regard to the following manufacturing mix criteria? 52.1. Cost 52.2. Quality 52.3. Speed 52.4. Dependability 52.5. Flexibility 1= Little or no benefit 7= Large benefit	1—2—3—4—5—6—7 1—2—3—4—5—6—7 1—2—3—4—5—6—7 1—2—3—4—5—6—7 1—2—3—4—5—6—7	— — — — —
UMM2	53. To what extent do you believe that manufacturing mix processes in your firm are affected by the following? 53.1. Organisational determinants 53.2. Competitors 53.3. External factors, i.e. social, economic and political.	1—2—3—4—5—6—7 1—2—3—4—5—6—7 1—2—3—4—5—6—7	— — —

Resource based view and transaction cost economic view

The Likert scale is used for the questions pertaining to the resource based view and transaction cost economic view, i.e. Questions 53 to 55. 1 indicates little or no effect and 7 indicates a Large effect.

URBV1	54. To what extent do you believe that your firm has a competitive advantage relative to key competitors with respect to the following:		
	54.1. Firm resources?	1—2—3—4—5—6—7	—
	54.2. Industry selection and positioning?	1—2—3—4—5—6—7	—
	54.3. Transactional benefits in transactional cost reduction or transactional value added?	1—2—3—4—5—6—7	—
	1= Little or no advantage 7= Large benefit		
URBV2	55. To what extent do you believe your firm has developed a diversification strategy with regard to the following?		
	55.1. Current resources as a basis for diversification.	1—2—3—4—5—6—7	—
	55.2. Resources to be developed through diversification.	1—2—3—4—5—6—7	—
	55.3. Identification of markets in which diversification should take place.	1—2—3—4—5—6—7	—
	55.4. What types of firms have been identified for acquisition.	1—2—3—4—5—6—7	—

Organisational and environmental evolution

The Likert scale is used for the questions pertaining to governance structures i.e. question 56.

1 indicates little or no effect and 7 indicates a Large effect.

OEE1	56. To what extent do you believe that your firm possesses competitive advantages with respect to the following?		
	56.1. Generalised factors like generic technologies, which are easy to source through global networks.	1—2—3—4—5—6—7	—
	56.2. Specialised factors like skilled labour and natural resources.	1—2—3—4—5—6—7	—
	56.3. Related and supporting industries like home-based suppliers and others	1—2—3—4—5—6—7	—
	56.4. Demand in South Africa.	1—2—3—4—5—6—7	—
	56.5. Firm's strategy, structure and rivalry.	1—2—3—4—5—6—7	—
	56.6. Government intervention, e.g. by its competition policies, creating an environment in which firms can gain competitive advantage, creation of large projects, etc.	1—2—3—4—5—6—7	—

Appendix E

System integrator questionnaire

General questions

Name: _____

Company name: _____

Tel. no. _____

E-mail address: _____

Date. _____

Designation _____

Screener Questions

S 1: Please indicate your position in the company:

1. Chairman/CEO/COO
2. Executive directors
3. Non-executive directors/General managers
4. Other

S 2: Please place your firm into one of the following categories

5. National local company
6. Multinational company
7. Joint venture, mergers or strategic alliance
8. Other e.g. franchises

S3: Would you be interested in participating in further research? Simply answer yes or no.

9. YES/NO

S4: Would you prefer that your firm be mentioned as one of the firms participating in the research?

10. Prefer not to be mentioned.
11. Prefer to be mentioned.

S5: In which of the following industry categories would you classify your firm?

12. Electronics and Electrical engineering.
13. Information technology industry.
14. Other

S6: Indicate your firm's size in terms of number of employees.

15. _____

Specific Questions

Technology Management

Technologies

The Likert scale is used for the questions pertaining to technology management, i.e. Question 1 to 16. 1 indicates little or no effect and 7 indicates a large effect.

Technological strategy

References	Questions	Answers	Do not know
STS1	1. To what extent do you believe that firm's implementing technologies have aligned their business strategy and technological strategy? 1= little or no alignment 7= Large alignment.	1—2—3—4—5—6—7	—
STS2	2. To what extent do you believe that technological strategy has a positive effect on a firm's competitive strategy?	1—2—3—4—5—6—7	—
STS3	3. Pick the technological approach that you believe is adopted by leading firms most frequently.	---Innovators ---Early adopters ---Early majority ---Late majority ---Laggards	—

Technological investment

References	Questions	Answers	Do not know
STINV1	4. For leading firms, in your opinion what proportion of investments are allocated to technology-related activities?	--- <= 5% --- >5% and <=10% --- >10% and <=25% --- >25% and <=50% --- >50% and <=75% ___ >75%	—
STINV2	5. For leading firms, in your opinion what proportion of technological investments are made in the latest available technologies?	--- <= 5% --- >5% and <=10% --- >10% and <=25% --- >25% and <=50% --- >50% and <=75% ___ >75%	—
STINV3	6. To what extent do you believe that technological investment in firms is restricted by the following risks? 6.1. Inability to quantify strategic benefits. 6.2. Lack of understanding of the benefits resulting from technological adoption. 6.3. Newness of the area of technology. 6.4. Concern about the lack of skills necessary to achieve the potential benefits.	1—2—3—4—5—6—7 1—2—3—4—5—6—7 1—2—3—4—5—6—7 1—2—3—4—5—6—7	— — — —

STINV4	7. In relation to technological investment, do you believe that firms invest adequately in staff training? 1= little or no investment 7= Large investment	1—2—3—4—5—6—7	—
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Technological change

References	Questions	Answers	Do not know
STC1	8. To what extent do you believe that technological implementations in firms, as opposed to conventional methods, has improved information flow and knowledge transfer between key partners 8.1. Within the firm? 8.2. Outside the firm? 1= little or no improvement 7= Large improvement.	1—2—3—4—5—6—7 1—2—3—4—5—6—7	— —
STC2	9. To what extent do you believe that firms have changed strategic partners because of technological change and the fact that existing partners were no longer capable of new competence in the technology? 1= Little or no change. 7= Large change.	1—2—3—4—5—6—7	—

Technological integration

References	Questions	Answers	Do not know
STI1	10. Indicate the extent to which you believe that data transactions are conducted in firms through the use of computers or computerised equipment.		
	10.1. Design, i.e. CAD, CAE, CAPP	1—2—3—4—5—6—7	—
	10.2. Process or manufacturing such as CAD linked to CNC, CAM, robots or FMS, bar coding, real time process systems, automated handling, robotics and group technology, i.e. generalists manufacturing and operations i.e. warehousing, distribution, process industries.	1—2—3—4—5—6—7	—
	10.3. Management information systems (MIS) such as MRP, office automated, accounting, electronic mail, EDI, decision support systems, knowledge base systems, i.e. Generalists.	1—2—3—4—5—6—7	—
	1= Little or no use 7= Large use.		

ST12	11. Do you have experience with firms which are involved in design and/or, manufacturing and/or MIS? Tick yes or no. If you answered yes, go to Question 12 If you answered no, go to Question 14.	Yes ____ No ____	—
ST13	12. To what extent do you believe that firms have adopted technology integration in design, process/manufacturing or MIS? 1= little or no integration 7= full total integration	1—2—3—4—5—6—7	—
ST14	13. In your opinion how long does it takes firms to integrate between technologies in design, process/manufacturing or management? 1= Within 3 months 2=Within 6 months 3=Within one year 4=Within 2 years 5= More than 2 years	1—2—3—4—5	—
ST15	14. How would you rate the competence of managers in firms when it comes to assessing the firm's technological needs? 1= Little or poor competence. 7= Large competence.	1—2—3—4—5—6—7	—

Technological importance

References	Questions	Answers	Do not know
STIMP1	15. To what extent do you believe that firms view the following criteria as important for competitive advantage?		
	15.1. Technologies	1—2—3—4—5—6—7	—
	15.2. Cost	1—2—3—4—5—6—7	—
	15.3. Quality	1—2—3—4—5—6—7	—
	15.4. Speed	1—2—3—4—5—6—7	—
	15.5. Dependability	1—2—3—4—5—6—7	—
	15.6. Flexibility	1—2—3—4—5—6—7	—
	1= indicates the least important 7= indicates the most important		

STIMP2	16. To what extent do you believe that firms have been influenced by the following factors for technological implementations? 16.1. Market threats 16.2. Current technology obsolete 16.3. To obtain benefits in criteria like cost, quality, speed, dependability and flexibility. 16.4. To improve information flow and knowledge transfer 16.5. In line with the firm's technological policy. 1= Least important 5= Most important	1—2—3—4—5—6—7 1—2—3—4—5—6—7 1—2—3—4—5—6—7 1—2—3—4—5—6—7 1—2—3—4—5—6—7	— — — — —
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Technology management and transaction processes**Technological resource skills**

The Likert scale is used for the questions pertaining to technology management and transaction processes, i.e. Questions 17 to 35. 1 indicates little or no effect and 7 indicates a large effect.

Competence enhancing and competence destroying

References	Questions	Answers	Do not know
STRS1	17. To what extent do you believe that firms have been affected by the following technologies over the last 5 years?		
	17.1. Competence destroying technologies.	1—2—3—4—5—6—7	—
	17.2. Competence enhancing technologies.	1—2—3—4—5—6—7	—

Tangible and intangible technological resources

References	Questions	Answers	Do not know
STRS2	18. To what extent do you believe that firms' tangible and intangible technological resources are matched, i.e. having the right match between technologies and technological resource skills? 1= little or no match 7= Large match	1—2—3—4—5—6—7	—

Firm competencies

Core competencies and general competencies

References	Questions	Answers	Do not know
SFC1	19. To what extent do you believe that firms view technological implementation as a means to improve core competencies? (Core competence being valuable, sustainable, versatile and difficult to imitate). 1= little or no importance 7= Large importance	1—2—3—4—5—6—7	—
SFC2	20. To what extent do you believe that firms view technological implementation as a means to improve general competencies? 1= little or no importance 7= Large importance	1—2—3—4—5—6—7	—

SFC3	21. To what extent do you believe that the following is important for competitive advantage?		
	21.1. Individuals, assets and organisational structures.	1—2—3—4—5—6—7	—
	21.2. Technological acquisition	1—2—3—4—5—6—7	—
	21.3. Patented process or design	1—2—3—4—5—6—7	—
	21.4. Know-how, shared among individuals in the firm.	1—2—3—4—5—6—7	—
	21.5. The firm's selection and positioning within an industry.	1—2—3—4—5—6—7	—
	1= indicates the least important 7= indicates the most important		

Transaction processes

Process/manufacturing mix criteria=cost, quality, speed, dependability and flexibility

References	Questions	Answers	Do not know
STP1	22. To what extent do you believe that firms' technological strategies are aimed at improving criteria like cost, quality, speed, dependability and flexibility? 1= little or no match. 7= total match.	1—2—3—4—5—6—7	—

STP2	23. To what extent do you believe that information flow and knowledge transfer in firms has led to improvements in manufacturing mix criteria i.e. cost, quality, speed, dependability and flexibility?	1—2—3—4—5—6—7	—
STP3	24. To what extent do you believe that organisational learning in firms has led to improvements in manufacturing mix criteria i.e. cost, quality, speed, dependability and flexibility?	1—2—3—4—5—6—7	—
STP4	25. To what extent do you believe that technological implementations have affected transactional processes in your firm with respect to: 25.1. Transactional cost reduction? 25.2. Transactional value added i.e. transactional efficiency, reliability, frequency, durability and transaction-specific interests?	1—2—3—4—5—6—7 1—2—3—4—5—6—7	— —

STP5	26. How long do you believe it takes technology implementations to affect transactional processes in your firm with respect to: 26.1. Transactional cost reduction? 26.2. Transactional value added i.e. transactional efficiency, reliability, frequency, durability and transaction-specific interests? 1= Within 3 months. 2= Within 6 months 3= Within one year. 4= Within 2 years 5= More than two years.	1—2—3—4—5 1—2—3—4—5	— —
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Technological sourcing

Strategic alliances/joint ventures

References	Questions	Answers	Do not know
STSP1	27. Would you say that technology relationships with firms and their key partners are based on an adversarial or partnership approach? Tick one option	___ Adversarial ___ Partnership	—
STSP2	28. To what extent do you believe that firms view strategic partnerships as a means to: 28.1. Acquire the capabilities, knowledge and technology of the other firm, thereafter dissolving the partnership? 28.2. Create a strategic alliance for the benefit of both firms, thereafter developing the partnership? 1= Little or no support 7= Large support	1—2—3—4—5—6—7 1—2—3—4—5—6—7	—
STSP3	29. To what extent do you believe that firms view strategic alliances as a source of competitive advantage?	1—2—3—4—5—6—7	—

Knowledge management

References	Questions	Answers	Do not know
SKM1	30. In your opinion what is the effect of information flow and knowledge transfer on transaction processes with regard to		
	30.1. Transactional cost reduction?	1—2—3—4—5—6—7	—
	30.2. Transactional value added, i.e. transactional efficiency, reliability, frequency, durability and transactional specific interests?	1—2—3—4—5—6—7	—
SKM2	31. To what extent do you believe firms have identified the benefits of information flow to improve technological resource skills in terms of the following criteria?		
	31.1. Competence destroying	1—2—3—4—5—6—7	—
	31.2. Competence enhancing	1—2—3—4—5—6—7	—
	31.3. Tangible and intangible technological resources.	1—2—3—4—5—6—7	—

SKM3	32. To what extent do you believe firms have identified the benefits of knowledge transfer to improve technological resource skills in terms of the following criteria? 32.1. Competence destroying 32.2. Competence enhancing 32.3. Tangible and intangible technological resource skills.	1—2—3—4—5—6—7 1—2—3—4—5—6—7 1—2—3—4—5—6—7	— — —
SKM4	33. To what extent do you believe firms have identified the benefits of new and emerging technologies to improve technological resource skills in terms of the following criteria? 33.1. Competence destroying 33.2. Competence enhancing 33.3. Tangible and intangible technological resource skills.	1—2—3—4—5—6—7 1—2—3—4—5—6—7 1—2—3—4—5—6—7	— — —

Technological gate-keeping

References	Questions	Answers	Do not know
SKM5	34. Indicate the extent to which the following control and monitoring systems are utilised by firms to control the flow of critical skills and technologies to technology partners.		
	34.1. Central collaboration office to interface with technology specific partners.	1—2—3—4—5—6—7	—
	34.2. Decentralised control through other divisions.	1—2—3—4—5—6—7	—
	34.3. Flat management and organisational structures for alliance partners.	1—2—3—4—5—6—7	—
	34.4. Limitation and control procedures for the transfer of information to partners through disciplines and procedures.	1—2—3—4—5—6—7	—
	34.5. Transfer of staff across the partnership agreement. 1= Least frequently. 7= Most frequently.	1—2—3—4—5—6—7	—

New and emerging technologies

References	Questions	Answers	Do not know
SKM6	35. Do you believe that firms possesses the necessary technological resources to cope with the effects of globalisation? 1= Little or no technological resources 7= Large technological resources	1—2—3—4—5—6—7	—

Governance structures

Relationship management

The Likert scale is used for the questions pertaining to governance structures, i.e. Questions 36 to 46. 1 indicates little or no effect and 7 indicates a large effect.

References	Questions	Answers	Do not know
SRM1	36. To what extent do you believe that technology management in firms has improved the following:		
	36.1. Social networks and embedded ties?	1—2—3—4—5—6—7	—
	36.2. Supplier closeness, communications, trust and goodwill?	1—2—3—4—5—6—7	—
	36.3. Market opportunities through partnering? 1= Least important 7= Most important	1—2—3—4—5—6—7	—
SRM2	37. To what extent do you believe that trust and goodwill have led to increased transactional history between firms and their key partners?	1—2—3—4—5—6—7	—

SRM3	38. To what extent do you believe that increased transactional history (i.e. an increased number of transactions over a long period of time say 5 years) has led to the following: 38.1. Opportunistic behaviour? 38.2. Transactional diversity? 38.3. Reduced the time taken to make decisions? 38.4. Accumulation of information regarding the predictability and reliability of partners? 38.5. Risks in terms of information asymmetry? 1=Least frequently 7=Most frequently	1—2—3—4—5—6—7 1—2—3—4—5—6—7 1—2—3—4—5—6—7 1—2—3—4—5—6—7 1—2—3—4—5—6—7	— — — — —
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SRM4	39. To what extent do you believe that firms adopt the following approaches which support effective governance? 39.1. Joint ventures and strategic alliances. 39.2. Two-way technology exchanges. 39.3. One-way technology exchange. 39.4. Direct investment. 39.5. Customer and supplier relationships. 1= least important 7= Most important.	1—2—3—4—5—6—7 1—2—3—4—5—6—7 1—2—3—4—5—6—7 1—2—3—4—5—6—7 1—2—3—4—5—6—7	— — — — —
SRM5	40. To what extent do you believe that technological implementation has led to improved network structures with firms and their key partners over the last 5 years?	1—2—3—4—5—6—7	—

Organisational learning

Learning-by-doing and learning-before-doing

References	Questions	Answers	Do not know
SOL1	41. To what extent has organisational learning affected transactional processes with regard to:		
	41.1. Transactional cost reduction?	1—2—3—4—5—6—7	—
	41.2. Transactional value added i.e. transactional efficiency, reliability, frequency, durability and transaction specific interests?	1—2—3—4—5—6—7	—
SOL2	42. To what extent do you believe that information flow and knowledge transfer has benefited firms in terms of the following		
	42.1. Learning-by-doing?	1—2—3—4—5—6—7	—
	42.2. Learning-before-doing?	1—2—3—4—5—6—7	—
	1= Little or no benefit 7= Large benefit		

References	Questions	Answers	Do not know
SOL3	43. To what extent do you believe that new and emerging technologies have affected firms in terms of		
	43.1. Learning-by-doing?	1—2—3—4—5—6—7	—
	43.2. Learning-before-doing?	1—2—3—4—5—6—7	—
	1= little or no benefit 7= large benefit		
SOL4	44. To what extent has organisational learning affected knowledge management in terms of the following:		
	44.1. Information flow?	1—2—3—4—5—6—7	—
	44.2. Knowledge transfer?	1—2—3—4—5—6—7	—
	44.3. New and emerging technologies?	1—2—3—4—5—6—7	—
SOL5	45. To what extent do you believe that organisational learning has affected the competitive environment of firms in terms of the following?		
	45.1. Market threats	1—2—3—4—5—6—7	—
	45.2. Market opportunities.	1—2—3—4—5—6—7	—
	45.3. External factors, i.e. social, economic and political.	1—2—3—4—5—6—7	—

Absorptive capacity

SOL6	46. To what extent do you believe that information flow and knowledge transfer have affected firms with regard to absorptive capacity?	1—2—3—4—5—6—7	—
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Investigative framework

Organisational determinants

The Likert scale is used for the questions pertaining to governance structures, i.e. Questions 47 to 53. 1 indicates little or no effect and 7 indicates a large effect.

SOD1	47. To what extent do you believe that the following criteria are important contributors to firms' performance?		
	47.1. Industry selection and positioning	1—2—3—4—5—6—7	—
	47.2. Organisational processes and administrative practices.	1—2—3—4—5—6—7	—
	47.3. Managerial capabilities.	1—2—3—4—5—6—7	—

Competitors

SC1	48. For leading firms, how would you rate their performance relative to their competitors as a result of technological implementation? 48.1. Sales growth 48.2. Return on sales 48.3. Earnings growth. 1= little or no performance advantage 7= Large performance advantage	1—2—3—4—5—6—7 1—2—3—4—5—6—7 1—2—3—4—5—6—7	— — —
SC2	49. For leading firms, how would you rate such firms relative to their competitors in their ability to adapt to rapidly changing technologies? 1= little or no adaptability advantage 7= Superior adaptability advantage	1—2—3—4—5—6—7	—
SC3	50. To what extent do you believe that firms will be affected by the following over the next 2 years: 50.1. New entrants? 50.2. Buying power of competitors? 50.3. Substitute products?	1—2—3—4—5—6—7 1—2—3—4—5—6—7 1—2—3—4—5—6—7	— — —

External factors

SEF1	51.	To what extent do you believe that firms will be affected by the following within the next 2 years:		
	51.1.	Globalisation?	1—2—3—4—5—6—7	—
	51.2.	E-business?	1—2—3—4—5—6—7	—
	51.3.	Social, economic and political factors?	1—2—3—4—5—6—7	—

Manufacturing mix

SMM1	52.	For leading firms to what extent do you believe that technological implementation has affected the following manufacturing mix criteria?		
	52.1.	Cost	1—2—3—4—5—6—7	—
	52.2.	Quality	1—2—3—4—5—6—7	—
	52.3.	Speed	1—2—3—4—5—6—7	—
	52.4.	Dependability	1—2—3—4—5—6—7	—
	52.5.	Flexibility	1—2—3—4—5—6—7	—
		1= Little or no benefit 7= Large benefit		
SMM2	53.	To what extent do you believe that manufacturing mix processes are affected by the following:		
	53.1.	Organisational determinants?	1—2—3—4—5—6—7	—
	53.2.	Competitors?	1—2—3—4—5—6—7	—
	53.3.	External factors, i.e. social, economic and political?	1—2—3—4—5—6—7	—

Resource based view and transaction cost economic view

The Likert scale is used for the questions pertaining to the resource based view and transaction cost economic view, i.e. Questions 54 to 55. 1 indicates little or no effect and 7 indicates a Large effect.

SRBV1	54. To what extent do you believe that firms have a competitive advantage relative to key competitors in respect of the following:		
	54.1. Firm resources?	1—2—3—4—5—6—7	—
	54.2. Industry selection and positioning?	1—2—3—4—5—6—7	—
	54.3. Transactional benefits in transactional cost reduction or transactional value added?	1—2—3—4—5—6—7	—
	1= Little or no advantage 7= Large advantage		

SRBV2	55. To what extent do you believe firms have developed a diversification strategy with regard to the following: 55.1. Current resources as a basis for diversification? 55.2. Resources to be developed through diversification? 55.3. Identification of what markets in which diversification should take place? 55.4. What types of firms have been identified for acquisition?	1—2—3—4—5—6—7 1—2—3—4—5—6—7 1—2—3—4—5—6—7 1—2—3—4—5—6—7	— — — —
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Organisational and environmental evolution

The likert scale is used for the questions pertaining to governance structures, i.e. Question 56. 1 indicates little or no effect and 7 indicates a good effect.

SOEE4	56. To what extent do you believe that firms possesses competitive advantages with regard to the following conditions?		
	56.1. Generalised factors like generic technologies, which are easy to source through global networks.	1—2—3—4—5—6—7	—
	56.2. Specialised factors like skilled labour and natural resources.	1—2—3—4—5—6—7	—
	56.3. Related and supporting industries like home-based suppliers and others.	1—2—3—4—5—6—7	—
	56.4. Demand in your country.	1—2—3—4—5—6—7	—
	56.5. Firms' strategy, structure and rivalry.	1—2—3—4—5—6—7	—
	56.6. Government intervention, e.g. by its competition policies, creating an environment in which firms can gain competitive advantage, creation of large projects, etc.	1—2—3—4—5—6—7	—

Appendix F

Initial user questionnaire before pilot run

Questionnaire

Screenener questions

S 1:Please indicate your position in the company:

1. Executive management or Senior management
2. Functional specialists involved in technology strategy and or technology implementation
3. Other specialists or managers not at a senior level

S 2:Please place your firm in one of the following categories

4. National local company
5. Multinational company
6. Joint venture, mergers or strategic alliance
7. Other, e.g. franchises

Specific Questions

Technology management

Technologies

Technological strategy

1. UTS 1:To what extent do you believe that your firm's business strategy and technological strategy are aligned? Indicate using a 7-point scale where 1 indicates little or no alignment and 7 indicates substantial alignment.

1----2---3---4---5---6---7.

2. UTS 2: To what extent do you believe that your firm's technological strategy has a positive effect on its competitive advantage? Use a 7-point Likert scale where 1 indicates little or no effect and 7 a substantial effect.

1----2---3---4---5---6---7

3. UTS 2:Indicate your firm's strategy towards the following technological adoption categories. Use a 5-point scale where 1 indicates a poor approach and 5 a significant approach. No two categories may be given the same weighting.

----- Innovators - technology enthusiasts

----- Early adopters - visionaries

- Early majority - pragmatists
- Late majority - conservatives
- Laggards - traditional bound

Technological investment

4. UTINV 1: Indicate your company's level of investment in technology. Use a 7-point likert scale. Where 1 indicates little or no investment and 7 substantial investment.

1----2---3---4---5---6---7

5. UTINV 2: In your firm indicate what proportion of technological investments are made in the latest available technologies. Use a 7-point Likert scale where 1 indicates little or no investment and 7 indicates substantial investment.

1----2---3---4---5---6---7

6. UTINV 3: To what extent do you believe that technological investment in your firm is restricted as a result of the following risks? Use a 7-point Likert scale where 1 indicates little effect and 7 a substantial effect.

6.1. Inability to quantify strategic benefits

1----2---3---4---5---6---7

6.2. Lack of understanding of the potential benefits from technological adoption

1----2---3---4---5---6---7

6.3. Newness of the area of technology

1----2---3---4---5---6---7

6.4. Concern over the lack of skills necessary to achieve the potential benefits.

7. UTINV 4: Do you believe that firms allocate an adequate investment towards staff training needs pertaining to newer technologies in relation to the level of technological investment? Use a 7-point Likert scale where 1 indicates little or no investment and 7 indicates substantial investment.

1----2---3---4---5---6---7

Technological change

8. UTC 1: To what extent has technological change in your firm affected the following transactional processes? Use a 7-point Likert scale where 1 indicates little or no effect and 7 a substantial effect.

8.1. Transactional certainty

1----2---3---4---5---6---7

7.1. Transaction-specific interests

1----2---3---4---5---6---7

7.3. Transactional frequency

1----2---3---4---5---6---7

7.4. Transactional durability

9. UTC 2: How long does it take changes in technology to affect transaction processes? Use a 7-point Likert scale where 1 indicates early changes within the first year and 7 late changes after 3 years.

9.1. Transactional certainty

1----2---3---4---5---6---7

9.2. Transaction-specific interests

1----2---3---4---5---6---7

9.3. Transactional frequency

1----2---3---4---5---6---7

9.4. Transactional durability

10. UTC 3: To what extent has technological change in your firm improved knowledge transfer and information flow between your key partners within the firm, as compared with conventional methods in the last 3 years? Use a 7-point Likert scale where 1 indicates no effect and 7 indicates a total effect.

1----2---3---4---5---6---7

11. UTC 4: To what extent has technology change in your firm improved information flow between your key partners outside the firm, as compared with conventional methods in the last 3 years. Use a 7-point Likert scale where 1 indicates no effect and 7 indicates a substantial effect.

1----2---3---4---5---6---7

12. UTC 5: To what extent has your firm entered into new strategic partners (changed partners) because of technological change in your industry and because existing partners were no longer capable of new competence in the technology? Use a 7-point Likert scale where 1 indicates no or little effect and 7 indicates a substantial effect.

1----2---3---4---5---6---7

Technological integration

13. UTI 1: Indicate the extent to which data transactions are conducted in your firm through the use of computers or computerised equipment, Where 1 indicates no computer-integrated transaction (0%) and 7 indicates substantial computer-integrated transactions (100%)

13.1. Design, i.e. CAD, CAE, CAPP, i.e. designers

1----2---3---4---5---6---7

13.2. Manufacturing such as CAD linked to CNC, CAM, robots or FMS, bar coding/automatic identification, real time process systems, automated handling, robotics, and group technology, i.e. Generalists Manufacturing and operations i.e. warehousing, distribution, process industries

1----2---3---4---5---6---7

13.3. Administrative such MRP, office automation, accounting, electronic mail, EDI, decision support systems, knowledge-based systems i.e. Generalists Administration

1----2---3---4---5---6---7

14. UTI 2: Indicate your company's level of integration in design, manufacturing and administrative, where 1 indicates little or no integration between typologies and 7 indicates substantial integration.

1----2---3---4---5---6---7

15. UTI 3: Indicate your company's trend regarding the time periods for integration between design, manufacturing and administrative functions, where 1 indicates very early adoption within the first year and 7 later than 5 years

1----2---3---4---5---6---7

16. UTI4: How would you rate the competence of managers in firms regarding their ability to access the firms technological needs? Use a 7-point Likert scale. Where 1 indicates little or no competence and 7 indicates substantial competence.

1----2---3---4---5---6---7

Technological importance

17. TIMP 1: How would you rate the importance of technology adoption in your firm relative to manufacturing mix criteria (i.e. cost, quality, delivery, speed, dependability and flexibility), where 1 indicates least important and 7 most important? (No two categories may have the same weighting.)

----- Technological investment

----- Cost

----- Quality

----- delivery

----- speed

----- dependability

----- flexibility

Technology management and transaction processes

Technological resource skills

Competence destroying technologies

18. UTRS 1: To what extent has your firm been affected by competence destroying technologies that have altered that way your firm has conducted business over the last 10 years? Indicate on the Likert scale where 1 indicates no effect, 4 indicates changes in processes and relationships with suppliers and customers, and 7 indicates fundamental repositioning of certain products.

1----2---3---4---5---6---7

competence enhancing technologies

19. UTRS 2: To what extent has your firm been affected by competence enhancing technologies that have strengthened your firm over the last 10 years. Indicate on the Likert scale where 1 indicates no change, 4 indicates changes in process and relationships with suppliers and customers, and 7 indicates an ability to leapfrog your competitors with major product or process innovations.

1----2---3---4---5---6---7

Tangible and intangible technological resources

20. UTRS 3: To what extent does your firm view tangible technological resources as a competitive advantage? Rate using a 7-point Likert scale where 1 indicates little or no competitive advantage and 7 indicates significant competitive advantage.

1----2---3---4---5---6---7

21. UTRS 4: To what extent does your firm view intangible technological resources as a competitive advantage? Rate using a 7-point Likert scale where 1 indicates little or no competitive advantage and 7 significant competitive advantage.

1----2---3---4---5---6---7

22. UTRS 5: To what extent do you believe that your firm's tangible and intangible technological resources are matched i.e. having the right match between technologies and technological resource skills? Indicate on a 7-point Likert scale where 1 indicates little or no match and 7 indicates a substantial match.

1----2---3---4---5---6---7

Firm competencies

Core competencies and general competencies

23. UFC 1: To what extent does your firm view technological implementation as a means to improve core competencies? Use a 7-point Likert scale where 1 indicates little or no interaction and 7 substantial interaction.

1----2---3---4---5---6---7

24. UFC 2: To what extent does your firm view technological implementation as a means to improve general competencies? Use a 7-point Likert scale where 1 indicates little or no interaction and 7 substantial interaction.

1----2---3---4---5---6---7

25. UFC 3: Please indicate in order of priority, which resources are regarded by your firm as core competencies, where 1 would indicate a low priority and 5 a high priority. No two categories may have the same weighting.

----- Individuals, assets and organisational structures

----- Technological acquisition, i.e. tangible technologies

----- Patented process or design

----- Know-how, shared among individuals in the firm i.e. intangible technologies

----- The firm's selection and positioning within an industry.

Manufacturing mix criteria

26. UFC 3: To what extent do you believe that your firm's technology implementation policies are aimed at improving manufacturing mix criteria i.e. speed, cost, quality, dependability and flexibility? Use a 7-point Likert scale where 1 indicates little or no effect and 7 indicates a substantial effect.

1----2---3---4---5---6---7

27. UC 4: To what extent has information flow and knowledge transfer in your firm led to improvements in manufacturing mix criteria like cost, quality, speed, dependability and flexibility, where 1 indicates a little or no effect and 7 a substantial improvement?

1----2---3---4---5---6---7

28. UFC 5: To what extent has organisational learning in your firm led to improvements in manufacturing mix criteria like cost, quality, speed, dependability and flexibility, where 1 indicates little or no effect and 7 a substantial improvement?

1----2---3---4---5---6---7

Technological sourcing

Strategic alliances/joint ventures

29. UTS 1: Does your firm view strategic partnerships as a means to: (choose one option)

29.1. Acquire the capabilities, knowledge and technology of the other firm?

29.2. Create a strategic alliance for the benefit of the competitiveness for both firms?

30. UTS 2: To what extent does your firm view alliances as a source of competitive advantage? Indicate on the Likert scale where 1 indicates little or no value and 4 indicates an adequate balance with backward and forward integration and 7 indicates significant weighting with your firm serving merely as intermediary.

1----2---3---4---5---6---7

Technology partnering

31. UTP 4: What proportion of your key technological resources are obtained through technology partnering with strategic alliances, joint ventures and outsourcing agreements with competitors? Indicate on the Likert scale where 1 indicates little or no collaboration, 4 indicates an average level of collaboration and 7 indicates significant proportion of key resources being obtained from outside the firm.

1----2---3---4---5---6---7

Knowledge management

32. UKM 1: To what extent has your firm identified the benefits of information flow to improve technological resource skills in terms of the following criteria? Use a 7-point Likert scale where 1 indicates little or no benefit and 7 a substantial benefits.

- 32.1. Competence enhancing

1----2---3---4---5---6---7

- 32.2. Competence destroying

1----2---3---4---5---6---7

- 32.3. Tangible and intangible technological resources

1----2---3---4---5---6---7

33. UKM 2: To what extent has your firm identified the benefits of knowledge transfer to improve technological resource skills in terms of the following criteria? Use a 7-point Likert scale where 1 indicates little or no benefit and 7 a substantial benefit.

- 33.1. Competence enhancing

1----2---3---4---5---6---7

- 33.2. Competence destroying

1----2---3---4---5---6---7

- 33.3. Tangible and intangible technological resources

1----2---3---4---5---6---7

34. UKM 3: To what extent has your firm identified the benefits of new and emerging technologies to improve technological resource skills in terms of the following criteria? Use a 7-point Likert scale where 1 indicates little or no benefit and 7 a substantial benefit.

- 34.1. Competence enhancing

1----2---3---4---5---6---7

- 34.2. Competence destroying

1----2---3---4---5---6---7

34.3. Tangible and intangible technological resources

1----2---3---4---5---6---7

35. UKM 4: Indicate the extent to which your firm uses the following mechanisms for knowledge management in an effort to improve capacity for learning? Use a 7-point Likert scale where 1 indicates little or no evidence and 7 indicates substantial evidence.

35.1. Highly specialised staff positions like chief or senior knowledge management officers. Indicate on the Likert scale where 1 indicates no use of such professionals and 7 indicates extensive use of such professionals (possible one individual per 500 employees).

1----2---3---4---5---6---7

35.2. Promoting the attendance of conferences, seminars, workshops, etc. Indicate on the Likert scale where 1 indicates no such policy, 3 indicates for key staff only and 7 indicates an open policy for all relevant staff.

1----2---3---4---5---6---7

35.3. Payment and reward systems for staff members to acquire additional skills such as advanced degrees, management courses, presentation at conference and journal publications, etc. Indicate on the Likert scale where 1 indicates no such mechanism and 7 indicates formalised policies to support such initiatives.

1----2---3---4---5---6---7

35.4. Promoting the advancement of staff through the granting of study benefit schemes and staff training schemes. Indicate on the Likert scale where 1 indicates no such mechanism and 7 indicates extensive use of such mechanisms with the incorporation of in-house training schemes in collaboration with advanced study institutions.

1----2---3---4---5---6---7

Technological gate-keeping

36. UKM 5: Please rate the following control and monitoring systems that are utilised by your firm to control the flow of critical skills and technologies to your technology partner. (Technology gate keeping)? Use a 5-point scale where 1 indicates the least important and 5 indicates the most important. No two categories may have the same weighting.

----- Central collaboration office to interface with technology specific partners

----- Decentralised control through other divisions

----- Flat management and organisational structures for the alliance operations

----- Limitation and control procedures for the transfer of information to partners through disciplines and procedures

----- Transfer of staff across the partnership agreement

New and emerging technologies

37. UKM 6: Do you believe that your firm possesses the necessary resources to cope with the effects of globalisation in terms of back office technologies to support customer needs, that is adequate communication, information, organisational skills in terms of knowledge and logistics channels to deliver and support demand in terms of the supply of goods and services? Please indicate on the Likert scale where 1 indicates extremely poor ability to adapt and 7 indicates an extreme readiness to adapt.

1----2---3---4---5---6---7

Governance structures

Relationship management

38. URM1 1: Please rate the benefits of technological change in your firm relative to the following criteria. Use a 7-point Likert scale where 1 indicates little or no effect and 7 indicates a substantial effect.

- 38.1. Social networks and embedded ties

1----2---3---4---5---6---7

- 38.2. Supplier closeness, communications, trust and goodwill

1----2---3---4---5---6---7

- 38.3. Improved market opportunities through partnering

1----2---3---4---5---6---7

39. URM 2: To what extent do you believe that trust and goodwill have led to an increased transactional history between your firm and its key partners? Use a 7-point Likert scale where 1 indicates little or no effect and 7 a substantial effect.

1----2---3---4---5---6---7

40. URM 3: To what extent do you believe that increased transactional history between your firm and its key partners have led to the following. Use a 7-point Likert scale where 1 indicates little or no effect and 7 a substantial effect.

- 40.1. Opportunistic behaviour

1----2---3---4---5---6---7

- 40.2. Transactional diversity

1----2---3---4---5---6---7

- 40.3. Accumulation of information regarding the predictability and reliability of partners

1----2---3---4---5---6---7

- 40.4. Risks in terms of information asymmetry as partners will share information more freely with each other

1----2---3---4---5---6---7

- 40.5. Reduced time taken to make decisions

1----2---3---4---5---6---7

41. URM 4: Rank your firm in terms of its approach towards the following criteria which support effective governance between firms. Use a 5-point scale. Where 1 indicates the least important and 5 indicates the most important.

----- Joint ventures and strategic alliances

----- Two-way technology exchange

----- One-way technology exchange

----- Direct investment

----- Customer and supplier relationships.

42. URM 5: To what extent has technological investment in your firm led to improved network structures (structure-reinforcing events) with key suppliers outside the firm over the last three years as compared to your major competitors? Please indicate on the Likert scale where 1 indicates a low influence and 7 a considerable influence.

1----2---3---4---5---6---7

43. URM 6: To what degree are transactions maintained or improved with key suppliers due to joint investment in technology, i.e. transaction-specific interests. Use a 7-point Likert scale where 1 indicates little or no effect and 7 indicates a substantial effect.

1----2---3---4---5---6---7

44. UOL 8: Would you say that supplier relationships with your firm's key suppliers are based on a partnership approach? Indicate on the Likert scale where 1 indicates a more adversarial approach and 7 a significant partnering approach.

1----2---3---4---5---6---7

Organisational learning

Learning-by-doing and learning-before-doing

45. UOL 1: To what extent has information flow and knowledge transfer benefited your firm in terms of learning-by-doing? Use a 7-point Likert scale where 1 indicates little or no benefit and 7 a substantial benefit.

1----2---3---4---5---6---7

46. UOL 2: To what extent has information flow and knowledge transfer benefited your firm in terms of learning-before-doing? Use a 7-point Likert scale where 1 indicates little or no benefit and 7 a substantial benefit.

1----2---3---4---5---6---7

47. UOL 3: To what extent have new and emerging technologies affected your firm in terms of learning-by-doing and learning-before-doing? Use a 7-point Likert scale where 1 indicates little or no effect and 7 a substantial effect.

1----2---3---4---5---6---7

48. UOL 4: To what extent has organisational learning, i.e. learning-by-doing and learning-before-doing and absorptive capacity, affected knowledge management in terms of the following? Use a 7-point Likert scale where 1 indicates little or no effect and 7 a substantial effect

48.1. Information flow

1----2---3---4---5---6---7

48.2. Knowledge transfer

1----2---3---4---5---6---7

48.3. New and emerging technologies

1----2---3---4---5---6---7

49. UOL 5: To what extent has organisational learning, i.e. learning-by-doing and learning-before-doing and absorptive capacity affected the firm's competitive environment? Use a 7-point Likert scale where 1 indicates little or no effect and 7 a substantial effect

49.1. Market threats

1----2---3---4---5---6---7

49.2. Market opportunities

1----2---3---4---5---6---7

49.3. External factors, i.e. social, economic and political

1----2---3---4---5---6---7

Absorptive capacity

50. UOL 6: How has information flow and knowledge transfer in your firm affected the firm's absorptive capacity? Please indicate on the Likert scale where 1 indicates little effect and 7 a significant effect.

1----2---3---4---5---6---7

51. UOL 7: Has the number of suppliers that your firm transacts with decreased over the last 5 years? Use a 7-point Likert scale where 1 indicates little or no effect and 7 indicates a substantial effect.

1----2---3---4---5---6---7

Investigative framework

Organisational determinants

52. UOD 1: To what extent do you believe that industry selection and positioning within the industry your firm competes in are important contributors for competitive advantage? Use a 7-point Likert scale where 1 indicates little or no contribution and 7 a substantial contribution.

1----2---3---4---5---6---7

53. UOD 2: To what extent do you believe that good administrative practices and processes are important contributors for your firm's competitive advantage? Use a 7-point Likert scale where 1 indicates little or no effect and 7 indicates a substantial effect.

1----2---3---4---5---6---7

54. UOD 3: To what extent are strong managerial capabilities and organisational processes a determinant towards the competitiveness of firms? (Where 1 indicates little or no effect and 7 indicates a substantial determinant.)

54.1. Managerial capabilities

1----2---3---4---5---6---7

54.2. Organisational processes

1----2---3---4---5---6---7

Competitors

55. UC 1: For your major product line, indicate your performance in respect of your competitors for the last three years, where 1 is significantly lower, 4 is equal and 7 is significantly higher.

55.1. Sales growth

1----2---3---4---5---6---7

55.2. Return on sales

1----2---3---4---5---6---7

55.3. Earnings growth

1----2---3---4---5---6---7

56. UC 2: How would you rate your firm relative to its competitors in its ability to transform itself in a rapidly changing environment of new technologies? (Where 1 indicates a low response to change and 7 a significant response to change.)

1----2---3---4---5---6---7

57. UC 3: To what extent do you believe that your firm is affected by the following? Use a 7-point Likert scale where 1 indicates little or no effect and 7 indicates a substantial effect.

57.1. New entrants

1----2---3---4---5---6---7

57.2. Buying power

1----2---3---4---5---6---7

57.3. Substitute products

1----2---3---4---5---6---7

External factors

58. UEF 1: To what extent do you believe that your firm will be affected by the following? Use a 7-point Likert scale where 1 indicates little or no effect and 7 indicates a substantial effect.

58.1. Globalisation

1----2---3---4---5---6---7

58.2. E-business

1----2---3---4---5---6---7

58.3. Social, economic and political factors

1----2---3---4---5---6---7

Manufacturing mix

59. UMM 1: From your experience how would you rate the benefits of technological change in terms of the following? Use a 7-point Likert scale where 1 indicates little or no benefit and 7 indicates a substantial benefit.

59.1. Cost

1----2---3---4---5---6---7

59.2. Quality

1----2---3---4---5---6---7

59.3. Speed

1----2---3---4---5---6---7

59.4. Dependability

1----2---3---4---5---6---7

59.5. Flexibility

1----2---3---4---5---6---7

60. UMM 2: To what extent do you believe that manufacturing mix processes in your firm are affected by the following? Use a 7-point Likert scale where 1 indicates little or no effect and 7 indicates a substantial effect.

60.1. Organisational determinants

1----2---3---4---5---6---7

60.2. Competitors

1----2---3---4---5---6---7

60.3. External factors

1----2---3---4---5---6---7

Organisational and environmental evolution

61. UOEE 1: To what extent has your firm engaged in backward integration to reduce costs as a result of improvements in manufacturing mix criteria by competitors? Use a 7- point Likert scale where 1 indicates little or no evidence or 7 indicates substantial evidence.

1----2---3---4---5---6---7

62. UOEE 2: To what extent has the market your firm competes in been penetrated by value added system integrators either using your firm's products or your competitors' products? Use a 7-point Likert scale where 1 indicates little or no effect and 7 indicates a substantial effect.

1----2---3---4---5---6---7

63. UOEE 3: To what extent has your firm diversified as a result of market penetration by system integrators (forward integration)? Use a 7-point Likert scale where 1 indicates little or no effect and 7 indicates a substantial effect.

1----2---3---4---5---6---7

Appendix G

Expert panel questionnaire

G1 Linking the technological framework

1. **Statement:** User firms do not see technologies and technological resource skills as linked, but system integrator firms do see this link. In addition user firms see technological change as linked to competence enhancing effects and technological implementation as linked to tangible and intangible technological resources. System integrator firms see technological change as linked to competence enhancing effects and technological implementation as linked to competence destroying effects.

Question: What do you believe are the possible reasons for the differences between user and system integrator firms?

2. **Statement:** User firms see technologies and firm competencies as linked, whereas system integrator firms do not see this link. None of the subsets of technologies and firm competencies show any significant links.

Question: What do you believe are the possible reasons for the differences between user and system integrator firms?

3. **Statement:** User firms see technologies and technological sourcing as linked. User firms see technological strategy as linked to technological implementation and technology partnering. System integrator firms see technological implementations as linked to technology partnering but see this as an ad hoc approach rather than a strategic approach.

Question: What do you believe are the possible reasons for the differences between user and system integrator firms?

4. **Statement:** User firms see technological resource skills and firm competencies as linked, whereas system integrators do not see this link. User firms believe competence enhancing and core competencies and general competencies are linked, and tangible and intangible technological resource skills and core competencies and general competencies are linked. System integrator firms believe competence enhancing and core competencies and general competencies are linked but they do not see a link to tangible and intangible technological resource skills.

Question: What do you believe are the possible reasons for the differences between user and system integrator firms?

5. **Statement:** User firms and system integrator firms see technological resource skills and knowledge management as linked. User firms believe that competence destroying effects lead to information flow, knowledge transfer and the use of new and emerging technologies. System integrator firms believe that competence destroying effects lead to information flow, but they do not see a link to knowledge transfer and the use of new and emerging technologies.
Question: What do you believe are the possible reasons for the differences between user and system integrator firms?
6. **Statement:** User firms and system integrator firms do not see firm competencies and transaction processes as linked.
Question: What do you believe are the possible reasons for the similarities between user and system integrator firms?
7. **Statement:** User firms see firm competencies and knowledge management as linked. User firms see core competencies and general competencies linked to knowledge transfer, system integrator firms also do not see this link.
Question: What do you believe are the possible reasons for the differences between user firms and system integrator firms?
8. **Statement:** User firms and system integrator firms do not see firm competencies and the competitive environment as linked. However, for the subsets of firm competencies and the competitive environment, system integrator firms see core competencies and general competencies as being linked to external factors.
Question: What do you believe are the possible reasons for the differences between user firms and system integrator firms?
9. **Statement:** System integrator firms see transaction processes and knowledge management as linked, but user firms do not see this linkage. Through the subsets of transaction processes and knowledge management, user firms see manufacturing mix criteria as linked to information flow and knowledge transfer. System integrator firms see manufacturing mix criteria as being linked only to information flow. In addition system integrator firms see transactional value-added activities as linked to knowledge transfer and new and emerging technologies.
Question: What do you believe are the possible reasons for differences between user firms and system integrator firms?
10. **Statement:** Knowledge management and organizational learning are linked for both user firms and system integrator firms. Both user firms and system integrator firms feel that information flow and knowledge transfer are linked to learning-by-

doing and learning-before-doing. However, only user firms link new and emerging technologies to learning-by-doing and learning-before-doing. System integrator firms do not see this link.

Question: What do you believe are the possible reasons for differences between user firms and system integrator firms?

11. **Statement:** System integrator firms believe that technological sourcing and knowledge management are linked, but user firms do not see this link. None of the subsets of technological sourcing or knowledge management support this link.

Question: What do you believe are the possible reasons for differences between user firms and system integrator firms?

12. **Statement:** Neither user nor system integrator firms see technological sourcing and relationship management as linked. However, through the subsets of technological sourcing and relationship management, system integrator firms see technology partnering as linked to supplier closeness, communications, trust and goodwill.

Question: What do you believe are the possible reasons for differences between user firms and system integrator firms?

13. **Statement:** System integrator firms believe that organizational learning and the competitive environment are linked. Through the subsets of organizational learning and the competitive environment the following links are formed: User firms see market threats as providing potential for absorptive capacity. However, system integrator firms see market opportunities as providing potential for absorptive capacity.

Question: What do you believe are the possible reasons for differences between user firms and system integrator firms?

14. **Statement:** System integrator firms believe that relationship management and knowledge management are linked. Through the subsets of relationship management and knowledge management the following links are formed: User firms see supplier closeness, communications, trust and goodwill linked to information flow and knowledge transfer. System integrator firms see social networks and embedded ties linked to information flow and new and emerging technologies.

Question: What do you believe are the possible reasons for differences between user firms and system integrator firms?

15. **Statement:** Relationship management and organizational learning are linked for system integrator firms. Through the subsets of relationship management and

organizational learning the following links were found: Both user and system integrator firms link supplier closeness, communications, trust and goodwill to learning-by-doing and learning-before-doing. However, system integrator firms believe that there are risks associated with learning-by-doing and learning-before-doing.

Question: What do you believe are the possible reasons for differences between user firms and system integrator firms?

16. **Statement:** No links were found for relationship management and the competitive environment. However, through the subsets of relationship management and the competitive environment, the following links were found: User firms see social networks and embedded ties as linked to market opportunities and external factors, whereas system integrator firms do not see this link

Question: What do you believe are the possible reasons for this linkage?

G2 Linking the investigative framework

17. **Statement:** Both user firms and system integrator firms see organizational determinants and competitors as linked. All the subsets are linked, i.e. organizational determinants and new entrants, organizational determinants and buying power, and organizational determinants and substitute products.

Question: What do you believe are the possible reasons for this linkage?

18. **Statement:** Both user firms and system integrator firms see organizational determinants and external factors as linked. However, through the subsets of organizational determinants and external factors, user firms felt that all of the subsets are linked, i.e. globalisation, E-business and social, economic and political factors whereas system integrator firms did not see these links.

Question: What do you believe are the possible reasons for this linkage?

19. **Statement:** Both user firms and system integrator firms see organizational determinants and manufacturing mix processes as linked. Through the subsets of organizational determinants and manufacturing mix processes, user firms see individuals, assets and organizational structures as linked to communications and IT technology, whereas system integrator firms do not see this link.

Question: What do you believe are the possible reasons for this linkage?

20. **Statement:** Manufacturing mix processes and competitors could not be linked. However, through the subsets of manufacturing mix processes and competitors user, firms felt that communication and IT technology were affected by new entrants.

Question: What do you believe are the possible reasons for this linkage?

21. **Statement:** Manufacturing mix processes and external factors are linked in the view of system integrator firms. In addition, through the subsets of manufacturing mix processes and external factors, user firms felt that communication and IT technology are linked to social, economic and political factors. System integrator firms did not see this link.

Question: What do you believe are the possible reasons for this linkage?

22. **Statement:** Manufacturing mix processes and technology management are linked for user firms. Through the subsets of manufacturing mix processes links were found from communications and IT technology [H] to technologies [3.1.1], technological resource skills [3.1.2] and firm competencies [3.1.3].

Question: What do you believe are the possible reasons for this linkage?

23. **Statement:** Technology management and transaction processes are linked, in the view of user firms.

Question: What do you believe are the possible reasons for this linkage?

24. **Statement:** Neither user firms nor system integrator firms see technology management and external factors as linked. However, through the subsets of technology management and external factors, user firms see technological resource skills as linked to social, economic and political factors.

Question: What do you believe are the possible reasons for this linkage?

25. **Statement:** Both user firms and system integrator firms see technology management and governance structures as linked. Through the subsets of technology management and governance structures the following links are formed: User firms see technological resource skills and organizational learning as linked. However system integrator firms see technologies and knowledge management and technological resource skills and knowledge management as linked.

Question: What do you believe are the possible reasons for this linkage?

26. **Statement:** Both user firms and system integrator firms believe transaction processes and governance structures are linked. However, through the subsets of transaction processes and governance structures the following links were found: User firms believe that transaction processes are linked to technological sourcing and relationship management, whereas system integrator firms believe that transaction processes are linked to knowledge management and organizational learning.

Question: What do you believe are the possible reasons for this linkage?

G3 Linking the technological framework and investigative framework

27. **Statement:** User firms found that organizational determinants could be linked to technologies, whereas system integrator firms did not see this link. Though the subsets of organizational determinants and technologies for user firms it was found that organizational determinants are linked to technological strategy and technological implementation .

Question: In your opinion, what are the possible reasons for this linkage?

28. **Statement:** User firms believe that organizational determinants are linked to technological resource skills. Through the subsets of organizational determinants and technological resource skills the following links were found. Organizational determinants are linked to tangible and intangible technological resources. System integrator firms do not see this link.

Question: In your opinion, what are the possible reasons for this linkage?

29. **Statement:** User firms see organizational determinants as linked to firm competencies. Through the subsets of organizational determinants and firm competencies, organizational determinants are linked core competencies and general competencies. However system integrator firms do not see this link.

Question: In your opinion, what are the possible reasons for this linkage?

30. **Statement:** User firms believe that organizational determinants are linked to knowledge management, and through the subsets of organizational determinants and knowledge management the following links were found: User firms saw individuals, assets and organizational structures [A] as linked to information flow [I] and knowledge transfer [m]. System integrator firms only saw the link to information flow [I].

Question: In your opinion, what are the possible reasons for this linkage?

31. **Statement:** No links were found for organizational determinants and technological sourcing. However, through the subsets of organizational determinants and technological sourcing the following links were found: User firms saw individuals, assets and organizational structures as linked to strategic alliances and joint ventures and technology partnering. System integrator firms did not see this link.

Question: In your opinion, what are the possible reasons for this linkage?

32. **Statement:** Both user firms and system integrator firms see organizational determinants and the competitive environment as linked. Through the subsets of organizational determinants and the competitive environment the following links were found: user and system integrator firms believe that individuals, assets and organizational structures are linked to market opportunities.

Question: In your opinion, what are the possible reasons for this linkage?

33. **Statement:** No links were found for competitors and the technological framework. However through the subsets of competitors and the technological framework the following links were found: System integrator firms saw new entrants linked to technological investment and technology partnering and buying power linked to transactional value-added activities and risks. User firms saw buying power linked to core competencies and general competencies and new entrants linked to technology partnering and risks. In addition both user firms and system integrator firms saw substitute products linked to transactional value-added activities.

Question: In your opinion, what are the possible reasons for this linkage?

34. **Statement:** System integrator firms believe that external factors and technologies are linked, whereas user firms do not see this link. Through the subsets of external factors and technologies system integrator firms believe that new technologies and technological strategy are linked and globalisation and technological investment are linked.

Question: In your opinion, what are the possible reasons for this linkage?

35. **Statement:** Neither user firms nor system integrator firms see external factors and technological resource skills as linked. However, through the subsets of external factors and technological resource skills the following links were found: User firms believe that social, economic and political factors are linked to competence enhancing. System integrator firms believe that newer technologies are linked to competence enhancing, and social, economic and political factors are linked to competence enhancing.

Question: In your opinion, what are the possible reasons for this linkage?

36. **Statement:** Neither user firms nor system integrator firms see external factors and firm competencies as linked, in addition neither of them saw external factors and transaction processes as linked. However through the subsets of external factors and transaction processes the following links were found: User firms and system integrator firms saw newer technologies linked to transaction value-added activities. System integrator firms saw social, economic and political factors linked to transaction cost reduction and manufacturing mix criteria.

Question: In your opinion, what are the possible reasons for this linkage?

37. **Statement:** External factors are linked to knowledge management. However through the subsets of external factors and knowledge management the following links were found: User firms believe that newer technologies are linked to new and emerging technologies, system integrator firms believe newer technologies are linked to knowledge transfer.

Question: In your opinion, what are the possible reasons for this linkage?

38. **Statement:** External factors and technological sourcing could not be linked. Nor could the subsets of external factors and technological sourcing be linked.

Question: In your opinion, what are the possible reasons for this linkage?

39. **Statement:** External factors and organizational learning are linked for user firms. Through the subsets of external factors and organizational learning it was found that user firms linked social, economic and political factors to absorptive capacity. System integrator firms did not see this link.

Question: In your opinion, what are the possible reasons for this linkage?

40. **Statement:** External factors and relationship management could not be linked.

Question: Do you agree with this statement? Please substantiate.

41. **Statement:** Both user and system integrator firms see external factors and the competitive environment as linked. Through the subsets of external factors and the competitive environment the following links were found: User firms see globalisation and market threats, newer technologies and market threats, globalisation and market opportunities, newer technologies and market opportunities and globalisation and external factors as linked. System integrator firms see social, economic and political factors linked to external factors.

Question: Do you agree with this statement? Please substantiate.

42. **Statement:** Technology management and knowledge management are linked, in the view of system integrator firms. Through the subsets of technology management and knowledge management the following links were found: User firms and system integrator firms saw managing the use and creation of technology as linked to information flow and knowledge transfer.

Question: Do you agree with this statement? Please substantiate.

43. **Statement:** User firms and system integrator firms see governance structures and relationship management as being. Through the subsets of governance structures

and relationship management it was found that technology partnering is linked to supplier closeness, communications, trust and goodwill for user firms and system integrator firms.

Question: Do you agree with this statement? Please substantiate.

Appendix H

User firms studied

No.	Name	Industry
1.	Didata	Information technology
2.	Comparex	Information technology
3.	Datatec	Information technology
4.	Reunert	Electronics and electrical
5.	Altech	Electronics and electrical
6.	Powtech	Electronics and electrical
7.	Fintech	Information technology
8.	Voltex	Electronics and electrical
9.	Delta Electrical	Electronics and electrical
10.	Grintek	Electronics and electrical
11.	Mustek	Information technology
12.	MGX	Information technology
13.	Softline	Information technology
14.	CCH	Information technology
15.	MBTech	Information technology
16.	Unihold	Information technology
17.	Spescom	Information technology
18.	Ixchange	Information technology
19.	Connect	Information technology
20.	Sethold	Electronics and electrical
21.	Sabvest	Diversified industrial
22.	IST	Electronics and electrical
23.	Seartec	Electronics and electrical
24.	Pinnacle	Information technology
25.	Baanware	Information technology
26.	Spicer	Information technology
27.	UCS	Information technology
28.	Macadam	Electronics and electrical
29.	Pasdec	Electronics and electrical
30.	Stantron	Electronics and electrical
31.	Faritec	Information technology
32.	Glotec	Information technology
33.	Rectron	Information technology
34.	MMW Tech	Information technology

35.	PTH	Information technology
36.	Crux	Information technology
37.	Elexir	Information technology
38.	CS Holding	Information technology
39.	Elsec	Electronics and electrical
40.	Microsoft	Information technology
41.	Oracle	Information technology
42.	IBM	Information technology
43.	Hewlett-Pakard	Information technology
44.	Xerox	Information technology
45.	Sun Microsystems	Information technology
46.	Data General	Information technology
47.	General Electric	Electronics and electrical
48.	Honeywell	Electronics and electrical
49.	Rockwell	Electronics and electrical
50.	ABB	Electronics and electrical

Appendix I

System integrator firms studied

No.	Name	Industry
1.	Alcom Systems	Electrical engineering
2.	Alstom Automation	Electrical engineering
3.	Autotronix	Electrical engineering
4.	AST	Electrical engineering
5.	Craigcor engineering	Electrical engineering
6.	CSMS	Electrical engineering
7.	CS System solutions	Electrical engineering
8.	Drivecor	Electrical engineering
9.	DRA(Dowding Reynard and associates)	Electrical engineering
10.	Electrahertz automation	Electrical engineering
11.	Grinaker systems technologies	Electrical engineering
12.	Hatch	Information technology and electrical engineering
13.	Inventory technologies	Electrical engineering
14.	ISI	Information technology
15.	IST Industrial	Electrical engineering
16.	Keops Isis Industrial information systems	Electrical engineering
17.	Process Dynamics	Electrical engineering and information technology
18.	RBF technology	Electrical engineering
19.	S&P Project engineering	Electrical engineering and information technology
20.	SAM System automation and management	Electrical engineering
21.	Siemens industrial projects	Electrical engineering
22.	Spectrum Communications	Electrical engineering
23.	Streamworks Group	Electrical engineering and information technology
24.	Supervisory and control engineering	Electrical engineering

25.	Synergy automation	Electrical engineering and information technology
26.	Commerce One	Information technology
27.	Dimension Data	Information technology
28.	EDS South Africa (Pty) Ltd	Information technology
29.	Hewlett-Packard South Africa (Pty) Ltd	Information technology
30.	Internet Solutions	Information technology
31.	Microsoft	Information technology
32.	Spescom Limited	Information technology
33.	Sun micro systems	Information technology
34.	The IQ Business Group (Pty) Ltd	Information technology

Appendix J

List of Tables

In Tables J1, J2 and J3 Pearson's correlation coefficient is used unless otherwise stated

Table J1: The technological framework (Linking technology management, transaction processes and governance structures)

Technology management, transaction processes and governance structures	Technology management, transaction processes & governance structures	Correlation User firms r_α	Correlation System integrators r_β	Significant At 0.05	Links formed
3.1.1 Technologies	3.1.2 Technological resource skills		0.345	0.05	
Technological strategy [a] Technological investment [b] Technological change [c] Technological implementation [d]	Competence destroying [e] Competence destroying [e] Competence destroying [e] Competence destroying [e]		0.476	0.01	Linkage formed
Technological strategy [a] Technological investment [b] Technological change [c] Technological change [c] Technological implementation [d]	Competence enhancing [f] Competence enhancing [f] Competence enhancing [f] Competence enhancing [f] Competence enhancing [f]	0.502	0.403	0.01 0.05	Linkage formed Linkage formed
Technological strategy [a] Technological investment [b] Technological change [c] Technological implementation [d]	Tangible and intangible technological resources [g] Tangible and intangible technological resources [g] Tangible and intangible technological resources [g] Tangible and intangible technological resources [g]	0.437		0.05	Linkage formed

Technologies	3.1.3 Firm competencies	0.400		0.05	
Technological strategy [a]	Core competencies and general competencies [h]				
Technological investment [b]	Core competencies and general competencies [h]				
Technological change [c]	Core competencies and general competencies [h]				
Technological implementation [d]	Core competencies and general competencies [h]				
3.1.1 Technologies	3.1.6 Technological sourcing	0.387¹		0.05	Linkage formed
Technological strategy [a]	Strategic alliances/joint ventures [o]				
Technological investment [b]	Strategic alliances/joint ventures [o]				
Technological change [c]	Strategic alliances/joint ventures [o]				
Technological implementation [d]	Strategic alliances/joint ventures [o]				
3.1.1 Technologies	3.1.6 Technological sourcing	0.387¹		0.05	Linkage formed
Technological strategy [a]	Technology partnering [p]	0.455		0.01	Linkage formed
Technological investment [b]	Technology partnering [p]				
Technological change [c]	Technology partnering [p]				
Technological implementation [d]	Technology partnering [p]	0.604		0.01	Linkage formed
Technological implementation [d]	Technology partnering [p]		0.373	0.05	Linkage formed
3.1.2 Technological resource skills	3.1.3 Firm competencies	0.476		0.01	Linkage formed
Competence destroying [e]	Core competencies and general competencies [h]				
Competence enhancing [f]	Core competencies and general competencies [h]	0.367	0.434	0.05	Linkage formed
Tangible and intangible	Core competencies and	0.408		0.05	Linkage formed

¹ Spearman's rank correlation coefficient

technological resource skills [g]	general competencies [h]				
3.1.2 Technological resource skills	3.1.5 Knowledge management	0.437	0.348	0.05	Linkage formed
Competence destroying [e]	Information flow [l]	0.398	0.369	0.05	Linkage formed
Competence enhancing [f]	Information flow [l]	0.380		0.05	Linkage formed
Tangible and intangible technological resource skills [g]	Information flow [l]				
Competence destroying [e]	Knowledge transfer [m]	0.361		0.05	Linkage formed
Competence enhancing [f]	Knowledge transfer [m]				
Tangible and intangible technological resource skills [g]	Knowledge transfer [m]				
Competence destroying [e]	New and emerging technologies [n]	0.426		0.05	Linkage formed
Competence enhancing [f]	New and emerging technologies [n]				
Tangible and intangible technological resource skills [g]	New and emerging technologies [n]				
3.1.3 Firm competencies	3.1.4 Transaction processes				
Core competencies and general competencies [h]	Transaction cost reduction [i]				
Core competencies and general competencies [h]	Transaction value added [j]				
3.1.3 Firm competencies	3.1.4 Knowledge management	0.361		0.05	Linkage formed
Core competencies and general competencies [h]	Information flow [l]				
Core competencies and general competencies [h]	Knowledge transfer [m]	0.351		0.05	Linkage formed
Core competencies and general competencies [h]	New and emerging technologies [n]				

3.1.3 Firm competencies	3.1.9 Competitive environment				
Core competencies and general competencies [h]	Market threats [v]				
Core competencies and general competencies [h]	Market opportunities [w]				
Core competencies and general competencies [h]	External factors [w]		0.367 ¹	0.05	Linkage formed
3.1.4 Transaction processes	3.1.5 Knowledge management		0.450	0.01	Linkage formed
Transaction cost reduction [l]	Information flow [l]				
Transactional value added [j]	Information flow [l]				
Manufacturing mix criteria [k]	Information flow[l]	0.584	0.661	0.01	Linkage formed
Transaction cost reduction [l]	Knowledge transfer [m]				
Transactional value added [j]	Knowledge transfer [m]		0.424	0.05	Linkage formed
Manufacturing mix criteria [k]	Knowledge transfer [m]	0.359		0.05	Linkage formed
Transaction cost reduction [l]	New and emerging technologies [n]				
Transactional value added [j]	New and emerging technologies [n]		0.407	0.05	Linkage formed
Manufacturing mix criteria [k]	New and emerging technologies [n]				
3.1.5 Knowledge management	3.1.7 Organisational learning	0.363¹	0.446¹	0.05	Linkage formed
Information flow [l]	Learning-by-doing and learning-before-doing [t]	0.697	0.549	0.01	Linkage formed
Knowledge transfer [m]	Learning-by-doing and learning-before-doing [t]	0.486	0.527	0.01	Linkage formed
New and emerging technologies [n]	Learning-by-doing and learning-before-doing [t]	0.503		0.01	Linkage formed
Information flow [l]	Absorptive capacity [u]		0.354	0.05	Linkage formed
Knowledge transfer [m]	Absorptive capacity [u]		0.394	0.05	Linkage formed
New and emerging technologies [n]	Absorptive capacity [u]				
3.1.6 Technological sourcing	3.1.5 Knowledge management		0.360	0.05	
Strategic alliances/joint ventures [o]	Information flow [l]				
Technology partnering [p]	Information flow [l]				

¹ Spearman's rank correlation coefficient

Strategic alliances/joint ventures [o] Technology partnering [p]	Knowledge transfer [m] Knowledge transfer [m]				
Strategic alliances/joint ventures [o] Technology partnering [p]	New and emerging technologies [n] New and emerging technologies [n]				
3.1.6 Technological sourcing	3.1.8 Relationship management				
Strategic alliances/joint ventures [o] Technology partnering [p]	Social networks and embedded ties [q] Social networks and embedded ties [q]				
Strategic alliances/joint ventures [o] Technology partnering [p]	Supplier closeness, communications, trust and goodwill [r] Supplier closeness, communications, trust and goodwill [r]		0.377	0.05	Linkage formed
Strategic alliances/joint ventures [m] Technology partnering [n]	Risks [s] Risks [s]				
3.1.7 Organisational learning	3.1.9 Competitive environment		0.391	0.05	Linkage formed
Learning-by-doing and learning-before-doing [t] Absorptive capacity [u]	Market threats [v] Market threats [v]	0.361		0.05	Linkage formed
Learning-by-doing and learning-before-doing [t] Absorptive capacity [u]	Market opportunities [w] Market opportunities [w]		0.357	0.05	Linkage formed
Learning-by-doing and learning-before-doing [t] Absorptive capacity [u]	External factors [x] External factors [x]				
3.1.8 Relationship management	3.1.5 Knowledge management		0.458	0.01	
Social networks and embedded ties [q] Supplier, closeness, communications, trust and goodwill [r] Risks [s]	Information flow [l] Information flow [l] Information flow [l]	0.415	0.438	0.01 0.05	Linkage formed Linkage formed
Social networks and embedded ties [q] Supplier, closeness, communications, trust and goodwill [r] Risks [s]	Knowledge transfer [m] Knowledge transfer [m] Knowledge transfer [m]	0.391		0.05	Linkage formed
Social networks and embedded ties [q]	New and emerging technologies [n]		0.347	0.05	Linkage formed

Supplier, closeness, communications, trust and goodwill [r] Risks [s]	New and emerging technologies [n] New and emerging technologies [n]				
3.1.8 Relationship management	3.1.7 Organisational learning		0.390	0.05	
Social networks and embedded ties [q] Supplier, closeness, communications, trust and goodwill [r] Risks [s]	Learning-by-doing and learning-before-doing [t] Learning-by-doing and learning-before-doing [t] Learning-by-doing and learning-before-doing [t]	0.355	0.439 0.377	0.05 0.05	Linkage formed Linkage formed
Social networks and embedded ties [q] Supplier, closeness, communications, trust and goodwill [r] Risks [s]	Absorptive capacity [u] Absorptive capacity [u] Absorptive capacity [u]				
3.1.8 Relationship management	3.1.9 Competitive environment				
Social networks and embedded ties [q] Supplier, closeness, communications, trust and goodwill [r] Risks [s]	Market threats [v] Market threats [v] Market threats [v]				
Social networks and embedded ties [q] Supplier, closeness, communications, trust and goodwill [r] Risks [s]	Market opportunities [w] Market opportunities [w] Market opportunities [w]	0.393		0.05	Linkage formed
Social networks and embedded ties [q] Supplier, closeness, communications, trust and goodwill [r] Risks [s]	External factors [x] External factors [x] External factors [x]	0.383		0.05	Linkage formed

Table J2: Linking the investigative framework¹

Technology management framework	Technology management framework	Correlation User firms α	Correlation System integrators β	Significant At 0.05	Delta
3.2.1 Organizational determinants	3.2.2 Competitors	0.638	0.693	0.05	Linkage formed
Individuals, assets and Organizational structures [A]. (question 47)	New Entrants [B] Question 50.1	0.533	0.541	0.01	Linkage formed
Individuals, assets and Organizational structures [A]. (question 47)	Buying Power [C] Question 50.2	0.524	0.558	0.01	Linkage formed
Individuals, assets and Organizational structures [A]. (question 47)	Substitute products [D] Question 50.3	0.449	0.523	0.01	Linkage formed
3.2.1 Organizational determinants	3.2.3 External Factors	0.444	0.397	0.01 0.05	Linkage formed
Individuals, assets and Organizational structures [A].	Globalisation [E]	0.611		0.01	Linkage formed
Individuals, assets and Organizational structures [A].	E-Business [F]	0.395		0.01	Linkage formed
Individuals, assets and Organizational structures [A].	Social, economic and political factors [G]	0.450		0.01	Linkage formed
3.2.1 Organizational determinants	3.2.4 Manufacturing mix processes	0.408	0.457	0.05 0.01	Linkage formed Linkage formed
Individuals, assets and Organizational structures [A].	Communications and IT technology [H]	0.398		0.05	Linkage formed
3.2.4 Manufacturing mix processes	3.2.1 Organizational determinants	0.408	0.457	0.05 0.01	Linkage formed Linkage formed
Communications and IT technology [H]	Individuals, assets and Organizational structures [A].				
3.2.4 Manufacturing mix processes	3.2.2 Competitors				
Communications and IT technology [H]	New Entrants [B]	0.383		0.05	Linkage formed
Communications and IT technology [H]	Buying Power [C]	0.398		0.05	Linkage formed

¹ Spearman's rank correlation coefficient

Communications and IT technology [H]	Substitute products [D]				
3.2.4 Manufacturing mix processes	3.2.3 External Factors		0.365	0.05	Linkage formed
Communications and IT technology [H]	Globalisation [E]				
Communications and IT technology [H]	E-Business [F]				
Communications and IT technology [H]	Social, economic and political factors [G]	0.414		0.05	Linkage formed
3.2.4 Manufacturing mix processes	3.2.5 Technology management	0.554		0.01	Linkage formed
3.2.4 Manufacturing mix processes	3.1.1 Technologies	0.433		0.05	Linkage formed
Communications and IT technology [H]	Technological strategy [a]				
Communications and IT technology [H]	Technological investment [b]				
Communications and IT technology [H]	Technological change [c]				
Communications and IT technology [H]	Technological implementation [d]	0.433	0.379	0.05	Linkage formed
3.2.4 Manufacturing mix processes	3.1.2 Technological resource skills	0.589	0.471	0.05	Linkage formed
Communications and IT technology [H]	Competence destroying [e]		0.463	0.01	Linkage formed
Communications and IT technology [H]	Competence enhancing [f]				
Communications and IT technology [H]	Tangible and intangible technological resource skills [g]	0.347		0.05	Linkage formed
3.2.4 Manufacturing mix processes	3.1.3 Firm competencies	0.359		0.05	Linkage formed
Communications and IT technology [H]	Core competencies and general competencies [h]		0.421	0.05	Linkage formed

3.2.5 Technology management	3.2.6 Transaction processes	0.347²		0.01	Linkage formed
[3.1.1] Technologies	[3.1.4] Transaction processes	0.260 ²		0.05	Linkage formed
[3.1.2] Technological resource skills	[3.1.4] Transaction processes				
[3.1.3] Firm competencies	[3.1.4] Transaction processes				
3.2.5 Technology management	3.2.3 External Factors				
[3.1.1] Technologies	Globalisation [E]				
[3.1.1] Technologies	E-Business [F]				
[3.1.1] Technologies	Social, economic and political factors [G]				
[3.1.2] Technological resource skills	Globalisation [E]				
[3.1.2] Technological resource skill	E-Business [F]				
[3.1.2] Technological resource skills	Social, economic and political factors [G]	0.352 ²		0.05	Linkage formed
[3.1.3] Firm competencies	Globalisation [E]				
[3.1.3] Firm competencies	E-Business [F]				
[3.1.3] Firm competencies	Social, economic and political factors [G]				
3.2.5 Technology management	3.2.7 Governance structures	0.535	0.402	0.01 0.05	Linkage formed
[3.1.1] Technologies	[3.1.5] Knowledge management		0.388	0.05	Linkage formed
[3.1.1] Technologies	[3.1.6] Technological sourcing				
[3.1.1] Technologies	[3.1.7] Organizational learning				
[3.1.1] Technologies	[3.1.8] Relationship management				
[3.1.2] Technological resource skills	[3.1.5] Knowledge management		0.389	0.05	Linkage formed
[3.1.2] Technological resource skill	[3.1.6] Technological sourcing				
[3.1.2] Technological resource skills	[3.1.7] Organizational learning	0.464		0.01	Linkage formed
[3.1.2] Technological resource skills	[3.1.8] Relationship management				
[3.1.3] Firm competencies	[3.1.5] Knowledge management				
[3.1.3] Firm competencies	[3.1.6] Technological sourcing				
[3.1.3] Firm competencies	[3.1.7] Organizational learning				

² Kendall's correlation coefficient used.

[3.1.3] Firm competencies	[3.1.7] Relationship management		0.374	0.05	Linkage formed
3.2.6 Transaction processes	3.2.7 Governance structures	0.296²	0.337²	0.05 0.01	Linkage formed
[3.1.4] Transaction processes	[3.1.5] Knowledge management		0.338	0.01	Linkage formed
[3.1.4] Transaction processes	[3.1.6] Technological sourcing	0.265		0.05	Linkage formed
[3.1.4] Transaction processes	[3.1.7] Organizational learning		0.279	0.05	Linkage formed
[3.1.4] Transaction processes	[3.1.8] Relationship management	0.323		0.05	Linkage formed

Table J3: Linking technology management, transaction processes and governance structures to the investigative framework

Investigative framework	Technology management, transaction processes & governance structures	Correlation User firms r_{α}	Correlation System integrators r_{β}	Significant	Links formed
Linking organizational determinants					
3.2.1 Organizational determinants	3.1.1 Technologies	0.390¹		0.05	Linkage formed
Individuals, assets, organizational structures [A]	Technological strategy [a]	0.349		0.05	Linkage formed
Individuals, assets, organizational structures [A]	Technological investment [b]				
Individuals, assets, organizational structures [A]	Technological change [c]				
Individuals, assets, organizational structures [A]	Technological implementation [d]	0.494		0.01	Linkage formed
3.2.1 Organizational determinants	3.1.2 Technological resource skills	0.402	0.373	0.05	
Individuals, assets, organizational structures [A]	Competence destroying [e]				
Individuals, assets, organizational structures [A]	Competence enhancing [f]				

² Kendall's correlation coefficient used

¹ Spearman's correlation coefficient.

Individuals, assets, organizational structures [A]	Tangible and intangible technological resources [g]	0.437		0.05	Linkage formed
3.2.1 Organizational determinants	3.1.3 Firm competencies	0.376		0.05	Linkage formed
Individuals, assets, organizational structures [A]	Core competencies and general competencies [h]	0.376		0.05	Linkage formed
3.2.1 Organizational determinants	3.1.4 Transaction processes				
Individuals, assets, organizational structures [A]	Transaction cost reduction [i]				
Individuals, assets, organizational structures [A]	Transaction value added [j]				
Individuals, assets, organizational structures [A]	Manufacturing mix criteria [k]	0.408	0.457	0.05 0.01	Linkage formed Linkage formed
3.2.1 Organizational determinants	3.1.5 Knowledge management	0.377		0.05	
Individuals, assets, organizational structures [A]	Information flow [l]	0.400	0.386	0.05	Linkage formed
Individuals, assets, organizational structures [A]	Knowledge transfer [m]	0.420		0.05	Linkage formed
Individuals, assets, organizational structures [A]	New and emerging technologies [n]				
3.2.1 Organizational determinants	3.1.6 Technological sourcing				
Individuals, assets, organizational structures [A]	Strategic alliances/joint ventures [o]	-0.379		0.05	Linkage formed
Individuals, assets, organizational structures [A]	Technology partnering [p]	0.528		0.05	Linkage formed

3.2.1 Organizational determinants	3.1.9 Competitive environment	0.436	0.404	0.05	Linkage formed
Individuals, assets, organizational structures [A]	Market threats [v]				
Individuals, assets, organizational structures [A]	Market opportunities [w]	0.606	0.505	0.01	Linkage formed
Individuals, assets, organizational structures [A]	External factors [x]				
Linking Competitors					
3.2.2 Competitors	3.1.1 Technologies				
New entrants [B] Buying power [C] Substitute products [D]	Technological strategy [a] Technological strategy [a] Technological strategy [a]				
New entrants [B] Buying power [C] Substitute products [D]	Technological investment [b] Technological investment [b] Technological investment [b]		0.382	0.05	Linkage formed
New entrants [B] Buying power [C] Substitute products [D]	Technological change [c] Technological change [c] Technological change [c]				
New entrants [B] Buying power [C] Substitute products [D]	Technological implementation [d] Technological implementation [d] Technological implementation [d]				
3.2.2 Competitors	3.1.2 Technological resource skills				
New entrants [B] Buying power [C] Substitute products [D]	Competence destroying [e] Competence destroying [e] Competence destroying [e]				
New entrants [B] Buying power [C] Substitute products [D]	Competence enhancing [f] Competence enhancing [f] Competence enhancing [f]				
New entrants [B] Buying power [C] Substitute products [D]	Tangible and intangible technological resources [g] Tangible and intangible technological resources [g] Tangible and intangible technological resources [g]				

3.2.2 Competitors	3.1.3 Firm competencies				
New entrants [B]	Core competencies and general competencies [h]	0.353		0.05	Linkage formed
Buying power [C]	Core competencies and general competencies [h]				
Substitute products [D]	Core competencies and general competencies [h]				
3.2.2 Competitors	3.1.4 Transaction processes				
New entrants [B]	Transaction cost reduction [l]				
Buying power [C]	Transaction cost reduction [l]				
Substitute products [D]	Transaction cost reduction [l]				
New entrants [B]	Transaction value added [j]	-0.368	-0.405	0.05	Linkage formed
Buying power [C]	Transaction value added [j]				
Substitute products [D]	Transaction value added [j]				
New entrants [B]	Manufacturing mix criteria [k]				
Buying power [C]	Manufacturing mix criteria [k]				
Substitute products [D]	Manufacturing mix criteria [k]				
3.2.2 Competitors	3.1.5 Knowledge management				
New entrants [B]	Information flow [l]				
Buying power [C]	Information flow [l]				
Substitute products [D]	Information flow [l]				
New entrants [B]	Knowledge transfer [m]				
Buying power [C]	Knowledge transfer [m]				
Substitute products [D]	Knowledge transfer [m]				
New entrants [B]	New and emerging technologies [n]				
Buying power [C]	New and emerging technologies [n]				
Substitute products [D]	New and emerging technologies [n]				

3.2.2 Competitors	3.1.6 Technological sourcing				
New entrants [B]	Strategic alliances/joint ventures [o]				
Buying power [C]	Strategic alliances/joint ventures [o]				
Substitute products [D]	Strategic alliances/joint ventures [o]				
New entrants [B]	Technology partnering [p]	0.298 ¹	0.364 ¹	0.05	
Buying power [C]	Technology partnering [p]				
Substitute products [D]	Technology partnering [p]				
3.2.2 Competitors	3.1.7 Relationship management				
New entrants [B]	Social networks and embedded ties [q]				
Buying power [C]	Social networks and embedded ties [q]				
Substitute products [D]	Social networks and embedded ties [q]				
New entrants [B]	Supplier closeness, communications, trust and goodwill [r]				
Buying power [C]	Supplier closeness, communications, trust and goodwill [r]				
Substitute products [D]	Supplier closeness, communications trust and goodwill [r]				
New entrants [B]	Risks [s]	0.394		0.05	Linkage formed
Buying power [C]	Risks [s]		0.363	0.05	Linkage formed
Substitute products [D]	Risks [s]				
3.2.2 Competitors	3.1.8 Organizational Learning				
New entrants [B]	Learning-by-doing and learning-before-doing [t]				
Buying power [C]	Learning-by-doing and learning-before-doing [t]				
Substitute products [D]	Learning-by-doing and learning-before-doing [t]				
New entrants [B]	Absorptive capacity [u]				
Buying power [C]	Absorptive capacity [u]				
Substitute products [D]	Absorptive capacity [u]				

¹ Spearman's correlation coefficient

3.2.2 Competitors	3.1.9 Competitive environment				
New entrants [B] Buying power [C] Substitute products [D]	Market threats [v] Market threats [V] Market threats [V]				
New entrants [B] Buying power [C] Substitute products [D]	Market opportunities [w] Market opportunities [W] Market opportunities [W]		0.349	0.05	Linkage formed
New entrants [B] Buying power [C] Substitute products [D]	External factors [x] External factors [X] External factors [X]				
Linking external factors					
3.2.3 External factors	3.1.1 Technologies		0.419	0.01	Linkage formed
Globalisation [E] Newer technologies [F] Social, economic and political factors [G]	Technological strategy [a] Technological strategy [a] Technological strategy [a]		0.456	0.01	Linkage formed
Globalisation [E] Newer technologies [F] Social, economic and political factors [G]	Technological investment [b] Technological investment [b] Technological investment [b]		0.391	0.05	Linkage formed
Globalisation [E] Newer technologies [F] Social, economic and political factors [G]	Technological change [c] Technological change [c] Technological change [c]				
Globalisation [E] Newer technologies [F] Social, economic and political factors [G]	Technological implementation [d] Technological implementation [d] Technological implementation [d]				
3.2.3 External factors	3.1.2 Technological resource skills				
Globalisation [E] Newer technologies [F] Social, economic and political factors [G]	Competence destroying [e] Competence destroying [e] Competence destroying [e]				
Globalisation [E] Newer technologies [F] Social, economic and political factors [G]	Competence enhancing [f] Competence enhancing [f] Competence enhancing [f]	0.360	0.420 0.355	0.05 0.05	Linkage formed Linkage formed
Globalisation [E] Newer technologies [F]	Tangible and intangible technological resources [g] Tangible and intangible technological resources [g]				

Social, economic and political factors [G]	Tangible and intangible technological resources [g]				
3.2.3 External factors	3.1.3 Firm competencies				
Globalisation [E]	Core competencies and general competencies [h]				
Newer technologies [F]	Core competencies and general competencies [h]				
Social, economic and political factors [G]	Core competencies and general competencies [h]				
3.2.3 External factors	3.1.4 Transaction processes				
Globalisation [E]	Transaction cost reduction [l]				
Newer technologies [F]	Transaction cost reduction [l]				
Social, economic and political factors [G]	Transaction cost reduction [l]		-0.400 ¹	0.05	Linkage formed
Globalisation [E]	Transactional value added [j]				
Newer technologies [F]	Transactional value added [j]	-0.378 ¹	-0.479 ¹	0.01	Linkage formed
Social, economic and political factors [G]	Transactional value added [j]				
Globalisation [E]	Manufacturing mix criteria [k]				
Newer technologies [F]	Manufacturing mix criteria [k]				
Social, economic and political factors [G]	Manufacturing mix criteria [k]		0.453	0.01	Linkage formed
3.2.3 External factors	3.1.5 Knowledge management		0.512¹	0.01	Linkage formed
Globalisation [E]	Information flow [l]				
Newer technologies [F]	Information flow [l]				
Social, economic and political factors [G]	Information flow [l]				
Globalisation [E]	Knowledge transfer [m]				
Newer technologies [F]	Knowledge transfer [m]		0.438	0.05	Linkage formed
Social, economic and political factors [G]	Knowledge transfer [m]				
Globalisation [E]	New and emerging technologies [n]				
Newer technologies [F]	New and emerging technologies [n]	0.423		0.05	Linkage formed
Social, economic and political factors [G]	New and emerging technologies [n]				

¹ Spearman's correlation coefficient

3.2.3 External factors	3.1.6 Technological sourcing				
Globalisation [E]	Strategic alliances-joint ventures [o]				
Newer technologies [F]	Strategic alliances-joint ventures [o]				
Social, economic and political factors [G]	Strategic alliances-joint ventures [o]				
Globalisation [E]	Technology partnering [p]				
Newer technologies [F]	Technology partnering [p]				
Social, economic and political factors [G]	Technology partnering [p]				
3.2.3 External factors	3.1.7 Organizational learning	0.371¹		0.05	Linkage formed
Globalisation [E]	Learning-by-doing and learning-before-doing [t]				
Newer technologies [F]	Learning-by-doing and learning-before-doing [t]				
Social, economic and political factors [G]	Learning-by-doing and learning-before-doing [t]				
Globalisation [E]	Absorptive capacity [u]				
Newer technologies [F]	Absorptive capacity [u]	0.429		0.05	Linkage formed
Social, economic and political factors [G]	Absorptive capacity [u]				
3.2.3 External factors	3.1.8 Relationship management				
Globalisation [E]	Social networks and embedded ties [q]				
Newer technologies [F]	Social networks and embedded ties [q]				
Social, economic and political factors [G]	Social networks and embedded ties [q]				
Globalisation [E]	Supplier closeness, communications trust and goodwill [r]				
Newer technologies [F]	Supplier closeness, communications trust and goodwill [r]				
Social, economic and political factors [G]	Supplier closeness, communications trust and goodwill [r]				
Globalisation [E]	Risks [s]				
Newer technologies [F]	Risks [s]				
Social, economic and political factors [G]	Risks [s]				

¹ Spearman's correlation coefficient

3.2.3 External factors	3.1.9 Competitive environment	0.529	0.354	0.05	Linkage formed
Globalisation [E]	Market threats [v]	0.410		0.05	Linkage formed
Newer technologies [F]	Market threats [V]	0.529		0.05	Linkage formed
Social, economic and political factors [G]	Market threats [V]				
Globalisation [E]	Market opportunities [w]	0.553		0.05	Linkage formed
Newer technologies [F]	Market opportunities [W]	0.361		0.05	Linkage formed
Social, economic and political factors [G]	Market opportunities [W]				
Globalisation [E]	External factors [x]	0.351		0.05	Linkage formed
Newer technologies [F]	External factors [X]				
Social, economic and political factors [G]	External factors [X]		0.355	0.01	Linkage formed
Strategic alliances and joint ventures [o]	Risks [s]				
Technology partnering [p]	Risks [s]				

Table J4: Comparing the RBT and TCE Theories³

Question Nos.	Variables	Firm Categories	RBT	TCE	RBT and TCE	
					RBT	TCE
1.	UTS1/STS1 Alignment of business strategy and technological strategy	User System integrators				
2.	UTS2/STS2 Extent to which a firm's technological strategy has a positive effect on a firm's competitive strategy	User System integrators		1		0.401
3.	UTS3/STS3 Pick the technological approach that is adopted by your firm most of the time	User System integrators	1 1		-0.452 ¹ -0.387	
4.	UTINV1/STINV1 Indicate your firm's level of technological investment as a percentage of total investments	User System integrators	1		0.570 ¹	
5.	UTINV2/STINV2 Indicate what proportion of your firm's technological investments is made in the latest available technologies	User System integrators	1 1		0.351 0.363	
6.	UTINV/STINV To what extent do you believe that technological investment in your firm is restricted by the following risks? 6.1 Inability to quantify strategic benefits 6.2 Lack of understanding of the benefits resulting from the technological adoption 6.3 Newness of the area of the technology	User System integrators User System integrators User System		1 1 1		0.359 -0.377 -0.372

³ Spearman's rank correlation coefficient used.¹ Correlation is significant at 0.01 level (2-tailed)

	6.4 Concern about the lack of skills necessary to achieve the potential benefits.	integrators User System integrators	1			-0.361
7.	UTINV4/STINV4 In relation to technological investment do you believe that your firm invests adequately in staff training?					
8.	UTC1/STC1 To what extent has technological implementation in your firm, as opposed to conventional methods, improved information flow and knowledge transfer between key partners? 8.1 Within the firm 8.2 Outside the firm	User System integrators User System integrators	1			0.355
9.	UTC2/STC2 To what extent has your firm changed strategic partners because of technological change in your industry and because existing partners were no longer capable of new competence in the technology over the last five years?	User System integrators				
10.	UTI/ST1 Indicate the extent to which data transactions are conducted in your firm through the use of computers or computerised equipment. 10.1 Design 10.2 Processes or manufacturing 10.3 Management or business planning	User System integrators User System integrators User System integrators	1			0.471 ¹
11.	UTI2/STI2 Is your firm involved in design manufacturing and MIS?	User System integrators				

¹ Correlation is significant at 0.01 level (2-tailed)

12.	UTI3/STI3 Indicate your firm's overall level of technology integration in design, manufacturing or administration/management/business planning?	User System integrators		1		0.365
13.	UTI4/STI4 How long do you believe it takes your firm to integrate between technologies in design, process/ manufacturing or administration/management/ business planning?	User System integrators				
14.	UTI5/STI5 How would you rate the competence of managers in your firm with regard to assessing the firm's technological needs?	User System integrators	1		-0.346	
15.	UTIMP1/STIMP1 To what extent do you believe your firm views the following criteria as important for competitive advantage? 15.1. Technologies User System integrator 15.2. Cost User System integrator 15.3. Quality User System integrator 15.4. Speed User System integrator 15.5. Dependability User System integrator 15.6. Flexibility User System integrator			1		0.526 ¹
				1		0.453 ¹
				1		0.350
16.	UTIMP2/STIMP2 To what extent do you believe that your firm has been influenced by the following factors for technological implementations? 16.1. Market threats User System integrators 16.2. Current technology User					
			1		-0.508 ¹	

¹ Correlation is significant at 0.01 level (2-tailed)

	obsolete	System integrators				
	16.3. To obtain benefits in manufacturing mix criteria	User System integrators		1		0.374
	16.4. To improve information flow and knowledge transfer	User System integrators		1		0.398
	16.5. In line with the firm's technological policy	User System integrators				
17.	UTRS1/STRS1 To what extent has your firm been affected by the following technologies that have altered the way it has conducted business over the last five years? 17.1. Competence destroying technologies 17.2 Competence enhancing technologies	User System integrators User System integrators				
18.	UTRS2/STRS2 To what extent do you believe that your firm's tangible and intangible technological resources are matched?	User System integrators				
19.	UFC1/SFC1 To what extent do you believe that your firm views technological implementations as a means to improve core competencies?	User System integrators		1 1		0.390 0.392
20.	UFC2/SFC2 To what extent do you believe that your firm views technological implementations as a means to improve general competencies?	User System integrators				
21.	UFC3/SFC3 Indicate the importance of the following in your firm: 21.1. Individuals, assets and organizational structures.	User System integrators	1	1	0.508 ¹	0.418

¹ Correlation is significant at 0.01 level (2-tailed)

	21.2 Technological acquisition. 21.3. Patented process or design. 21.4. Know-how shared among individuals in the firm 21.5. The firms selection and positioning within the industry	User System integrators User System integrators User System integrators User System integrators	1	1	0.383	0.401
22.	UTP1/STP1 To what extent do you believe that your firm's technological strategies are aimed at improving manufacturing mix criteria?	User System integrators		1		0.406
23.	UTP2/STP2 To what extent has information flow and knowledge transfer in your firm led to improvements in manufacturing mix criteria?	User System integrators		1		0.439
24.	UTP3/STP3 To what extent has organizational learning in your firm led to improvements in manufacturing mix criteria?	User System integrators		1		0.364
25.	STP4/UTP4 To what extent do you believe that technological implementations in your firm have affected transaction processes with respect to: 25.1. Transactional cost reduction? 25.2. Transactional value added?	User System integrators User System integrators				

26.	UTP5/STP5 How long do you believe it takes technological implementations in your firm to affect the following transactional processes with regard to. 26.1. Transaction costs 26.2. Transactional value added	User System integrators User System integrators				
27.	UTSPI/STSP1 Would you say that technology relationships with your firm's key partners are based on an adversarial or partnership approach?	User System integrators	1	1	-0.363	0.398
28.	UTSP2/STSP2 Does your firm view strategic partnerships as a means to: 28.1 Acquire the capabilities, knowledge and technology of the other firm, thereafter dissolving the partnership? 28.2 Create a strategic alliance for the benefit of both firms, thereafter developing the partnership further?	User System integrators User System integrators				
29.	UTSP3/STSP3 To what extent does your firm view strategic alliances as a source of competitive advantage?	User System integrators		1		0.625 ¹
30.	UKM1/SKM1 What is the effect of information flow and knowledge transfer on the following transaction processes? 30.1 Transaction cost reduction. 30.2 Transaction value added	User System integrators User System integrators				

¹ Correlation is significant at 0.01 level (2-tailed)

31.	UKM2/SKM2 To what extent has your firm identified the benefits of information flow to improve technological resource skills in terms of the following criteria? 31.1 Competence destroying 31.2 Competence enhancing 31.3 Tangible and intangible technological resources	User System integrators User System integrators User System integrators	1	1	0.366	0.377
32.	UKM2/SKM2 To what extent has your firm identified the benefits of knowledge transfer to improve technological resource skills in terms of the following criteria? 32.1 Competence destroying 32.2 Competence enhancing 32.3 Tangible and intangible technological resources	User System integrators User System integrators User System integrators		1		0.432
33.	UKM2/SKM2 To what extent has your firm identified the benefits of new and emerging technologies to improve technological resource skills in terms of the following criteria? 33.1 Competence destroying 33.2 Competence enhancing 33.3 Tangible and intangible technological resources	User System integrators User System integrators User System integrators	1		0.386	
34.	UKM5/SKM5 Indicate the extent to which the following control and monitoring systems are utilised by your firm to control the flow of critical skills and technologies to your technology partner.					

	34.1 Central collaboration office to interface with technology specific partners	User System integrators				
	34.2 Decentralised control through other divisions	User System integrators				
	34.3 Flat management and organizational structures for alliance operations	User System integrators		1		0.487 ¹
	34.4 Limitation and control procedures for the transfer of information to partners through disciplines and procedures.	User System integrators				
	34.5 Transfer of staff across the partnership agreement.	User System integrators				
35.	UKM6/SKM6 Do you believe that your firm possesses the necessary technological resources to cope with the effects of globalisation?	User System integrators				
36.	URM1/SRM1 To what extent do you believe that technological implementations in your firm have improved the following					
	36.1 Social networks and embedded ties?	User System integrators		1		0.347
	36.2 Supplier closeness, communications, trust and goodwill?	User System integrators		1		0.399
	36.3 Improved market opportunities through partnering?	User System integrators		1 1		0.551 ¹ 0.382
37.	URM2/SRM2 To what extent do you believe that trust and goodwill have led to increased transactional history between your firm and its key partners?	User System integrators				

¹ Correlation is significant at 0.01 level (2-tailed)

38.	URM3/SRM3 To what extent do you believe that increased transactional history has led to the following:					
	38.1 Opportunistic behaviour?	User System integrators	1		0.404	
	38.2 Transactional diversity?	User System integrators				
	38.3 Reduced the time taken to make decisions?	User System integrators				
	38.4 Accumulation of information regarding the predictability and reliability of partners?	User System integrators	1		0.355	
	38.5 Risks in terms of information asymmetry	User System integrators				
39.	URM4/SRM4 To what extent does your firm adopt the following approaches which support effective governance?					
	39.1 Joint ventures and strategic alliances	User System integrators		1		0.441
	39.2 Two-way technology exchanges	User System integrators		1		0.401
	39.3 One-way technology exchanges	User System integrators				
	39.4 Direct investment	User System integrators	1		0.423	
	39.5 Customer and supplier relationships	User System integrators				
40.	URM5/SRM5 To what extent have technological implementations in your firm led to improved network structures with key partners over the last 5 years?	User System integrators		1		0.377
41.	UOL1/SOL1 To what extent has organizational learning affected the following transactional processes:					
	41.1 Transactional costs?	User System				

	41.2 Transactional value added?	integrators User System integrators				
42.	UOL2/SOL2 To what extent has information flow and knowledge transfer benefited your firm in terms of the following: 42.1 Learning-by-doing? 42.2 Learning-before-doing?	User System integrators User System integrators	1		0.431	
43.	UOL3/SOL3 To what extent have new and emerging technologies affected your firm in terms of the following? 43.1 Learning-by-doing 43.2 Learning-before-doing	User System integrators User System integrators	1		0.359	
44.	UOL4/SOL4 To what extent has organizational learning affected knowledge management in your firm in terms of the following: 44.1 Information flow? 44.2 Knowledge transfer? 44.3 New and emerging technologies?	User System integrators User System integrators User System integrators	1		0.387	
45.	UOL5/SOL5 To what extent has organizational learning affected the firm's competitive environment in terms of the following: 45.1 Market threats? 45.2 Market opportunities?	User System integrators User System integrators		1		0.398

	45.3 External factors i.e. social, economic and political ?	User System integrators		1		0.349
46.	UOL6/SOL6 To what extent do you believe that information flow and knowledge transfer has affected your firm's absorptive capacity?	User System integrators				
47.	UOD1/SOD1 To what extent do you believe that the following criteria are important contributors to your firm's performance? 47.1 Industry selection and positioning 47.2 Organizational processes and administrative practices 47.3 Managerial capabilities	User System integrators User System integrators User System integrators	 1	 1	 0.397	 0.370
48.	UC1/SC1 For your major product line indicate your firm's performance relative to your major competitors as a result of technological implementation: 48.1 Sales growth 48.2 Return on sales 48.3 Earnings growth	User System integrators User System integrators User System integrators	 1	 1 1	 0.434	 0.368 0.461 ¹ 0.405
49.	UC2/SC2 Rate your firm relative to its competitors in its ability to adapt to rapidly changing technologies.	User System integrators	1	1	0.455 ¹	0.577 ¹ 0.463 ¹
50.	UC3/SC3 To what extent do you believe that your firm will be affected by the following within the next two years: 50.1 New entrants?	User System	1		-0.452 ¹	

¹ Correlation is significant at 0.01 level (2-tailed)

	50.2 Buying power of competitors? 50.3 Substitute products?	integrators User System integrators User System integrators				
51.	UEF1/SEF1 To what extent do you believe that your firm will be affected by the following within the next 2 years: 51.1 Globalisation? 51.2 E-business? 51.3 Social, economic and political factors?	User System integrators User System integrators User System integrators				
52.	UMM1/SMM1 To what extent do you believe that technological implementation has affected your firm with regard to the following manufacturing mix criteria: 52.1 Cost? 52.2 Quality? 52.3 Speed? 52.4 Dependability? 52.5 Flexibility?	User System integrators User System integrators User System integrators User System integrators User System integrators				
53.	UMM2/SMM2 To what extent do you believe that manufacturing mix criteria in your firm is affected by the following: 53.1 Organizational determinants? 53.2 Competitors?	User System integrators User System	1		0.358	

	53.3 External factors i.e. social, economic and political?	integrators User System integrators		1		0.514 ¹
54.	URBV1/SRBV1 To what extent do you believe that your firm has a competitive advantage relative to key competitors with regard to the following: 54.1 Firm resources? 54.2 Industry selection and positioning? 54.3 Transactional benefits?	User System integrators User System integrators User System integrators				
55.	URBV2/SRBV2 To what extent do you believe that your firm has developed a diversification strategy with regard to the following: 55.1 Current resources as a basis for diversification? 55.2 Resources to be developed through diversification? 55.3 Identified into what markets diversification should take place? 55.4 Identified what types of firms have been identified for acquisition?	User System integrators User System integrators User System integrators User System integrators		1		0.532 ¹

¹ Correlation is significant at 0.01 level (2-tailed)¹ Correlation is significant at 0.01 level (2-tailed)

56.	UOEE1/SOEE1 To what extent do you believe that your firm possesses competitive advantages with regard to the following?					
	56.1 Generalised factors like generic technologies, which are easy to source through global networks.	User System integrators				
	56.2 Specialised factors like skilled labour and natural resources.	User System integrators	1	1	0.455 ¹	0.407 0.433
	56.3 Related and supporting industries like home-based suppliers and others.	User System integrators				
	56.4 Demand in South Africa	User System integrators				
	56.4 Firm's strategy, structure and rivalry	User System integrators	1	1	0.370	0.388 0.375
	56.5 Government intervention, e.g. by its competition policies creating an environment in which firms can gain competitive advantage, through the creation of large projects, etc.	User System integrators				

¹ Correlation is significant at the 0.01 level (2-tailed)

Table J5: Testing Hypothesis one, firms that adopt new technologies grow at different rates to other firms that maintain older technologies, comparing two groups

Firm Category	Technological Approach	Question No.	Question	N	Mean	Std. Deviation
User firms	Innovators and early adopters	4.	Level of technological investment as a percentage of total investment.	21	3.52	1.40
		5.	Proportion of technological investment made in the latest available technologies.	21	4.52	1.57
		48.	Firm's performance relative to major competitors with regard to sales growth, return on sales and earnings growth	21	5.08	1.37
	Early adopters and late majority	4.	Level of technological investment as a percentage of total investment.	12	3.42	1.38
		5.	Proportion of technological investment made in the latest available technologies.	12	3.58	1.62
		48.	Firms performance relative to major competitors with regard to sales growth, return on sales and earnings growth	12	4.72	1.01
System integrator firms	Innovators and early adopters	4.	Level of technological investment as a percentage of total investment.	17	2.35	1.06
		5.	Proportion of technological investment made in the latest available technologies.	17	3.18	1.74
		48.	Firm's performance relative to major competitors with regard to sales growth, return on sales and earnings growth	17	4.90	0.81
	Innovators and early adopters	4.	Level of technological investment as a percentage of total investment.	14	2.29	1.33
		5.	Proportion of technological investment made in the latest available technologies.	14	2.93	1.38
		48.	Firm's performance relative to major competitors with regard to sales growth, return on sales and earnings growth	14	4.86	0.98

Table J6: Testing Hypothesis one, firms that adopt new technologies grow at different rates to other firms that maintain older technologies, comparing four groups

Firm Category	Technological Approach	Question No.	Question	N	Mean	Std. Deviation
User firms	Innovators	48.	Firm's performance relative to major competitors with regard to sales growth, return on sales and earnings growth	8	5.38	0.603
	Early adopters	48.	Firm's performance relative to major competitors with regard to sales growth, return on sales and earnings growth	13	4.90	1.69
	Early majority	48.	Firm's performance relative to major competitors with regard to sales growth, return on sales and earnings growth	7	4.95	1.08
	Late majority	48.	Firm's performance relative to major competitors with regard to sales growth, return on sales and earnings growth	5	4.400	0.92
System integrator firms	Innovators	48.	Firm's performance relative to major competitors with regard to sales growth, return on sales and earnings growth	2	5.33	0.47
	Early adopters	48.	Firm's performance relative to major competitors with regard to sales growth, return on sales and earnings growth	15	4.84	0.84
	Early majority	48.	Firm's performance relative to major competitors with regard to sales growth, return on sales and earnings growth	12	4.86	1.07
	Late majority	48.	Firm's performance relative to major competitors with regard to sales growth, return on sales and earnings growth	2	4.83	0.24

Table J7: Testing hypothesis 2, managers rate manufacturing mix criteria as more important than technological leadership

Firm category		Question	N	Mean	Std. Deviation
User firms	Importance of technology for competitive advantage	15.1	33	5.64	1.17
	Importance of manufacturing mix criteria	15.2-15.6	33	5.64	0.901
System integrator firms	Importance of technology for competitive advantage	15.1	33	4.723	1.039
	Importance of manufacturing mix criteria	15.2-15.6	33	5.30	0.580

Appendix K

Cronbach Alpha Tests

K1: Reliability for User and system integrators all questions

Notes		
Output Created		20-DEC-2002 09:57:10
Comments		
Input	Data	E:\Research\Company Data & Research\ADhoc research sets\Raj PHD\PHD data.sav
	Filter	<none>
	Weight	<none>
	Split File	User or System Integrator
	N of Rows in Working Data File	66
Syntax	RELIABILITY /VARIABLES=q1 q2 q6.1 q6.2 q6.3 q6.4 q7 q8.1 q8.2 q9 q10.1 q10.2 q10.3 q15.1 q15.2 q15.3 q15.4 q15.5 q15.6 q16.1 q16.2 q16.3 q16.4 q16.5 q17.1 q17.2 q18 q19 q14 q20 q21.1 q21.2 q21.3 q21.4 q21.5 q22 q23 q24 q25.1 q25.2 q28.1 q28.2 q29 q30.1 q30.2 q31.1 q31.2 q31.3 q32.1 q32.2 q32.3 q33.1 q33.2 q33.3 q34.1 q34.2 q34.3 q34.4 q34.5 q35 q36.1 q36.2 q36.3 q37 q38.1 q38.2 q38.3 q38.4 q38.5 q39.1 q39.2 q39.3 q39.4 q39.5 q40 q41.1 q41.2 q42.1 q42.2 q43.1 q43.2 q44.1 q44.2 q44.3 q45.1 q45.2 q45.3 q46 q47.1 q47.2 q47.3 q48.1 q48.2 q48.3 q49 q50.1 q50.2 q50.3 q51.1 q51.2 q51.3 q52.1 q52.2 q52.3 q52.4 q52.5 q53.1 q53.2 q53.3 q54.1 q54.2 q54.3 q55.1 q55.2 q55.3 q55.4 q56.1 q56.2 q56.3 q56.4 q56.5 q56.6 /FORMAT=NOLABELS /SCALE(ALPHA)=ALL/MODEL=ALPHA /STATISTICS=SCALE /SUMMARY=TOTAL .	
Resources	Elapsed Time	0:00:00.22

***** Method 1 (space saver) will be used for this analysis *****

USERSYST: 1.00 user

R E L I A B I L I T Y A N A L Y S I S - S C A L E (A L P H A)

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	580.2727	2891.8920	53.7763	122

USERSYST: 1.00 user

R E L I A B I L I T Y A N A L Y S I S - S C A L E (A L P H A)

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Alpha if Item Deleted
Q1	575.2121	2866.6723	.1855	.9220
Q2	574.6970	2830.4053	.4600	.9210
Q6.1	576.9697	2994.9053	-.5925	.9262
Q6.2	576.9697	2913.1553	-.1372	.9238
Q6.3	576.7273	2985.4545	-.4784	.9262
Q6.4	576.4848	2948.1326	-.3431	.9248
Q7	575.8182	2802.6534	.5725	.9203
Q8.1	575.0000	2872.6250	.1749	.9221
Q8.2	575.7576	2836.6894	.3585	.9213
Q9	576.6970	2879.0928	.0527	.9230
Q10.1	574.8485	2859.7576	.1534	.9224
Q10.2	576.4545	2797.3182	.4160	.9209
Q10.3	574.5152	2861.4451	.2750	.9217
Q15.1	574.6364	2823.1761	.5428	.9207
Q15.2	574.8182	2866.3409	.1525	.9223
Q15.3	574.1818	2855.7159	.3152	.9216
Q15.4	574.9697	2830.3428	.4210	.9211
Q15.5	574.2727	2835.8295	.4728	.9210
Q15.6	574.9091	2844.7727	.3430	.9214
Q16.1	575.3939	2865.0587	.1817	.9221
Q16.2	575.6364	2861.3011	.2340	.9219
Q16.3	574.5758	2858.1269	.3118	.9216
Q16.4	574.9697	2874.0928	.1324	.9222
Q16.5	575.5758	2816.8769	.4237	.9209
Q17.1	576.6667	2808.5417	.4534	.9208
Q17.2	575.0303	2865.5928	.2752	.9218
Q18	575.5455	2841.5682	.3717	.9213
Q19	575.0303	2814.6553	.5587	.9205
Q14	575.6970	2841.2178	.3283	.9215
Q20	575.5758	2872.0019	.1192	.9224
Q21.1	574.8485	2861.2576	.2275	.9219
Q21.2	575.2424	2859.3144	.2401	.9218
Q21.3	576.0303	2795.2803	.4416	.9207
Q21.4	575.1515	2828.5701	.5253	.9208
Q21.5	574.4848	2856.3201	.3802	.9215
Q22	574.7273	2834.3295	.4719	.9210
Q23	575.1818	2834.8409	.5566	.9209
Q24	575.6970	2810.6553	.5463	.9205
Q25.1	575.3636	2860.4886	.2640	.9218
Q25.2	575.1515	2859.2576	.3088	.9216

USERSYST: 1.00 user

RELIABILITY ANALYSIS - SCALE (ALPHA)

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Alpha if Item Deleted
Q28.1	578.2727	2929.7670	-.2642	.9241
Q28.2	574.3636	2855.5511	.3074	.9216
Q29	574.6970	2826.5303	.5389	.9208
Q30.1	575.4545	2857.2557	.2305	.9219
Q30.2	574.9091	2884.6477	.0611	.9224
Q31.1	576.6970	2828.4053	.3727	.9212
Q31.2	575.3030	2813.3428	.6134	.9204
Q31.3	575.5152	2817.5076	.5075	.9207
Q32.1	576.7273	2832.7045	.3276	.9214
Q32.2	575.3030	2828.9678	.5257	.9208
Q32.3	575.6061	2833.9962	.4357	.9211
Q33.1	576.4545	2830.3182	.3357	.9214
Q33.2	575.0909	2831.0227	.4831	.9209
Q33.3	575.4242	2845.3769	.3514	.9214
Q34.1	576.1515	2845.3826	.2207	.9221
Q34.2	575.7576	2856.8769	.1574	.9225
Q34.3	575.3333	2800.4167	.5709	.9203
Q34.4	575.6364	2827.5511	.3544	.9213
Q34.5	576.2727	2850.2045	.1892	.9223
Q35	575.2727	2815.0170	.4909	.9207
Q36.1	575.4848	2843.2576	.3897	.9213
Q36.2	575.3939	2830.8712	.4808	.9209
Q36.3	575.1212	2809.5473	.6652	.9202
Q37	574.8182	2835.5909	.4872	.9210
Q38.1	576.5758	2917.3769	-.1788	.9238
Q38.2	575.8485	2862.6951	.1938	.9220
Q38.3	575.8182	2831.0284	.3723	.9212
Q38.4	575.0909	2875.2727	.1230	.9223
Q38.5	576.6970	2912.5928	-.1417	.9237
Q39.1	575.5455	2811.6932	.5899	.9204
Q39.2	576.0303	2833.2178	.3480	.9213
Q39.3	576.6061	2860.3712	.1805	.9222
Q39.4	576.3030	2847.2803	.2351	.9219
Q39.5	574.7879	2844.0473	.3797	.9213
Q40	575.3333	2853.9792	.2786	.9217
Q41.1	575.4848	2840.8201	.4449	.9211
Q41.2	575.4545	2821.0682	.5277	.9207
Q42.1	575.1212	2842.5473	.4669	.9211
Q42.2	576.1515	2822.1951	.5799	.9206
Q43.1	575.4545	2856.9432	.2529	.9218

USERSYST: 1.00 user

RELIABILITY ANALYSIS - SCALE (ALPHA)

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Alpha if Item Deleted
Q43.2	574.6667	2802.6667	.1052	.9300
Q44.1	575.2727	2834.5170	.5294	.9209
Q44.2	575.6970	2818.3428	.5934	.9205
Q44.3	575.3939	2836.6837	.4443	.9211
Q45.1	575.4848	2869.8201	.1441	.9222
Q45.2	575.3333	2822.5417	.4414	.9209
Q45.3	575.5455	2853.1932	.3034	.9216
Q46	575.4848	2845.1951	.3478	.9214
Q47.1	574.7273	2875.0170	.1530	.9221
Q47.2	574.7576	2877.8769	.1420	.9221
Q47.3	574.4242	2865.2519	.2663	.9218
Q48.1	575.0909	2821.4602	.4449	.9209
Q48.2	575.3939	2796.3712	.5988	.9201
Q48.3	575.4848	2784.6326	.6859	.9197
Q49	575.4242	2801.0644	.5201	.9204
Q50.1	576.6061	2841.1212	.3097	.9215
Q50.2	576.3333	2862.1042	.1746	.9222
Q50.3	576.3030	2903.0303	-.0817	.9234
Q51.1	575.4848	2848.2576	.3170	.9215
Q51.2	575.4545	2854.3807	.2332	.9219
Q51.3	574.8485	2851.8201	.3435	.9215
Q52.1	575.2121	2863.2973	.2584	.9218
Q52.2	574.9091	2843.3352	.3790	.9213
Q52.3	575.0303	2872.8428	.1743	.9221
Q52.4	574.8485	2852.8826	.4320	.9214
Q52.5	575.1212	2836.4223	.4937	.9210
Q53.1	575.4848	2830.6951	.3500	.9213
Q53.2	576.1212	2856.5473	.2370	.9219
Q53.3	575.6364	2829.4886	.3961	.9211
Q54.1	575.1515	2857.3201	.2287	.9219
Q54.2	575.1212	2879.4223	.0904	.9224
Q54.3	575.5152	2799.0076	.6278	.9201
Q55.1	575.8788	2777.8598	.7647	.9195
Q55.2	576.1212	2798.8598	.6390	.9201
Q55.3	575.3939	2805.1212	.5261	.9205
Q55.4	576.1212	2750.3598	.7026	.9192
Q56.1	575.8182	2884.0909	.0327	.9229
Q56.2	575.3939	2804.0587	.7358	.9200
Q56.3	576.5455	2879.6307	.0672	.9226
Q56.4	575.9091	2870.7727	.1316	.9223

USERSYST: 1.00 user

R E L I A B I L I T Y A N A L Y S I S - S C A L E (A L P H
A)

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Alpha if Item Deleted
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Q56.5	575.3030	2861.4053	.3143	.9217
Q56.6	576.2727	2867.9545	.0962	.9229

Reliability Coefficients

N of Cases = 33.0

N of Items =122

Alpha = .9222

USERSYST: 2.00 system integrator

R E L I A B I L I T Y A N A L Y S I S - S C A L E (A L P H A)

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	561.6970	2265.4678	47.5969	122

USERSYST: 2.00 system integrator

R E L I A B I L I T Y A N A L Y S I S - S C A L E (A L P H A)

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
Q1	558.0303	2229.8428	.2532	.9269
Q2	556.2424	2239.3769	.2643	.9268
Q6.1	556.7879	2285.6098	-.1478	.9292
Q6.2	556.8182	2263.5284	-.0008	.9281
Q6.3	557.1212	2272.4848	-.0739	.9282
Q6.4	557.2121	2231.9848	.2393	.9270
Q7	558.4848	2267.6951	-.0318	.9281
Q8.1	556.7879	2236.9223	.2126	.9271
Q8.2	557.5455	2239.0057	.1930	.9272
Q9	557.0606	2227.0587	.3539	.9265
Q10.1	556.3333	2244.9167	.1171	.9277
Q10.2	556.8485	2228.0076	.2910	.9267
Q10.3	556.6061	2256.9962	.0672	.9276
Q15.1	556.9697	2245.1553	.1953	.9271
Q15.2	555.7273	2251.0170	.1562	.9272
Q15.3	556.1515	2268.4451	-.0463	.9277
Q15.4	556.6667	2256.9792	.0670	.9276
Q15.5	556.5455	2253.2557	.1135	.9273
Q15.6	556.9091	2248.4602	.1591	.9272
Q16.1	556.9697	2225.4053	.3245	.9266
Q16.2	556.7879	2265.1723	-.0114	.9281
Q16.3	556.4545	2237.2557	.2619	.9268
Q16.4	557.1212	2219.1723	.4164	.9262

Q16.5	557.8788	2223.7973	.3369	.9265
Q17.1	557.7273	2189.7045	.4794	.9257
Q17.2	556.8485	2218.6951	.3537	.9264
Q18	557.9394	2232.4337	.3634	.9265
Q19	557.0303	2218.5303	.4930	.9260
Q14	558.3333	2226.7917	.3664	.9264
Q20	557.2424	2267.2519	-.0286	.9279
Q21.1	555.7273	2217.0795	.4311	.9261
Q21.2	556.9091	2251.8352	.1990	.9270
Q21.3	557.5455	2217.2557	.3298	.9265
Q21.4	555.7879	2223.1098	.4201	.9263
Q21.5	556.3939	2259.9337	.0537	.9275
Q22	556.5152	2242.1326	.2181	.9270
Q23	556.6667	2224.7917	.4788	.9262
Q24	556.7576	2215.3144	.5069	.9259
Q25.1	556.9697	2242.1553	.2068	.9270
Q25.2	557.0606	2240.4962	.2639	.9268

USERSYST: 2.00 system integrator

R E L I A B I L I T Y A N A L Y S I S - S C A L E (A L P H
A)

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Alpha if Item Deleted
Q28.1	558.3030	2234.7803	.2040	.9272
Q28.2	557.0303	2263.4678	-.0016	.9282
Q29	556.2424	2230.2519	.4026	.9264
Q30.1	557.4242	2253.0644	.1148	.9273
Q30.2	556.6667	2228.7292	.4311	.9263
Q31.1	558.3636	2199.7386	.4831	.9258
Q31.2	556.9091	2188.0852	.6026	.9253
Q31.3	557.6061	2200.0587	.5095	.9257
Q32.1	558.3333	2187.1667	.5208	.9255
Q32.2	557.1818	2196.3409	.5636	.9255
Q32.3	557.3939	2191.8712	.5972	.9253
Q33.1	558.2727	2220.3295	.3478	.9265
Q33.2	557.6061	2231.7462	.2966	.9267
Q33.3	557.7273	2243.3295	.1894	.9271
Q34.1	557.9697	2207.2803	.3734	.9263
Q34.2	557.8788	2283.6098	-.1482	.9288
Q34.3	557.7576	2209.1269	.3728	.9263
Q34.4	557.5152	2233.6951	.2334	.9270
Q34.5	558.4848	2182.3201	.5269	.9254
Q35	558.2424	2229.3769	.2919	.9267
Q36.1	557.7273	2198.2045	.4658	.9258
Q36.2	557.3333	2228.0417	.3271	.9266
Q36.3	556.7576	2191.1894	.6988	.9251
Q37	556.0909	2245.0852	.1759	.9272
Q38.1	558.0000	2226.1875	.3037	.9267
Q38.2	557.1818	2240.6534	.2160	.9270
Q38.3	556.8182	2254.2159	.0597	.9280
Q38.4	556.3333	2236.9792	.3762	.9265

Q38.5	558.4242	2232.2519	.2554	.9269
Q39.1	557.1212	2211.6098	.4186	.9261
Q39.2	557.8485	2214.0076	.3773	.9263
Q39.3	557.7273	2252.6420	.0695	.9279
Q39.4	557.8485	2204.0076	.4327	.9260
Q39.5	556.6061	2220.5587	.5117	.9260
Q40	556.5758	2229.3769	.3516	.9265
Q41.1	557.4242	2206.7519	.4839	.9259
Q41.2	557.2424	2206.9394	.5176	.9258
Q42.1	557.1515	2238.8201	.1873	.9272
Q42.2	557.1818	2242.4034	.2112	.9270
Q43.1	557.0909	2216.1477	.4248	.9262

USERSYST: 2.00 system integrator

R E L I A B I L I T Y A N A L Y S I S - S C A L E (A L P H A)

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Alpha if Item Deleted
Q43.2	557.4848	2233.3201	.2546	.9269
Q44.1	556.9697	2256.9053	.0985	.9273
Q44.2	557.1212	2224.2348	.4005	.9263
Q44.3	557.2424	2188.2519	.5977	.9253
Q45.1	556.9697	2204.2803	.5820	.9256
Q45.2	556.6970	2223.6553	.4823	.9261
Q45.3	557.3030	2210.4678	.4370	.9261
Q46	557.2727	2219.5795	.3185	.9266
Q47.1	556.0606	2213.5587	.4838	.9260
Q47.2	556.7273	2232.7045	.2733	.9268
Q47.3	555.7576	2247.8769	.2056	.9270
Q48.1	557.0909	2228.7102	.4415	.9263
Q48.2	556.7576	2215.2519	.5075	.9259
Q48.3	556.7879	2211.7973	.4701	.9260
Q49	556.7576	2217.6269	.3568	.9264
Q50.1	557.7273	2239.3295	.1669	.9274
Q50.2	557.4848	2223.6326	.3293	.9265
Q50.3	556.7273	2265.7670	-.0144	.9279
Q51.1	556.1818	2232.7159	.2693	.9268
Q51.2	556.8485	2211.7576	.4520	.9260
Q51.3	556.2121	2224.5473	.3481	.9265
Q52.1	556.8182	2225.5909	.3686	.9264
Q52.2	556.8182	2200.9034	.6074	.9255
Q52.3	556.5152	2239.0076	.3374	.9266
Q52.4	557.0303	2197.0303	.5873	.9255
Q52.5	556.9394	2252.8712	.0824	.9277
Q53.1	556.3636	2254.7386	.0999	.9274
Q53.2	557.1515	2231.6951	.3071	.9266
Q53.3	557.3939	2238.4962	.2466	.9269
Q54.1	556.1818	2244.0909	.1795	.9272
Q54.2	556.7576	2204.2519	.4540	.9259
Q54.3	556.8788	2238.4848	.2403	.9269
Q55.1	557.6970	2241.4053	.2217	.9270

Q55.2	557.4545	2217.6932	.4101	.9262
Q55.3	557.1212	2222.1723	.3884	.9263
Q55.4	557.0909	2215.6477	.4622	.9260
Q56.1	557.6364	2233.7386	.2309	.9270
Q56.2	556.3636	2225.1761	.4706	.9262
Q56.3	557.3939	2259.3712	.0465	.9276
Q56.4	557.1515	2235.6326	.2287	.9270

USERSYST: 2.00 system integrator

R E L I A B I L I T Y A N A L Y S I S - S C A L E (A L P H A)

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Alpha if Item Deleted
Q56.5	556.4545	2215.8182	.4478	.9261
Q56.6	557.0303	2202.9053	.4180	.9261

Reliability Coefficients

N of Cases = 33.0

N of Items =122

Alpha = .9272

K2: Reliability for Combined User and System Integrator groups - 122 items

Notes		
Output Created		20-DEC-2002 09:57:33
Comments		
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	Split File	<none>
	N of Rows in Working Data File	66
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		q33.3 q34.1 q34.2 q34.3 q34.4 q34.5 q35 q36.1 q36.2 q36.3 q37 q38.1 q38.2 q38.3 q38.4 q38.5 q39.1 q39.2 q39.3 q39.4 q39.5 q40 q41.1 q41.2 q42.1 q42.2 q43.1 q43.2 q44.1 q44.2 q44.3 q45.1 q45.2 q45.3 q46 q47.1 q47.2 q47.3 q48.1 q48.2 q48.3 q49 q50.1 q50.2 q50.3 q51.1 q51.2 q51.3 q52.1 q52.2 q52.3 q52.4 q52.5 q53.1 q53.2 q53.3 q54.1 q54.2 q54.3 q55.1 q55.2 q55.3 q55.4 q56.1 q56.2 q56.3 q56.4 q56.5 q56.6 /FORMAT=NOLABELS /SCALE(ALPHA)=ALL/MODEL=ALPHA /STATISTICS=SCALE /SUMMARY=TOTAL .
Resources	Elapsed Time	0:00:00.06

***** Method 1 (space saver) will be used for this analysis *****

R E L I A B I L I T Y A N A L Y S I S - S C A L E (A L P H A)

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	570.9848	2626.5998	51.2504	122

R E L I A B I L I T Y A N A L Y S I S - S C A L E (A L P H A)

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Alpha if Item Deleted
Q1	566.6212	2583.9928	.2698	.9224
Q2	565.4697	2582.3452	.3804	.9219
Q6.1	566.8788	2703.0312	-.4260	.9265
Q6.2	566.8939	2651.6040	-.1588	.9248
Q6.3	566.9242	2686.1019	-.3669	.9258
Q6.4	566.8485	2644.4998	-.1294	.9244
Q7	567.1515	2572.4382	.3451	.9220
Q8.1	565.8939	2599.6655	.2136	.9226
Q8.2	566.6515	2582.9998	.2987	.9222
Q9	566.8788	2611.6774	.0797	.9234
Q10.1	565.5909	2600.0916	.1381	.9231
Q10.2	566.6515	2571.5844	.2866	.9223
Q10.3	565.5606	2601.2655	.2128	.9226
Q15.1	565.8030	2574.4068	.4210	.9217
Q15.2	565.2727	2611.8322	.1060	.9230
Q15.3	565.1667	2605.1872	.2055	.9226
Q15.4	565.8182	2589.5664	.2825	.9223

Q15.5	565.4091	2585.1685	.3470	.9221
Q15.6	565.9091	2589.6839	.2956	.9222
Q16.1	566.1818	2592.2434	.2537	.9224
Q16.2	566.2121	2613.9851	.0876	.9231
Q16.3	565.5152	2591.8536	.3129	.9222
Q16.4	566.0455	2588.3210	.3014	.9222
Q16.5	566.7273	2561.0629	.4163	.9216
Q17.1	567.1970	2551.7298	.4327	.9215
Q17.2	565.9394	2586.9501	.3299	.9221
Q18	566.7424	2576.6557	.4015	.9218
Q19	566.0303	2560.1221	.5503	.9212
Q14	567.0152	2571.5536	.3794	.9218
Q20	566.4091	2615.4147	.0750	.9232
Q21.1	565.2879	2592.9159	.2633	.9224
Q21.2	566.0758	2601.5788	.2386	.9225
Q21.3	566.7879	2554.4466	.3934	.9217
Q21.4	565.4697	2582.1606	.3723	.9220
Q21.5	565.4394	2601.8501	.2563	.9224
Q22	565.6212	2583.3774	.3742	.9220
Q23	565.9242	2577.9172	.5182	.9216
Q24	566.2273	2565.3783	.4850	.9215
Q25.1	566.1667	2597.9564	.2461	.9224
Q25.2	566.1061	2593.7270	.3181	.9222
Q28.1	568.2879	2643.7774	-.1206	.9244

RELIABILITY ANALYSIS - SCALE (ALPHA A)

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Alpha if Item Deleted
Q28.2	565.6970	2596.3991	.1927	.9227
Q29	565.4697	2575.9452	.4835	.9216
Q30.1	566.4394	2598.3732	.2155	.9226
Q30.2	565.7879	2601.8312	.2514	.9224
Q31.1	567.5303	2560.7145	.4285	.9216
Q31.2	566.1061	2548.1270	.6049	.9209
Q31.3	566.5606	2551.6040	.5280	.9212
Q32.1	567.5303	2557.2068	.4185	.9216
Q32.2	566.2424	2557.3557	.5555	.9212
Q32.3	566.5000	2558.4692	.5239	.9213
Q33.1	567.3636	2570.3888	.3557	.9219
Q33.2	566.3485	2570.0459	.4257	.9217
Q33.3	566.5758	2584.7096	.3166	.9222
Q34.1	567.0606	2571.3809	.3011	.9222
Q34.2	566.8182	2611.8434	.0690	.9235
Q34.3	566.5455	2544.6517	.4984	.9212
Q34.4	566.5758	2575.0480	.3218	.9221
Q34.5	567.3788	2557.8697	.3605	.9219
Q35	566.7576	2557.0172	.4294	.9215
Q36.1	566.6061	2561.9963	.4493	.9215
Q36.2	566.3636	2573.3427	.4307	.9217
Q36.3	565.9394	2547.5040	.6828	.9208

Q37	565.4545	2590.2825	.3140	.9222
Q38.1	567.2879	2619.8082	.0356	.9234
Q38.2	566.5152	2600.8690	.1929	.9227
Q38.3	566.3182	2595.1434	.1878	.9228
Q38.4	565.7121	2606.1159	.1940	.9226
Q38.5	567.5606	2617.6040	.0489	.9234
Q39.1	566.3333	2559.1795	.5067	.9213
Q39.2	566.9394	2568.7040	.3764	.9218
Q39.3	567.1667	2607.6487	.1056	.9232
Q39.4	567.0758	2573.2403	.3226	.9221
Q39.5	565.6970	2577.2606	.4529	.9217
Q40	565.9545	2591.8902	.2888	.9223
Q41.1	566.4545	2567.7594	.4806	.9215
Q41.2	566.3485	2559.5228	.5356	.9213
Q42.1	566.1364	2583.5657	.3318	.9221
Q42.2	566.6667	2584.6872	.3599	.9220
Q43.1	566.2727	2583.1245	.3409	.9221
Q43.2	566.0758	2554.1942	.1421	.9267
Q44.1	566.1212	2591.5851	.3622	.9221

RELIABILITY ANALYSIS - SCALE (ALPHA
A)

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Alpha if Item Deleted
Q44.2	566.4091	2570.0916	.4976	.9215
Q44.3	566.3182	2557.4510	.5316	.9212
Q45.1	566.2273	2585.0399	.3278	.9221
Q45.2	566.0152	2572.4459	.4372	.9217
Q45.3	566.4242	2577.3557	.3824	.9219
Q46	566.3788	2577.6235	.3451	.9220
Q47.1	565.3939	2593.5963	.3022	.9223
Q47.2	565.7424	2598.5019	.2441	.9225
Q47.3	565.0909	2605.6839	.2244	.9225
Q48.1	566.0909	2568.4839	.4592	.9216
Q48.2	566.0758	2555.4249	.5455	.9212
Q48.3	566.1364	2548.5196	.5748	.9210
Q49	566.0909	2559.1916	.4357	.9215
Q50.1	567.1667	2591.6179	.2164	.9226
Q50.2	566.9091	2593.9301	.2180	.9226
Q50.3	566.5152	2641.9152	-.1190	.9242
Q51.1	565.8333	2595.9872	.2221	.9226
Q51.2	566.1515	2581.9767	.3198	.9221
Q51.3	565.5303	2587.2991	.3321	.9221
Q52.1	566.0152	2591.1844	.3203	.9222
Q52.2	565.8636	2566.3965	.5021	.9214
Q52.3	565.7727	2603.6245	.2454	.9225
Q52.4	565.9394	2566.7040	.5258	.9214
Q52.5	566.0303	2589.4145	.2873	.9223
Q53.1	565.9242	2596.4096	.2069	.9226
Q53.2	566.6364	2596.3273	.2286	.9225
Q53.3	566.5152	2579.4844	.3499	.9220

Q54.1	565.6667	2602.8103	.1716	.9228
Q54.2	565.9394	2588.3347	.2836	.9223
Q54.3	566.1970	2568.1606	.4502	.9216
Q55.1	566.7879	2554.9389	.5522	.9212
Q55.2	566.7879	2558.1389	.5214	.9213
Q55.3	566.2576	2559.7326	.4791	.9214
Q55.4	566.6061	2536.7347	.5614	.9208
Q56.1	566.7273	2603.4629	.1409	.9230
Q56.2	565.8788	2567.8620	.5555	.9214
Q56.3	566.9697	2623.0760	.0139	.9235
Q56.4	566.5303	2603.2375	.1596	.9228
Q56.5	565.8788	2589.7389	.3433	.9221
Q56.6	566.6515	2590.4152	.1829	.9230

RELIABILITY ANALYSIS - SCALE (ALPHA)

Reliability Coefficients

N of Cases = 66.0

N of Items =122

Alpha = .9229

K3: Reliability for User and System group interval method

Notes		
Output Created		19-DEC-2002 15:18:28
Comments		
Input	Data	E:\Research\Company Data & Research\ADhoc research sets\Raj PHD\PHD data.sav
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	N of Rows in Working Data File	66
Syntax		RELIABILITY /VARIABLES=ntechman ntranspr ngovstru neinvesf nrsbt norgenv /FORMAT=NOLABELS /SCALE(ALPHA)=ALL/MODEL=ALPHA /STATISTICS=SCALE /SUMMARY=TOTAL .
Resources	Elapsed Time	0:00:00.04

***** Method 1 (space saver) will be used for this analysis *****

USERSYST: 1.00 user

R E L I A B I L I T Y A N A L Y S I S - S C A L E (A L P H
A)

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	27.4751	7.2985	2.7016	6

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Alpha if Item Deleted
NTECHMAN	22.9583	6.0346	.6165	.7715
NTRANSPR	23.1028	5.7258	.5588	.7693
NGOVSTRU	22.8524	5.0245	.7999	.7162
NEINVESF	22.5689	5.6106	.4671	.7848
NRSBT	22.8171	3.7042	.7959	.7006
NORGENV	23.0761	5.5426	.3271	.8290

Reliability Coefficients

N of Cases = 33.0

N of Items = 6

Alpha = .7975

USERSYST: 2.00 system integrator

R E L I A B I L I T Y A N A L Y S I S - S C A L E (A L P H
A)

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	27.2304	4.9012	2.2139	6

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Alpha if Item Deleted
NTECHMAN	22.8838	4.1997	.4861	.8066
NTRANSPR	22.9100	4.1816	.4053	.8149
NGOVSTRU	22.9577	3.3264	.7207	.7502
NEINVESF	22.3025	3.4180	.6970	.7569
NRSBT	22.5594	3.0297	.6525	.7671
NORGENV	22.5385	3.0327	.5941	.7880

Reliability Coefficients

N of Cases = 33.0

N of Items = 6

Alpha = .8124

K4: Reliability for Combined User and system group interval method

Notes		
Output Created		17-DEC-2002 14:48:29
Comments		
Input	Data	E:\Research\Company Data & Research\Adhoc research sets\Raj PHD\PHD data.sav
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	Split File	<none>
	N of Rows in Working Data File	66
Syntax	RELIABILITY /VARIABLES=ntechman ntranspr ngovstru neinvesf nrsbt norgenv /FORMAT=NOLABELS /SCALE(ALPHA)=ALL/MODEL=ALPHA /STATISTICS=SCALE /SUMMARY=TOTAL .	
Resources	Elapsed Time	0:00:00.12

***** Method 1 (space saver) will be used for this analysis *****

RELIABILITY ANALYSIS - SCALE (ALPHA)

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	27.3528	6.0212	2.4538	6

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
NTECHMAN	22.9210	5.0398	.5502	.7727
NTRANSPR	23.0064	4.8869	.4999	.7740
NGOVSTRU	22.9050	4.1140	.7161	.7209
NEINVESF	22.4357	4.4629	.5534	.7591
NRSBT	22.6883	3.3320	.7322	.7102
NORGENV	22.8073	4.2950	.3926	.8105

Reliability Coefficients

N of Cases = 66.0

N of Items = 6

Alpha = .7923

K5: Reliability for subscales user and system integrator group**K5.1: Reliability for technology management**

Notes		
Output Created		19-DEC-2002 12:28:06
Comments		
Input	Data	E:\Research\Company Data & Research\Adhoc research sets\Raj PHD\PHD data.sav
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	N of Rows in Working Data File	66
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Resources	Elapsed Time	0:00:00.03

***** Method 1 (space saver) will be used for this analysis *****

USERSYST: 1.00 user

 RELIABILITY ANALYSIS - SCALE (ALPHA)
 A)

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	170.1515	208.5076	14.4398	35

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
Q1	165.0909	196.5227	.3143	.6875
Q2	164.5758	193.6269	.3923	.6827
Q6.1	166.8485	229.7576	-.4839	.7425
Q6.2	166.8485	216.8826	-.2313	.7251

Q6.3	166.6061	230.8087	-.4566	.7474
Q6.4	166.3636	215.1761	-.1979	.7222
Q7	165.6970	191.5303	.3745	.6819
Q8.1	164.8788	204.6723	.1030	.6987
Q8.2	165.6364	196.3011	.2626	.6898
Q9	166.5758	203.5019	.0405	.7072
Q10.1	164.7273	192.7045	.2582	.6897
Q10.2	166.3333	189.6042	.2597	.6901
Q10.3	164.3939	198.4962	.3194	.6886
Q15.1	164.5152	187.5076	.6140	.6706
Q15.2	164.6970	201.9053	.1109	.6998
Q15.3	164.0606	196.0587	.3895	.6848
Q15.4	164.8485	188.6326	.4937	.6750
Q15.5	164.1515	192.9451	.4748	.6798
Q15.6	164.7879	197.7348	.2633	.6902
Q16.1	165.2727	197.7045	.2511	.6907
Q16.2	165.5152	203.6951	.1035	.6992
Q16.3	164.4545	199.6307	.2845	.6904
Q16.4	164.8485	202.3826	.1450	.6969
Q16.5	165.4545	188.8807	.3849	.6799
Q17.1	166.5455	193.5057	.2615	.6894
Q17.2	164.9091	200.5227	.2945	.6908
Q18	165.4242	192.8769	.4125	.6814
Q19	164.9091	183.5227	.6759	.6643
Q14	165.5758	189.8769	.4349	.6782
Q20	165.4545	197.8807	.2194	.6926
Q21.1	164.7273	198.4545	.2548	.6908
Q21.2	165.1212	198.8598	.2394	.6917
Q21.3	165.9091	184.6477	.3693	.6794
Q21.4	165.0303	187.7803	.6400	.6704
Q21.5	164.3636	202.9886	.1959	.6948

USERSYST: 1.00 user

RELIABILITY ANALYSIS - SCALE (ALPHA)
A)

Reliability Coefficients

N of Cases = 33.0 N of Items = 35

Alpha = .6995

USERSYST: 2.00 system integrator

RELIABILITY ANALYSIS - SCALE (ALPHA)
A)

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	165.8485	157.5076	12.5502	35

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Alpha if Item Deleted
Q1	162.1818	146.5284	.2642	.6847
Q2	160.3939	150.1212	.2596	.6862
Q6.1	160.9394	160.8087	-.1443	.7192
Q6.2	160.9697	152.5928	.0811	.6989
Q6.3	161.2727	157.1420	-.0357	.7045
Q6.4	161.3636	153.0511	.0728	.6992
Q7	162.6364	152.3636	.1128	.6954
Q8.1	160.9394	147.9337	.2409	.6865
Q8.2	161.6970	148.6553	.2138	.6885
Q9	161.2121	144.3598	.4453	.6742
Q10.1	160.4848	144.4451	.2689	.6842
Q10.2	161.0000	142.6875	.4220	.6733
Q10.3	160.7576	144.7519	.4230	.6754
Q15.1	161.1212	145.6098	.4314	.6761
Q15.2	159.8788	157.7348	-.0464	.7018
Q15.3	160.3030	155.6553	.0558	.6964
Q15.4	160.8182	154.3409	.0671	.6975
Q15.5	160.6970	151.4678	.1952	.6897
Q15.6	161.0606	155.6212	.0295	.6991
Q16.1	161.1212	146.4848	.3104	.6817
Q16.2	160.9394	155.8712	-.0023	.7036
Q16.3	160.6061	149.4962	.2558	.6861
Q16.4	161.2727	143.9545	.4449	.6737
Q16.5	162.0303	147.5303	.2737	.6843
Q17.1	161.8788	136.9223	.4702	.6655
Q17.2	161.0000	142.0000	.4257	.6725
Q18	162.0909	152.0227	.1995	.6897
Q19	161.1818	148.5909	.3290	.6825
Q14	162.4848	150.9451	.2021	.6893
Q20	161.3939	156.4962	-.0067	.7015
Q21.1	159.8788	149.3598	.2403	.6868
Q21.2	161.0606	157.6212	-.0342	.6992
Q21.3	161.6970	149.8428	.1508	.6938
Q21.4	159.9394	142.3087	.5678	.6679
Q21.5	160.5455	153.5682	.1361	.6929

USERSYST: 2.00 system integrator

R E L I A B I L I T Y A N A L Y S I S - S C A L E (A L P H
A)

Reliability Coefficients

N of Cases = 33.0

N of Items = 35

Alpha = .6952

K5.2: Reliability for transactional processes

Notes		
Output Created		19-DEC-2002 12:28:06
Comments		
Input	Data	E:\Research\Company Data & Research\ADhoc research sets\Raj PHD\PHD data.sav
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	N of Rows in Working Data File	66
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Resources	Elapsed Time	0:00:00.02

***** Method 1 (space saver) will be used for this analysis *****

USERSYST: 1.00 user

RELIABILITY ANALYSIS - SCALE (ALPHA)

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	116.4545	222.8182	14.9271	25

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
Q22	110.9091	205.2102	.5093	.8113
Q23	111.3636	213.4261	.3068	.8185
Q24	111.8788	195.1098	.6749	.8026
Q25.1	111.5455	218.2557	.1079	.8246
Q25.2	111.3333	216.2917	.1984	.8216
Q28.1	114.4545	228.7557	-.1870	.8383
Q28.2	110.5455	214.0057	.2445	.8203
Q29	110.8788	208.1098	.4168	.8145
Q30.1	111.6364	210.7386	.2661	.8200
Q30.2	111.0909	222.2727	-.0133	.8276
Q31.1	112.8788	200.4223	.4586	.8116
Q31.2	111.4848	196.6326	.7454	.8019
Q31.3	111.6970	193.3428	.7384	.8000

Q32.1	112.9091	201.8352	.3982	.8145
Q32.2	111.4848	206.8201	.4657	.8129
Q32.3	111.7879	203.6098	.5108	.8106
Q33.1	112.6364	202.8011	.3686	.8160
Q33.2	111.2727	206.3920	.4534	.8130
Q33.3	111.6061	208.8712	.3598	.8163
Q34.1	112.3333	207.5417	.2256	.8245
Q34.2	111.9394	205.8087	.2513	.8234
Q34.3	111.5152	195.5701	.6064	.8048
Q34.4	111.8182	205.0284	.3226	.8183
Q34.5	112.4545	202.3807	.3142	.8199
Q35	111.4545	202.5057	.4465	.8123

Reliability Coefficients

N of Cases = 33.0

N of Items = 25

Alpha = .8223

USERSYST: 2.00 system integrator

R E L I A B I L I T Y A N A L Y S I S - S C A L E (A L P H A)

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	105.5455	202.1307	14.2173	25

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Alpha if Item Deleted
Q22	100.3636	196.1761	.1596	.8317
Q23	100.5152	189.0701	.5055	.8217
Q24	100.6061	187.8712	.4680	.8218
Q25.1	100.8182	195.9034	.1574	.8320
Q25.2	100.9091	189.0852	.4579	.8225
Q28.1	102.1515	199.8826	.0015	.8410
Q28.2	100.8788	195.3598	.1088	.8366
Q29	100.0909	196.4602	.1914	.8302
Q30.1	101.2727	198.5170	.0866	.8338
Q30.2	100.5152	193.2576	.3295	.8265
Q31.1	102.2121	176.7348	.6260	.8133
Q31.2	100.7576	181.8144	.5122	.8187
Q31.3	101.4545	176.9432	.6610	.8123
Q32.1	102.1818	173.7159	.6330	.8120
Q32.2	101.0303	183.9678	.4769	.8204
Q32.3	101.2424	177.1269	.6818	.8119
Q33.1	102.1212	183.1723	.4803	.8201
Q33.2	101.4545	186.4432	.4548	.8217
Q33.3	101.5758	186.8769	.4391	.8222
Q34.1	101.8182	179.9034	.4631	.8205
Q34.2	101.7273	202.7670	-.0657	.8431

Q34.3	101.6061	187.9962	.2786	.8292
Q34.4	101.3636	183.9886	.4429	.8216
Q34.5	102.3333	176.4167	.5306	.8170
Q35	102.0909	190.5227	.2904	.8277

Reliability Coefficients

N of Cases = 33.0

N of Items = 25

Alpha = .8305

K5.3: Reliability for Governance structures

Notes		
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Comments		
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	N of Rows in Working Data File	66
Syntax	RELIABILITY /VARIABLES=q36.1 q36.2 q36.3 q37 q38.1 q38.2 q38.3 q38.4 q38.5 q39.1 q39.2 q39.3 q39.4 q39.5 q40 q41.1 q41.2 q42.1 q42.2 q43.1 q43.2 q44.1 q44.2 q44.3 q45.1 q45.2 q45.3 /FORMAT=NOLABELS /SCALE(ALPHA)=ALL/MODEL=ALPHA /STATISTICS=SCALE /SUMMARY=TOTAL .	
Resources	Elapsed Time	0:00:00.03

***** Method 1 (space saver) will be used for this analysis *****

USERSYST: 1.00 user

R E L I A B I L I T Y A N A L Y S I S - S C A L E (A L P H
A)

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	126.8485	240.8826	15.5204	27

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Alpha if Item Deleted
Q36.1	122.0606	224.9962	.4270	.7194
Q36.2	121.9697	222.4678	.4903	.7160
Q36.3	121.6970	226.0928	.3898	.7210
Q37	121.3939	222.1837	.5542	.7145
Q38.1	123.1515	239.7576	-.0205	.7423
Q38.2	122.4242	228.3769	.2688	.7262
Q38.3	122.3939	221.3712	.3930	.7183
Q38.4	121.6667	229.6667	.2814	.7261
Q38.5	123.2727	233.7045	.1074	.7356
Q39.1	122.1212	223.9848	.4072	.7192
Q39.2	122.6061	223.8712	.3228	.7225
Q39.3	123.1818	231.3409	.1574	.7326
Q39.4	122.8788	233.3598	.0931	.7375
Q39.5	121.3636	224.8636	.4266	.7193
Q40	121.9091	227.3352	.3267	.7236
Q41.1	122.0606	226.3087	.4248	.7204
Q41.2	122.0303	219.7803	.5340	.7129
Q42.1	121.6970	229.5303	.3533	.7241
Q42.2	122.7273	224.7670	.4466	.7188
Q43.1	122.0303	233.2803	.1608	.7318
Q43.2	121.2424	203.8769	.0512	.8281
Q44.1	121.8485	218.6951	.7164	.7087
Q44.2	122.2727	216.0170	.6988	.7061
Q44.3	121.9697	222.2178	.5114	.7154
Q45.1	122.0606	234.4337	.1169	.7342
Q45.2	121.9091	224.0227	.3446	.7215
Q45.3	122.1212	226.4223	.3784	.7215

Reliability Coefficients

N of Cases = 33.0

N of Items = 27

Alpha = .7338

USERSYST: 2.00 system integrator

RELIABILITY ANALYSIS - SCALE (ALPHA)

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	121.5455	191.0057	13.8205	27

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Alpha if Item Deleted
Q36.1	117.5758	172.8144	.4080	.8087

Q36.2	117.1818	175.9659	.4414	.8078
Q36.3	116.6061	170.8712	.6472	.8002
Q37	115.9394	180.3712	.3035	.8132
Q38.1	117.8485	178.9451	.2950	.8137
Q38.2	117.0303	179.6553	.3257	.8123
Q38.3	116.6667	184.7917	.0896	.8249
Q38.4	116.1818	183.1534	.3414	.8127
Q38.5	118.2727	176.7670	.3610	.8109
Q39.1	116.9697	178.5928	.3014	.8135
Q39.2	117.6970	180.0303	.2413	.8164
Q39.3	117.5758	189.5019	-.0223	.8305
Q39.4	117.6970	179.7178	.2338	.8171
Q39.5	116.4545	179.6307	.4302	.8095
Q40	116.4242	177.1894	.4530	.8079
Q41.1	117.2727	173.7045	.4746	.8061
Q41.2	117.0909	172.0852	.5690	.8027
Q42.1	117.0000	180.8750	.2184	.8174
Q42.2	117.0303	183.2178	.2228	.8160
Q43.1	116.9394	177.4337	.3805	.8101
Q43.2	117.3333	179.4792	.2917	.8138
Q44.1	116.8182	184.9034	.2365	.8153
Q44.2	116.9697	175.5928	.5078	.8059
Q44.3	117.0909	166.1477	.6628	.7969
Q45.1	116.8182	177.3409	.4263	.8087
Q45.2	116.5455	182.1307	.3314	.8125
Q45.3	117.1515	174.8826	.4207	.8083

Reliability Coefficients

N of Cases = 33.0

N of Items = 27

Alpha = .8175

K5.4: Reliability for Investigative framework

Notes		
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Comments		
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	Split File	User or System Integrator
	N of Rows in Working Data File	66
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Resources	Elapsed Time	0:00:00.06
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***** Method 1 (space saver) will be used for this analysis *****

USERSYST: 1.00 user

RELIABILITY ANALYSIS - SCALE (ALPHA)

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	103.0303	158.7803	12.6008	21

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Alpha if Item Deleted
Q47.1	97.4848	152.7576	.2116	.8234
Q47.2	97.5152	152.3826	.2625	.8215
Q47.3	97.1818	151.8409	.2742	.8211
Q48.1	97.8485	143.1951	.3899	.8165
Q48.2	98.1515	140.2576	.4683	.8122
Q48.3	98.2424	138.0644	.5451	.8079
Q49	98.1818	131.0284	.6861	.7984
Q50.1	99.3636	139.1136	.5040	.8102
Q50.2	99.0909	143.9602	.3563	.8184
Q50.3	99.0606	149.1837	.1940	.8278
Q51.1	98.2424	142.8769	.4828	.8120
Q51.2	98.2121	146.1723	.3072	.8209
Q51.3	97.6061	148.8087	.3415	.8186
Q52.1	97.9697	153.9678	.1541	.8255
Q52.2	97.6667	148.4792	.3141	.8198
Q52.3	97.7879	151.2348	.2771	.8210
Q52.4	97.6061	148.3712	.4805	.8148
Q52.5	97.8788	141.6723	.6513	.8064
Q53.1	98.2424	135.5644	.5648	.8063
Q53.2	98.8788	151.3598	.1736	.8269
Q53.3	98.3939	140.7462	.4703	.8121

Reliability Coefficients

N of Cases = 33.0

N of Items = 21

Alpha = .8238

USERSYST: 2.00 system integrator

RELIABILITY ANALYSIS - SCALE (ALPHA)

Statistics for SCALE Mean 103.4848 Variance 103.5076 Std Dev 10.1739 N of Variables 21

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Alpha if Item Deleted
Q47.1	97.8485	93.8201	.3919	.7507
Q47.2	98.5152	96.1326	.2486	.7605
Q47.3	97.5455	97.8807	.2855	.7579
Q48.1	98.8788	94.5473	.4890	.7475
Q48.2	98.5455	91.6307	.5492	.7414
Q48.3	98.5758	88.3769	.6178	.7340
Q49	98.5455	93.9432	.2901	.7582
Q50.1	99.5152	93.5076	.2643	.7614
Q50.2	99.2727	91.3295	.4250	.7474
Q50.3	98.5152	96.5076	.2667	.7589
Q51.1	97.9697	99.5303	.1008	.7708
Q51.2	98.6364	92.3011	.4111	.7488
Q51.3	98.0000	93.8750	.3515	.7532
Q52.1	98.6061	93.7462	.3962	.7504
Q52.2	98.6061	93.5587	.4054	.7498
Q52.3	98.3030	99.1553	.2298	.7607
Q52.4	98.8182	92.0284	.4285	.7476
Q52.5	98.7273	101.0795	.0200	.7790
Q53.1	98.1515	98.4451	.1985	.7628
Q53.2	98.9394	97.1837	.2294	.7613
Q53.3	99.1818	96.2159	.2806	.7580

Reliability Coefficients

N of Cases = 33.0

N of Items = 21

Alpha = .7644

K5.5: Reliability for Resource based and Transactional based economic view

Notes		
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Comments		
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	Split File	User or System Integrator

	N of Rows in Working Data File	66
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Resources	Elapsed Time	0:00:00.02

***** Method 1 (space saver) will be used for this analysis *****

USERSYST: 1.00 user

RELIABILITY ANALYSIS - SCALE (ALPHA)

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	32.6061	40.1837	6.3391	7

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Alpha if Item Deleted
Q54.1	27.4848	34.0701	.2758	.7507
Q54.2	27.4545	39.6932	-.0573	.7999
Q54.3	27.8485	28.6951	.6549	.6699
Q55.1	28.2121	28.3598	.6678	.6660
Q55.2	28.4545	29.5682	.5995	.6832
Q55.3	27.7273	30.2045	.4611	.7131
Q55.4	28.4545	24.8807	.6313	.6673

Reliability Coefficients

N of Cases = 33.0 N of Items = 7

Alpha = .7441

USERSYST: 2.00 system integrator

RELIABILITY ANALYSIS - SCALE (ALPHA)

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	32.6970	20.2178	4.4964	7

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Alpha if Item Deleted
Q54.1	27.1818	16.2159	.2766	.5784
Q54.2	27.7576	14.9394	.3111	.5696
Q54.3	27.8788	15.7973	.3496	.5540
Q55.1	28.6970	17.2178	.2004	.6010
Q55.2	28.4545	14.2557	.4992	.4977
Q55.3	28.1212	15.4848	.3789	.5438
Q55.4	28.0909	16.9602	.2188	.5960

Reliability Coefficients

N of Cases = 33.0

N of Items = 7

Alpha = .6022

K5.6: Reliability for Organizational and environmental evolution

Notes		
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Comments		
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	Weight	<none>
	Split File	User or System Integrator
	N of Rows in Working Data File	66
Syntax	RELIABILITY /VARIABLES=q56.1 q56.2 q56.3 q56.4 q56.5 q56.6 /FORMAT=NOLABELS /SCALE(ALPHA)=ALL/MODEL=ALPHA /STATISTICS=SCALE /SUMMARY=TOTAL .	
Resources	Elapsed Time	0:00:00.07

***** Method 1 (space saver) will be used for this analysis *****

USERSYST: 1.00 user

R E L I A B I L I T Y A N A L Y S I S - S C A L E (A L P H A)

Statistics for	Mean	Variance	Std Dev	N of
SCALE	26.3939	20.9337	4.5753	Variables
				6

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Alpha if Item Deleted
Q56.1	21.9394	12.3712	.5695	.2691
Q56.2	21.5152	18.6326	.1111	.5218
Q56.3	22.6667	15.1042	.3454	.4165
Q56.4	22.0303	17.2178	.1635	.5076
Q56.5	21.4242	19.1269	.1329	.5109
Q56.6	22.3939	13.3712	.2626	.4763

Reliability Coefficients

N of Cases = 33.0

N of Items = 6

Alpha = .5070

USERSYST: 2.00 system integrator

R E L I A B I L I T Y A N A L Y S I S - S C A L E (A L P H A)

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	28.1515	16.6326	4.0783	6

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Alpha if Item Deleted
Q56.1	24.0909	13.1477	.1627	.5492
Q56.2	22.8182	13.2784	.3952	.4545
Q56.3	23.8485	12.9451	.3110	.4751
Q56.4	23.6061	13.2462	.1788	.5376
Q56.5	22.9091	12.4602	.3531	.4547
Q56.6	23.4848	10.6951	.3571	.4449

Reliability Coefficients

N of Cases = 33.0

N of Items = 6

Alpha = .5332

Appendix L

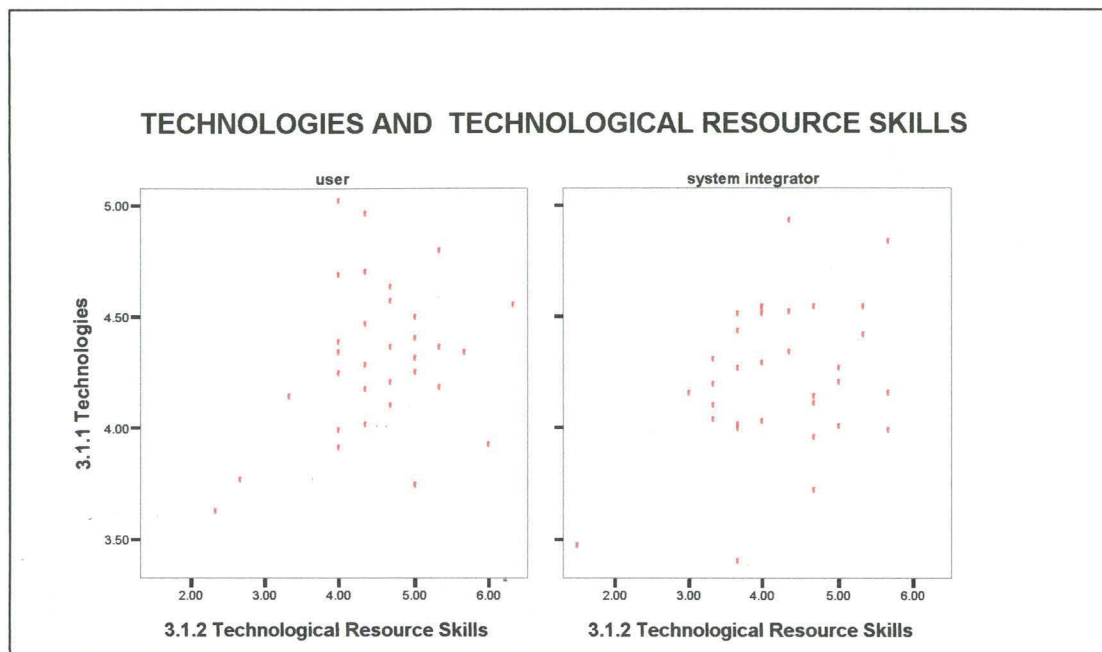
L1 Scatter plots for the technological framework

Figure L1: Scatter plot for technologies and technological resource skills

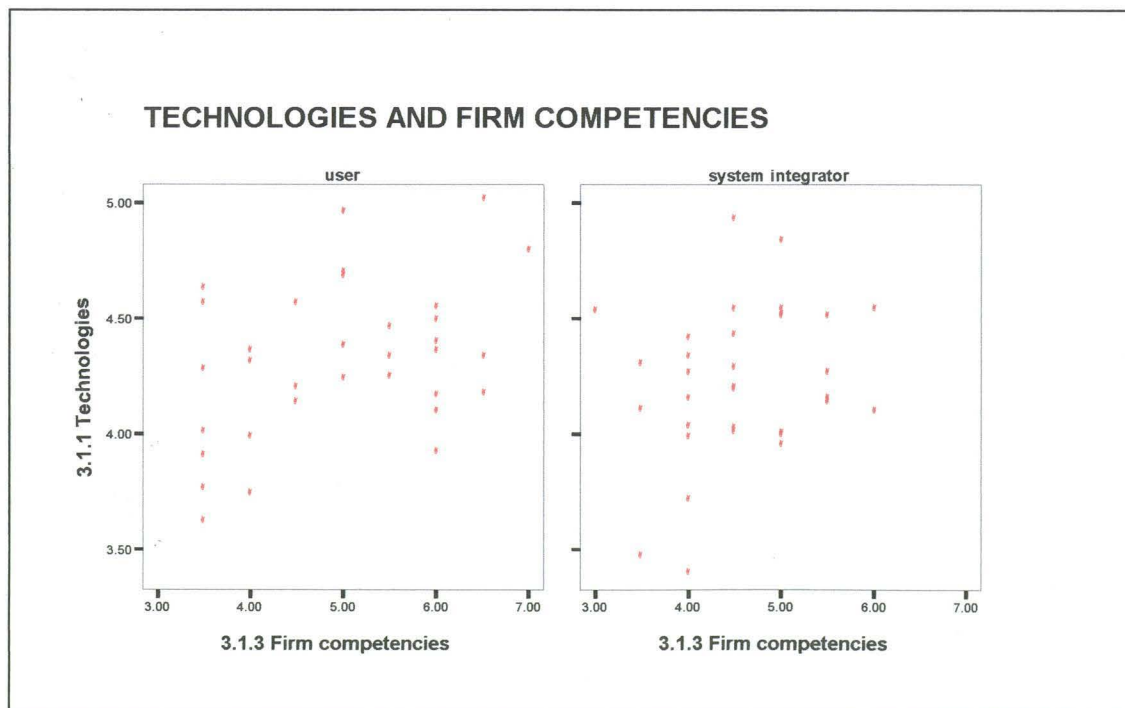


Figure L2: Scatter plot for technologies and firm competencies

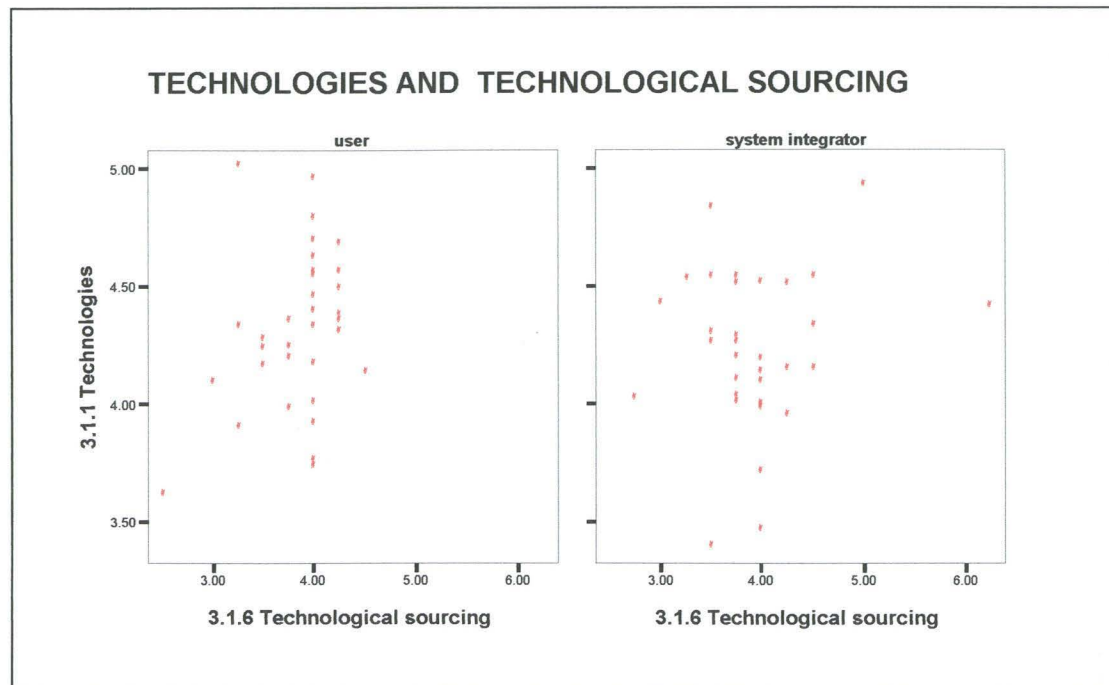


Figure L3: Scatter plot for technologies and technological sourcing

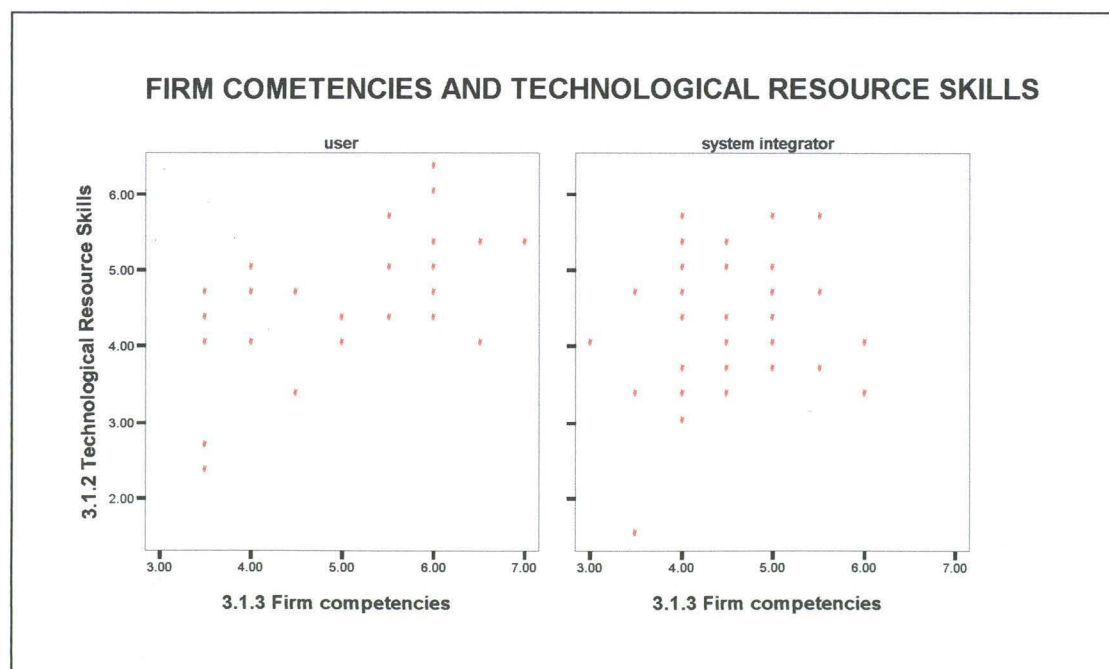


Figure L4: Scatter plot for firm competencies and technological resource skills

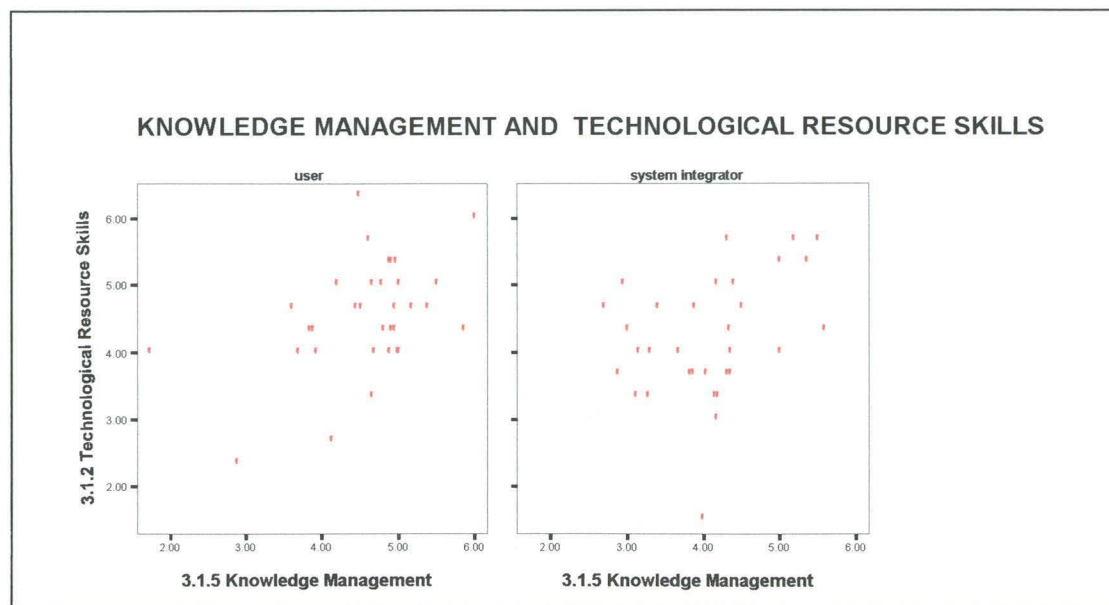


Figure L5: Scatter plot for knowledge management and technological resource skills

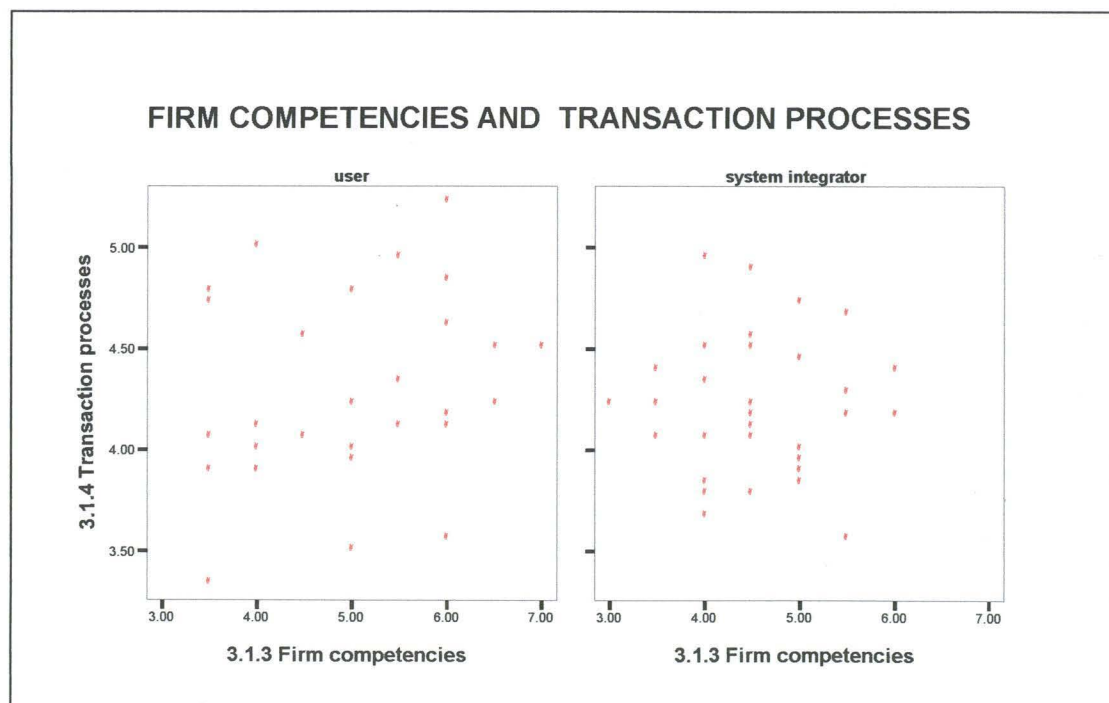


Figure L6: Scatter plot for firm competencies and transaction processes

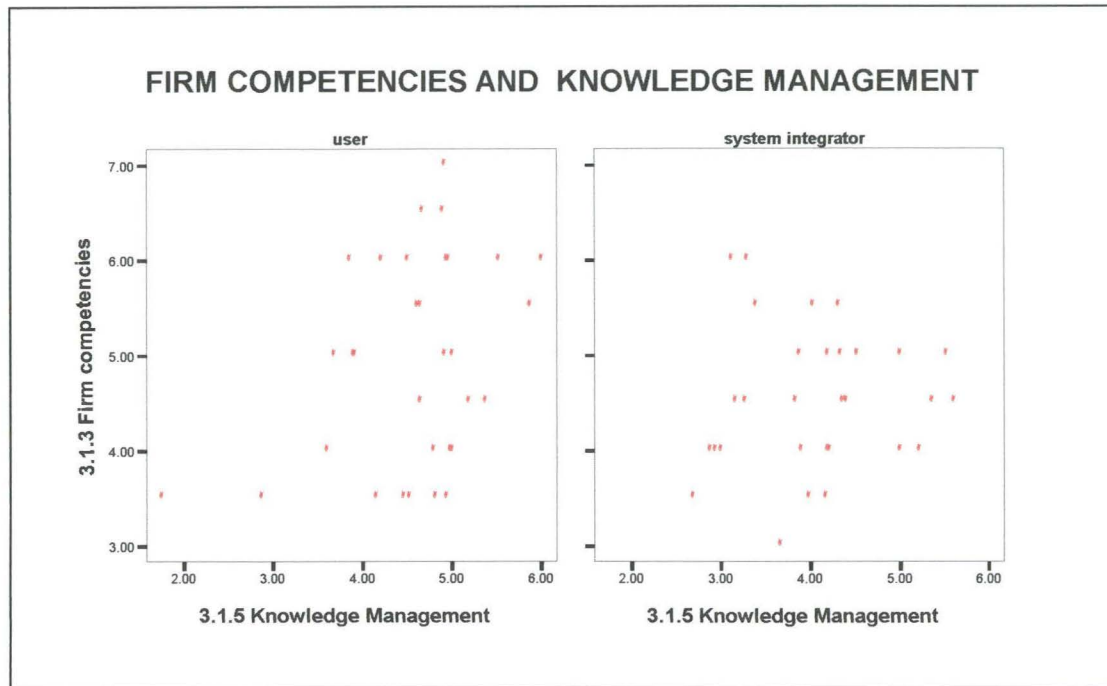


Figure L7: Scatter plot for firm competencies and knowledge management

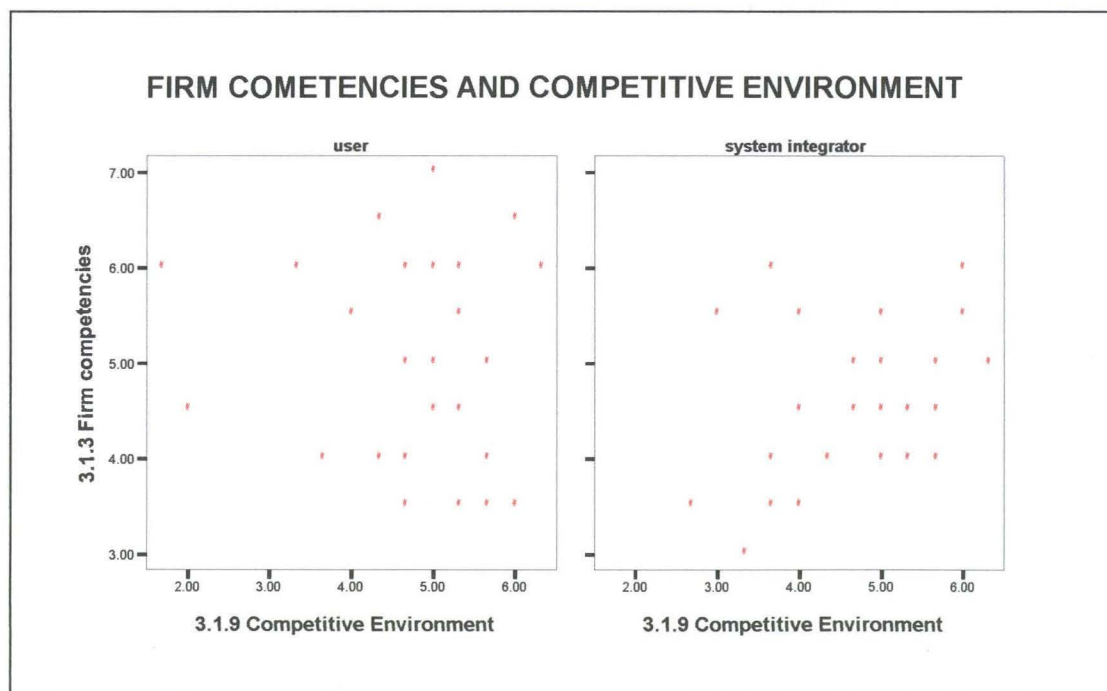


Figure L8: Scatter plot for firm competencies and the competitive environment

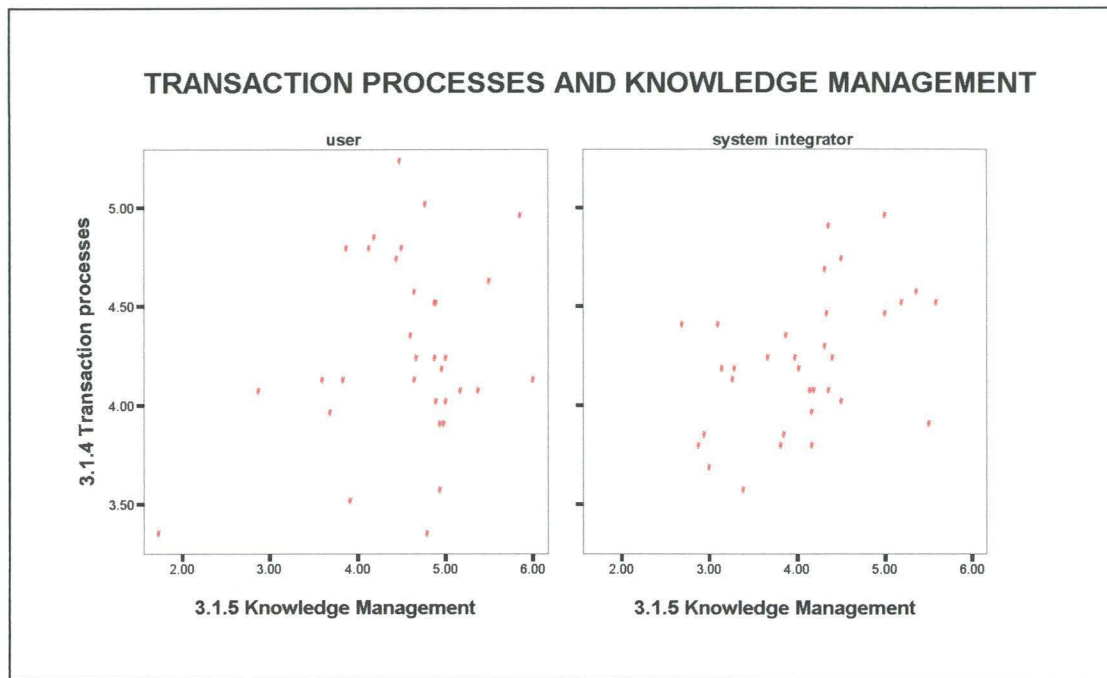


Figure L9: Scatter plot for transaction processes and knowledge management

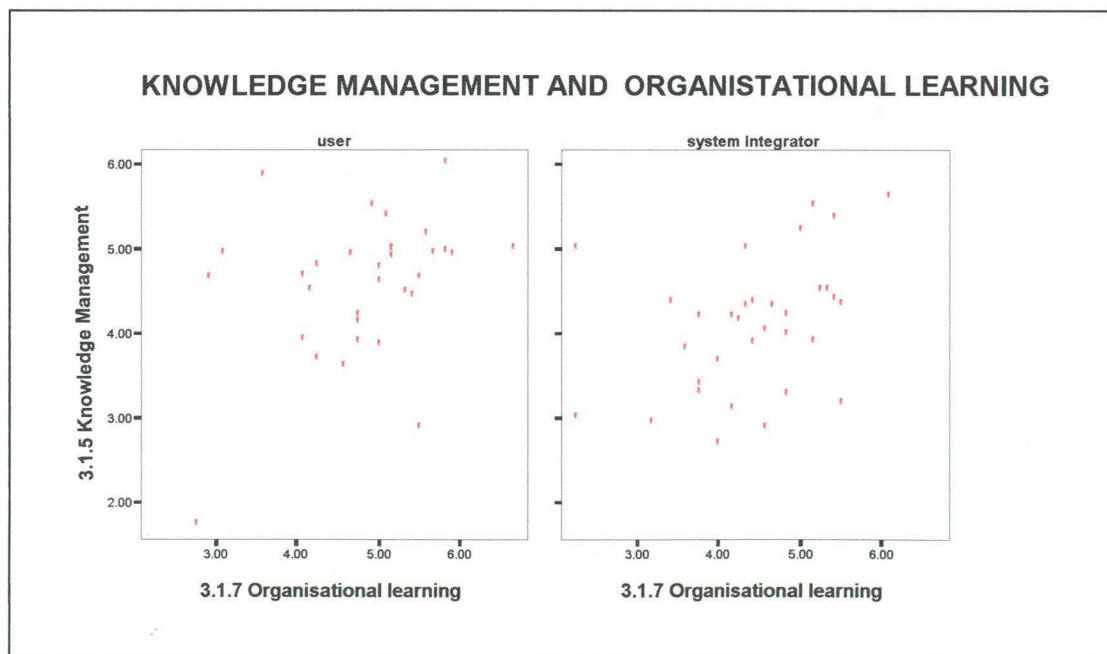


Figure L10: Scatter plot for knowledge management and organizational learning

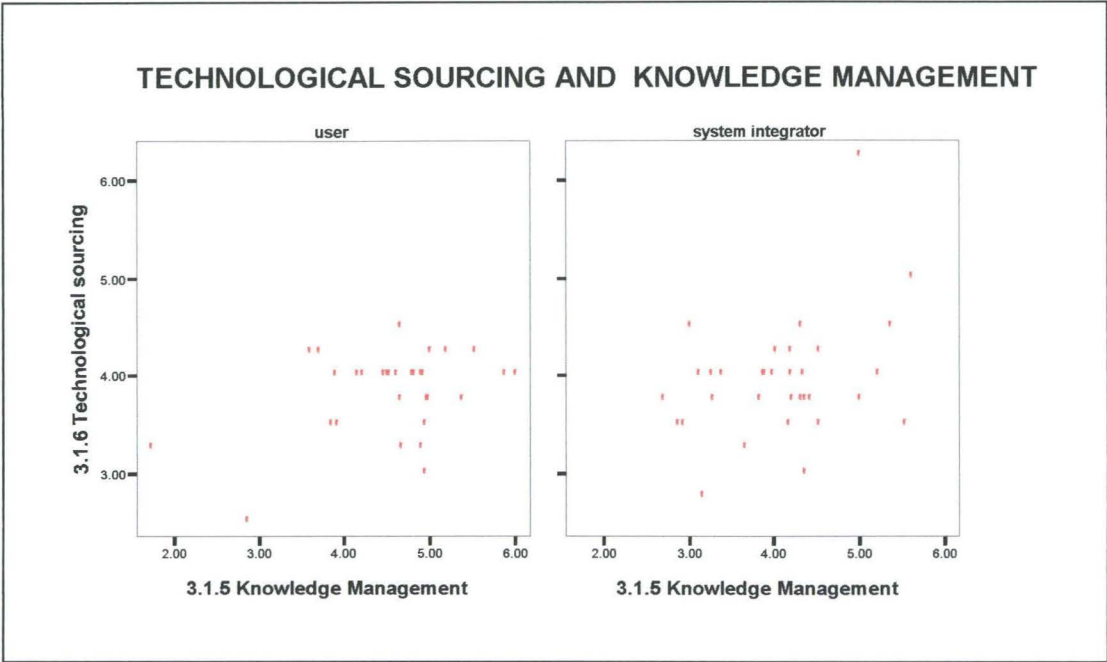


Figure L11: Scatter plot for technological sourcing and knowledge management

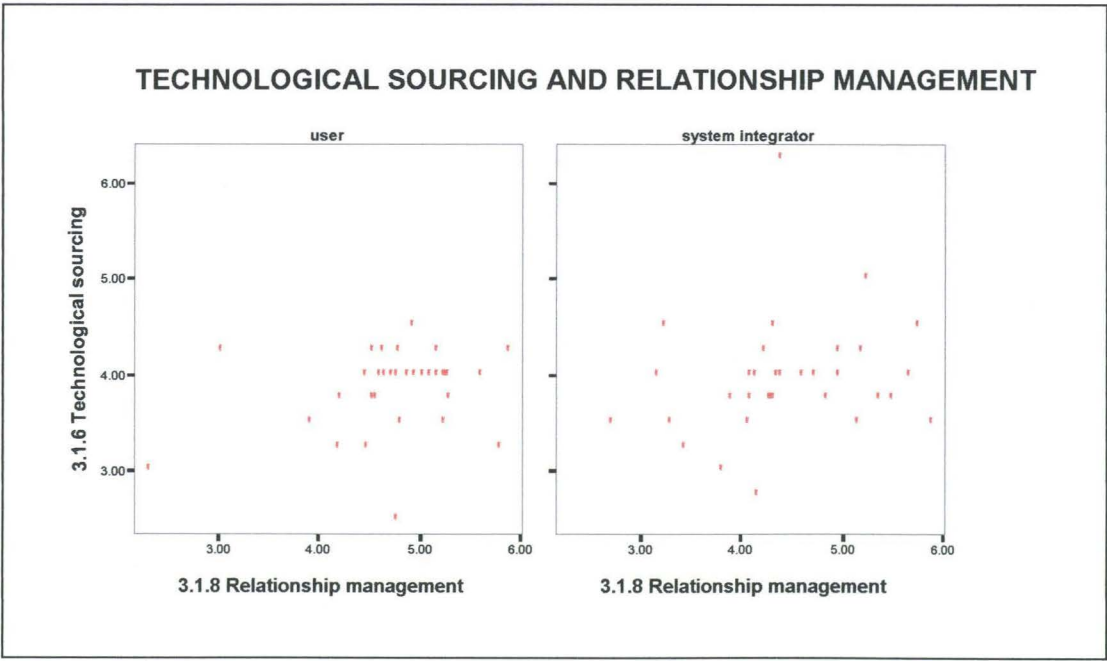


Figure L12: Scatter plot for technological sourcing and relationship management

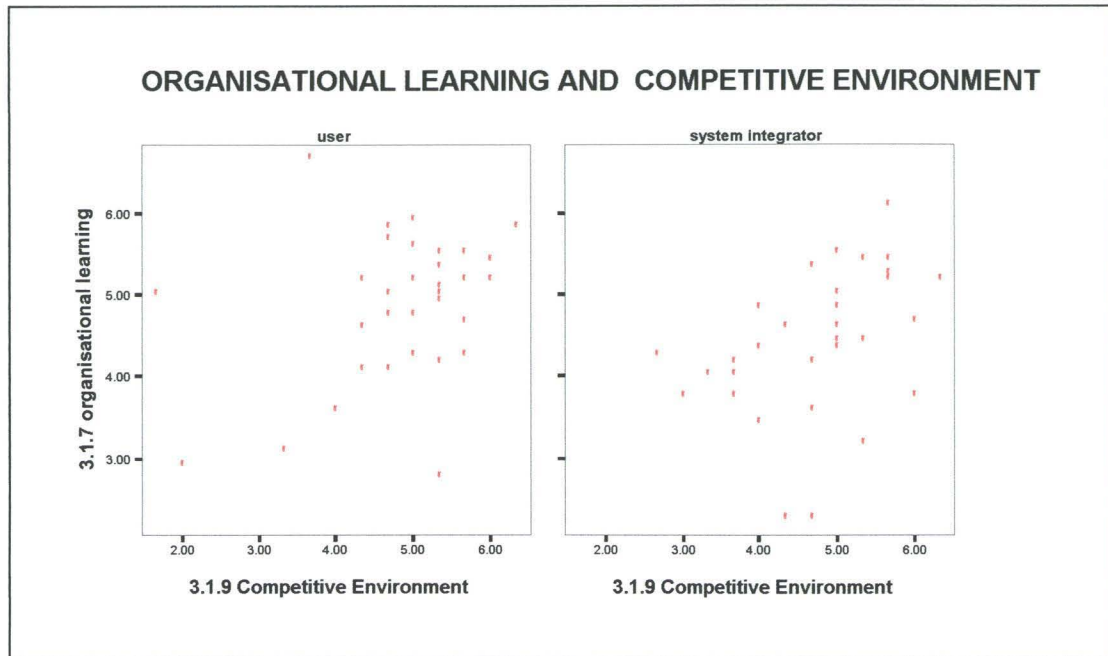


Figure L13: Scatter plot for organizational learning and the competitive environment

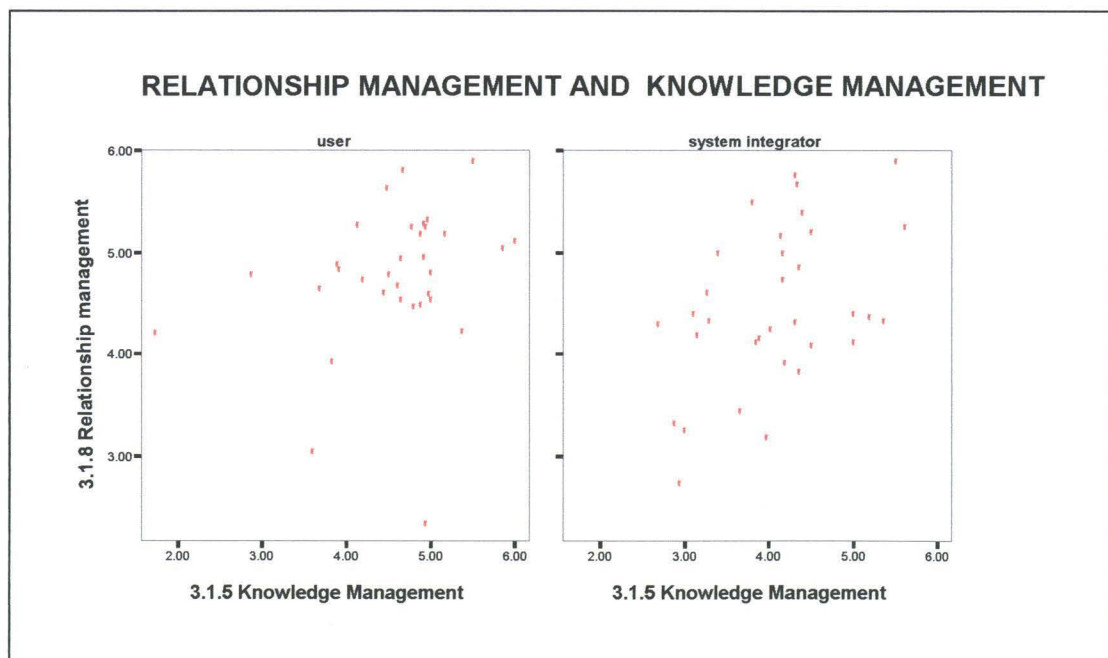


Figure L14: Scatter plot for relationship management and knowledge management

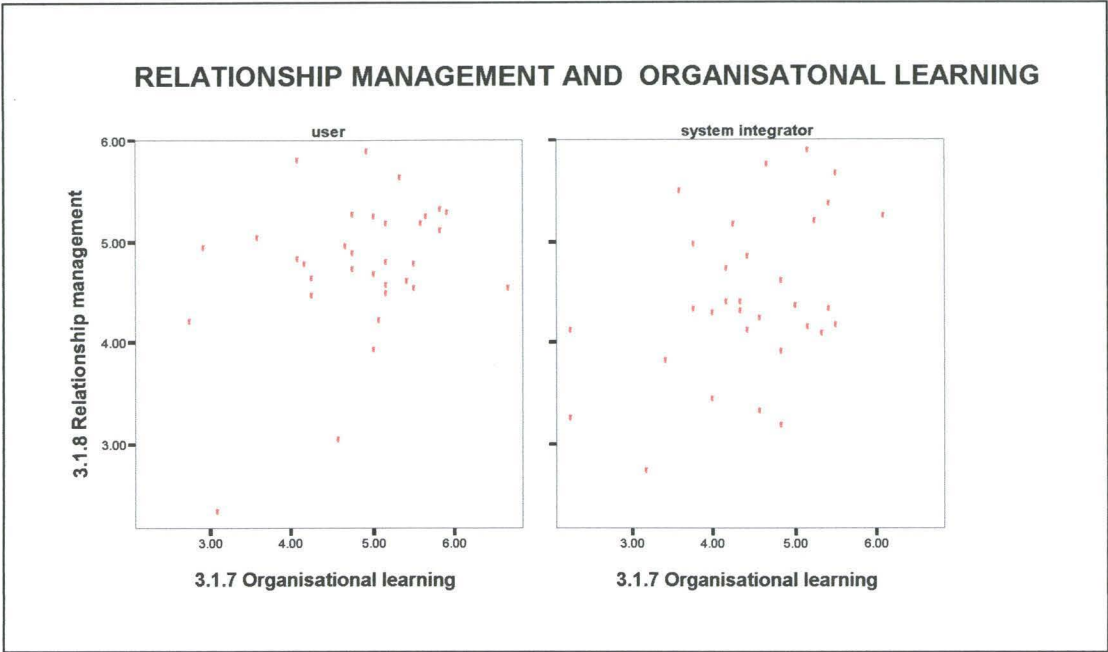


Figure L15: Scatter plot for relationship management and organizational learning

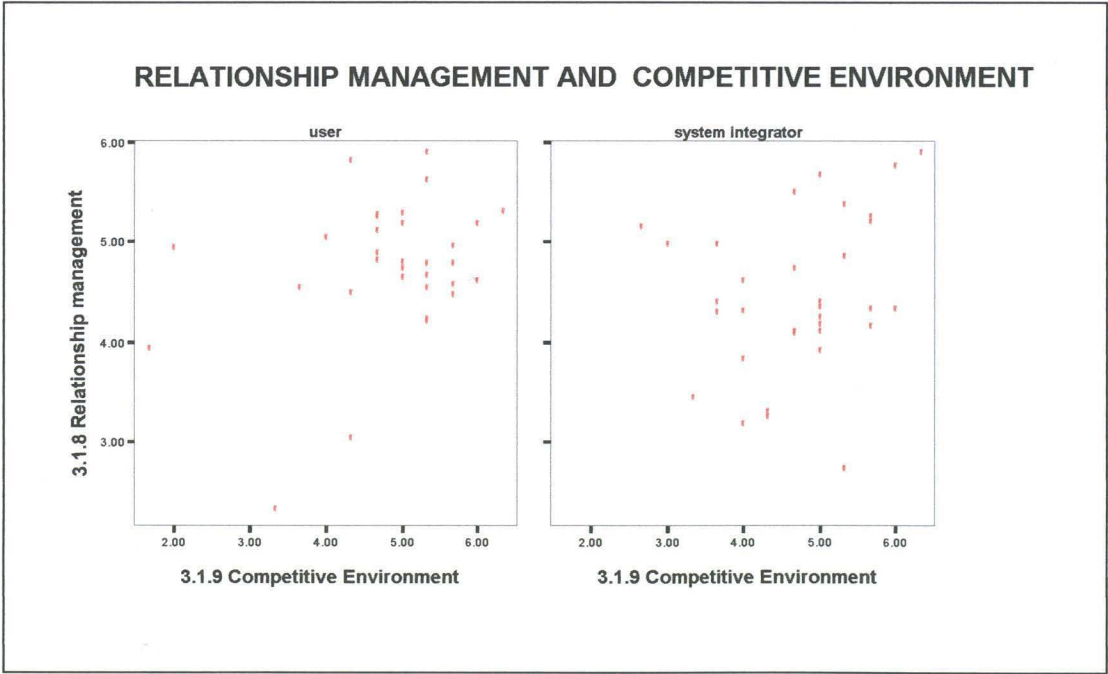


Figure L16: Scatter plot for Relationship management and the competitive environment

L2 Scatter plots for the investigative framework

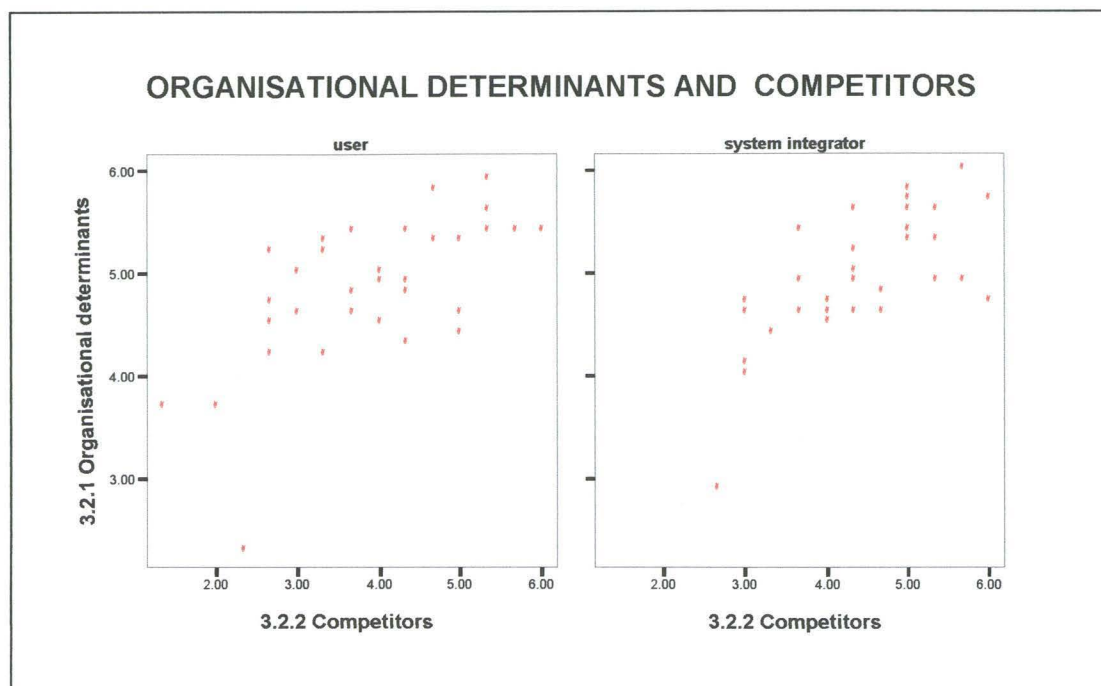


Figure L17: Scatter plot for organizational determinants and competitors

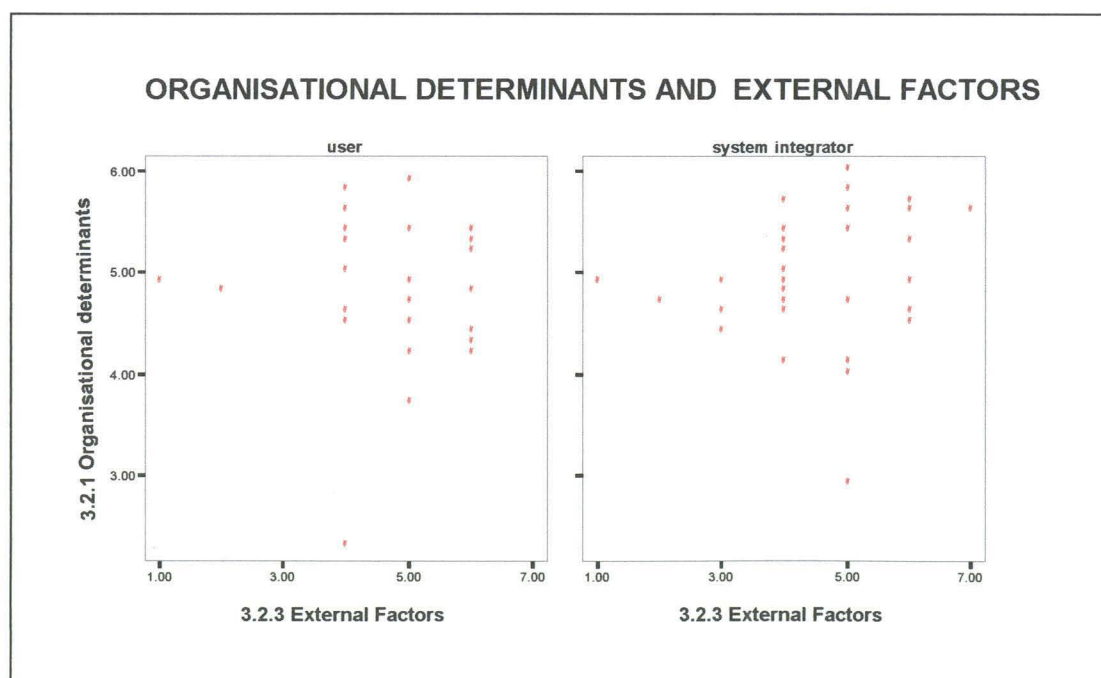


Figure L18: Scatter plot for organizational determinants and external factors

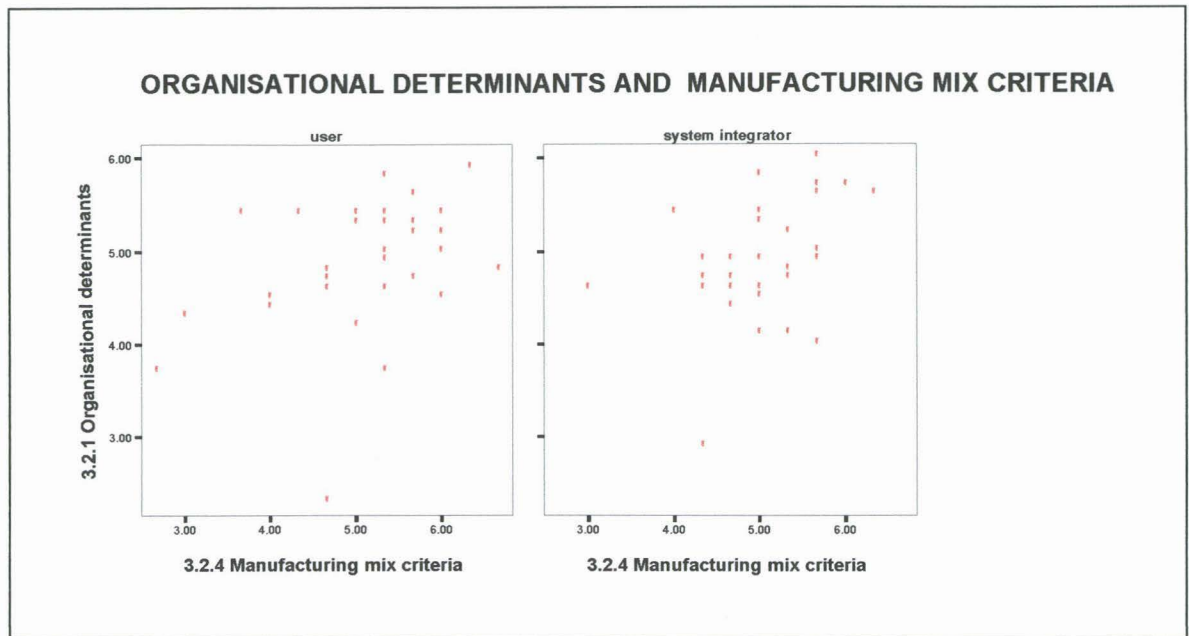


Figure L19: Scatter plot for organizational determinants and manufacturing mix criteria

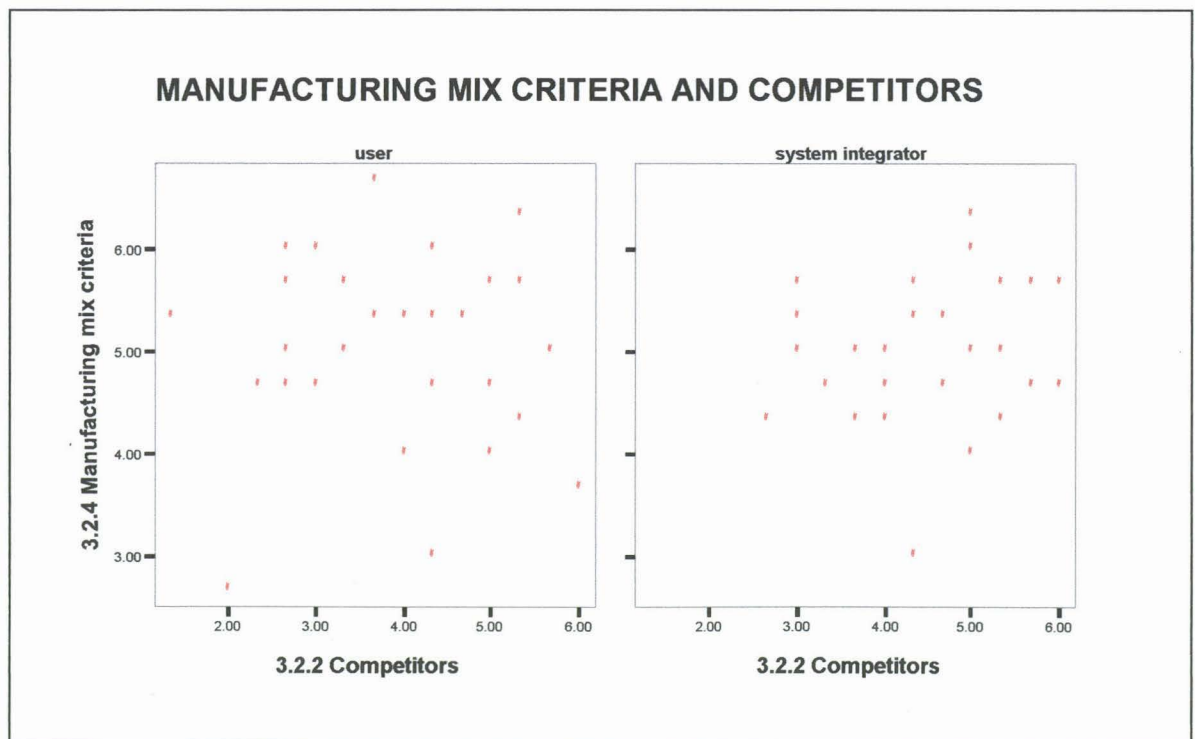


Figure L20: Scatter plot for manufacturing mix criteria and competitors

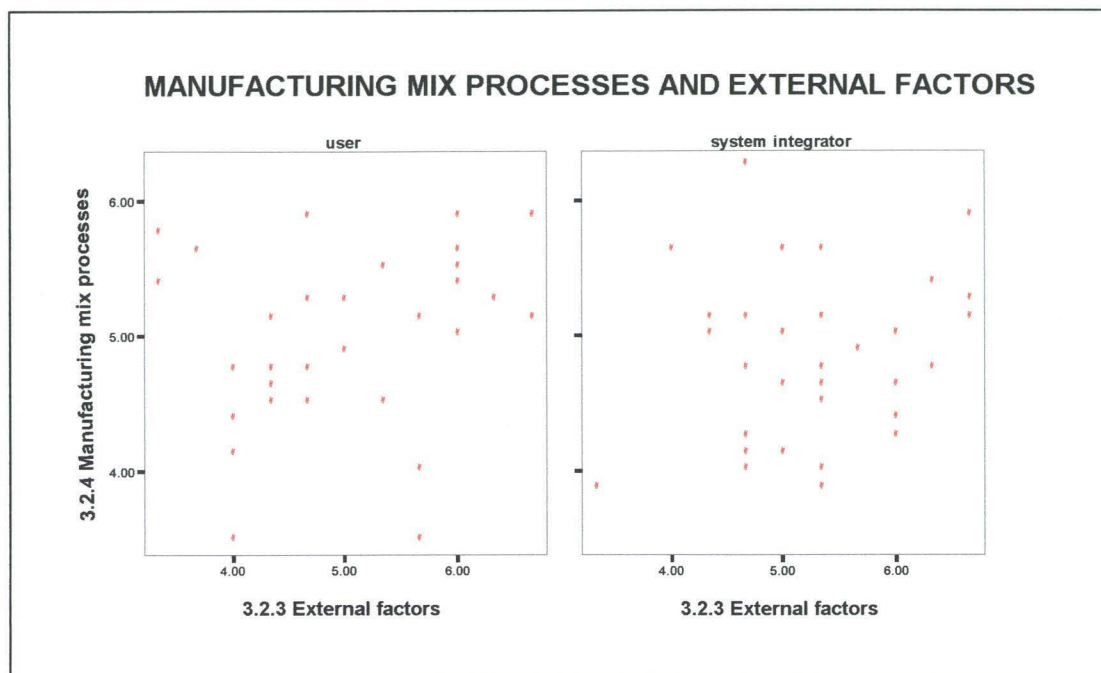


Figure L21: Scatter plot for manufacturing mix processes and external factors

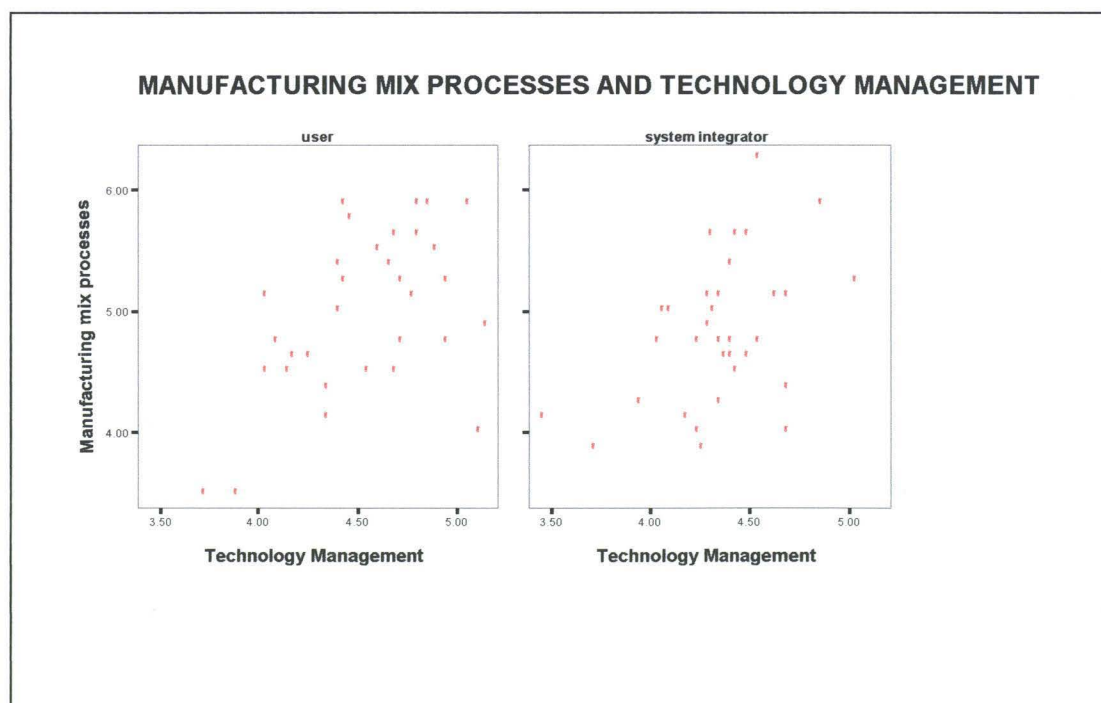


Figure L22: Scatter plot for manufacturing mix processes and technology management

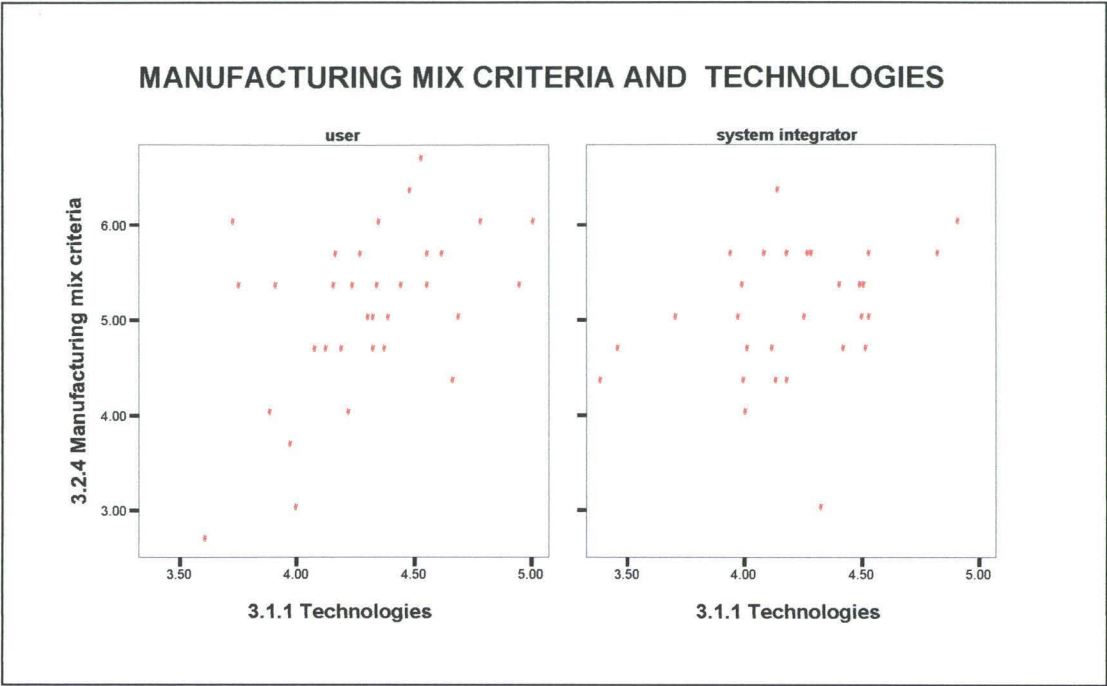


Figure L23: Scatter plot for Manufacturing mix processes and technologies

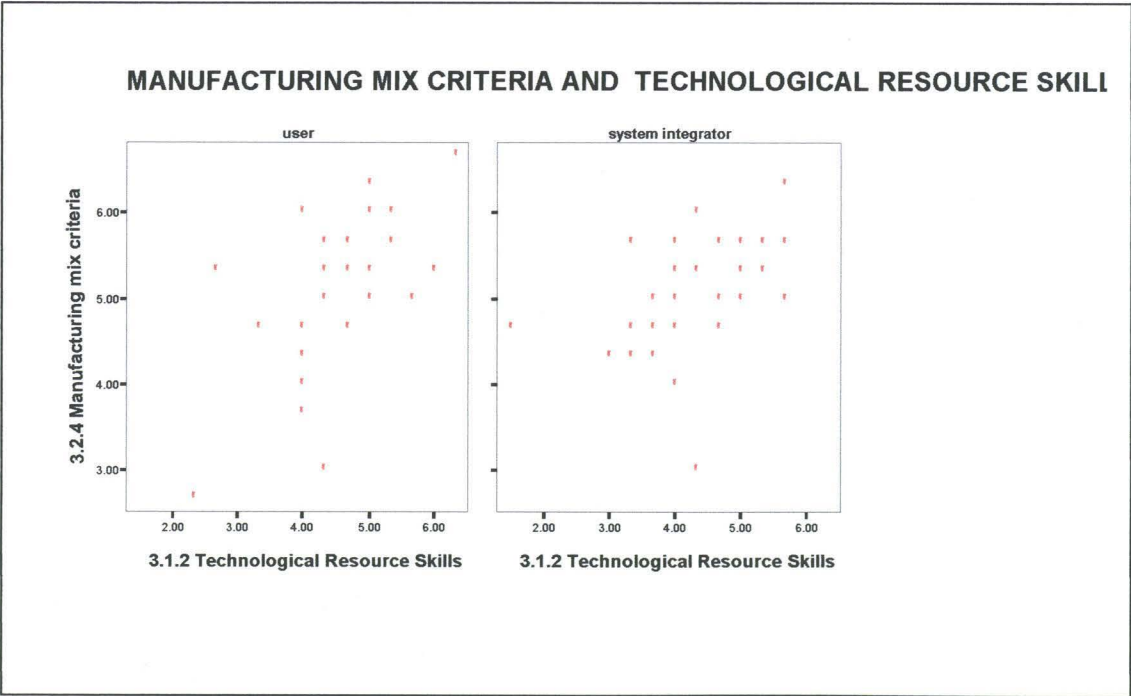


Figure L24: Scatter plot for manufacturing mix processes and technological resource skills

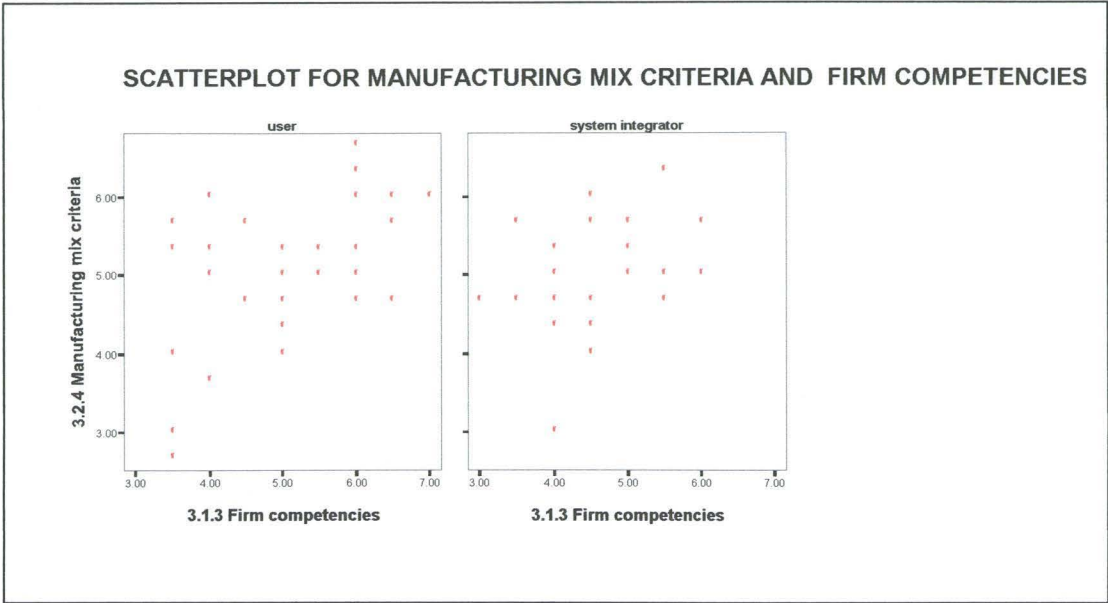


Figure L25: Scatter plot for Manufacturing mix processes and firm competencies

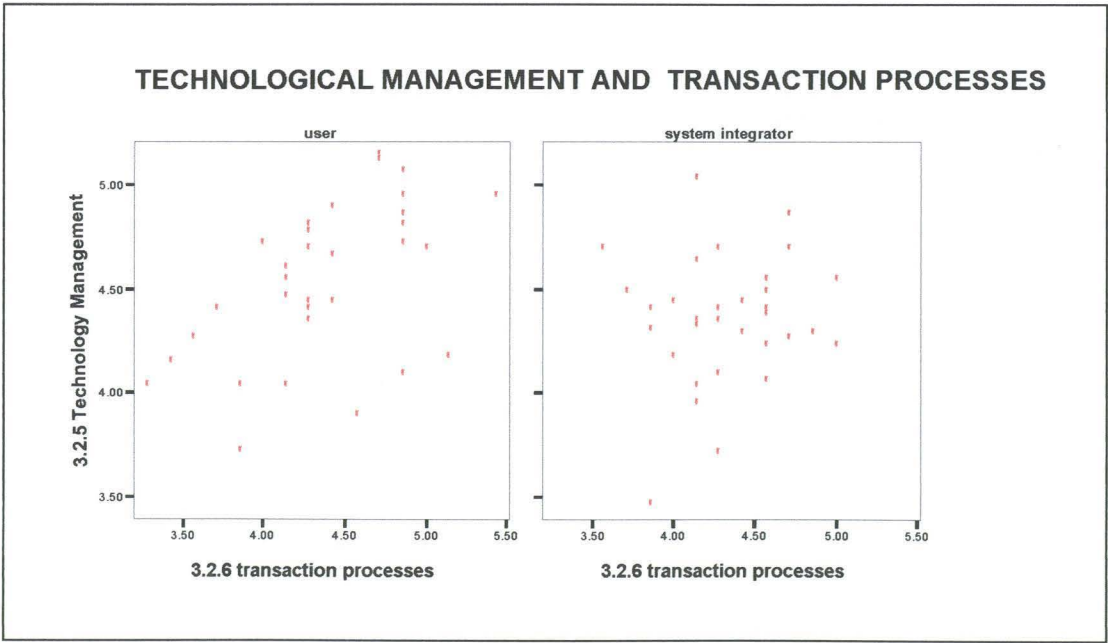


Figure L26: Scatter plot for technology management and transaction processes

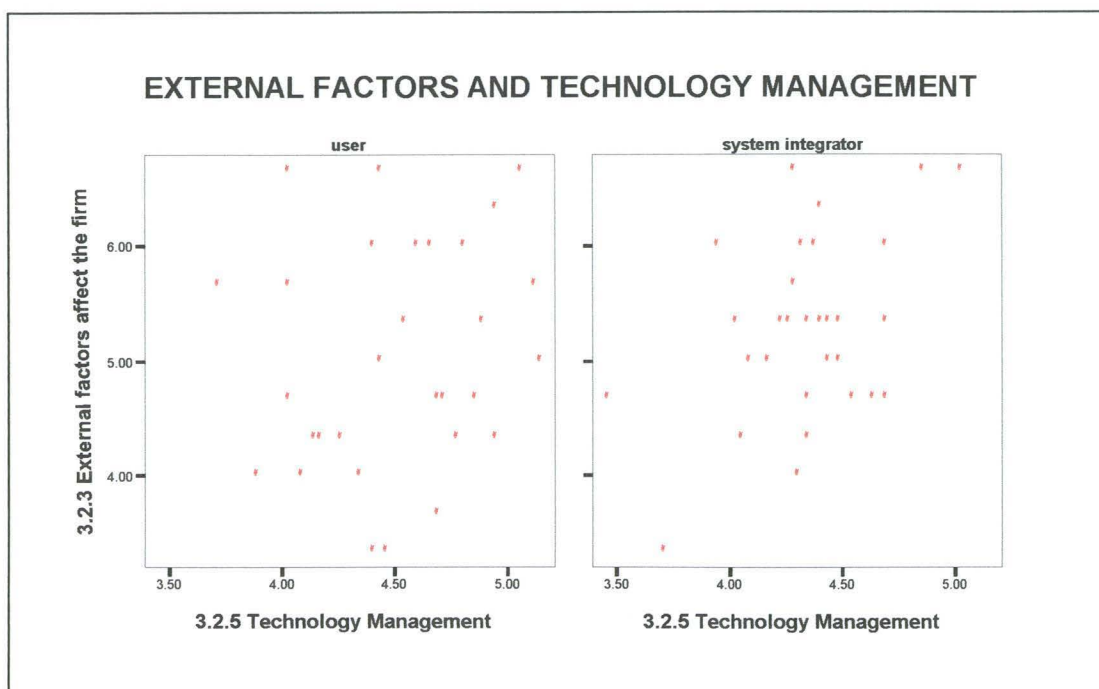


Figure L27: Scatter plot for technology management and external factors

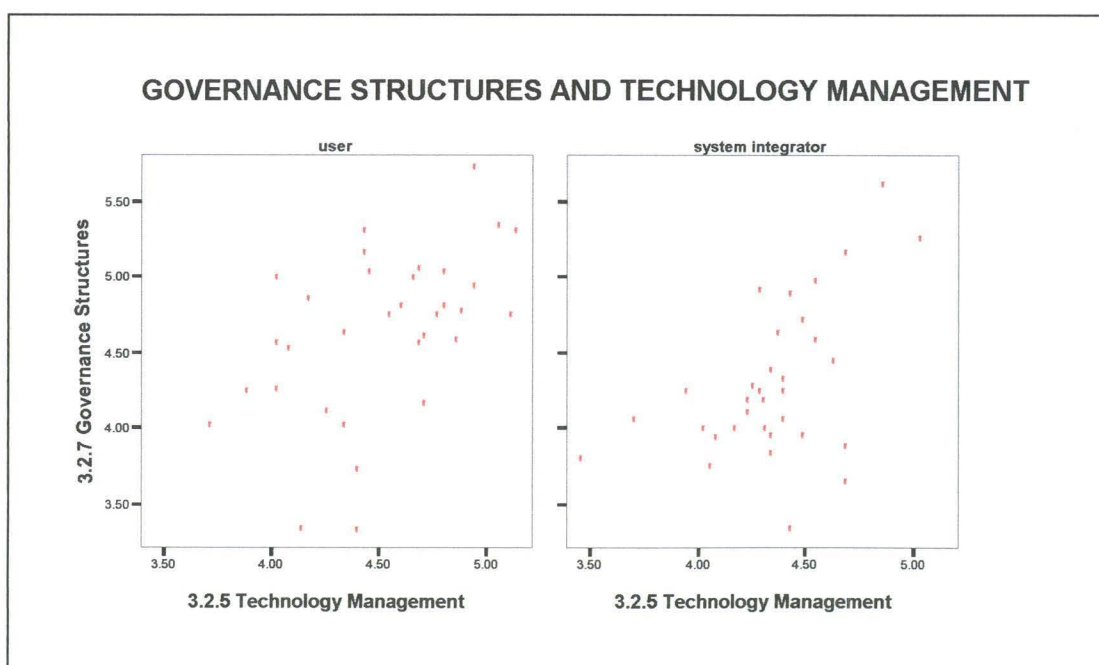


Figure L28: Scatter plot for technology management and governance structures

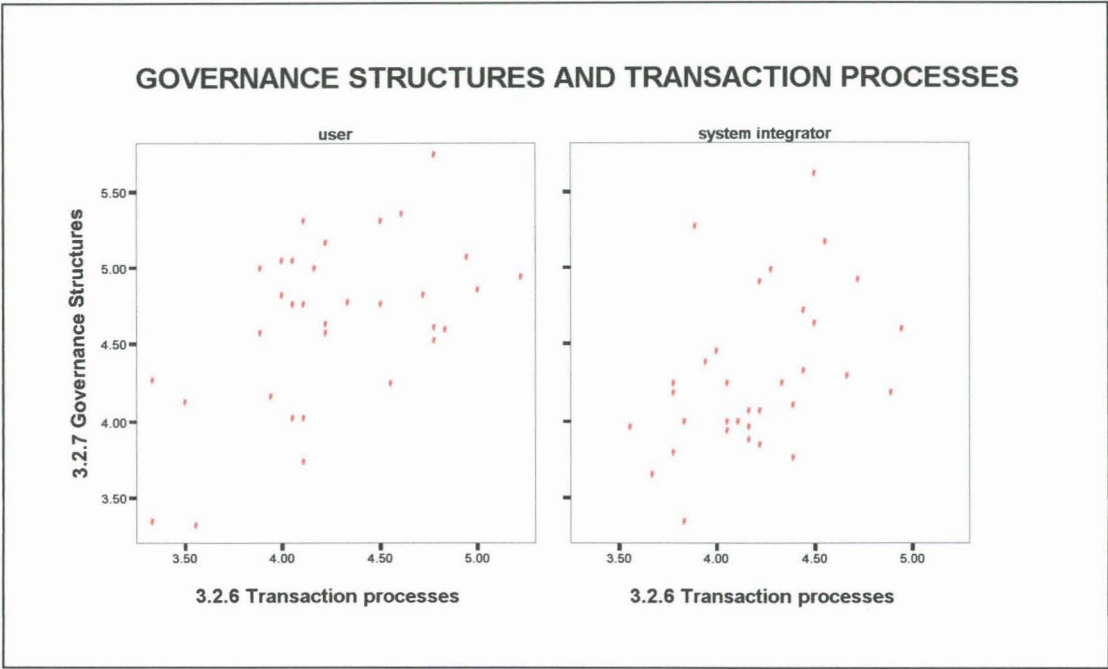


Figure L29: Scatter plot for transaction processes and governance structures

L3 Scatter plots for linking the technological and investigative framework

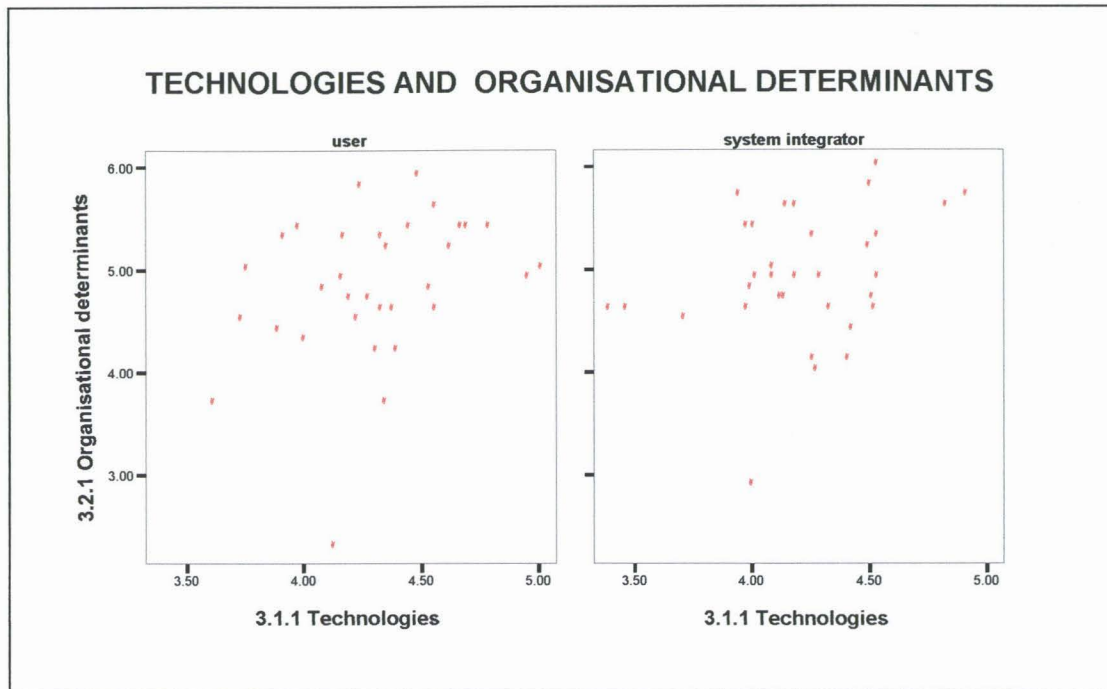


Figure L30: Scatter plot for organizational determinants and technologies

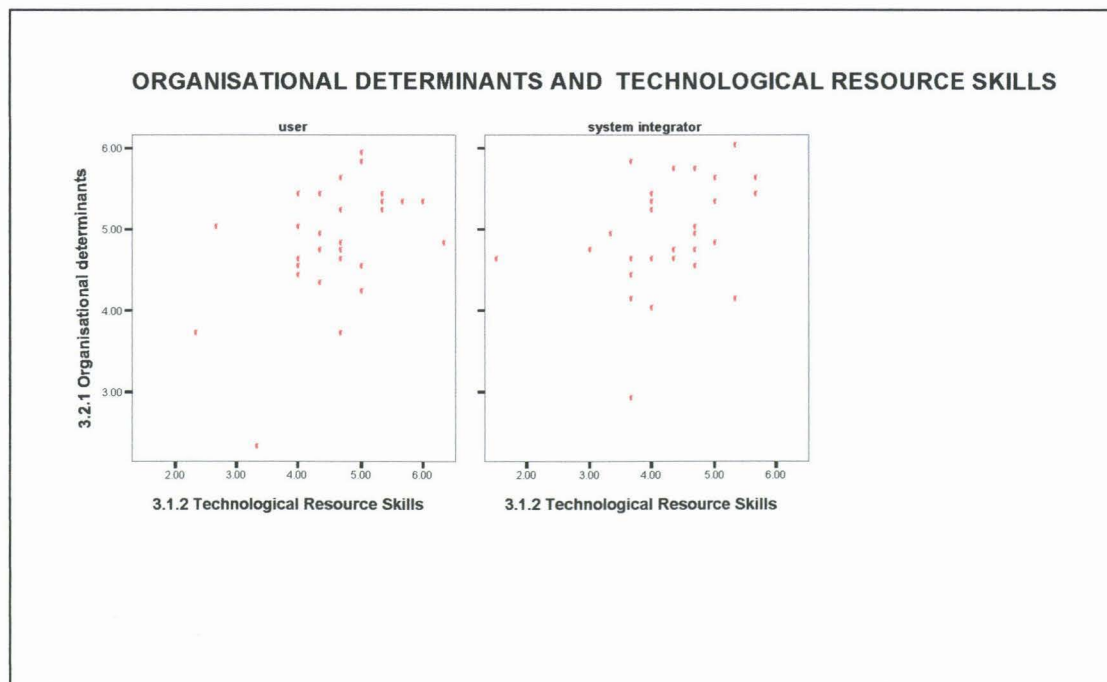


Figure L31: Scatter plot for organizational determinants and technological resource skills

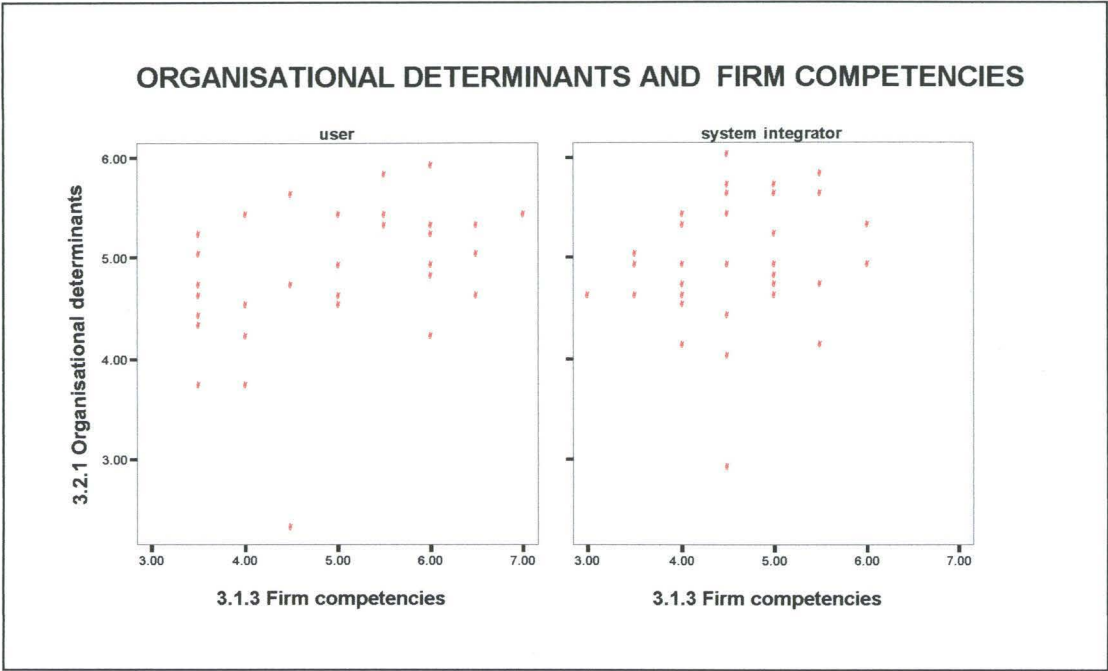


Figure L32: Scatter plot for organizational determinants and firm competencies

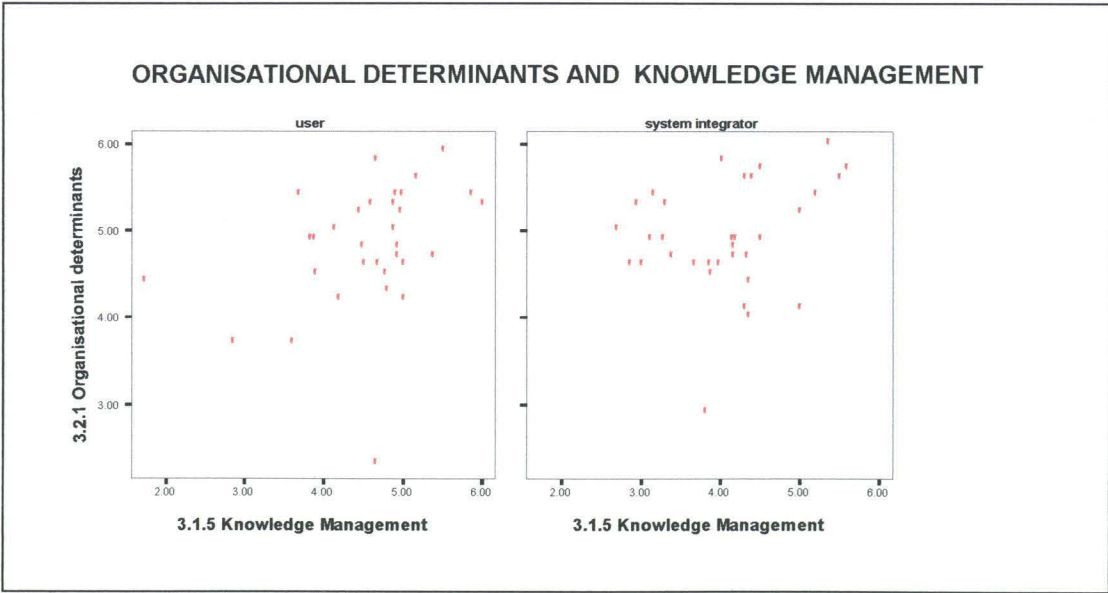


Figure L33: Scatter plot for organizational determinants and knowledge management

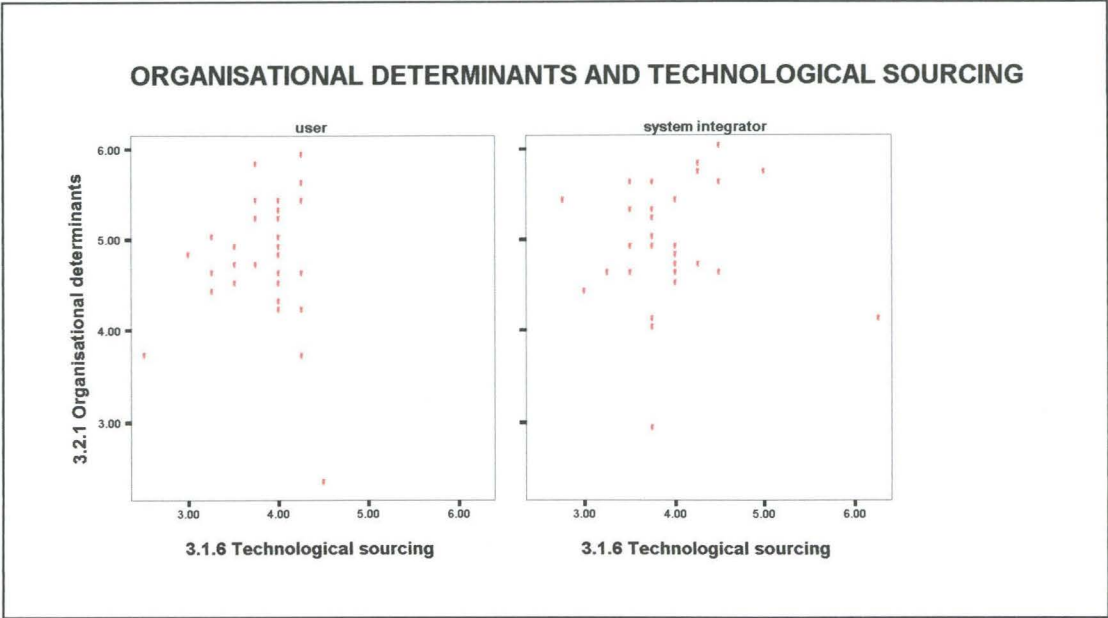


Figure L34: Scatter plot for organizational determinants and technological sourcing

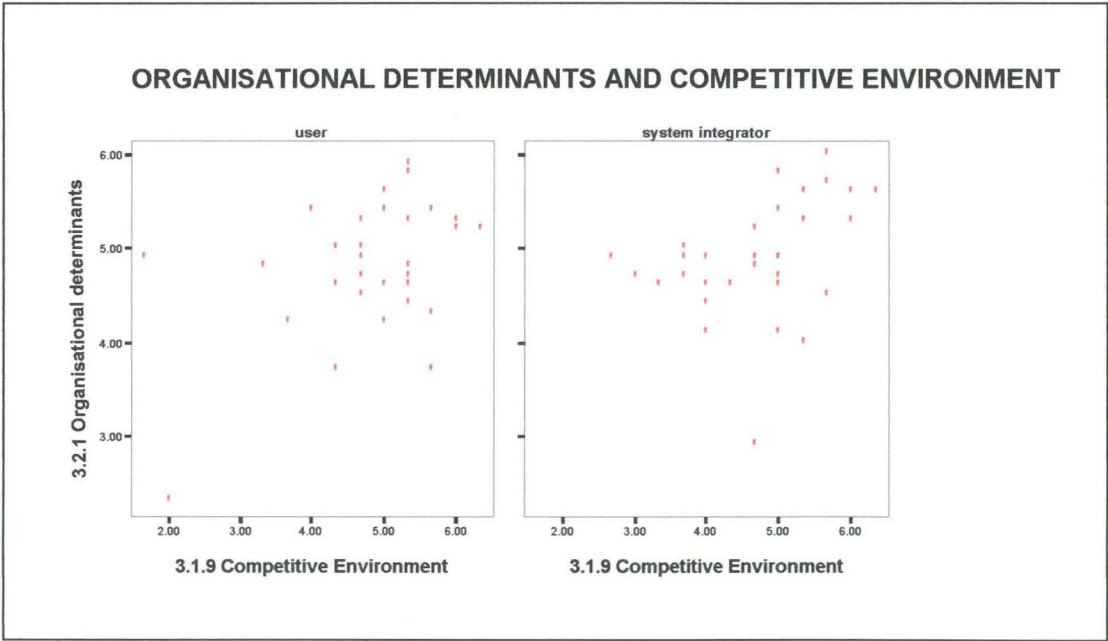


Figure L35: Scatter plot for organizational determinants and the competitive environment

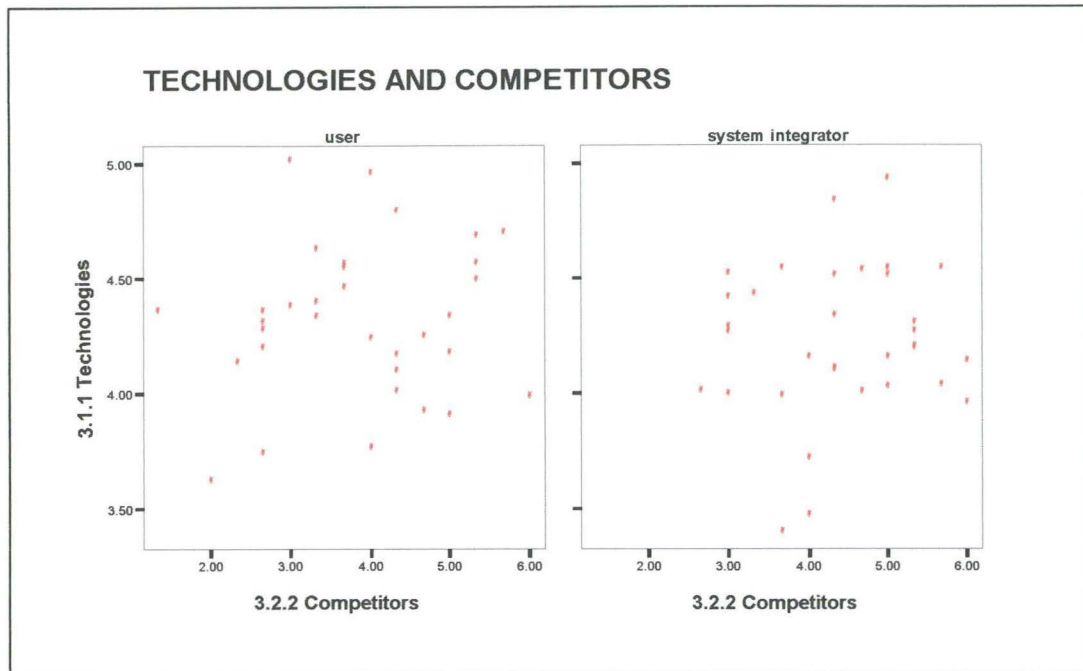


Figure L36: Scatter plot for technologies and competitors

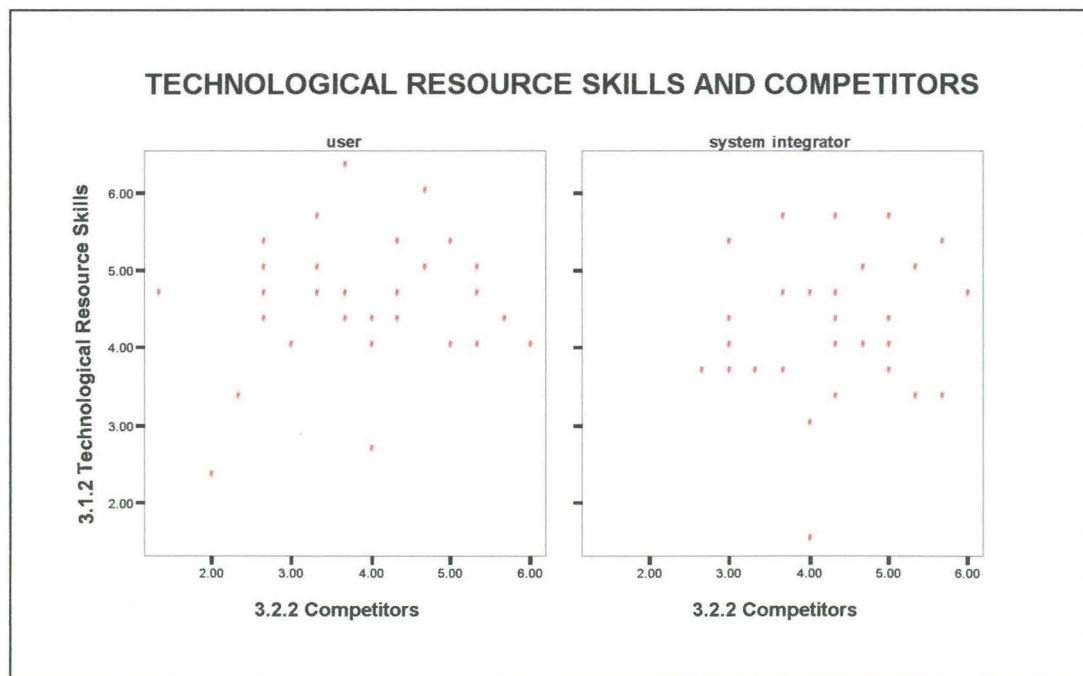


Figure L37: Scatter plot for technological resource skills and competitors

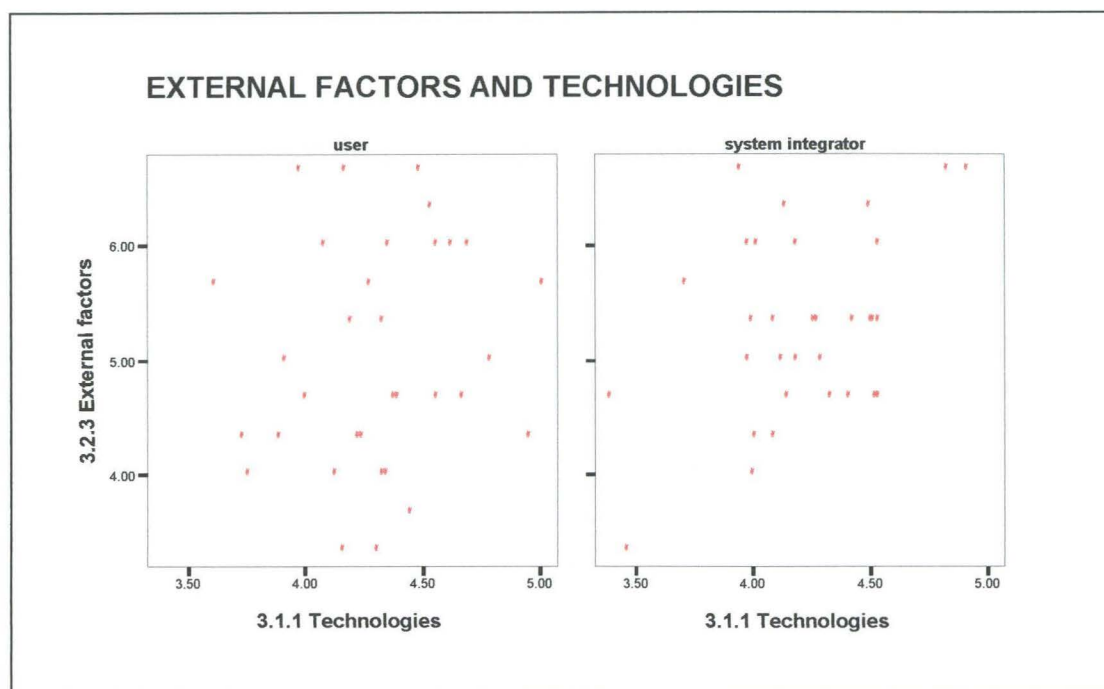


Figure L38: Scatter plot for external factors and technologies

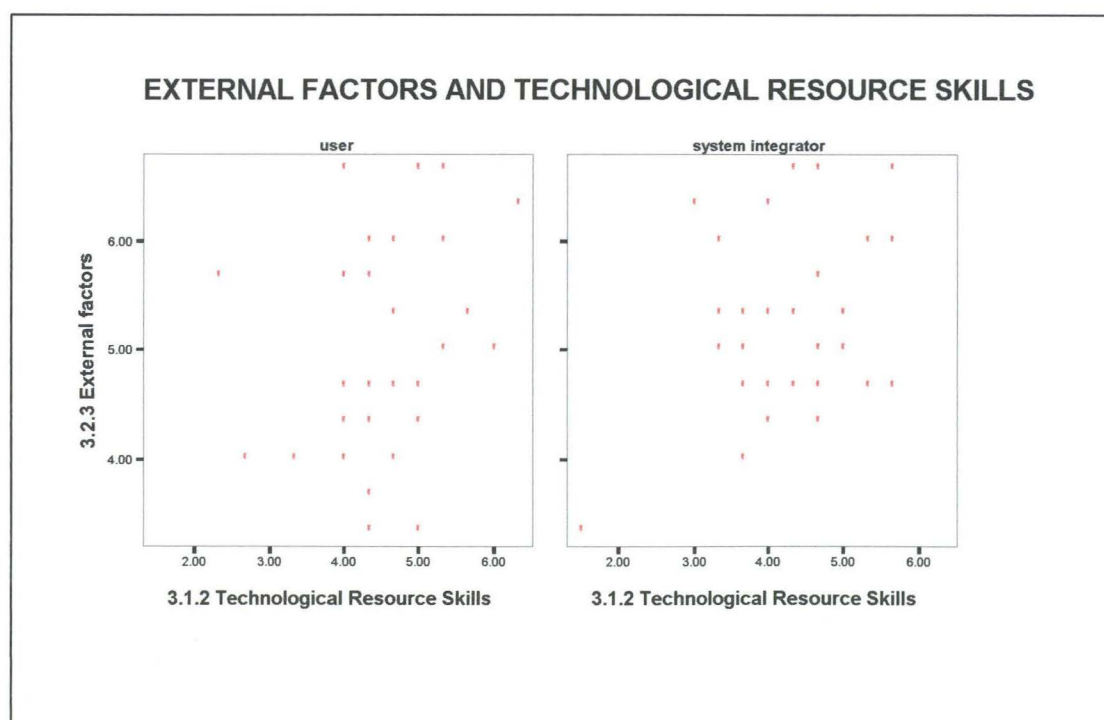


Figure L39: Scatter plot for external factors and technological resource skills

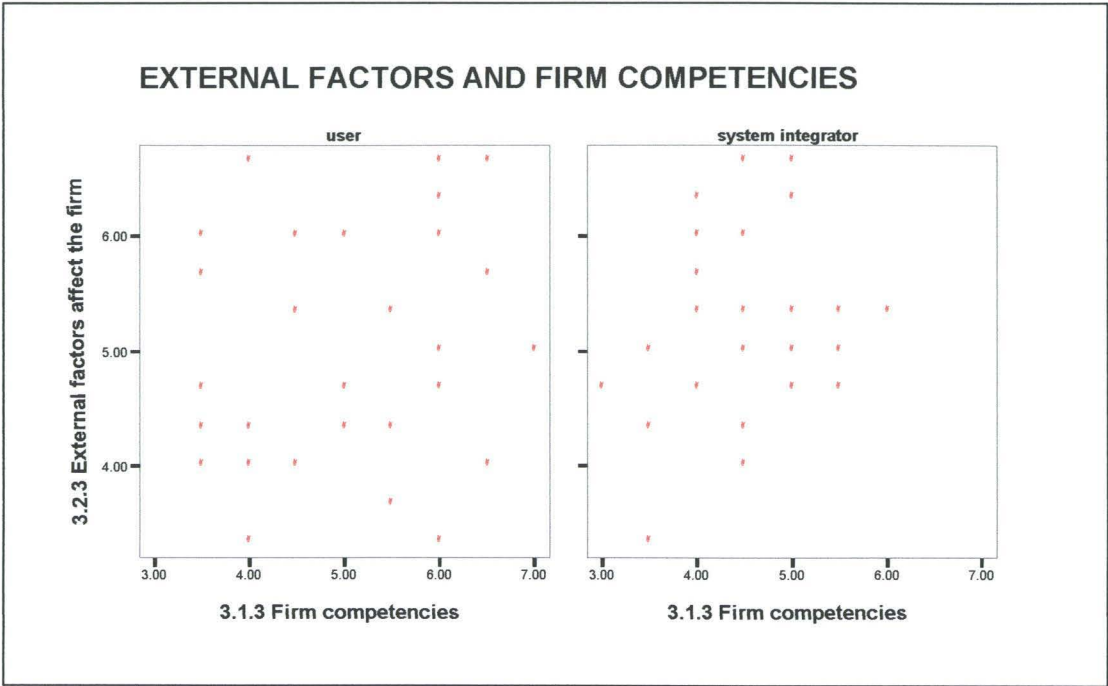


Figure L40: Scatter plots for external factors and firm competencies

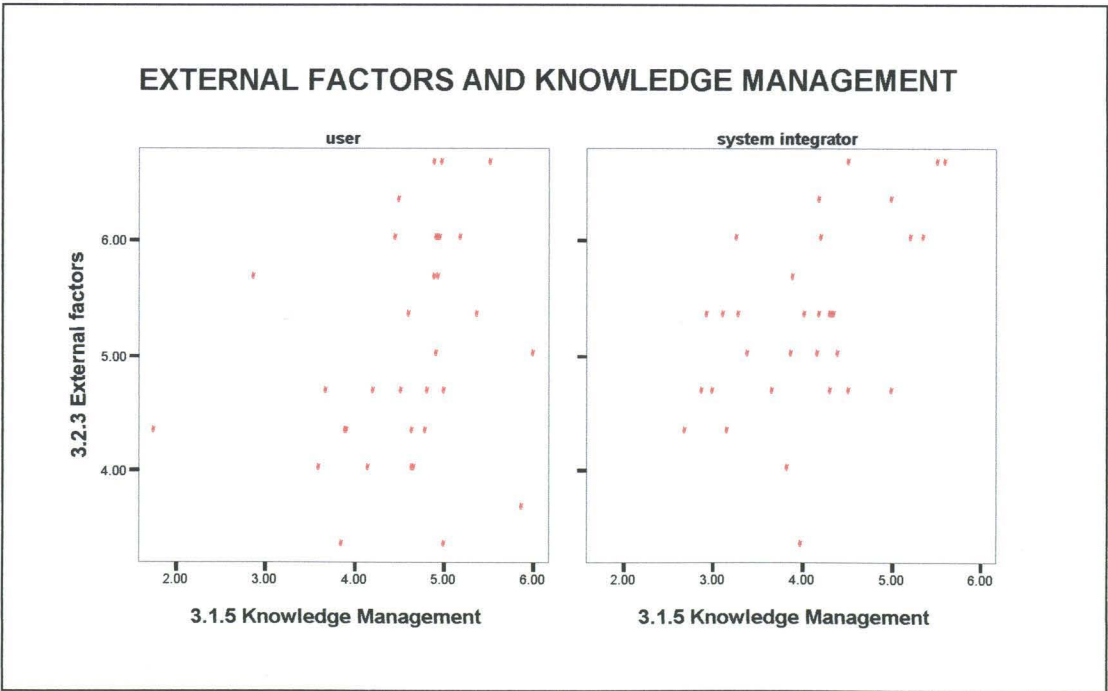


Figure L41: Scatter plot for external factors and knowledge management

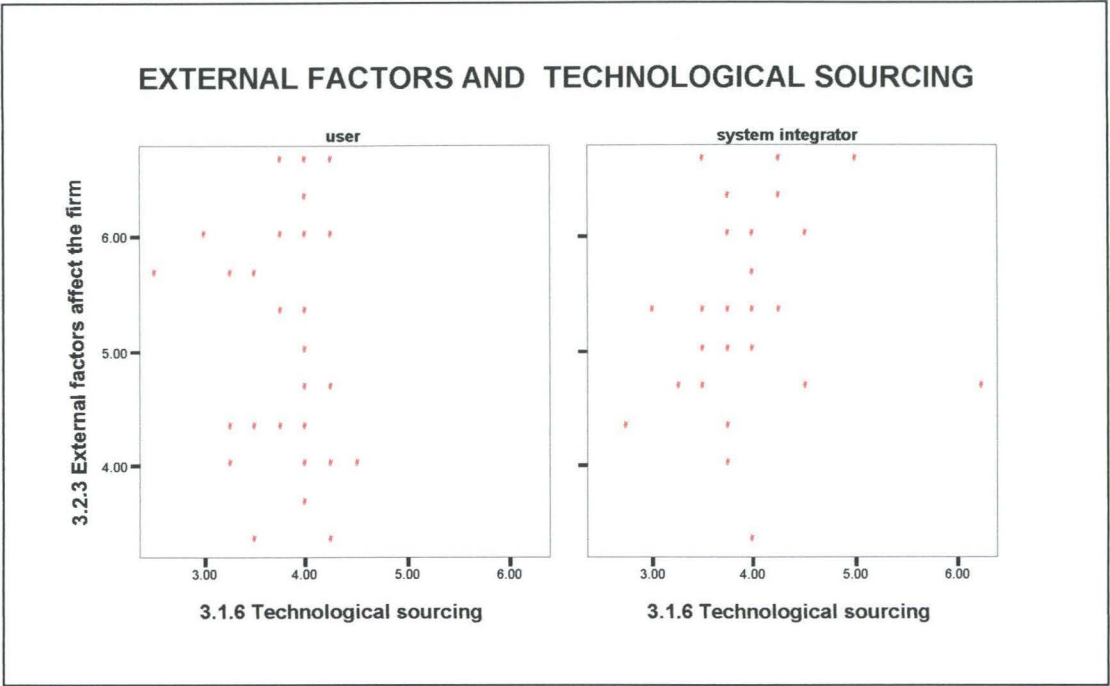


Figure L42: Scatter plot for external factors and technological sourcing

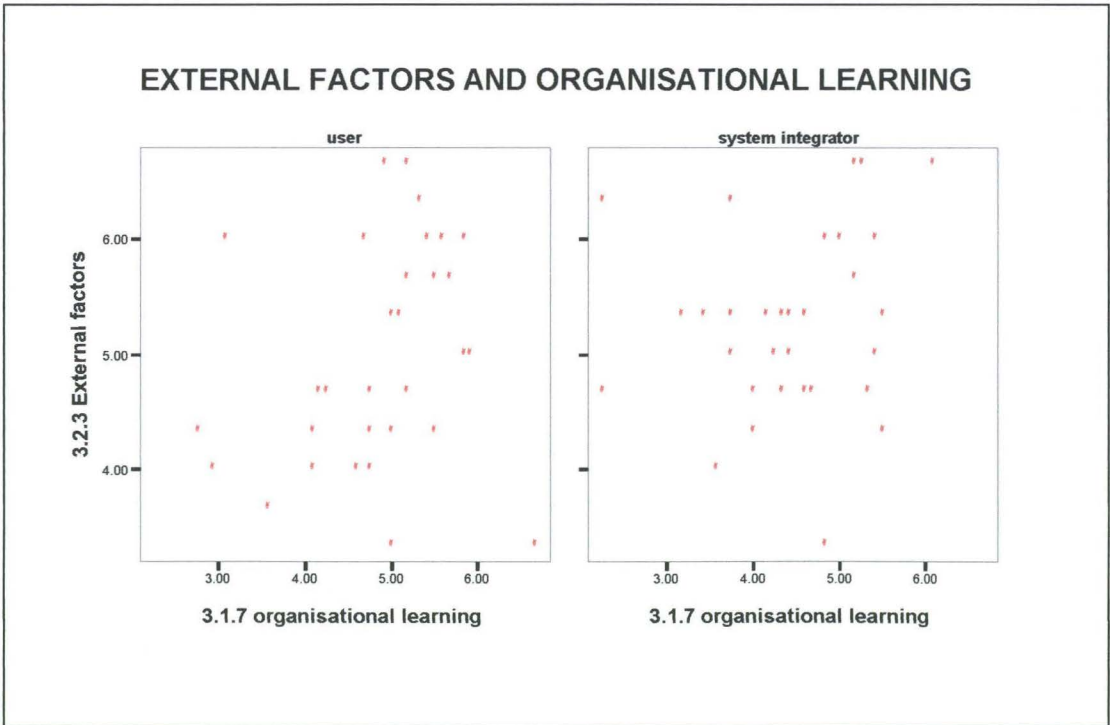


Figure L43: Scatter plot for external factors and organizational learning

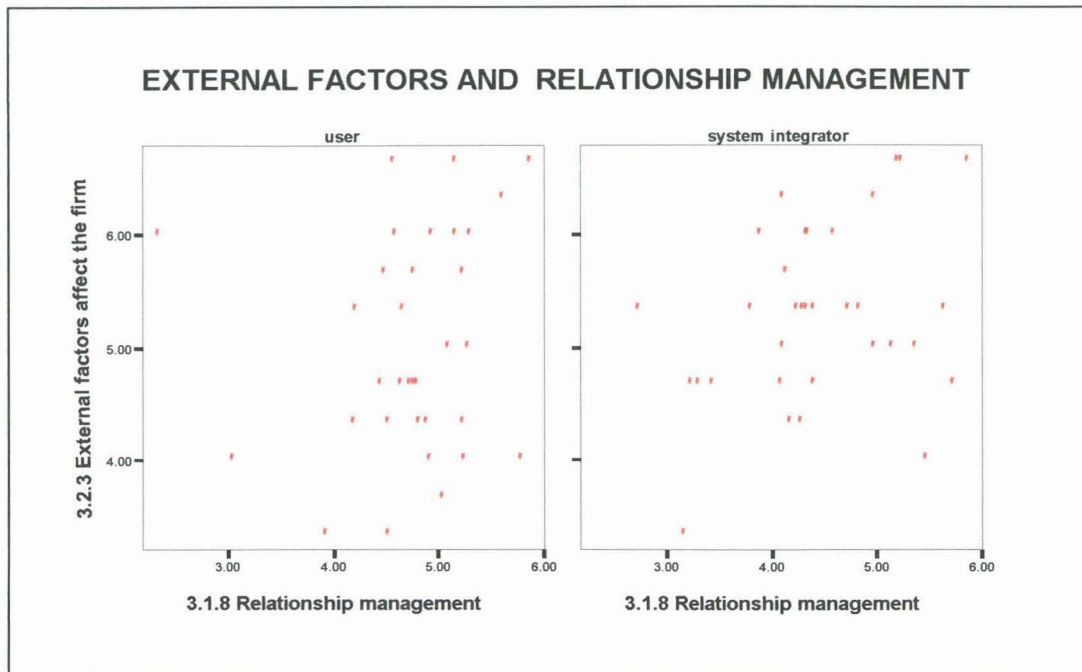


Figure L44: Scatter plot for external factors and relationship management

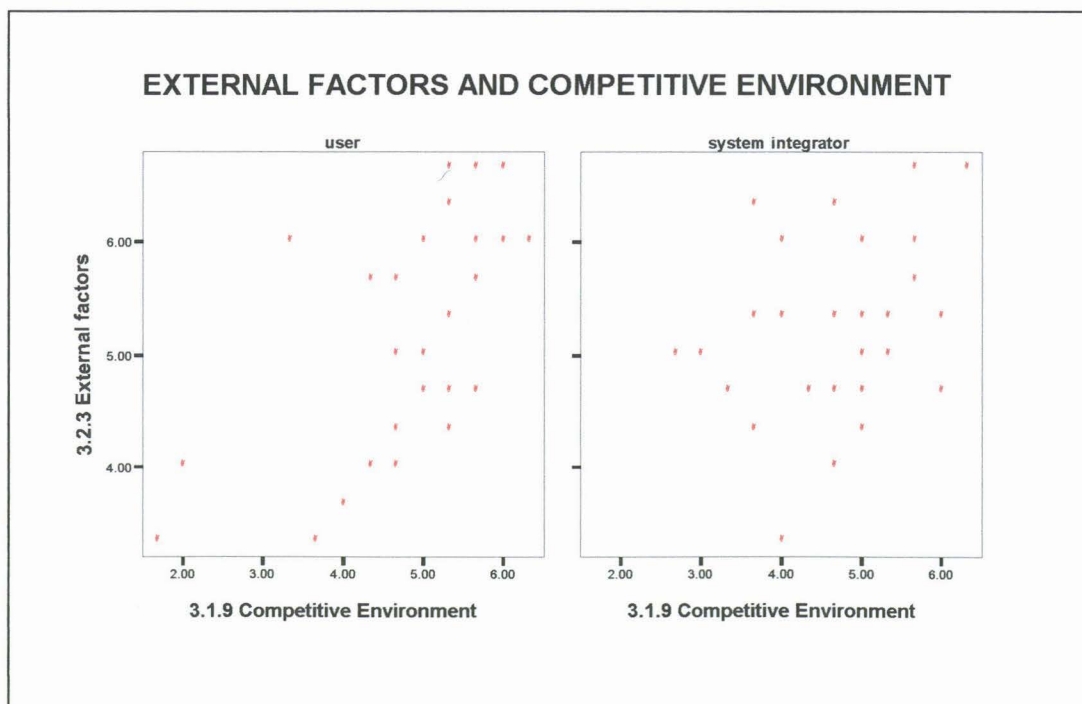


Figure L45: Scatter plot external factors and the competitive environment

Appendix M

Hay and Morris Model

As firms exist for economic reasons, economic theories of firms need to be explained and integrated. The integrated framework of firms and markets adapted from Hay and Morris (1991) (Figure M1) underpins the investigate framework for this thesis. The shaded arrows in Figure M1 demarcate the foundation for the research framework. The areas of focus are as follows:

- Management [3] affects efficiency [6], Investment R&D [15] and technology [1]. This means that the decisions that are made by management affect the efficiency [6] of firms because managers make process improvements regarding criteria such as cost, quality, speed, dependability and flexibility, which improve firm efficiency. In addition, management decisions involve and affect technology [1]. The adoption of technologies within and between firms affects the way people work. Technological adoption may result in competitive advantages. Managers also make investments in R&D, which results in the firm producing better products. It will be shown later that the product features, branding, etc, are no longer sufficient to sustain firm profit and growth. What is required are improvements in criteria like cost, quality, speed, dependability and flexibility. These improvements may lead to increased firm growth, which may be measured in terms of sales growth, return on sales and earnings growth. This is the basis for the first hypothesis, i.e. firms that adopt new technologies grow at different rates to other firms that maintain older technologies.
- Through technology [1] economies of scale [4] may be achieved. This may allow the firm to increase profit and growth [14]. In other words, the effects of technology implementation are more important than the technology itself. Managers are more concerned with the outcome than the adoption of the technological implementations. This is the basis for the second hypothesis, i.e. managers rate cost, quality speed, dependability and flexibility as being more important than technological leadership.

Figure M1 provides a foundation for the investigative framework that will be developed for this thesis. The framework will accommodate the drivers for technology management, i.e. organisational determinants, competitors, external factors (social, economic and political), and manufacturing mix criteria (cost, quality, speed, dependability and flexibility). These drivers are shown in Figure 2.1, the investigative framework. Thereafter the effects of technology management on transaction processes and governance structures will be investigated.

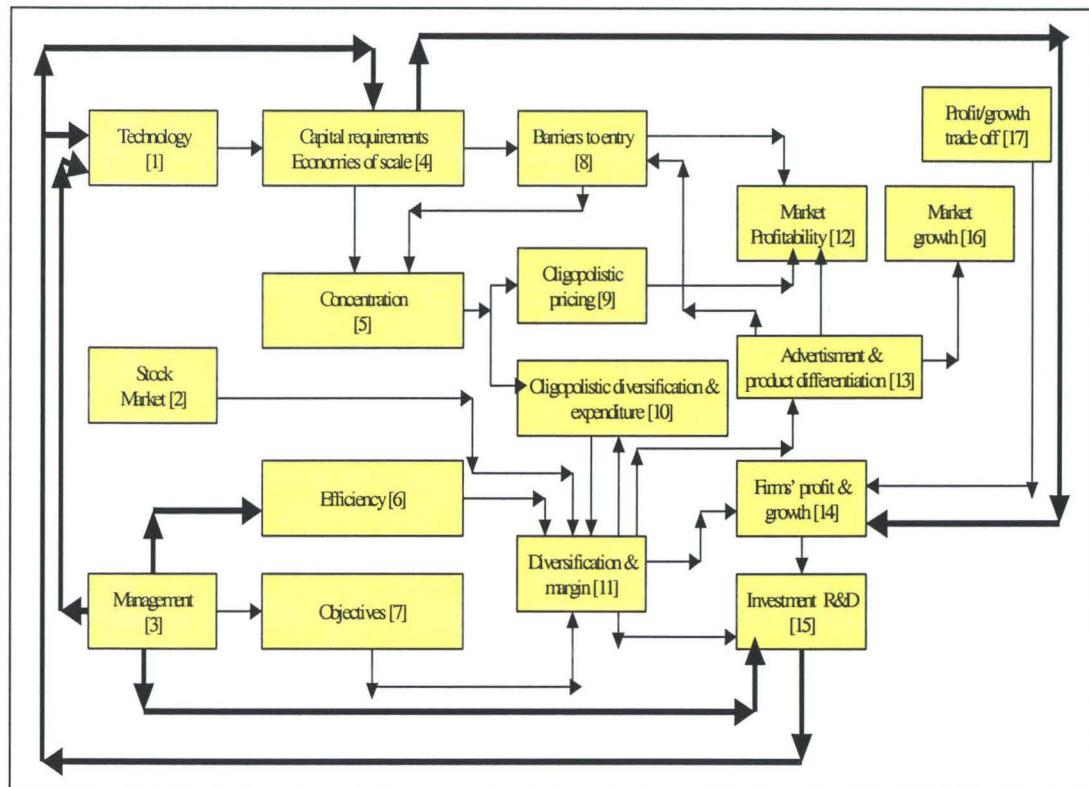


Figure M1: SCP Theory - The firm and the market: an integrated framework (Adapted from Hay and Morris (1991))⁶.

⁶ Adapted from lecture notes by Professor D.R. Snaddon, Barlow Chair of Industrial Engineering, University of Witwatersrand, Johannesburg, South Africa. (Engineering Economics notes from M.Sc. programme in Industrial Engineering, undated)

Appendix N

The business performance model

To substantiate the arguments posed, reference can be made to the capabilities model by White (1996) and the 'sand cone' model of Ferdows and De Meyer (1990). Referring to these models may help determine a particular sequence in which a firm's manufacturing capabilities may be developed. White (1996) summarises empirical evidence of relationships between manufacturing capabilities and business performance. Snaddon (1996, p.388) identifies these manufacturing capabilities as cost, quality, speed, dependability and flexibility, which he terms 'manufacturing mix criteria'. The work by White (1996) builds upon the framework of Skinner (1969). He postulated that firms could capitalise on manufacturing capabilities and use these capabilities as weapons for competitive advantages. The sequence for the development of a firm's manufacturing mix is the proposition of the second hypothesis, i.e. managers rate manufacturing mix criteria as more important than new technologies. In terms of this thesis, manufacturing capabilities are likened to manufacturing mix criteria, which include cost, quality, speed, dependability and flexibility. White (1996) proposes a model developed by meta-analysis shown in Figure N1.

The model is based on empirical evidence and arguments and proposes relationships that exist among competitive capabilities (manufacturing mix criteria). The following are some propositions of the model:

- The most direct relationships between manufacturing capabilities and business performance are those involving conformance quality, delivery speed, dependability and product flexibility, which lead to higher profitability as a result of lower costs. Conformance quality results in lower scrap, rework and liability, which therefore reduces manufacturing cost. Inevitably conformance quality also results in delivery dependability and product flexibility. The variables associated with conformance quality are response time and delivery speed as goods and services are supplied on time due to the reduction of wasted time related to rework. Changeover and set up times are reduced due to lower rework.
- The company's performance in respect of manufacturing capabilities will influence market share, which would also be influenced by marketing. The benefits associated with conformance quality, delivery speed, dependability and product flexibility (by our definition manufacturing mix criteria) result in speed competitiveness, dependability competitiveness, flexibility competitiveness and cost competitiveness, thereby offering a competitive edge for market share improvement.
- This provides an alternative explanation for models such as the 'sand cone'. In the 'sand cone' (Figure O1) cost efficiency is the last capability. In the proposed

model conformance quality, delivery speed, delivery dependability, product flexibility and cost reductions are directly related to business performance.

White (1996, p.330) asserts that the model explicitly does not cater for the time dimension, mainly because the data were primarily of a cross-sectional nature.

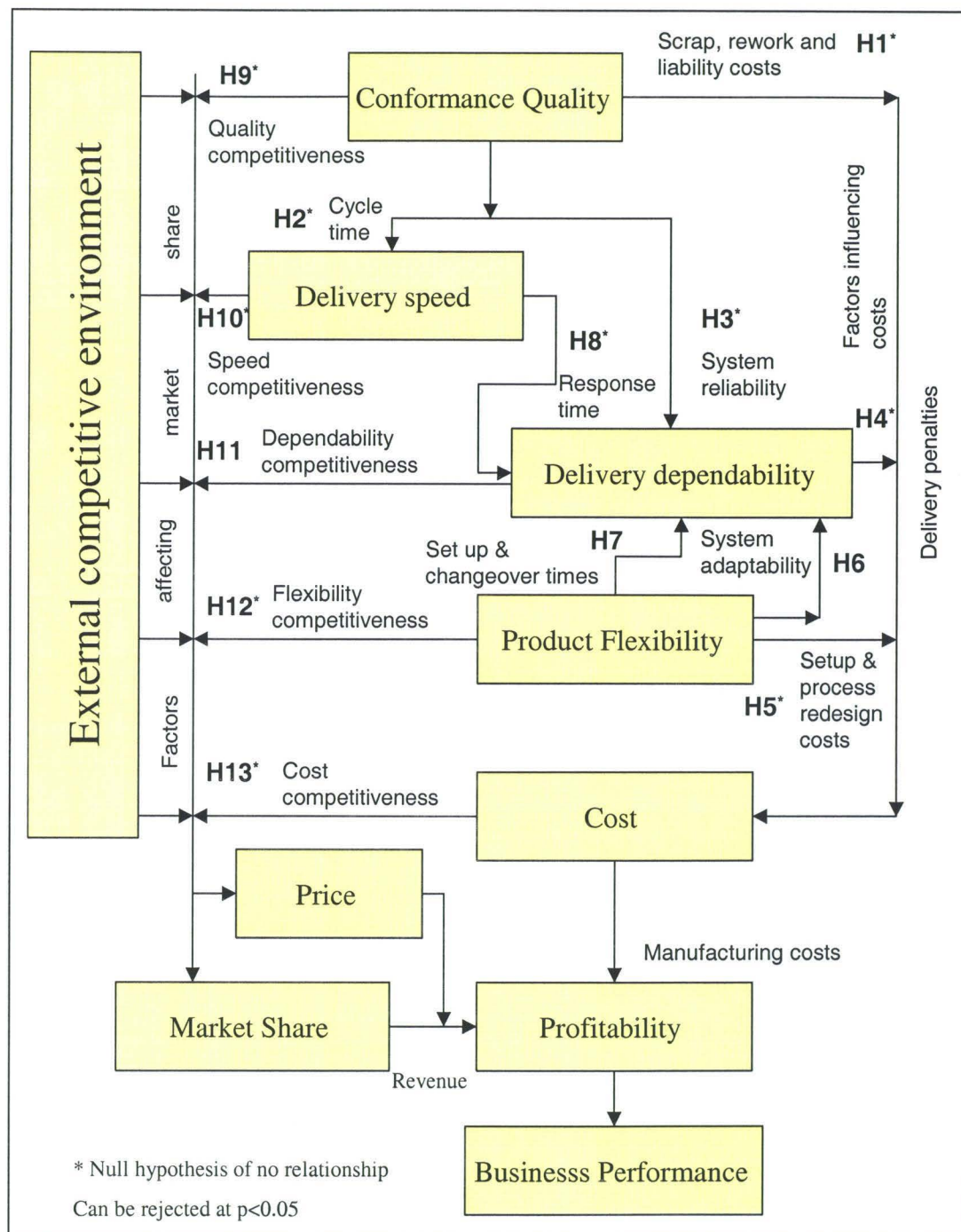


Figure N1: Model of manufacturing capabilities and business performance (Source White 1996, p.324)

White (1996, p.329) acknowledges that factors outside the control of manufacturing such as organisational structure or management style, may have effects that are not included in this model. The investigative framework and model proposed in this thesis will include factors like

organizational determinants, industry selection and positioning, organizational processes and administrative practises, managerial capabilities, etc. White (1996, p.329) also says that there is empirical evidence for relationships that have not been explicitly included such as the relationship between quality and flexibility. However their empirical support is limited. Recent work by Cohen and Levinthal (1990) allows for this dimension of absorptive capacity to develop the capability of innovation.

Appendix O

The Sandcone model

Other models like the sand cone model also try to prioritise manufacturing mix criteria. The sand cone model is discussed next.

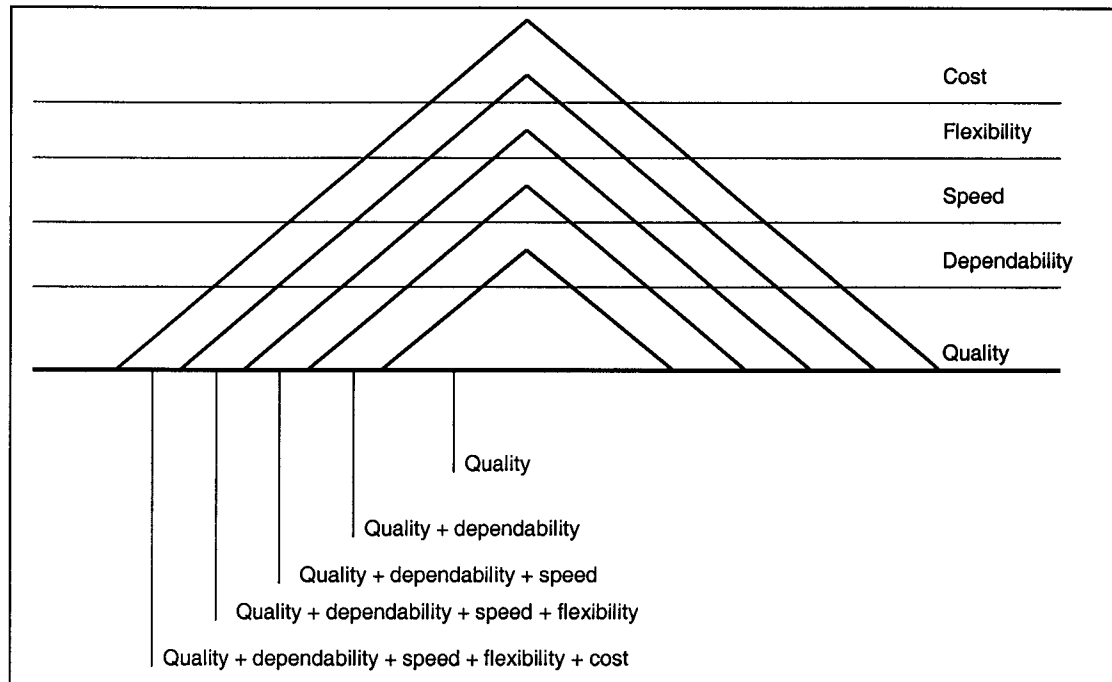


Figure O1: The Sandcone model (Source adapted from Ferdows and de Meyer (1990) and Slack (1991, p.115))

The Sandcone model starts with a foundation of quality and dependability, speed and cost are then added. White (1996, p.328) describes comparisons between the Sandcone model and the model proposed in Figure N1:

- Like the Sandcone model, the model by White suggests that quality is an important competitive capability to develop.
- Like the Sandcone model, cost capabilities are best developed later as cost is not shown as influencing any of the other capabilities but is influenced by them.
- The Sandcone model requires that quality comes first. The manufacturing capabilities and business performance model does not have this requirement. White (1996, p.328) supports this by saying that an example of this could be that a company begins by focusing on flexibility. This would lead to improvements in delivery speed and delivery dependability, and cost performance. This, however, will only be feasible if the company's existing levels of performance in conformance quality, delivery speed and flexibility are competitive.

Appendix P

Benefits and risks of manufacturing technologies

In both the models discussed, however, the impact of technology management, which forms the basis of this thesis, is not considered. Modern technologies may offer advantages in cost, quality, speed, dependability and flexibility. These benefits will offer competitive advantages to companies that invest in such technologies. Meredith (1987, p.252) gives the following benefits, costs and risks of new technologies.

Table P1: Benefits and risks of manufacturing technologies source Meredith (1987, p.252)

Technology	Technology Benefits											
	Flexibility	Quality	Lead time	Cycle time	Reduced labour	Reduced inventory	less space	Image	Capacity	Safety	Cost	Risk
NC,DNC,CNC	++	++	+	+	++	+	+	+	+	+	-	-
Robots	++	++	+	+	++	+	+	++	+	++	-	-
GT	+	+	++	++	+	++			++		-	-
CAD	++	++	++		++			++			-	-
CAE	++	++	++		++			+			-	-
CAPP	++		++		++						-	-
CAM	++	++	+	+	++	+	+	++	++	+	-	-
AS/RS			+	+	+	+	++	++	+	+	-	-
FMS	++	++	+	++	++	+	++	++	++	+	-	-
MRP II			+	++	+	+			++		-	-

+ An improvement over current technologies
++ A significant advantage of this technology
- A negative cost or risk aspect of the technology
- A significant cost or risk disadvantage

However Meredith (1987, p.252) points out that the actual benefits and risks of any one of these technologies depend on the situation in which it is used and how it is implemented. The primary benefits shown in the table above are clearly flexibility, quality, lead-time and reduced labour. It may therefore be argued that technological implementation leads to benefits in manufacturing mix criteria. These benefits then lead to competitive advantages.

Appendix Q

Dynamic Capabilities View

This approach has two additional aspects, which were not part of the competitive forces and resource-based models. Teece, Pisano and Sheun (1997, p.515) state that the first term, "dynamic", refers to the ability to renew competencies to achieve congruence/equilibrium with the changing business environment. The second term, "capabilities", looks at the role of strategic management in adapting, integrating and reconfiguring internal and external organisational skills, resources, and functional competencies to match the requirements of a changing environment. In this changing environment certain innovative processes are required when time to market and timing are critical, the rate of technological change is rapid and the nature of future competition and markets is difficult to determine. The time to market, rate of technological change and the nature of competition and markets are all affected by the firm's ability to develop and utilise resources effectively. The coupling of the TCE, RBV and KBT as suggested by some authors certainly has some merit. The ability of firms to first develop firm-specific capabilities and the manner in which they renew competencies to respond to shifts in the business environment relate to the firm's processes, market positions and expansion paths. Teece, Pisano and Sheun (1997, 516) maintains that there are different approaches to strategy. These can be described as follows:

- The competitive forces model sees strategy in terms of industry structure, barriers to entry and positioning.
- Game-theoretic models see strategy as the interaction between rivals with certain expectations about how the other one will behave.
- The resource based approach focuses on the exploitation of firms' specific assets.

Teece, Pisano and Sheun (1997, p.516) maintains that to focus on that which is strategic, we have to know what is not strategic. He says that for a capability to be strategic, it must be directed to a unique user need, and be difficult to replicate. It must be unique so that the products/services can be priced without too much competition. Porter (1991, p.108) also suggests that what makes resources valuable is that they are superior to use, hard to imitate, difficult to substitute and more valuable within the firm than outside the firm. To understand what makes firms competitive, we have to understand how they function. The exchange process inside and outside firms differs. Teece, Pisano and Sheun (1997, p.517) argue that firms are different in that they have competencies/capabilities which are processed to get things done and which cannot be accomplished by using a price system. Teece, Pisano and Sheun (1997, p.518) list three classes of factors that determine a firm's competence and dynamic capabilities, namely process, positions and paths. Each of these factors will now be discussed.

Process

Teece, Pisano and Sheun (1997, p.518) go on to say that a firm's competitive advantage lies in its managerial and organisational processes, which are constrained only by the firm's specific asset position and paths available. Some of the following authors also subscribe to this school of thought:

- Mahoney and Pandian (1992, p.367) say the total managerial services of a firm are partly constrained by the necessity to run the firm at its current size, while exploring new ventures.
- Tallman (1991, p.70) say that competitive strategies are based on FSRs.

The authors argue that strong managerial capabilities and organisational processes are still important factors for the competitiveness of firms. It must, however, be remembered that managerial capabilities and organisational processes are influenced by FSRs. In terms of this thesis the benefits could be measured or correlated by improvements in manufacturing mix criteria. Pisano (1994, p.87) asserts that the fundamental challenge of process development is quite similar across industries, despite differences in specific activities. Teece, Pisano and Sheun (1997, p.518) looks at managerial and organisational processes as the way things are done in terms of routines or methods of current practice and learning. The authors divide organisational and managerial processes into three parts namely, co-ordination/integration, learning and transformation processes. Each of these three parts will be discussed in the paragraphs that follow.

Coordination and integration: Managers co-ordinate and integrate activities within a firm. Therefore they influence strategic advantages and firms' competitive advantages by the integration of external activities and technologies. The ability of managers to adopt and integrate new technologies into work processes such as alliances, buyer-supplier relations, external integration of suppliers, outsourcing, core competencies, etc, is what make firms distinctive. Teece, Pisano and Sheun (1997, p.519) cites Gavin (1988), in a research study of air conditioning plants. He found that quality performance was driven by organisational processes. These processes included methods for gathering and processing information, which was used to link customer experiences with engineering design alternatives/choices and for co-ordinating factories and component suppliers. Teece, Pisano and Sheun (1997, p.519) relate much of the benefits in development cost, development lead times and quality to the efficient gathering and processing of information. Teece, Pisano and Sheun (1997, p.519) argue that organisational processes display complex levels of integration and in such cases, replication may be difficult because of the systematic changes throughout the organisation and inter-organisation linkages which may be hard to re-create. The author adds that there is some rationality to processes and systems, which is different from corporate culture, corporate culture itself being a governance structure in terms of individual behaviour and economising on administrative methods. Having discussed the relative advantages of co-ordination integration, the learning aspects are discussed next.

Learning is a process that improves performance through repetition and experimentation. It allows new production opportunities to be identified. Teece, Pisano and Sheun (1997, p.520) says that in the context of the firm, learning involves organisational as well as individual skills. Moreover learning requires common codes for communication and co-ordinated search procedures. Teece, Pisano and Sheun (1997, p.520) say that organisational knowledge generated by these activities resides in new patterns of activity, in routines or a new logic of organization. It is the interaction of these methods and processes that generates solutions to problems. Pisano (1994) also support learning as a driver for competitive advantage. Pisano (1994, p.86) says that if proficiency at a particular activity is critical to competitive advantage and such proficiency can be improved over time, then learning must play a key role in the competitive advantage of firms. He also states that without learning it would be difficult to imagine where a firm's unique skills and competencies originate.

Pisano (1994, p.86) argues that not only do firms continually create and implement new organisational and technical processes through R&D, but they also re-engineer business processes such as customer services, order fulfilment and distribution. He maintains that the fundamental challenges of innovation lie not only in designing processes but also in implementing and replicating them within the firm. Pisano (1994, p.86) proposes two strategies for learning namely, 'learning-by-doing' and 'learning-before-doing'. He defines these two strategies as follows: learning-by-doing occurs where prior knowledge is weak; high-fidelity feedback requires experimentation in the production environment. Learning-before-doing occurs where reliable theoretical models and heuristics exist. The author emphasises that the concept of learning-by-doing stems from the fact that only through actual production experience can a firm discover process problems that determine the difference between actual and potential performance. He also says that experiments in factories are costly but production plants should nevertheless become venues for experimentation early in the product development cycle because test conditions will be different to actual production conditions. As an alternative, formal or informal models should be used where possible. In research conducted in the pharmaceutical industry, Pisano (1994, p.98) concludes that there is no one best approach to learning (learning-by-doing or learning-before-doing) it all depends on the firm's knowledge environment. Having understood the aspects of learning, the transformation processes are discussed next.

Transformation is a process that enables firms to adapt to rapidly changing environments. As environments change, firms have to transform internally and externally. This requires continual market surveillance, new technologies and a willingness to adopt this practice. Therefore this could involve market research, benchmarking, competitor analysis, etc. Teece, Pisano and Sheun (1997, p. 521) state that the ability for a firm to reconfigure and transform itself is a learned organisational skill. They maintain (1997, p.521) that change is costly and

therefore economizing measures must be taken. Transformation of information may take different forms, one of these forms being replication.

Replication is more than a simple transformation of information. It requires the understanding of information and transparency regarding processes. In addition the firm undertaking replication must have the foundations in place for learning and improvement. Teece, Pisano and Sheun (1997, p.525) say that there is considerable empirical evidence supporting the notion that the understanding of processes, both in production and management, is the key to process improvement. Teece, Pisano and Sheun (1997, p.525) maintain that a firm cannot improve what it does not understand. Imitation occurs when firms simply copy another firm's organisational processes and procedures. It is simply replication performed by a competitor. The barriers to imitation are similar to that of replication and therefore the tacit nature of a firm's productive knowledge is itself a barrier. Nelson (1991, p.69) argues that technological imitation often requires the imitating firm to go through many of the same design, development, implementation and production processes that the innovator did. Therefore firms with similar capabilities and strategies are in a better position to imitate or learn from and build upon each other's work than are firms with different strategies and capabilities. Other barriers to entry could include intellectual property rights, trade secrets and trademarks, etc.

Mahoney and Pandian (1992, p.371) are of the opinion that sustainability of rents is also a barrier to imitation. In terms of product technology, reverse engineering is a means of replication. However, in process technology this kind of copying is not apparent. Process technologies have the added advantage that processes need not be revealed so that competitors can learn about them, but the relationship with suppliers can open the door to opportunism. Processes, however, are embedded in intangible technologies. Intangible technologies are embedded in the skills of individuals. Intangible technologies will be discussed later, in Chapter 3. The ability of firms to control the flow of information and knowledge transfer between firms is a mechanism that may be used to prevent copying. This can occur when suppliers divulge process technology to competitors, or in partnerships where firms have opportunistic reasons for joining partnerships or forming alliances. Researchers opinions on this differ:

- Hamel, Doz and Prahalad (1996, p.593) says that using an alliance with a competitor to acquire new technologies or skills is not devious but reflects the commitment of each partner to absorb the skills of the other. Hamel, Doz and Prahalad (1996, p.595) also state that when both partners are equally intent on internalising the other's skills, distrust and conflict may spoil the alliance and threaten its survival.
- Ring and Van De Ven (1992, p.489) assert that firms with a history of successful transactions are less likely to be hampered by the effects of information asymmetry. This is because they will more freely share information that reduces

technological or commercial risk with each other. They will place greater reliance on parties not to act opportunistically when given access to proprietary information.

As can be seen from the above at least two authors see monitoring and control of information and knowledge between partners as a possible source of barriers to entry. Positions are discussed next.

Positions

Teece, Pisano and Sheun (1997, p.518) say positions are taken as current specific endowments of technology, intellectual property, complementary assets, customer base and external relationships with suppliers and complementors. They maintain (1997, p.521) that market position firm is determined by its learning processes, the interaction of internal and external processes, incentives and the firm's specific assets (specific assets being the firms specialised plant and equipment). He says that these assets consist of the following:

- Technological assets, which may or may not be protected by intellectual property law. These are among the differentiators between firms for competitiveness.
- Complementary assets are assets required to produce and deliver new products and services. These assets have secondary uses as well and lie lower down in the value chain.
- Financial assets are a firm's cash position and degree of leverage, which may have strategic implications.
- Reputation assets are responses of customers, suppliers and competitors to the firm. It is difficult to differentiate between a firm's financial assets and market position. Reputation assets are intangible assets but they also enable firms to achieve goals in the market. They are predominantly externally focused and therefore often based on perceptions rather than actual knowledge.
- Structural assets are the elements of the firm-specific structure such as vertical and lateral integration.
- Institutional assets, are public policies, antitrust laws, and regulatory and intellectual property regimes. The author says that such assets may not be entirely firm-specific.
- Market assets are product market positions, i.e. the market in which a firm competes.
- Organisational boundaries are the location of the firm's boundaries; in other words the degree of vertical, lateral and horizontal integration.

As can be seen positions are considered to be important. Paths are discussed next.

Paths

Paths are referred to as strategic options, that are available to the firm, and the presence or absence of increasing returns and attendant path dependencies. Teece, Pisano and Sheun

(1997, p.523) say that a firm's history constrains its future behaviour because learning tends to be local. Put differently, opportunities for learning will be concentrated on previous methods. If too many technologies are implemented simultaneously, the ability to differentiate between cause and effect will be difficult. Teece, Pisano and Sheun (1997, p.523) focus on technological opportunities and assessments. These areas are discussed next.

Teece, Pisano and Sheun (1997, p.524) assert that technological opportunities are affected by the organisational structures that link institutions engaging in basic research (primarily universities) to the business enterprise. Therefore technological opportunities can be quite firm-specific.

Assessment reveals the opportunities that lie in constraints imposed by processes, positions and paths and are ignored in the competitive forces and strategic conflict model. Teece, Pisano and Sheun (1997, p.524) maintain that what the firm can do and where it can go are constrained by its positions and paths, and its competitors are likewise constrained. The author says that the firm is much more than the sum of its parts. Individuals can be moved in and out of firms to some extent as long as the internal processes and structures remain in place. In such instances performance will not be impaired. Teece, Pisano and Sheun feel that a change in the environment is far more crucial than the loss of individuals since it is easier to replace individuals than to transform a firm.

In summary we can say that the competitive advantage of firms lies their competencies and capabilities which may be enforced by processes, and governed by positions and paths. This competitive advantage can only be diminished if the competence no longer matters in the marketplace or if it can be replicated, imitated or emulated by competitors.

Appendix R

Technological implementation a value chain perspective

The functions in a firm involve customers, suppliers, products, processes, etc. These functions involve transactions within and between the firm. Each of these fields involve some kind of technology which is used in the day-to-day operations. It is the integration of these technologies in each of the areas that facilitate the flow of information, material, people and money through the firm. These functions are cumulatively referred to as a 'value chain'. Improvements in the value chain may lead to competitive advantage. The value chain includes activities in marketing, design, manufacturing, logistics and distribution.

Managers in firms have tended to regard some aspects of the value chain as less important than others. An example is the case of manufacturing systems. Top management, however, distance themselves from such decisions in the company as they believe that the firm's growth and success have been based on engineering and R&D and therefore process improvements are routine and require a lower level of complexity and brainpower (Skinner (1969, p.140). Skinner (1969) relates this behaviour to two issues: firstly, a sense of personal inadequacy on the part of top management who often have the tendency to regard this area as a technical or engineering speciality; secondly, a lack of awareness that technological investments in process technology involves trade-offs and compromises which have to be related to the firm's strategic objectives. Goldhar and Jelinek (1983, p.141) suggest that manufacturing systems often represent the lion's share of a firm's human and financial assets, but managers have been slow to acknowledge the central importance of these systems to the overall performance of their organizations. Therefore it may be argued that such decisions should not be passed to the lower levels of the firm without some intervention. Even though Goldhar and Jelinek refer to manufacturing decisions, the decisions relating to technological investment also apply. The benefits associated with manufacturing systems are discussed next. These benefits may allow managers to become more involved in areas like manufacturing, logistics, distribution and other operational areas.

Computer-integrated manufacture or management

Firms are moving towards a new business model that challenges the idea of fixed corporate boundaries to include internal and external customers, suppliers, vendors and partners. There are many challenges facing firms. These may be external and/or internal. The external challenges facing firms are as follows:

- Niche market entrants
- Traditional competition
- Suppliers
- Global economy
- Cost of money

- Customers

The following are the internal challenges facing firms:

- Analyse every product and agree on the order-qualifying and order-winning criteria for the current conditions for every product.
- For every product, project the order-winning criteria in the market in the future.
- Determine the fit between the criteria necessary to succeed in the market place and the current capability in the organisation.
- Change or modify either the marketing goals or the manufacturing process choices and infrastructure to enforce internal consistency.

These challenges require a holistic approach towards the value chain. Computer integration across the value chain may provide opportunities for competitive advantage. Upton (1995, p.75) says that a high level of computer integration can provide critical advantages in quality and cost competitiveness, but for operational flexibility it is the individuals in firms and the extent to which managers cultivate, measure and communicate with these individuals that is important. Equipment and computer integration are secondary. This has sparked the market for value chain management solutions that merge form marketing, engineering, manufacturing, logistics, distribution and operations into an integrated offering. This integrated approach of people, processes, systems and technologies may provide added advantages. Upton (1995, p.75) states that: "most managers put too much faith in machines and technology, and too little faith in the day-to-day management of people". In view of this statement it may be concluded that technology is only part of the system, which together with people leads to competitive advantage. Integrating technology and management constitutes a synergetic approach to CIM (computer integrated management).

There are many definitions of CIM but for the purposes of this thesis the definition given by Luscombe (1993) will be used: "CIM is concerned with the integration of commercial, financial, engineering and production systems to improve responsiveness, quality, cost and competitiveness. Rosenthal (1984, p.204) provides a CIM umbrella to include computer hardware, software and data bases, which are joined with shop floor robots and other automated equipment to form an integrated, highly automated and flexible manufacturing system. Upton (1995, p.84), however, finds that the right mix of machines, computer systems and people and finding out the most effective way to use them is what is required. He says "people count more than machines". Skinner (1969, p.142) notes that the majority of earlier failures associated with manufacturing strategy could be allocated to the technical emphasis, which often produced an inward focus towards cost that ignored the customer, markets and service. Skinner (1969, p.140) points out that the variables of cost, time, quality, technology and customer satisfaction place constraints on what managers can do, force compromises, and demand an explicit recognition of a multitude of trade-offs and choices. Skinner (1969, p.138) also says that there is a lack of awareness among top executives that a production system inevitably involves trade-offs and compromises and so must be designed to perform a

limited task as well, with that task being defined by corporate objectives. Upton (199, p.745) agrees that achieving low cost and high quality is no longer enough to guarantee success. He says that the trend is towards low-cost competition, high quality suppliers and flexibility as a way to achieve new forms of competition. The CIM vision is one of total business integration, with local, departmental systems, no data that is duplicated unnecessarily, and no barriers between different functions. This view is no different from that of White (1996) and the Sandcone model of Ferdows and De Meyer. To gain a better understanding of the synergies that exist between the different technologies, technologies are classified into different categories.

For this thesis we will use the AMT classification suggested by Meredith (1987). The term 'AMT' (Advanced manufacturing technologies) will be used as an umbrella term as defined by Boyer, Ward and Leong (1996), that applies to a variety of technologies that utilise computers to control, track or monitor manufacturing or business activities either directly or indirectly. Technologies such as CAD, CAM, CNC, CAPP, EDI, FMS, ERP, e-commerce, etc., involve the use of computers to control tools and machines, store product information and control the manufacturing and business processes. In addition several technologies that do not directly involve computers are considered to be AMTs such examples include bar-coding, GT, etc. Boyer, Ward and Leong (1996, p.299) cite Meredith (1987) who says that AMT classification in terms of their application will include engineering, manufacturing, or business planning. The activities will be broken down as follows:

- Engineering to include activities such as CAD, CAM, CAPP, which are generally the first type of AMTs to be implemented.
- Manufacturing equipment to include robots, FMS and automated materials handling.
- Business planning systems to include MRP, JIT, etc.

Several other authors offer classifications for AMT and these are shown in Table R1, adapted from Boyer, Ward and Long (1996, p.300). As can be seen from the table, the authors are generally consistent regarding the classification of AMTs. The authors indicate that the AMT typologies are conceptually based and therefore lack empirical validation. It would therefore be supportive to conduct a meta-analysis of these AMT typologies.

Table R1: AMT classifications adapted from Boyer, Ward and Leong (1996, p.300)

AMT classification	Rosenthal (1984)				Meredith (1987)			Adler (1988)			Lei & Goldner (1991)			Saraph & Sebastian (1992)		Totals
	CAD	CAD/CAM	CAM	Factory management and control	Engineering	Manufacturing	Business	Design	Manufacturing	Administrative	CAD	CAM	Planning	Process Technology	Planning Software	
Design																
CAD	x				x			x			x			x		5
CAE					x			x			x					3
CAPP				x	x						x					3
Manufacturing						x										1
CNC			x			x			x			x		x		5
CAM		x				x			x			x				4
FMS			x													1
Automated handling			x			x			x			x		x		5
Cellular manufacturing						x										1
GT					x	x	x								x	4
Robotics			x			x										2
Administrative								x								1
MRP				x			x			x			x		x	5
JIT													x		x	1
Shop floor control				x						x			x			3
MRP II										x			x		x	3
Activity-based accounting										x						1

Upton (1995, p.83) points out that CIM is a tool rather than an end in its self. CIM may exclude most individuals in a firm from the process of shaping and improving the way the firm runs. Modern technological systems across AMTs coupled with knowledge management and organizational learning, have attempted to close this gap. New and emerging technologies to improve information flow and knowledge transfer are a means to close the technology gap. Managers must be aware of these constraints. ERP (Enterprise resource planning) systems allow managers to implement and integrate technologies and business processes into an integrated unit. ERP typically integrates internal suppliers and customers and does not extend beyond the firm. The use of ERP applications to extend the firm is one of the fastest growing trends in business today. ERP packages are increasing their capabilities by either building or acquiring bolt-on modules for supply planning, scheduling, demand planning, and logistics management. Extending links outside the firm has advantages in terms of information management. Rapid technological change makes information management difficult as market factors change quickly and this makes it difficult for managers to keep abreast of the latest market environment. Several authors have identified information management as a driver for competitiveness these authors include:

- Lorenzoni and Lipparini (1999, p.320) who say that the ability to interact and share knowledge with other companies is a distinctive organizational competence for firms that are transactionally intensive.
- Dyer (1997, p.547) who says that the high degree of information sharing reduces information asymmetries, thereby reducing contracting and monitoring costs, because both parties are negotiating with similar information.
- Hamel (1991, p.83) talks about firms as a portfolio of core competencies and disciplines and this suggests that inter-firm competition, as opposed to inter-

product competition, is concerned with the acquisition of skills. He says in this view "global competition is largely a function of the firm's pace, efficiency, and extent of knowledge accumulation."

- Shapiro (1989, p.ix) talks about the current shifts in technology, he goes beyond the e-commerce hype and discusses how firms are using technology in innovative ways and how technology can foster innovation. This innovation looks at the signalling and control of information between firms and could lead to strategic advantages.

To survive in competitive business, management has to take cognisance of all technologies available and consider how best to apply them. The AMT typologies proposed by Boyer, Ward and Leong (1996) and the integration thereof, support this stance. In addition Boyer, Ward and Leong (1996, p.298) say that one of the primary objectives of AMTs is the capability to combine economies of scale with economies of scope to achieve both flexibility and efficiency. Upton (1995, p.74) showed us that many computerised systems have been installed with a failure to improve flexibility, the main reasons being that managers did not understand exactly what is meant by flexibility.

Upton (1995, p.76) shows that up to 40% of flexibility improvement programmes proved to be unsatisfactory and, he traces the cause to a failure to identify precisely what kind of flexibility is needed, how it should be measured and which factors affected it most. Upton (1995, p.79) points out that many computer systems have been installed for reasons other than improving flexibility. These reasons include facilitating the tracking and delivery of information and improving the quality of the process and such objectives were accomplished. The new industry sector enhances communication and commerce, and increases the value to customers. Shapiro (2002, p.3) says the current shift in technology is the most exciting yet-the convergence of the internet, WWW, e-mail, telecommunications, computer networks. This leads to an era of collaboration, integration and innovation. The business driver is fierce global competition that:

- Forces companies to reduce product cycle time.
- Responds to a more versatile and segmented demand.
- Gets to market much faster than in the past.
- Focuses on core competencies and out-sources non-core activities.
- Partners with key strategic suppliers.
- Provides their customers with immediate access to information.

Fierce global competition is being enhanced through digital economies. New technologies like the Internet, WWW, email, telecommunications and computer networks have the potential to change existing business models.

The digital economy

Stonehouse et al (2000, p.31) says that globalisation will force industries to focus on worldwide competition, with opportunities for economies of scale and scope, rapid technological change, common technical standards and favourable trading conditions. This will extend the barriers of the firm to worldwide competition.

To understand the implications of the digital economy, it is necessary to elaborate on what the future transactional chain will look like. The competitive advantage for manufacturing companies has shifted fundamentally. In the 1980s the main management tool for change was quality. Total quality and continuous improvement helped companies to adjust to the newly emerging global situation. Business process re-engineering shifted the attention in the 1990s to new business processes, management practices, organisational structures and methods of working. However BPR is in trouble. The improving customer service idea behind BPR will not be adequate for success in the future. Old business processes diehard and people resist change. Companies need to go beyond re-engineering the transformation of the corporation enabled by information technology. BPR is necessary but will be an inadequate condition for competitiveness in the new millennium. The new economy will be based on knowledge. The application of human know-how to everything that is produced and how it is produced becomes crucial.

As regards global competition the shift is away from production towards collaboration and integration with customers and suppliers. Understanding customer requirements assists in achieving competitive advantages. Suppliers and customers will become a continuous part of the firms end-to-end processes. Firms take input from suppliers and add value to create outputs that are required by customers. Managing suppliers and their costs, leveraging firm core competencies and understanding the requirements of customers enable products and services to be successfully marketed. Lorenzoni and Lipparini (1999, p.330) provide evidence that the willingness to interact with suppliers as external sources of knowledge and to access their complementary capabilities were driving forces behind the improvement of network structures. In addition, techniques such as supplier evaluation schemes, frequent seminars with key suppliers on issues such as TQM, stock reduction, strategic cost analysis and techniques aimed at improving responsiveness were used. The value chain concept is applicable to relationships within firms. Organisational exchange by physical means (paper documents such as letters, reports, invoices, computer printouts, telephone calls, etc. is becoming less important). Now computer systems are internal to each organisation and are being used for transactions and communications, extending beyond the firm to customers, suppliers, partners, and even competitors. The physical exchange is becoming a virtual exchange. The virtual exchange reduces costs, speeds up communications, provides more timely information, and enables new kinds of relationships between firms and people.

The focus for the future is to integrate manufacturers and suppliers and the outcome will be to have strong supplier relationships, which can be achieved through holding partner firms hostage, but also through goodwill and trust, joint sharing of risks and benefits, etc. Suppliers and manufacturers should become focused on a single goal, which would benefit both parties. The focus will be on partnership agreements rather than formal contracts. The new focus will enhance communication, information sharing and value to customers.

Some of the technologies that are used in each area are shown in Figure R1. It shows the interfaces of functions in a firm and the value chain with applicable technologies for implementation. An example of inbound logistics is the firm's interfaces with suppliers. Technologies such as communication systems that include telephone, faxes, e-mail, EDI, etc can be used to communicate between the firm and suppliers. An information system would also be required to monitor and control inbound logistical functions. Such an information system could be the firm's management information system, which would give feedback on supplier deliveries, lead times, quality, delivery costs, etc. The adoption and effective use of technologies in each functional area and the interfaces between these technologies are what gives firms added advantages for competitiveness. The speed of information transfer between functions (including sections of firms) is what enables the firm to react to changes, thus creating faster throughput time. Other benefits include improvements in cost, quality, speed, dependability and flexibility. The extent to which these benefits materialize depends on the efficient implementation of the right technology. The technology life cycle and the potential for competitiveness are dependent upon the firm's ability to manage technological change.

The functional activities of the firm rely on support functions like technology management, human resource management and firm organisational structures. Simply adopting the right technology is not good enough; firms have to be able to learn and improve processes and in so doing create a learning organisation. Competitors can imitate new technologies but it is far more difficult to imitate the methods and patterns involved in technological adoption. Value chain analysis includes internal and external analysis to create competitive advantages. Firms must be able to stretch existing resources to create radically new competitive advantages. Managers must be aware of the firm's strategic intent and then leverage resources to achieve that intent (Hamel and Prahalad (1996)). Interfacing the different sections of the firm to create a common knowledge pool is essential. CIM must be seen as a means of linking the different sections of the firm. CIM gives rise to better control capabilities. Love and Barton (1996, p.5) say that new control capabilities arise from the ability to automatically monitor and even trigger activities that span the product design, manufacturing and finance functions. The authors argue that the growth in automation and integration makes it conceivable to view the implementation of technology as a single coherent system.

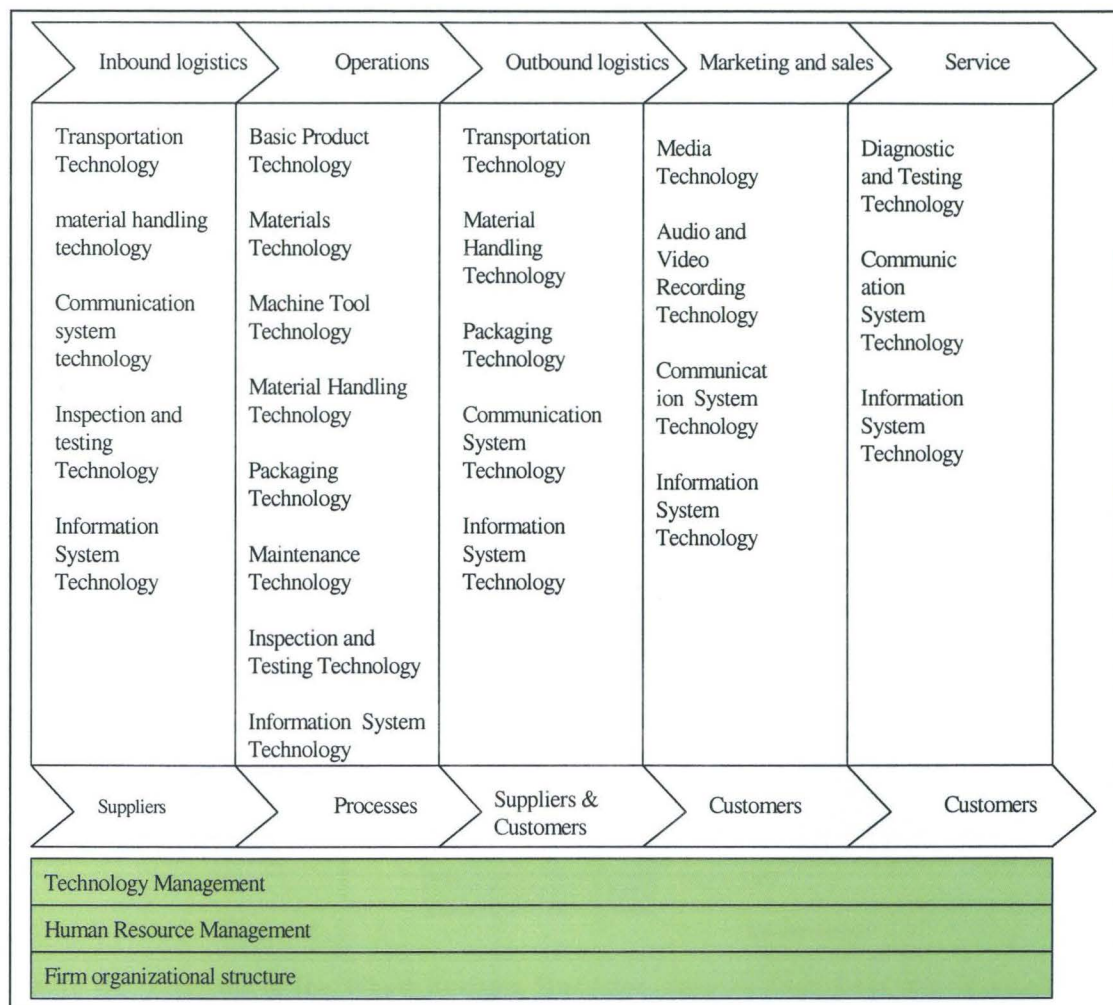


Figure R1: Technologies in a Firm's value chain and interfaces with other functions

Love and Barton (1996, p.6) propose an enterprise model called the Whole Business Simulator. The WBS system could be used to simulate investment decisions for CIM implementations. The architecture of this model consists of the following functions:

- A customer model/demand generator
- The design function
- Production engineering (process planning)
- Materials requirements planning
- Suppliers
- Manufacturing operations
- Ancillary cost generators (to generate overhead costs not covered elsewhere)
- An accounting system.

These are the requirements of a minimum system but the architecture could be extended to include other functions. The major elements of the core system are shown in Figure R2. The basic operation is as follows: sales demand generates sales orders in the materials planning (MRP) system, which is passed to the master production schedule (MPS) system. Thereafter works orders and purchase orders are generated and passed on to the factory, which handles

production and warehousing. In addition, standard accounting functions are carried out from the events that have occurred. This brief description covers some of the major linkages between the elements but many other transactions have to be supported to create a comprehensive model.

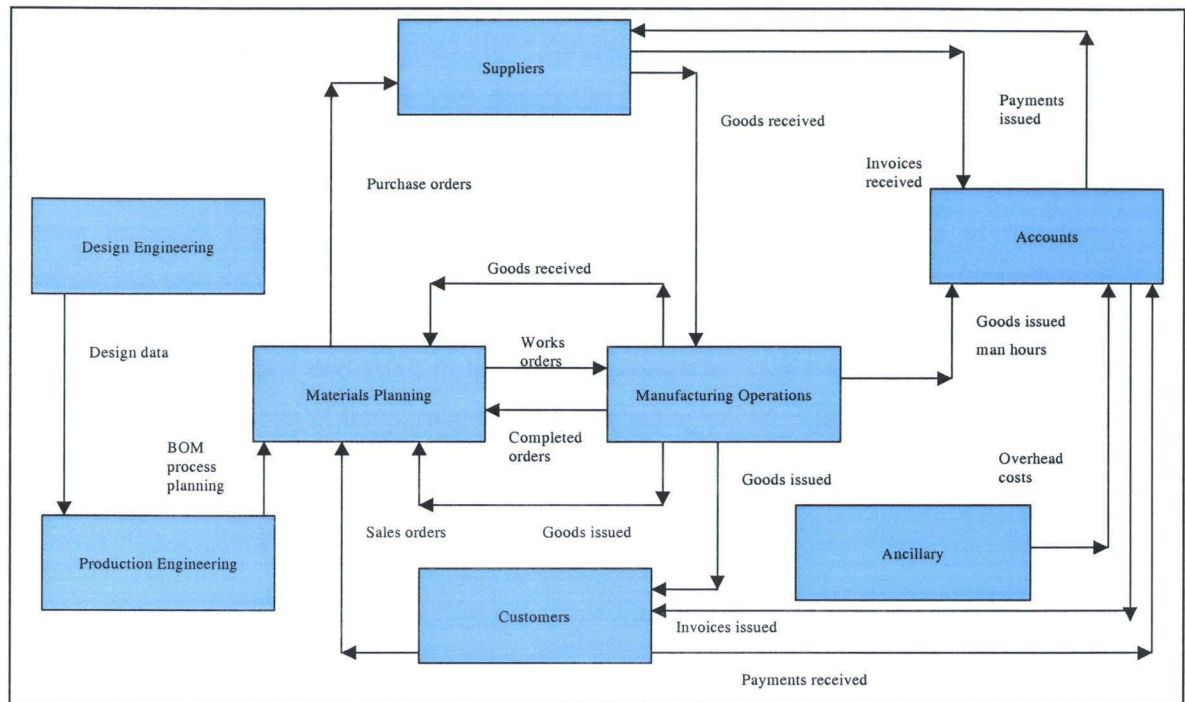


Figure R2: Elements of the Whole Business Simulator, adapted from Love and Barton (1996, p.7)

Krause et al (2001, p.218) refers to a model similar to the WBS model, in the late 1980s a method of integrated enterprise modelling (IEM) was developed by the division of Corporate Management at the Fraunhofer Institute of Production Systems and Design Technology. This model was used to analyse and design processes in organizations. This model differentiated between three categories: product, order and resource.

These models (WBS and IEM) are necessary to create a coherent working system. Goldhar and Jelinek (1983, p.146) say that the biggest barrier to the effective use of technology is the lack of understanding of its impact on strategy. This technology opens up new responsiveness to customer needs and a willingness to compete in new markets. The pressure, however, is to integrate marketing with design, design with manufacturing and manufacturing with strategic positioning. This form of integration makes older functional organisational structures obsolete. Goldhar and Jelinek add that the main reason for this is that structure represents power arrangements and new technologies imply a shift in power. The transactions between the elements (functions/sections) of the firm then draw our attention to the transaction processes that need to be considered when technology is implemented in a firm. For example, marketing must rethink about custom markets versus

mass markets, accounting and finance should *rethink* the terms of allocating overhead and other costs, and accounting methods should recognise shared resources that reflect more accurately on the risks and opportunities of investment decisions (Goldhar and Jelinek (1983, p.146). Hamel and Prahalad (1996) maintain that management must create challenges to meet the strategic intent. These challenges should be effective and individuals throughout the organisation must understand them and see their implications for their own jobs. Thereafter implications along the value chain can be monitored and controlled. Only then will management be able to educate staff about the hazards of opportunistic behaviour and bounded rationality. Rosenthal (1984, p. 204) provides support from the CIM industry where the majority of failures associated with CIM implementation were related to inadequate internal technical resources, resistance to communication across sections of the firm. However this was compensated for by reward systems to encourage risk-taking for long-term strategic gains (these could be seen as safeguards against opportunistic behaviour). The next section is therefore dedicated to transaction processes where special attention will be devoted to the resources of firms, relationships, technological sourcing, information flow and knowledge transfer.

Appendix S

Firm and Industry effects

Following from the discussion by Tallman (1991, p.71) on firm and industry effects Porter (1991, p.100) provides further support. Porter (1991, p. 100) argues that firm profitability can be broken down into two kinds of effects namely:

- Industry effects-some firms succeed mainly because of the industry in which they compete and most of their competitors are successful as well.
- Firm positioning effects-other firms can be differentiated by firm positioning effects, which can be created by the way in which the firm chooses strategies that will benefit itself while simultaneously putting competitors at a disadvantage.

For example some firms and their competitors are successful because the industry in which these firms compete, these industries provide opportunities for have high growth, high returns, etc. In other cases firms utilise their resources to create competitive advantages. Examples could include the effective use of technology to create improvements in manufacturing mix criteria and relationships with other firms. This could position the firm in a manner that could create barriers for other firms wanting to enter the market. These situations could lead to competitive advantage, thereby also providing higher growth, higher returns etc. Competitive advantage could arise from barriers to entry, which include amongst others high entry costs, high failure costs, high asset specificity etc. Wernerfelt (1984, p.173) compares resource position barriers to product entry barriers. Resource positions barriers defined as “a holder of a resource is able to maintain a relative position vis-à-vis other holders and third persons, as long as these act rationally”. This implies that if another party already owns a resource, the resource affects the costs/revenues of later acquirers adversely. In such cases the owner is said to benefit from the protection of a resource position barrier. He also identifies attractive resources around which resource position barriers can be built. These resources could include machine capacity via economies of scale, customer loyalty, production experience (through learning effects), technological leads (first to market) etc.

Other examples of resource position barriers are described by at least the following two authors viz.

- Tushman et al (1988, p.190) refers to these types of strategies as either competence enhancing or competence destroying.
- Madahavan, Koka and Prescott (1998, p.444) refers to these types of strategies as uses structural reinforcing or structural loosening events, which are used by firms to strengthen their competitive position.

More attention will be devoted to structural reinforcing, structural loosening events; competence enhancing and competence destroying effects under the sections in technological discontinuities.

Some evidence in support of firm effects and industry effects are next discussed viz.

- Abernathy and Clark (1984, p.3) suggested that it was the personality traits of individuals, the origins of innovative ideas and the way in which the administrative practises and firm structure influenced the growth of the firm.
- Mauri and Michaels (1998, p.211) provide support for firm differences they say firm differences are persistent from a RBV, whereas IO theory suggests that firm effects dominate over time. The authors suggest that firm and industry effects capture the degree of heterogeneity within an industry and they involve important concepts in strategic management like distinctive competence and competitive advantage.
- Tallman (1991, p.70) views firm level strategies as a means to competitiveness. However the authors do recognise some differences as a result of firm specific assets but argue that differences between firms are largely due to scale. Tallman (1991, p. 71) argues that the choice of strategies guides decisions about resource allocation, governance structures, environmental action, etc.
- Porter (1991, p.98) points out four important strategy issues; two of these issues are: Chain of causality and time horizon. He says the focus from a chain of causality perspective is to look at causes and not outcomes or symptoms. He argues that a firms competitive conditions and industry change wholly over time and therefore emphasis should be placed on the firm's ability to transform itself. Porter (1991, p. 104) says the reason that some firms are able to perform better than other firms is primarily because of firm drivers. He says some of the most important drivers for competitive advantage in an activity include its scale, cumulative learning in the activity, linkages between the activity and other activities, the ability to share the activity with other business units, the pattern of capacity utilisation in the activity over the relevant cycle, the activities location, the timing of investment choices in the activity, the extent of vertical integration in performing the activity, government regulation, the firm's policy choices about how to configure the activity independent of other drivers.

He says that the mix and significance of the drivers vary by activity, the firm and industry. It is the proper mix that leads to sustainable competitive advantage. He further adds that sustainability is however dependent on the number of competitive advantages in the value chain and especially the particular drivers underlying each competitive advantage. Porter (1991, p.105) says that there are two reasons why firms possess superior drivers for competitive advantages in the value chain. Firstly this is due to the firm's history i.e. its initial conditions either within the firm or in the environment in which the firm is based and secondly the managerial choices that determine the firm's ability to compete. These could include assets, skills, resources etc.

- Mahoney and Pandian (1992, p.370) say most successful firms possess one or more types of intangible resources such as technological know-how, patented process or design, know-how shared among individuals in the firm and marketing assets. These are some of the core resources proposed by Mauri and Michaels (1998, p.212). Mahoney and Pandian (1992, p.365) argue that it is the heterogeneity of firms that lead to sustained competitive advantage. Mahoney and Pandian (1992, p.370) argue that it is the idiosyncratic physical, human and intangible resources that supply the genetics for firm differences. These can be related to the concepts of strategic management like distinctive competence and competitive advantage as proposed by Mauri and Michaels (1998, p. 211). Mahoney and Pandian (1992, p.365) say that quote "The firm's unique capabilities in terms of technical know-how and managerial ability are important sources of heterogeneity that may result in sustained competitive advantage." However it is also the resources of a firm that limit its growth, the authors include the following as key resource constraints:

- Shortage of labour or physical inputs,
- shortage of finance,
- lack of suitable investment opportunities and,
- lack of sufficient managerial capacity.

Mahoney and Pandian (1992, p.367) argue that the nature of a firm's available resources, market opportunities and environment gives direction to a firm's diversification.

- Teece, Pisano and Sheun (1997, p.511) argue that differences between industries or industry sub-sectors is what allows firms better opportunities for sustainable competitive advantage.
- Mauri and Michaels (1998, p. 212) notice that other authors like Wernerfelt (1984), and Mahoney and Pandian (1992)), share the view that firm effects are the basis for sustainable competitive advantage. The resource-based approach views firms as having marked lower costs, or offering higher quality or product performance, this could be related to criteria like cost, quality, speed, dependability and flexibility. In terms of this thesis resource utilisation can be measured in terms of improvements in criteria such as cost, quality, speed, dependability and flexibility.

Having discussed evidence in support of firm effects and industry effects, it may be concluded that both firm effects and industry effects are equally important. It is the right mix between the two that may drive competitive advantage.

For firms to capitalise on firm effects or industry effects, these effects should be developed. Some of these developmental criteria that may trigger competitive advantage are next discussed viz.

- Tallman (1991, p.71) further adds that the competitive advantage of firms are unique due to the complex interactions of skills, managerial action, and location factors. The

author confirms that in terms of the SM, perspective higher performance is expected from an effective fit of strategy, structure and environment and in relation to a firm's competitors. This means that firm's structure must support its strategy and environment.

Structure in terms of organisational determinants i.e. individuals, assets (specific, physical and human) and organisational structures may be able to create barriers to entry from market threats like existing and potential competitors, substitute products, buying power of buyers etc. and in so doing leverage competitive advantages for improved business performance. Organisational determinants in turn may affect manufacturing mix criteria thus forcing firms to initiate the use of technology to improve transaction processes and governance structures, thereby creating competitive advantages. Figure 3.2 shows a more detailed framework.

- Teece (1997, p.513) et al says that the competitive advantage lies 'upstream' of product markets and rests instead on the firms idiosyncratic and difficult-to-imitate resources. The author says that a firm not only reacts to the opportunities it confronts, but it also depends on what resources the firm can muster.
- Mauri and Michaels (1998, p.213) say that firms invest in resources that permit differentiation from competitors. This differentiation may create gaps for competitiveness giving firms the opportunity to sustain advantage over others in the market.
- Hansen and Wernerfelt (1989, p.404) argue that individuals that are properly rewarded with pay and recognition and who have leaders/managers who train, help, listen and in addition are experts in performing their own functions, are more productive. This view also supports the development of intangible resources as a means to competitive advantage. This argument also supports the view by Tallman (1991, p.70) i.e. competitive strategies are based on FSR's to gain competitive advantage.
- Porter (1991, p.104) says that the best strategy depends on the capabilities and likely behaviour of rivals, as determined by their value chains and drivers. Knowing the capabilities of competitors will assist firms in planning their strategy. For example firms form relationships with other firms and in so doing create network structures. Some network structures are based on arms length contracts while others are based on good will and trust. Firms should be wary of other firms that merely form relationships (alliances, joint ventures, merges, etc.) for the purpose of acquiring skills or knowledge from the other partner, once such skills or knowledge have been internalised firms abandoned the partnership. To prevent such cases firms may adopt monitoring and control systems between firms to filter information flow and knowledge transfer between firms. In addition network structures and the threat of

structure loosening events can make firms vulnerable to market threats created by other firms.

Mauri and Michaels (1998, p.214) use technology and marketing resources as variables for core strategies. Several other authors also suggest that these intangible resources are a potential for competitive advantage. Technological resources could include technological investment, R&D expenditure, etc. and marketing resources could include brand name, reputation, etc. However the authors find from their research that R&D and advertising expenditures do not cater for the idiosyncratic firm resources that form the basis for competitive advantage. The authors argue that more empirical research needs to be carried out on leveraging the four drivers of competitive advantage within the RBV i.e. resources, routines, replication and rents (Winter (1995)). Porter (1991, p.110) says that critical resources are the firms capacity to learning and adaptation. He substantiates this by pointing out that firms can create and sustain competitive advantage because of the capacity to continuously improve, innovate and upgrade competitive advantages over time. Upgrading throughout the value chain and employing higher levels of skill and technology can accomplish this. Porter views the attributes for innovation and upgrading to encompass the following areas, information firms have to perceive opportunities, the pool of inputs and knowledge available to the firm, the goals that condition investment and the pressures on firms to act. The author terms this the diamond approach.

Wernerfelt (1984, p. 175) also states that mergers and acquisitions provide an opportunity to trade non-marketable resources and to buy or sell resources in bundles. Wernerfelt (1984) says that the resource-based approach also allows for consideration of managerial strategies for developing new capabilities. Porter (1991, p.106) points out that simply having pools of skills, knowledge, or other resources is not a guarantee of success but however having the right resources is what counts. Managers must understand the competitive environment and the sources of competitive advantage and then they can configure the value chain to obtain advantages over competitors. In this way firm can define new positions or create new value from the value chain. These steps can lead to diversification and performance.

Teece et al (1997, p.514) points out that firm's are heterogeneous with respect to their resources/capabilities/endowments and resources are 'sticky' in the short run. This implies that firms are stuck with what they have and may have to live with what they lack. This stickiness is viewed as a complex process since firms lack the organisational capacity to develop new competencies quickly. Teece et al (1997, p.514) cites Teece (1976, 1980) suggests that some assets are simply not readily tradable for example tacit know-how. As suggested managers may configure the value chain for diversification and performance, which may lead to competitive advantage.

Diversification and Performance

Porter (1991, p.110) argues that the firm should not only be able to choose among well defined options from its resources, it must also be able to create new options. This means that the firm must not only identify opportunities by increasing value from its resources. It should also be able to move constraints - thus allowing it greater agility to compete within the industry. The firm must be able to focus outwards to obtain those resources, which it cannot create cost effectively within the firm. Such outward focus could encompass the forming of relationships with other firms to acquire additional resources. Mergers, joint ventures and acquisitions could be used to obtain such resources that aid diversification strategy. The impact of the historical origins of the firm and the managerial choices that are made will influence the ability of the firm to shift constraints. Diversification strategy is a method that firms could use to move constraints. There is evidence from various authors (Montgomery and Wernerfelt 1988) that the resource based theory of diversification suggests that firm effects might exist in the form of focus effects. Firms, however, should stick to their core competencies when they opt for diversification strategies. Other schools of thought say that firms could develop resources through diversification.

Mahoney and Pandian (1992, p.368) investigate the proposition that widely diversified firms (less focused) are unable to transfer their competence to a variety of different markets. They provide two reasons for this proposition. Firstly the wider the diversification the less focused is the firm-specific resources and normally yield lower rents. Secondly, a particular resource will lose more value when it is transferred to markets that are different to the original market. Furthermore, the authors differentiate between related and unrelated diversification, where unrelated diversification is unlikely to enhance technological complementarities (i.e. economies of scope) or increase market power relative to related diversification.

Mahoney and Pandian (1992, p.371) remind us that the resource based view of focusing on firm effects is important in developing and combining resources to achieve competitive advantage. However, the industry product analysis concerned with yields of return is no less important. Mahoney and Pandian (1992, p.371) argue: "The crucial aspect for competitive advantage involves the productive services of rent-generating resources and resource combinations which cannot be easily imitated or substituted." In addition, Mahoney and Pandian (1992,p.364) say that a firm selects its strategy to generate rents based upon its resource capabilities. Furthermore Mahoney and Pandian (1992, p.373) add that the resource-based view must also aid management practice on the choice of the governance structure i.e. during mergers and acquisitions, internal development, and intermediate means such as joint ventures. Wernerfelt (1984, p.175) suggests that mergers and acquisitions provide the opportunity to trade non-marketable resources and to buy or sell resources in bundles. This could provide the means to achieve a combination of technological capabilities,

which otherwise would be too costly to obtain. Such technological capabilities could include technological skills, trade contracts, efficient procedures, etc.

In conclusion, Mahoney and Pandian (1992, p.364) say that the resource-based view stimulates conversation within the mainstream strategy research, organisational economics and Industrial organisation and also provides a framework for discussion between these research perspectives. In the author's view, the resource-based theory is linked to transaction cost theory because resource combinations are influenced by transaction economising costs. The links between technology management, transaction processes and governance structures are further described by Hanson (1995) where he identified two critical business processes viz. relationship management and know-how management. Therefore relationship management and knowledge management shall be use as subsets of governance structures in Chapter 3. More attention will be devoted to these issues later when linkages are discussed.

Resource motivation for growth

In the following section the firm's resources are studied and an effort is made to argue their motivation for growth. Firm resources include amongst others individuals, assets, finance, knowledge, technologies, intellectual capital, time etc. Wernerfelt (1984) says that a resource is meant anything which could be thought of as a strength or weakness of a firm. He gives the following examples of resources brand names, in-house knowledge of technology, employment of skilled personnel, trade contracts, machinery, efficient procedures, capital etc. Mahoney and Pandian (1992, p.367) share the view that a firm's diversification is due to the nature of its available resources and the market opportunities in the environment. It has been argued that firm's diversification strategies may be linked to a firms performance. The authors, however, argue that the total managerial services of a firm are partly constrained by the necessity to run the firm at its current size, while exploring new ventures. While new managerial staff increase growth and potential of the firm at the same time they take up valuable resources of time of other managers, which are involved in their training and development etc. The authors stress that this reduces the managerial services available for growth as managers have less time to focus on their tasks that drive firm performance.

Williamson (1981) shares the view with Penrose (1985) that firms are administrative organisations and collections of physical, human and intangible assets. Williamson however takes this approach from a transaction cost economics stance while Penrose takes this view from a resource-based stance. This combination of resources is a complex working system with opportunities for growth in all areas, as it is not possible for all areas to function at full capacity all the time. The rent theory thus provides a means of identifying avenues for growth because it is the difference in firms in respect of managing these resources that generate the ability to obtain rents.

It is the distinctive competence and organisational methods of firms through the value chain that enable firms to generate rents from a resource advantage. Together with the involvement of technology and effective implementation thereof, is it possible for firms to obtain more from the value chain? The linking of resources to activities was also identified by Porter (1991, p.109). During a study of the relative importance of economic and organisational factors in explaining inter-firm differences, Hansen and Wernerfelt (1989, p.406) found that organisational determinants accounted for approximately twice as much variance in firm profit rates as economic factors. The optimisation of the manufacturing mix variables such as cost, quality, speed, dependability and flexibility provides avenues for a competitive advantage.

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⁷ Adapted from lecture notes by Mr E.R Fielding, University of Witwatersrand, Johannesburg, South Africa. (Advanced Manufacturing Technology notes from M.Sc. programme in Industrial Engineering, undated).

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