# Adaptive IT Capability and its Impact on the Competitiveness of Firms: A Dynamic Capability Perspective

**A thesis submitted in fulfilment of the requirement for the degree of Doctor of Philosophy**

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# DECLARATION

I certify that except where due acknowledgement has been made, the work is that of the author alone; the work has not been submitted previously, in whole or in part, to qualify for any other academic award; the content of this thesis is the result of work which has been carried out since the official commencement date of the approved research program; any editorial work, paid or unpaid, carried out by a third party is acknowledged; and, ethics procedures and guidelines have been followed.

Signed:

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30. March 2009

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# ABSTRACT

The link between information technology (IT) and competitive advantage has been the preoccupation of many IT researchers. IT plays a key role as a necessary, but not sufficient, source of value. Prior research has in most cases investigated the direct link between IT and competitive advantage. Other researchers have examined the effect of IT on mediating factors (such as firm strategy) or applied higher order IT support for core competences in their research constructs. Only a few have recognised the potential of IT in enabling dynamic capabilities, and the question of precisely how this occurs remains less understood. This thesis argues that the dynamic capability perspective of strategic management provides a better insight into how IT, beyond its traditional role, needs to be converted into a higher order resource to deliver competitive advantage.

The objectives of the study are therefore: (1) to apply the concept of the dynamic capability perspective to the IT–competitive advantage research in order to explicate the strategic role of IT in attaining competitive advantage; and (2) to examine the antecedent capabilities and competences that may lead towards developing adaptive IT capability. Following on from work on dynamic capabilities and drawing from the previous literature on IT and competitive advantage and on categories of IT capabilities, this study proposes and empirically tests a dynamic capability–based model of IT and competitive advantage. The proposed model posits adaptive IT capability as a mediating higher order resource that relies on IT capabilities (infrastructure, personnel and management) and IT support for core competences (operational and market) to influence a firm's competitive position (competitive edge in market and financial performance). The model also hypothesises that IT support for operational and market competence can lead to advantages in market and financial performance.

The development of the research model followed a rigorous research design which included the theoretical and operational definitions of the constructs, the identification of appropriate methods of data collection, representative sample design, survey of a panel of experts and pilot study. To test the model, data were collected from a cross- sectional sample of 203 medium- and large-sized Australian organisations. Descriptive and analytical (structural equation modelling) tools were employed to test both the measurement and structural models. The findings reveal that the developed model explained 28% of the variance in competitive advantage, 72% for adaptive IT capability, 52% for IT support for operational competence and 51% for IT support for market competence, demonstrating the strategic role of adaptive IT capabilities as sources of competitive advantage. This shows that those firms that deploy IT for creating operational and market competences require a further capacity to rebuild and reconfigure their resources to improve market and financial performance. Thus, it appears that the impact

of IT support for core competences on competitive advantage is not direct, but indirect through adaptive IT capability. Several IT capabilities and competences were identified as antecedents for building adaptive IT capabilities.

This PhD study's main contribution lies in bridging a research gap by developing and empirically testing a model of adaptive IT capability that measures how IT can enable firms' dynamic capabilities. The model includes both the antecedent factors that build the higher order resource of adaptive IT capability (upstream factors) as well as the effect on competitive advantage (downstream factors). Practitioners can benefit from the results of this study in terms of the ramifications for investment decisions as well as to benchmark where they stand with their IT in terms of potential for value creation and business support.

# GLOSSARY OF TERMS

| | |
|---|---|
| ave $\rho_{vc(\eta)}$ | Average Variance extracted |
| CR | Critical Ratio |
| CA | Competitive Advantage |
| CEO | Chief Executive Officer |
| CFA | Confirmatory Factor Analysis |
| CFI | Comparative Fit Index |
| CIO | Chief Information Officer |
| CRM | Customer Relationship Management |
| DCP | Dynamic Capability Perspective |
| df | Degrees of Freedom |
| DSS | Decision Support System |
| DWH | Data Warehouse |
| E | Estimate |
| EFA | Exploratory Factor Analysis |
| ERP | Enterprise Resource Planning |
| GFI | Goodness of Fit Index |
| GOF | Goodness of Fit Indices |
| IS | Information Systems |
| IT | Information Technology |
| ITPC | IT Personnel Capability |
| ITSMC | IT support for market competence |
| ITSOC | IT support for operational competence |
| MI | Modification Index |
| ML | Maximum Likelihood |
| $\rho$ | Correlation |
| $\rho^2$ | Squared Correlation |
| RBV | Resource Based View |
| RMR | Root Mean Residual |
| RMSEA | Root Mean Square Error of Approximation |
| SE | Standard Estimate |
| SCA | Sustained Competitive Advantage |
| SEM | Structural Equation Modelling |
| SMC | Squared Multiple Correlations |
| $X^2$ | Chi-Square |

# Adaptive IT Capability and its Impact on the Competitiveness of Firms: A Dynamic Capability Perspective

# Chapter 1

## INTRODUCTION

This PhD study draws from the dynamic capability perspective (DCP) and examines how information technology (IT)[1] can be a source of competitive advantage by enabling organisations to adapt to environmental changes. In particular, adaptive IT capability and its role in the competitiveness of firms are examined. To understand the role of IT in the contemporary business environment section 1.1 provides an overview of the research environment in which this study is located. The research rationale in section 1.2 delineates IT's potential source of value creation as delineated in the outlined research environment. Building on the research rationale, the concluding research questions and objectives are presented in section 1.3. This is followed by an outline of the research methods and assumptions (section 1.4), contribution to the body of knowledge (section 1.5) and organisation (section 1.6).

[1] This study uses the generic term IT to cover both IT and IS. For details see Chapter 3, section 2

## 1.1. RESEARCH ENVIRONMENT

*'panta rhei' (gr. πάντα ῥεῖ, 'everything is in a state of flux')*[2]

*(Heraclites ca. 535–475 BC)*

The phrase '*panta rhei'* cites a reflection of the Greek philosopher Heraclites and in English means: '*All things are instable'*. Although ancient this wisdom prevails, and can be used to describe the contemporary business environment. In the past the business environment has undergone dramatic changes, understood as creating the information revolution. This created a turbulent environment, often referred to as the phenomenon of '*Hypercompetition*' (D'Aveni & Gunther 1994; Wiggins & Ruefli 2005) and can be characterised by several trends.

Firstly, similar to the industrial revolution of the 19th century the information revolution has impacted the competitive environment of organisations. The contemporary information age is characterised not only by a revolution in the ways in which information flows and interacts, it has also reduced organisational and geographic barriers. Geographical strongholds are breached by foreign competitors and seemingly impenetrable industry barriers are trespassed, overcoming the status quo and resource limitations of in situ companies. Customers nowadays are presented with a wide selection of choices to shop. Hence, the market power has shifted towards favouring customers (Boar 2001).

Secondly, this ongoing revolution has not only significantly influenced the exchange processes of information, services and products, but has also changed the sources of competitive advantage for businesses. Once, tangible assets such as physical resources and financial power were dominant sources for value creation. Now this traditional focus on physical assets has shifted towards intangible assets (Bradley & Nolan 1998). Information and human capabilities have become increasingly important and are often sources for competitive advantage (Carr 2004; Keil et al. 2001).

Thirdly, parallel influential developments in globalisation, governmental deregulation and changes in consumer demands and behaviour have transformed the rules of competition and challenged organisations across the globe. Successful organisations have managed to transform themselves from traditional brick-and-mortar companies into virtual market spaces (Boar 2001) and so-called 'click-and-mortar' companies. Finally, the ingenuity of

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[2] The sentence "Everything is in flux" (panta rhei) is attributed by Aristotle to Heraclitus. Today it is debated whether it belongs to the originals of the fragments handed down (Amoroso et al. 2000).

creative and ambitious competitors has overcome many barriers to market entry (Wang & Ahmed 2007).

These trends within the contemporary business environment have altered decision making within organisations, transforming managerial approaches from 'make and sell' towards 'sense and respond' (Bradley & Nolan 1998). Instead of long-term forecasts on customer need and production planning, organisations must continuously scan the environment for changes and be able to adapt to them rapidly and effectively. In the contemporary environment, competitive advantage is rarely gained from maintaining a static position, strategy or resource bundle.

Once gained, advantages are likely to erode or become obsolete. To sustain competitiveness, companies have to constantly renew their sources of competitive advantage and obtain the essential responsiveness and potential to launch competitive actions. This notion is addressed by the '*dynamic capability perspective*' of competitive advantage (Eisenhardt & Martin 2000; Teece & Pisano 1994; Teece, Pisano & Shuen 1997). The 'dynamic capability perspective' regards firms' ability to constantly adapt, renew and reconfigure their capabilities and competences as the major source of competitive advantage (Teece, Pisano & Shuen 1997). Dynamic capabilities have been theorised to have a significant impact on competitive advantage and provide the latest explanation on how market uncertainty and contemporary business environments create business conditions in which continued success depends on an organisation's ability to adapt itself to environmental change (Eisenhardt & Martin 2000; Teece, Pisano & Shuen 1997; Wang & Ahmed 2007).

IT plays an important part in this information revolution and as business and IT become increasingly interlinked, IT can influence the ability of organisations to adapt to change, and thereby to gain competitive advantage through

- providing support for a wide variety of business processes and information sharing options (Sambamurthy, Bharadwaj & Grover 2003)
- enabling resource re-configurability (Pavlou & El Sawy 2006)
- IT dependent strategic initiatives (Piccoli & Ives 2005)
- knowledge management (Sher & Lee 2004)
- information, systems and strategic agility (Fink & Neumann 2007)
- or other digital options (Sambamurthy, Bharadwaj & Grover 2003)

In sum, contemporary business environments are turbulent (Wang & Ahmed 2007) and companies need to adapt themselves continuously to stay ahead of the competition. IT can be a source of competitive advantage by enhancing organisations' ability to react to changes in the environment. This notion is the foundation for the research rationale, which is discussed in section 1.2 below.

## 1.2. RESEARCH RATIONALE

*'IT doesn't matter'*
*(Carr 2003)*

This provocative statement is the title of Carr's (2003) article in the *Harvard Business Review*. Carr (2003) claimed that since the commercial IT infrastructure in most enterprises is nearing perfection, investments in IT no longer provide any strategic advantages to firms. Carr (2003) further argued that IT has become a commodity on a par with electrical power and water supply and therefore can be called an infrastructure technology, which is essential to competition, but inconsequential to strategy. The publication of Carr's article sparked a wide debate among practitioners and academics with different opinions on the topic.

The debate on IT's potential contribution to competitive advantage is not new. The link between IT and competitive advantage has been investigated by numerous studies since the 1980s (e.g. Barua, Kriebel & Mukhopadhyay (1995); Barua & Lee (1997); Bharadwaj (2000); Brynjolfsson (1993; 2003); Brynjolfsson & Hitt (2003); Byrd & Turner (2001b); Carr (2003); Chan (2000); Clemons & Row (1991); Davenport & Lindner (1994); Davis, Dehning & Stratopoulos (2003); Dedrick, Gurbaxani & Kraemer (2003); Mata, Fuerst & Barney (1995); Melville, Kraemer & Gurbaxani (2004); McFarlan 1984; Powell & Dent-Micallef 1997; Ross, Beath & Goodhue 1996; Zhang & Lado (2001); and Zhang (2007)).

Regardless of the fact that the purpose of IT for firms should be to enable a foundation for sustained competitive advantage (Boar 2001), many massive investments in IT fail to contribute to this goal. This was particularly the case in the early 1990s which witnessed massive corporate spending on IT, often without deeper managerial understanding of IT's main purpose: to provide the foundation for competitiveness (Boar 2001). This became known as the 'productivity paradox'. Economic analysis revealed no relationship between investments in IT and economic performance of companies (Brynjolfsson 1993). Even though mismeasurement between IT capital and output as well as ignored time lags between the IT investment and productivity gains have been discussed as possible explanations (Brynjolfsson 1993), these issues could not hide the fact that investments in IT often do not directly or unconditionally lead to competitive advantage. Rosenberg (2000) argued that it might be to early to estimate the productivity benefits of IT investments because IT has changed fundamentally over the previous years. Despite the fact that IT components are readily and cheaply available, skills to use and manage the technology might be in short supply or they might be new and untested in organisational settings (Webb & Schlemmer 2008). In more recent years the 'productivity paradox' has been resolved and sufficiently explained away. For example the seminal work of Brynjolfsson and Hitt (2000) discovered positive returns on IT investments. So did Dedrick at. al. (2003) who concluded that greater investments in IT are associated with greater productivity growth at company and country levels.

Despite acknowledgement among academics and practitioners that IT is essential to compete in many businesses these days (Wade & Hulland 2004), or the fact that some research attests to a strong relationship between IT and improvements in economic performance (Indjikian & Siegel 2005; Kohli & Devaraj 2004), IT's strategic role as a source for sustained competitive advantage is under question (Carr 2003). Furthermore, there is no clear evidence for a direct relation between investment in IT, competitive advantage and firm performance (Chan 2000; Kohli & Grover 2008). Hence, while top managers are very interested to know the effects of IT investments on firms' performance and competitive advantage, the answers to these questions are ambiguous among academics and practitioners. Therefore, the crucial question for IT researchers' remains: *how does IT contribute to competitive advantage?*

Although previous IT research has investigated the contribution of IT to competitive advantage from several perspectives and the research is fragmented, most IT researchers have acknowledged several points. Firstly, IT resources are necessary, but not sufficient, for sustained competitive advantage (Wade & Hulland 2004). Secondly, a direct impact of IT on competitive advantage and firm performance does not exist. IT forms part of a complex chain of assets and capabilities and may lead to sustained performance if they form complementarities with other firm competences (Zhang 2007). IT can be critical to the firm's long-term competitiveness if it helps to develop, add, integrate and release other key resources over time (Melville, Kraemer & Gurbaxani 2004). Thirdly, especially in turbulent environments, the dynamic capability perspective on IT and competitive advantage provides useful insights into how IT can generate competitive advantage (Pavlou & El Sawy 2006).

In general, four research perspectives on IT and competitive advantage can be identified. These are the *economic, strategic, resource-based* and *dynamic capability perspective*s on IT and competitive advantage. The *economic* perspective on IT and firm performance commonly focuses on the impacts of IT investments on firm performance (Chatterjee, Pacini & Sambamurthy 2002; Huang et al. 2006; Indjikian & Siegel 2005; Tam 1998). In contrast, the three perspectives concerned with strategic management (*strategic,* *resource-based* and *dynamic capability*) most commonly use competitive advantage as the dependent variable (Pavlou & El Sawy 2006; Ravichandran & Lertwongsatien 2005; Wade & Hulland 2004). While the strategic perspective on IT and competitive advantage focuses on how IT can be utilised to shape the external business environment of a firm (McFarlan 1984), the resource-based view emphasises IT's ability to leverage organisational resources to provide competitive advantage (Wade & Hulland 2004). The dynamic capability perspective (DCP) stresses the role of IT in enabling firms to respond to changes in their market environment to maintain their competitive advantage (Pavlou & El Sawy 2006; Sambamurthy, Bharadwaj & Grover 2003).

The dynamic capability perspective provides a cogent framework to explain IT-derived competitive advantage in the contemporary business environment (Pavlou & El Sawy 2006; Sambamurthy, Bharadwaj & Grover 2003; Wade & Hulland 2004). The dynamic capability perspective provides new insight into how IT resources, IT capabilities and IT support for core competences can be a source of competitive advantage beyond their traditional interpretation of the resource-based view (Wade & Hulland 2004). Research into the strategic role and competitive advantage of IT in contemporary environments should, therefore, be refocused on the role of IT as an enabler of organisations' ability to respond to change (Pavlou & El Sawy 2006; Peak, Guynes & Kroon 2005).

Research from the dynamic capability perspective on IT and competitive advantage covers several areas but only a few have considered investigating the role IT can play in enabling organisational dynamic capabilities or have investigated the relationships between the characteristics of IT capabilities, IT support for core competences and organisational dynamic capabilities. While IT can support firms' ability to deal with environmental change in various ways, only a few IT researchers (e.g. Pavlou 2006) have investigated a higher order IT resource that measures the degree to which IT can enables organisational dynamic capabilities. Finally, to the knowledge of this researcher, no research study exists with a framework that includes the interlinked drivers of IT capabilities, IT support for core competences and their effect on a higher order IT resource which measures IT's impact on organisational dynamic capabilities as well as its impact on competitive advantage within a single conceptual model.

Hence, there is a need for a framework that includes the interlinked drivers for IT capabilities and IT support for core competences and their impact on adaptive IT capability, as well as its impact on competitive advantage in one conceptual model. Furthermore, most studies that examine the impact of IT on competitive advantage and in particular the impact of IT-enabled dynamic capabilities have been conducted in North America. This current PhD study examines Australian organisations. This study attempts to address these research gaps, by empirically examining the impact of adaptive IT capability and IT support for core competences on competitive advantage (downstream factors) and their antecedent attributes (upstream factors) among Australian organisations.

## 1.3. Research Questions and Objectives

Three research questions evolved out of the research gap identified above. Firstly, '*Is adaptive IT capability a source of competitive advantage?*' Secondly, '*Is adaptive IT capability mediating the relationship between IT support for core competence and competitive advantage?*' Finally, if adaptive IT capability is a higher order construct and builds on other factors, '*Which factors influence adaptive IT capability?*' To answer these research questions this PhD study proposes a dynamic capability–based model of IT and competitive advantage. The proposed model builds on Ravichandran and Lertwongsatien's (2005) model but incorporates adaptive IT capability as a mediating factor that relies on a firm's IT capabilities and IT support for core competences.

The objective of this study is to apply the dynamic capability perspective to an investigation of the IT–competitive advantage link, in order to:

1. Explicate the strategic role of IT in attaining competitive advantage
2. Test existing research on IT and competitive advantage
3. Extend existing research of IT and competitive advantage by introducing the construct of adaptive IT capability
4. Examine the antecedent IT-based constructs that lead towards developing adaptive IT capability

## 1.4. Research Method and Assumptions

This PhD research draws from two main theoretical perspectives. Firstly, the perspectives of competitive advantage from the viewpoint of strategic management argue for a dynamic capability perspective as the most relevant approach to achieve competitive advantage in contemporary business environment. Secondly, IT research is used to understand the role of IT as a possible source of competitive advantage. Combining the strategic management and IT research perspectives of competitive advantage serves as the foundation for the theoretical framework of adaptive IT capability and competitive advantage developed in this research.

In light of the two main research paradigms (interpretivism and positivism), this work is grounded in the positivistic research paradigm. Hence, this work uses the inductive method to draw conclusions from a smaller number of observations. The only contact with the data subjects was via the research instrument which was an online survey of CIOs/CEOs from 250 Australian firms. Descriptive and analytic (structural equation modelling, or SEM) statistical methods are used to investigate the research questions and empirically test the research model.

This research is built on two primary assumptions. Firstly, since the major unit of analysis is the organisation, data is collected from the business and IT managers of organisations. The elemental assumption is that the addressed CIOs/CEOs are capable of providing exact and unbiased information about their organisations, especially about their IT departments. Secondly, this research seeks to explore the research questions in the context of organisations in general, thus assuming that no inter-industry differences impact on the research variables. Therefore, this study did not select any specific industry.

## 1.5. FINDINGS OF THIS STUDY

The findings of the study reveal that the developed model explained 28% of the variance in competitive advantage, 72% for adaptive IT capability, 52% for IT support for operational competence and 51% for IT support for market competence, demonstrating the strategic role of adaptive IT capabilities as sources of competitive advantage. This shows that those firms that deploy IT for creating operational and market competences require a further capacity to rebuild and reconfigure their resources to improve market and financial performance. Thus, it appears that the impact of IT support for core competences on competitive advantage is not direct, but indirect through adaptive IT capability. Several IT capabilities and competences were identified as antecedents for building adaptive IT capabilities.

## 1.6. CONTRIBUTION OF THIS STUDY

The PhD study's main contribution lies in bridging a research gap by developing and empirically testing a model of adaptive IT capability that measures how IT can enable firms' dynamic capability. The model includes both the antecedent factors that build the higher order resource of adaptive IT capability (upstream factors) as well as the effect on competitive advantage (downstream factors). To the best knowledge of the researcher no such model exists in the literature.

Consequently, this PhD study contributes to the existing body of knowledge in several ways. Firstly, it enhances our understanding of how IT can contribute to firms' dynamic capabilities through introducing and examining a higher order resource of adaptive IT capability. Secondly, it synthesises previous fragmented work on various IT-based constructs and empirically examines the impact of adaptive IT capability on competitive advantage and compares this to the impact of IT support for core competences. This adds to the body of knowledge on the relationship between IT and competitive advantage. Thirdly, taking advantage of the analytic power of structural equation modelling (SEM), relationships between IT support for core competences (market and operational) are examined and this study integrates and empirically investigates the IT factors which enable adaptive IT capability. Finally, it enhances the understanding of dynamic capabilities by introducing a validated measurement model to quantify one of its antecedent factors—adaptive IT capability. Practitioners can benefit from the results of this study in terms of investment decisions as well as to benchmark where they stand with their IT in terms of potential for value creation and business support.

## 1.7. ORGANISATION OF THESIS

The organisation and structure of this study is described in Figure 1-1 below. This PhD study consists of nine chapters, including this chapter, and begins with a discussion of the theoretical framework utilised, which consists of three parts. Firstly, as this study examines the role of adaptive IT capability on competitive advantage, the main dependent variable is discussed through a literature review of the perspectives of competitive advantage in Chapter 2. This is followed by a literature review in Chapter 3 of perspectives on IT and competitive advantage. Informed by the two literature reviews, the research model for adaptive IT capability and its influence on the competitiveness of firms is developed in Chapter 4. A rigorous research methodology is utilised to examine the phenomena under question, which is discussed in Chapter 5. Data preparation is conducted in Chapter 6, followed by instrument validation and assessment of the measurement model in Chapter 7. The structural model and hypothesis are tested and the research findings discussed in Chapter 8. Finally, the research questions are revisited, leading into a discussion of the theoretical and managerial contributions as well as limitations and avenues for further research.

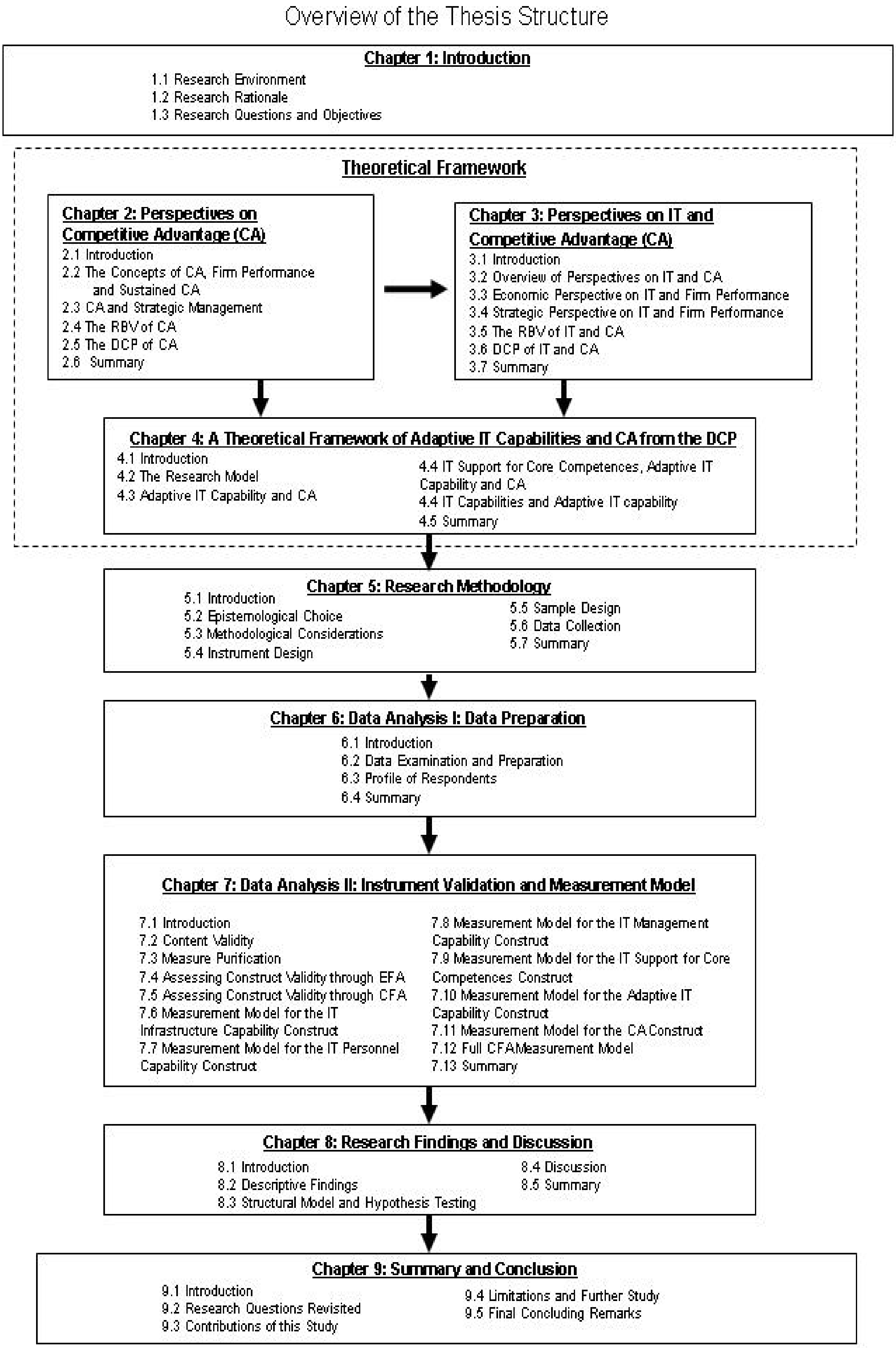


**Figure 1-1: Overview of Thesis Structure**

## 1.8. SUMMARY

This introduction chapter outlined the research background in which this PhD study is situated and discussed the research rationale. In short, while IT plays an important role in contemporary organisations the strategic role of IT as a contributor to competitive advantage is still under question. This study draws from the dynamic capability view of strategic management and argues for the role of adaptive IT capability as potential source of competitive advantage and mediator of IT support for core competences and competitive advantage. This chapter introduced the research questions and objectives resulting from the research rationale and theoretical background and outlined the research methods utilised as well as the underlying assumptions of this research. Finally, the organisation of the thesis was delineated.

# Chapter 2

# PERSPECTIVES ON COMPETITIVE ADVANTAGE

*'Competition is becoming less like chess and more like an interactive video-game.'*
*(Stalk, Evans & Shulman 1992)*

## 2.1. INTRODUCTION

This research investigates the relationship of adaptive IT capability to competitive advantage. The concept of competitive advantage is the main dependent variable of this research. Hence, it is important to understand the sources and underlying theories of competitive advantage. This chapter discusses the various sources and theories of competitive advantage from several perspectives. The first section of this chapter (section 2.1) provides an overview of the sources, the historical development and the concept of competitive advantage. Furthermore, the concept of competitive advantage is delineated based on concepts of firm performance and sustained competitive advantage (SCA). Understanding the sources of competitive advantage is a major area of research in strategic management (Barney 1991). Hence, the next section 2.2 reviews the research on competitive advantage and different perspectives of strategic management.

In section 2.3, the resource-based view, a perspective on strategic management, provides a cogent framework to investigate the sources of competitive advantage by examining the internal factors of firms. In the contemporary turbulent environment once achieved competitive advantage can erode due to environmental changes or possible imitations from competitors. Hence, a more dynamic approach to investigating competitive advantage is necessary. The dynamic capability view (DCP) of competitive advantage is based on the resource-based view (RBV) but enhances it by focusing on firms' ability to adapt to change. Hence, the DCP of competitive advantage provides an important perspective on examining sources of competitive advantage in the contemporary turbulent environment and is discussed in section 2.4.

## 2.2. The Concepts of Competitive Advantage, Firm Performance and Sustained Competitive Advantage

The question of why some firms have advantages over their competitors and outperform them has been discussed for some time. In fact this debate has continued since the industrial revolution in the 18th century, when large-scale production and group work increasingly displaced traditional craftsmen working in cottages (Viljoen & Dann 2003). In mid-18th century Scotland, Lord Kames identified entrepreneurship and documented the links between success and financial performance as the country was undergoing a transition from an agrarian society to an industrial society and developing a wealthy merchant class (Harvey 2004). A major figure at that time, Smith (1937; originally 1776) stated that firms could perform better than others by being more productive or having better craftsmanship. Higher productivity leads to cost advantages and the ability to put more products on the market at lower prices and, therefore, to higher sales. Smith (1937; originally 1776) saw differences in output, for example, resulting from greater skills of labour or the invention and utilisation of devices as either improving quality or shortening the time of the production process. However, according to Smith (1937; originally 1776), productivity was not always the main goal, as craftsmanship was often required as well, and better craftsmanship enabled firms to achieve higher revenues by charging premium prices.

Schumpeter's (1934; 1939) concept of '*creative destruction*' picked up Kames's ideas about entrepreneurship, further outlining that, in order to survive, firms continuously had to improve their products and services or replace them with new ones. This involved continually creating new resource bundles, and replacing old ones in order to adapt to changing circumstances (Mathews 2002). Competition in the Schumpeterian perspective is seen as dynamic and often unpredictable. This perspective underlies the proposition of incomplete information and conjectures which stipulates that often luck and acumen are needed to acquire, combine and deploy the adequate combination of resources to achieve superior returns (Conner 1991). The RBV adopted the assumption of luck from the Schumpeterian perspective, as well as another key similarity, the assumption that competition involves unpredictable revolutionary innovations called '*creative destruction'*. In terms of industry, this can be seen as the occurrence of large-scale paradigm shifts.

Although the earlier literature in particular uses the terms competitive advantage and firm performance interchangeably, and in most cases equates firm performance with financial performance, they are different constructs. In contrast to firm performance, competitive advantage is a relational measure on the basis of competition among different firms (Peteraf 1993; Porter 1980b) and is context-specific (Teece & Pisano 1994). The relationship between competitive advantage and firm performance is complex, and competitive advantage, being relational (Peteraf 1993; Porter 1980a) and context-specific (Teece & Pisano 1994), does not definitely and unconditionally lead to superior firm performance (Sanders & Premus 2002).

Competitive advantage is related to the competitive position of an organisation within its industry and reflects firms' ability to achieve a performance greater than the average of that industry (Barney 1991; Porter 1985a).

From a historical perspective, one of the first conceptual works on factors that lead to competitive advantage was undertaken by Chamberlin (1933). In their works, Schumpeter (1939) and Penrose (1959) later discussed the relationship between innovation, entrepreneurship and competitive advantage, and Selznik (1957) first linked the idea of competency with advantage. In the contemporary global environment, the literature about firm performance and competitive advantage becomes increasingly important owing to the compression of time and distance and with managerial attention focusing more on multiple external and internal factors (Thomas, Pollock & Gorman 1999).

Scholars have realised more and more that some forms of competitive advantage are hard to imitate and can therefore lead to long-lasting, superior economic performance (e.g. Amit & Schoemaker 1993; Barney 1991; Black & Boal 1994). This insight expanded the concept of competitive advantage from the industrial organisations (IO) as well as the resource-based views in the years leading up to the development of the concept of sustained competitive advantage (SCA) (Amit & Schoemaker 1993; Barney 1991; Barney & Arikan 2001; Black & Boal 1994; Porter 1985a). Porter (1985a) defines SCA as above average performance in the long run. Hence, SCA includes two components: firstly, the notion of above average performance, as a relational measure within an industry; and, secondly, the notion of durability. Whereas above average performance within an industry can be measured unambiguously as the returns in comparison to the industry average, the notion of durability is not so clear (Wiggins & Ruefli (2005), for example, propose a minimum five-year period to ascertain durability).

The concept of SCA departs from the traditional economic theories presented in the section above. The Austrian school of economics (Schumpeter 1934) as well as the neoclassical school presumed that competitive advantage erodes over time due to imitation or the introduction of substitutes. This perception is also found in more recent works. In their seminal work '*Hyper competition'*, D'Aveni and Gunther (1994) delineate the dynamics of competition and argue against the concept of persistent competitive advantage. This notion was confirmed by Wiggins and Ruefli (2002, 2005), who researched the persistence of SCA and the persistence of superior economic performance. In their longitudinal study with a sample of 6,772 firms in 40 industries over 25 years, Wiggins and Ruefli (2005) came to three major conclusions. Firstly, some firms do exhibit superior economic performance; secondly, only a very small minority do so; and, finally, the phenomenon very rarely persists for long time frames. These results, while not providing direct support for a particular extant strategic management or economic theory in regards to competitive advantage, have implications for significant aspects of many strategic management and economic theories. They are most consonant with a particular strategic management perspective, known as the resource-based theory of the firm (Wiggins & Ruefli 2002), which will be investigated in later sections.

In sum, even though the concepts of firm performance, competitive advantage and SCA are often used interchangeably, they are distinct. Firm performance measures the output of a firm (predominantly in financial terms). Competitive advantage is relational and reflects the superior competitive position of a firm within its industry. SCA builds upon competitive advantage and relates to the ability of firms to maintain a superior position in their industry for a long period of time. SCA is achieved when an achieved competitive advantage cannot be duplicated or imitated by competitors (Wiggins & Ruefli 2002). Research on competitive advantage and SCA often comprises the major area of research in strategic management (Barney 1991). It offers the current explanations for heterogeneity in firm performance and is an integral part of strategic management. Therefore, in the literature on strategic management, the terms competitive advantage and SCA are widely used, and have become central issues used to understand and explain causality (Schendel 1994).

The concepts of competitive advantage are the key concepts of strategic management. Hence, the following section will discuss the concepts of competitive advantage from the viewpoint of strategic management theory.

## 2.3. COMPETITIVE ADVANTAGE AND STRATEGIC MANAGEMENT

This section considers the different treatments of competitive advantage within strategic management theory (Barney 1986a). Despite the fact that the historical inputs into the area of strategy date back a long time (see Appendix A for an overview of the history of strategic management), the field of strategic management as a distinct area of academic study is relatively young, and the seminal body of literature mostly stems from the 1960s and 1970s (Birkinshaw 2004). Strategic management began as a sub-discipline of management and was termed '*business policy'* (Levinthal & Myatt 1994). The term '*competitive advantage*' started to appear in the literature on strategic management with the early works of Ansoff (1965). However, it became most popular and is most associated with the works of Porter (1980b) and the *Harvard Business School*. Then as scholars increased their work and theoretical input into the field, strategic management became ever more complex and confusing (Birkinshaw 2004). The first subsection (2.3.1) provides an overview of the different perspectives of strategic management theories. This is followed by a discussion of the industrial economics perspective and competitive advantage in section 2.3.2.

### 2.3.1. Different perspectives on competitive advantage in strategic management

Within strategic management, different perspectives explain competitive advantage in different ways. The major distinction within strategic management theories in relation to competitive advantage is between the environment–organisation relationship and the locus from which competitive advantage derives (whether an outside or inside view of the firm). Firstly, there are two different perspectives regarding the nature of the relationship between environment and organisations. The first one is called '*environmental determinism*' and implies that the environment determines organisations' management behaviour (Whittington 1988). In contrast to classical theory, the industrial organisations perspective, or market-based view, regards the organisation–environment relationship as '*environmental determinism'*, which focuses more on the role of constraints than on free choice. The 'environmental determinism' perspective states that the environment determines organisational behaviour (Hrebiniak & Joyce 1985). According to this perspective, barriers to control of access to markets exist in the form of laws or mobility (Caves & Porter 1977) and managers' primary task is to protect the organisation from environmental change (Porter 1981). This perspective, also called the '*adoption perspective*', assumes that management has little choice other than to adjust to the perceived changing conditions of the environment (Hannah & Freeman 1977). The second perspective on relationships between environment and organisations is called '*strategic choice*' and suggests that organisations are not dependent on the environment. Instead, they have a degree of autonomy in their strategic choices. This perspective is supported by many theorists (Barney 1991; Penrose 1959; Schumpeter 1934; Smith 1937, originally 1776) and is the foundation for the resource-based view (Barney 1991).

Secondly, explanations for competitive advantage in strategic management theory posit a different locus as the source of competitive advantage. As a result of the different perceptions of the environment–organisation relationship and different foci on sources of competitive advantage, a number of perspectives have evolved over time. Table 2.1 below provides an overview of the various perspectives on competitive advantage.

**Table 2-1: Perspectives on Competitive Advantage**

| | Economic | Industrial organisations | Resource-based | Dynamic capabilities |
|---|---|---|---|---|
| Locus of competitive advantage | Internal | External | Internal | Internal / External |
| Sources of competitive advantage | For example, craftsmanship, financial power | Superior position in the industry | Unique resources, capabilities and competences | Ability to adapt resources, capabilities and competences to external changes |
| Common dependent variable | Firm performance | Competitive advantage | Competitive advantage / sustained competitive advantage | Competitive advantage / sustained competitive advantage |
| Seminal reference | Smith (1937, originally 1776) | Porter (1981, 1985) | Barney (1991), Wernerfelt (1984) | Teece (1997) |
| Implications for IT & competitive advantage (Chapter 3) | Higher investment in IT might increase firm performance | Utilisation of IT to strengthen position within industry (e.g. heighten entry barriers, increase bargaining power) | IT can support/ complement firms' resources, capabilities and competences | IT can enable organisational dynamic capabilities |

Table 2.1 above delineate the explanations for competitive advantage, loci, common dependent variables and the seminal references of the different perspectives on competitive advantage. Furthermore, as this study is investigating the impact of IT on competitive advantage, above also illustrates the implications for the IT–competitive advantage relationship based on the different perspectives. The implications of IT derived from these perspectives are discussed in Chapter 3 in greater detail.

Early economic literature saw the inside of the firm (e.g. craftsmanship) as a source of competitive advantage (Smith 1937; originally 1776). The implications for IT in this perspective are simple: IT investments can lead to increased firm performance (Hitt & Brynjolfsson 1996). After discussion about the relationship between resources and competitive advantage recommenced in the 1950s, it declined. In the 1970s, the pendulum of strategic management began to swing towards the outside view of the firm. The dominant perspective of this time was the so-called ‘market-based view’ (Porter 1985a), rooted in industrial organisation economics, a section of micro-economics which investigates the impact of industry structure on firm behaviour and profitability (Porter 1980b, 1981, 1985a). Strategic management’s investigation of the sources of competitive advantage during this era was primarily focused on the external environment (Hoskisson et al. 1999). On this view, IT can be utilised to strengthen the firm’s position within the industry (e.g. heighten entry barriers or increase bargaining power) (McFarlan 1984).

The idea of internal factors (resources) as key drivers of competitive advantage was never really forgotten, and survived, for example, in the concepts of Learned (1965) and Andrews (1971) as inner strengths or weaknesses. With the rise of the resource-based view through the work of Wernerfelt (1984) and other scholars, the pendulum swung back to a focus on the inside of the firm, with its resources, capabilities and competences (see Table 2.1). The implications for the effective use of IT derived from the resource-based view are that it can support and complement firms’ resources, capabilities and competences (Wade & Hulland 2004). The DCP views the source of competitive advantage as organisational ability to renew its resources, capabilities and competences in order to keep up with environmental change (Teece & Pisano 1994). Hence, the DCP builds upon the resource- based view but integrates the focus on the outer environment. IT, on this account, can lead to competitive advantage by enabling the adaptation of organisational resources, capabilities and competences (Pavlou & El Sawy 2006). The following sections discuss the industrial organisations, resource-based and DCP.

### 2.3.2. Competitive advantage in the industrial organisations perspective

The industrial organisations (IO) perspective is grounded in micro-economics and looks externally into the marketplace. Therefore, it is the industry structure that determines competition in the IO perspective (Rumelt 1991), and the existence and strength of barriers to entry that determine the structure of the industry. This external perspective, along with its protagonists Ansoff (1965), Andrews (1971), Hofer and Schendler (Hofer & Schendel 1978), and Porter (1980, 1985) and the structure–conduct–performance paradigm which stipulates that it is the strategic position (structure) that determines firms’ performance, dominated the field of strategic management between the late 1960s and the 1980s. Because it was originally developed by Mason and Bain in the 1930s and 1940s, it is also known as the *‘Bain-Mason Paradigm’* (Bain 1959). According to Bain (1959), it is the structure of an industry, including technical and economic factors such as barriers of entry and size that determines firm performance. Therefore, on this view strategy or conduct, such as firms’ decisions concerning variables like advertising, price capacity or quality, can be ignored.

The theory of IO economics is based on four main presumptions. First, strategies for above normal returns are determined by pressures and constraints imposed by the external environment. Second, the strategies and control of strategic relevant resources of firms within a particular industry or within a certain segment of an industry are mostly congeneric. Third, resources are mobile and whenever differences between firms' resources develop, they will rapidly equalise. Last, a profit maximising and rational orientation according to the best interests of the firm is assumed for organisational decision makers (Seth & Thomas 1994).

Through his research within the consumer goods industry, Porter (1979) supports the argument that the environment determines the behaviour of organisations, including their activities and performance. These findings led to his seminal work *Competitive Strategy* (Porter 1980a), in which he stresses the importance of creating defensive barriers facing the strength and impact of environmental and competitive forces. His work influenced the predominant firm strategies of the 1980s.

In order to capture the complexity of competition, Porter developed the '*Five force model of competition*'. This analytical tool includes many variables and helps firms to find the industry with the highest profit potential, and to learn to use their internal resources to implement the best strategy that is required by the structural characteristics of the industry to achieve high profits. The model implies that the profitability of an industry is a function of these five external forces (Porter 1980b):

- Threat of new market entrants
- Bargaining power of suppliers
- Bargaining power of buyers
- Threat of substitute products
- Rivalry among competing firms

Being one of the main proponents of the IO perspective, Porter (1980b) saw customer value as the price a customer is willing to pay for a product or service, and he argued that competitive advantage is the difference between the value a firm can create for its buyers and the cost that the firm incurs in creating it. He also argued that firms can create two primary forms of competitive advantage: cost advantage and differentiation advantage. Cost leadership advantage derives from firms' ability to offer lower prices for equivalent benefits, whereas differentiation advantage results from firms' ability to provide unique benefits that more than offset a higher price (Porter 1985a). These two main ways to achieve competitive advantage are the basis for his three generic strategies for success based on the IO perspective on competitive advantage. Firstly is the low-cost strategy, with its focus on offering low-cost products through mass production and on efficiency. Second is the differentiation strategy, which focuses on offering products and services that differentiate themselves from competitors and, thus, allow the firm to charge a premium price. Lastly is the niche strategy, with its focus on offering products and services in a neglected niche market that is not covered by competitors. The niche focus strategy emphasises the combination of the low-cost and differentiation strategies.

The IO perspective on competitive advantage concentrates outside the firm and has, on the one hand, provided interesting and useful insights for practitioners and researchers alike, while one the other hand suffering from several problems. Black and Boal (1994), for example, argue that it risks becoming tautological. Porter (1991) criticises his own framework for being concerned only with cross-sectional problems rather than longitudinal ones. Its concern is with the attractiveness of industries and positions within them, but it does not explain how firms can get into advantageous positions and sustain them over periods of time (Porter 1991). Another criticism comes from McWilliams and Smart (1993), who assert that firms that invest in order to alter the industry structure, and hopefully make their industry more attractive, might not directly profit from these investments, and could even end up giving a free ride to their competitors.

In summary, the industrial organisations theory, with Porter's model of five forces (Porter 1985a) and his generic strategies (Porter 1985a), dominated the strategy discussion in the 1980s. However, neither Porter's model nor the many other works in the structure–conduct–performance paradigm could explain why firms, facing equal conditions of competition in the same strategic group or in the same industry, perform differently. Most of their work did not consider the individual strengths, resources and competences that allowed some firms to outperform others in their industry or strategic group. In an attempt to explain these missing links, research began to refocus its attention onto internal issues which regained importance in the mid 1980s. The rediscovery and the further development of these ideas took place in a series of papers in the late 1980s, and the resource-based perspective was finally constituted in the 1990s. The following section discusses the advantages of focusing on internal factors, utilising the resource-based view to identify sources of competitive advantage

## 2.4. THE RESOURCE-BASED VIEW OF COMPETITIVE ADVANTAGE

In contrast to the industrial organisations perspective, which believes competitive advantage comes from the external environment (especially the market), the resource- based view (RBV) locates the source of competitive advantage in the firm itself (Barney 1991). The RBV of the firm argues that a key determinant for competitive advantage and firm performance is the existence of adequate resources and capabilities (Grant 1991; Penrose 1959; Wernerfelt 1984). The RBV did not emerge from nowhere. Many of its roots and ideas came from various fields and can be traced back to a wide variety of theories and concepts such as the industrial organisations perspective on economics, and the field of strategy and strategic management. Subsection 2.4.1 provides an overview of the main influences on and the historical development of competitive advantage from the RBV. Following that, the concepts and terminology of the RBV are presented in section 2.4.2. Three main concepts can be identified within the RBV: namely those related to resources, capabilities and competences. These are discussed succinctly in sections 2.4.3–2.4.5 below. Finally, section 2.4.6 provides a summary of competitive advantage from the resource-based perspective.

### 2.4.1. Overview of competitive advantage from the resource-based view

The primary influences on the RBV came from the works of Schumpeter (1934, 1939), Chamberlin (1933), Penrose (1959), Wernerfelt (1984), Barney (1991) and Prahalad and Hamel (1990). Most of the economic tools for analysing the resource position operate on the product-market side (Wernerfelt 1984), like the industrial organisations perspective on economics.

While the roots of the RBV can be traced back a long time, many academics date the emergence of this view to the 1950s and the works of Selznik (1957) and Penrose (1959). Penrose’s seminal book *The theory of the growth of the firm* (Penrose 1959) is seen by many academics as the key contribution to the RBV. In her work, Penrose (1959) delineates the significance of heterogeneous assets and establishes that it is the heterogeneity of firms’ resources that gives firms a unique character and a chance to differentiate their products and services from those of their competitors. Sharing the perception that firms’ success is not totally dominated by the environment with the protagonists of the ‘environmental determinism’ perspective, Penrose (1959) believed in free will and strategic choice and argued that the success of firms was not fully dependent on good fortune or the environment. Penrose (1959) turned to an internal view of the firm and described firms as collections of productive resources whose main source of differentiation lies in their resources, especially their labour. This view is complementary to Selznik’s (1957) findings of the same period. Selznik (1957) came up with the idea that firms have ‘distinctive competences’. This concept was later integrated into the RBV as the natural outcome of distinctive resource profiles.

Nevertheless, internal factors faded in importance during the 1970s and early 1980s, and apart from the work of Rubin (1973), little formal attention was paid to the firm as a broader set of resources (Wernerfelt 1984). Rubin (1973) views the firm as a  collection of particular resources, which are worth more than their market value because of the specialised experience within the firm (Rubin 1973). He also introduces aspects of learning, as he argues that not only can resources be used to produce new output but also to train new employees (Rubin 1973).

It was Wernerfelt's (1984) seminal work ‘*A resource based view of the firm’* which breathed new life into resource-centred perspectives on the firm. Wernerfelt (1984) developed a new model of competitive advantage, which mostly ignores the impact of external forces on a company and rather emphasises internal factors as sources of strength or weakness in determining firm-level competitive advantage. In order to implement and gain advantage from product market strategies, firms have to compete for resources based on their resource profiles. To explain this, Wernerfelt (1984) used and complemented Porter's (1981) product market position theory of competitive advantage, which was originally intended to be used as a tool for analysis of products only. Wernerfelt (1984) defined resources very generally as 'anything which could be thought of as a strength or weakness of a given firm' and as assets which are semi-permanently tied to a firm. These assets can be intangible or tangible. When the tangible and intangible assets of a firm are heterogeneous and not tradeable on factor markets, the resource position of a firm may be an entry barrier at the industry level of analysis and may grant high returns (Wernerfelt 1984). Wernerfelt (1984) further argued that suppliers and customers can have bargaining power for a resource and that the returns of an utilised resource are dependent on the power of both the supplier and the buyer side in the resource market. Monopolistic control over the inputs of a resource, and the presence of only one or a few buyers for a resources' product on the output side, reduces rent from resources (Wernerfelt 1984). The availability of substitute resources is another factor which could depress firms' rent from a utilised resource (Wernerfelt 1984). Resources can achieve high profits if a company manages to set up resource position barriers, which restrict the utilisation of a resource by competitors. These resource position barriers are most effective when combined with product entry barriers for the resources' products (Wernerfelt 1984).

### 2.4.2. Concepts and terminology in the resource-based view

Many scholars have sought to define new distinctions between terms like '*resources*', '*capabilities*', '*competences*', and '*distinctive*' or '*dynamic capabilities*', and have often labelled their works as 'new' theories of persistent performance. Consequently, the literature of strategic management has current proponents of '*core competence theories of superior performance*' (Prahalad & Hamel 1990), '*knowledge based theories of superior performance*', '*capability theories of superior performance*' (Stalk, Evans & Shulman 1992), and '*dynamic capability theories of superior performance*' (Teece & Pisano 1994). Despite the fact that all of these theories have slightly different ways of characterising firm attributes, they share the same underlying theoretical structure. All specify the conditions under which firms' attributes will enable competitive advantage, and focus on similar kinds of firm attributes as critical independent variables (Barney & Arikan 2001).

In their attempt to conceptualise the components of the RBV, Lado et al. (1992) proposed a system model that integrally links four components of the RBV, which they generically call competences. Later, these competences are also referred to as organisational competences (Zhang & Lado 2001). These four competences include input, transformational, managerial and output competences (Lado, Boyd & Wright 1992). Input-based competences enable firms' transformational processes and include physical, capital and human resources. Transformational-based competences are organisational capabilities that transform inputs into outputs, and include innovation that enables firms to generate new processes, products and services more quickly than their competitors, and organisational culture which can enhance organisational learning and adaptation (Lado, Boyd & Wright 1992). Managerial competences delineate the strategic focus of the organisation and can be seen as the capabilities of strategic leaders to develop a strategic vision, communicate it and empower employees to realise it (Lado & Wilson 1994). Finally, output-based competences refer to firms' visible output (e.g. products and services) and invisible output (e.g. reputation).

On the basis of the above discussion, the following sections of the literature review are structured into three subsections, to cover resources, capabilities and competences, as illustrated in Figure 2-1 below.

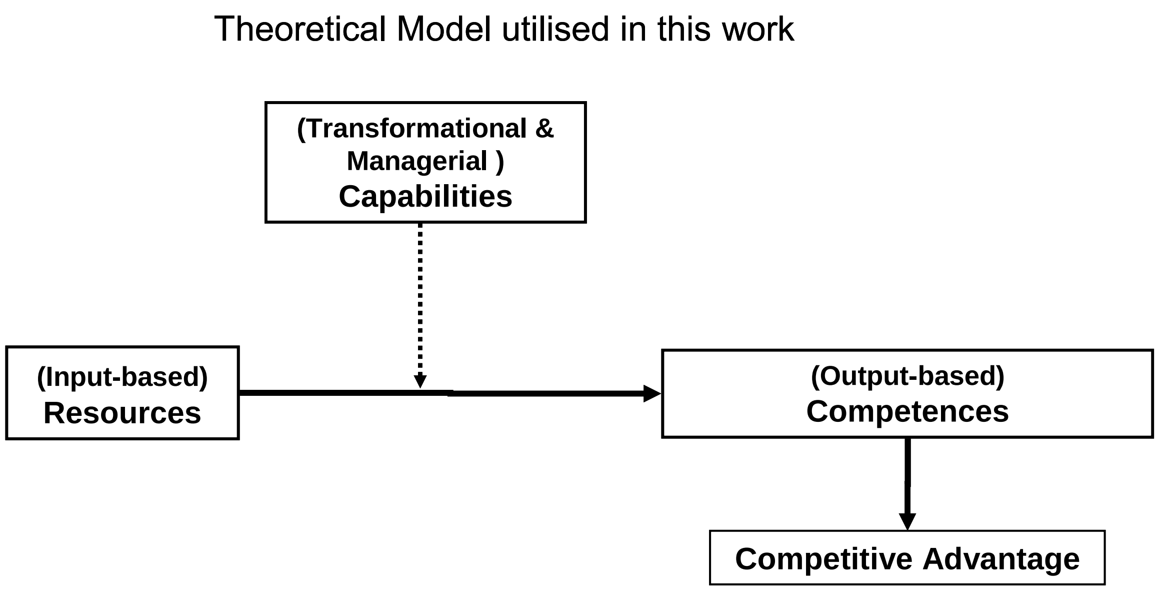


**Figure 2-1: Classification of the Resource Based View Concepts utilized in this Study**

Figure 2-1 illustrates the classification of the RBV concepts utilised in this chapter. The classification is derived from Lado and Wilson's (1994) classification which distinguishes in hierarchical order between different levels of resources, capabilities and competences. Firstly, resources are classified as input-based according to Lado's input-based competences and a zero order construct. Secondly, capabilities are classified as throughput-oriented, incorporating what Lado and Wilson (1994) classify as managerial and transformational-based competences. Capabilities are considered first order and build on zero order input-based resources. Capabilities are those mechanisms that generate competences (Stalk, Evans & Shulman 1992). Finally, the concept of competences in this work is also derived from Lado and Wilson (1994) as second order, output-based competences. Competences are built upon zero order resources and first order capabilities.

The following subsections discuss each of the three concepts in sequence. Hence, section 2.4.3 looks at the concept of resources, followed by section 2.4.4 which investigates the concept of capabilities and, finally, section 2.4.4 discusses the concept of competences.

### 2.4.3. Resources and competitive advantage

The unique resources that are essential in the RBV to implement product market strategies can be acquired or developed on the basis of what Barney (1986a) calls the strategic factor market. Barney (1991) built on the work of Draft (1983), and defined firm resources as ‘all assets, capabilities, organizational processes, firm attributes, information, knowledge, etc. controlled by a firm that enable the firm to conceive of and implement strategies that improve its efficiency and effectiveness’. Furthermore, drawing from traditional strategic analysis and linking to the works of Porter (1981) and Learned et al. (1969), Barney (1991) defines resources as ‘strengths that firms can use to conceive of and implement their strategies’. Amit and Schoemaker (1993) define resources as ‘stocks of available factors that are owned or controlled by the firm’.

In general, resources are characterised as being either tangible or intangible. This distinction is not always precise but in general tangible resources include a firm’s financial capital (e.g. equity capital, dept capital or retained earnings) and physical capital (e.g. machines and buildings). Intangible resources generally include a firm’s human capital (e.g. the training, experience, judgement, intelligence, relationships, and insights of individual managers and workers) and organisational capital (e.g. attributes of collections of individuals associated with a firm, a firm’s culture, or its reputation) (Barney & Arikan 2001). Other authors also include social capital (interpersonal dynamics and relationships) (Lesser 2000), intellectual property rights in patents, copyrights, trademarks, registered designs, databases, trade secrets or contracts (Hall 1993).

These definitions of resources that emerged in the late 1980s and early 1990s continued to be less than categorical owing perhaps to an inherent uncertainty in the external environment (Peteraf 1993). Furthermore, these broad definitions encompassed many firm attributes which did not necessarily have the potential to create and maintain a sustainable competitive advantage for a firm. The *‘resource necessity*’ perspective provides explanations of which attributes are necessary for a resource to create SCA, which is discussed below.

The *‘resource necessity’* perspective argues that only resources that are valuable, rare, non-substitutable, inimitable, non-replicable, heterogeneous and immobile (Barney 1991) can lead to SCA. In his seminal work, Barney (1991) argues that a resource must have four attributes to be able to create a sustainable competitive advantage: valuable, rare, imperfectly imitable, and the absence of an equivalent substitute.

*Valuable* is the first attribute a potential resource must possess in order to be regarded as a resource, and is defined by its potential to enable and support strategies that improve efficiency and effectiveness. In other words, the better the resource fits with the firm's strategy and the more the firm's strategy fits with its environment, the higher will be the value of the resource (Black & Boal 1994). This concept draws on the existing theories and components of the *SWOT* (Strengths, Weaknesses, Opportunities, and Threats) analysis and determines the value of potential resources as the degree to which a potential resource enables a firm to exploit opportunities and neutralise threats in that firm's environment (Barney 1991).

In addition to being valuable to a firm, a potential resource must also be *rare* according to Barney (1991), in order to be regarded as an actual resource. A valuable resource that is possessed by many competitors or by potentially competing firms will not enable competitive advantage or SCA, because all possessing firms have the same opportunity to exploit this resource for their strategies. Therefore, common resources only enable common strategies (Barney 1991) and there is no chance to differentiate in competition. Determining precisely what degree of rareness allows a competitive advantage is a difficult task. Hirshliefer (1980) argues that as long as the number of firms that utilise a valuable resource is not sufficient to generate perfect competition dynamics in an industry, there is still potential for resources to generate a competitive advantage. This view is in accord with other views which state that complete competitive parity in an industry gives no single firm a chance to achieve competitive advantage (Porter 1980a).

The third attribute a potential resource should possess is to be *imperfectly inimitable* (Barney 1986a, 1986b; Lippman & Rumelt 1982). Dierickx, Cool and Barney (1989) define three factors which render firm resources imperfectly inimitable: first, unique historical conditions are necessary to obtain the resource; second, causal ambiguity exists between a resource possessed by a firm and the firm's SCA; and, third, social complexity characterises the nature of the resource. These factors can alone or in combination complicate or totally block the imitation of a resource.

In his earlier work, Barney (1991) describes a fourth attribute, *non-substitutability*, as an independent attribute. Non-substitutability exists when there is no equivalent valuable, rare and imitable resource that can be exploited to implement the same strategies (Barney 1991). In later works which refer to Barney's original framework, the attributes of inimitability and non-substitutability are combined and non-substitutability is regarded as a specialised case of inimitability. Subsequently, another attribute was added: organisational orientation to utilise its strategic resources (Black & Boal 1994).

Barney's (1991) theory of resource attributes—commonly referred to as VRIN—is one of the most referenced works on resource attributes and is widely referenced by other authors (e.g. Black and Boal 1994) as the *VRIN Framework*. In their work on strategic resources, Black and Boal (1994) argue that prevailing resource classification systems miss the key issue in the search for the creation and maintenance of sustainable competitive advantage (SCA), which is the ability of a resource to create rent. According to Barney (1991), only rare resources have the potential to create SCA, and the effort required to identify the underlying factors that create rare resource is high, adding to the scarcity of that resource. The simpler a factor bundle that leads to resources is to identify, the easier it is for competitors to imitate or substitute the resource and thus the rent generation potential of this resource will decrease (Grant 1991). For this reason, Black and Boal (1994) based their resource categorisation on the degree to which the factor bundles that lead to resources could be identified. Resources in this categorisation are either contained resources or system resources. Contained resources comprise resource factors which can be identified and monetarily valued, whereas system resources are socially created, difficult to identify or ascribe with a monetarily value (Black & Boal 1994).

### 2.4.4. Capabilities and competitive advantage

The term 'capability' arose from the work of Stalk (Stalk 1992), who suggested that there is a difference between core competences and capabilities. Drawing from Lado and Wilson's (1994) framework, this study classifies capabilities as first order transformational and managerial abilities of an organisation that can transfer zero order resources into second order competences. Capabilities are responsible for differentiation among competitors and can explain differences in profitability (Stalk 1992). Capabilities are information based, tangible or intangible firm-specific processes (Amit & Schoemaker 1993; Stalk 1992) that represent firms' skills at coordinating and deploying their resources, and emerge over time through complex interactions among intangible and tangible resources (Amit & Schoemaker 1993). Feeny and Willcocks (1998) argue for nine core capabilities that form a firm (leadership, business-system thinking, relationship building, architecture planning, contract facilitation, making information technology work, contact monitoring, informed buying and vendor development). Furthermore, capabilities include functional skills (the know-how of employers, suppliers, and distributors) (Hall 1993) and cultural capabilities (perceptions of customer service and quality standards, ability to manage change and innovate, team-working ability) (Hall 1993).

Capabilities are regarded as a major contributor to competitive advantage, and companies that adopt '*capability based competition'* are often more successful than their competitors (Stalk, Evans & Shulman 1992). Organisations can utilise transformational and managerial capabilities to gain competitive advantage in several ways. By utilising managerial and transformational capabilities, firms can gain competitive advantage through learning about, perfecting, improving and leveraging their resources (Stalk, Evans & Shulman 1992; Teece & Pisano 1994).

Capabilities can be used to bind the organisation together and enable the most productive deployment of resources (Amit & Schoemaker 1993). Inherent in firms' organisational routines, these skills reside in decision making and the management of internal processes, and are a product of companies' control systems and organisational structures (Hill & Jones 1998). For example, superior managerial capabilities in the coordination of diverse production skills and the integration of multiple streams of technology can be sources of competitive advantage (Prahalad & Hamel 1990). In organisational learning and knowledge creation capabilities can be particularly vital Leonard-Barton (1992) stated that capabilities are essential to knowledge creation, and emphasised the importance of knowledge for competitive advantage. The formation of firm capabilities is a complex process and is often hard to imitate due to path dependence (a capability develops over time and can only be duplicated if its history can also be duplicated), causal ambiguity (uncertainty surrounding which resources are driving firm performance), time lag (time is needed to determine how a capability is built) and economic reasons (copying a capability entails a significant investment in its underlying resources) (Dierickx, Cool & Barney 1989; Grant 1991). Hence, the often non-substitutable, unique, ambiguous and immobile nature of firm capabilities can be a source of competitive advantage (Madhok 2002). As capabilities cannot be bought, but have to be built within a company (Teece, Pisano & Shuen 1997), it is a manager's responsibility to enable an environment of capability building and improvement.

### 2.4.5. Competences and competitive advantage

Competences as defined in this study are output-based, higher order constructs which build on lower order resources and capabilities and are a source of competitive advantage. The word 'competences' is utilised by many different authors in many different contexts and ways, including '*distinctive competence*' (a bundle of activities that a firm performs better than its competitors) (Hitt & Ireland 1985; Turner & Crawford 1994), '*core competences*' (a combination of firm-specific skills and cognitive traits that can be leveraged either indirectly to develop a range of core services and products or directly to satisfy existing customer needs) (Prahalad & Hamel 1990), and '*strategic assets*' (Amit & Schoemaker 1993). Even though the terminology and definitions of competences vary slightly across different works, they all share similar underlying assumptions. Competences need to be competitively unique (Hamel & Heene 1994) and to meet the criteria of the four attributes (valuable, rare, inimitable and non-substitutable) (Barney 1991). Furthermore, competences have to contribute to customer perceived value, enable the opportunity to enter a new market (Hamel & Heene 1994) and provide a firm with sustainable competitive advantage (Amit & Schoemaker 1993).

Competences enable organisations to achieve competitive advantage by building appropriate cognitive traits, including a tacit understanding of the relationship between product markets, organisational dynamics and technology, and a shared value system as well as organisational routines and recipes for dealing with organisational problems (Bogner & Thomas 1994). Competences, therefore, include activity-oriented and cognitive aspects, which are built up cumulatively through learning, and constantly utilised to apply firm skills for achieving competitive advantage (Bogner & Thomas 1994).

In general, competences can achieve SCA in three categories: market-access competences, integrity-related competences and functionality-related competences (Hamel 1994a). Firstly, market-based competences enable a company to remain close to its customers, and to gain the timely market information and brand loyalty that will generate higher sales in comparison to its competitors (Lado, Boyd & Wright 1992). Secondly, integrity-related competences can be a source of competitive advantage by facilitating such advantages as providing superior quality, cycle time management or just-in time inventory management more quickly and reliably than competitors (Hamel 1994a). Finally, the skills required to provide unique products and services are subsumed under the category of functionality-related competences. Providing products and services with distinctive customer benefits can be a source of competitive advantage (Hamel 1994a).

In sum, competences are internal to a firm (Reed & DeFillippi 1990), are produced through the way a firm utilises its resources and capabilities, and are accumulated from both implicit and explicit knowledge, as well as through the integration of different skills (Hamel 1994a).

Competences cannot be bought; they must be built. Competences are built on the basis of unique capabilities and develop alongside organisational routines/paths. Hence, competences are hard to imitate and can be a source of SCA (Amit & Schoemaker 1993; Prahalad & Hamel 1990). It is management's responsibility to guide competence building.

### 2.4.6. Summary of competitive advantage from the resource-based view

The purpose of section 2.4 was to review the literature on the resource-based perspective and to point out its advantages in explaining competitive advantage in comparison to prior theories. The implications of the above discussed RBV for IT research include that, in order to contribute to competitive advantage, IT needs to support organisational capabilities and competences. IT can support capability-building and improvement through a variety of ways (e.g. enhancing information sharing or providing quality information to assist managerial decision making). IT can achieve this either by supporting knowledge management and organisational learning, or by supporting firms' products and services. IT can enable firms to provide distinctive customer value or access to customers and markets in a variety of ways. Chapter 3 discusses IT's potential contribution to competitive advantage in more detail.

While the RBV provides useful explanations of competitive advantage in stable environments, it fails to address firms' ability to keep up with environmental changes. Once achieved, resource, capability and competency configurations can be a source of advantage for a short period of time, but as environments change they may become obsolete. In contemporary environments, firms must be able to adapt available resources, capabilities and competences as priorities and demands change (Teece, Pisano & Shuen 1997). This notion is captured by the dynamic capability perspective on competitive advantage, which is discussed in the following section.

## 2.5. The Dynamic Capability Perspective on Competitive Advantage

*Strategy is dynamic, competition a 'war of movement' rather than a 'war of position' with static strategies. (Stalk, Evans & Shulman 1992)*

Due to the permanent risk of erosion of superior firm-specific resources and competences in the contemporary business environment of hypercompetition (D'Aveni & Gunther 1994), companies face the omnipresent risk of erosion of their competitive advantage. To maintain competitiveness, companies are forced to continually generate new competitive advantages. In accordance with the RBV, this means a continual redevelopment of firm resources, capabilities and competences to obtain the necessary responsiveness and the potential to launch competitive actions when needed. In order to respond to and operate in rapidly changing environments, companies need the ability to adapt to change quickly and efficiently. Competitive advantage in the dynamic capability view (DCP) involves companies' ability to adapt to environmental change through building, renewing and reconfiguring capabilities and competences (Teece, Pisano & Shuen 1997).

### 2.5.1. The concept and building of dynamic capabilities

The term '*dynamic capabilities'* was chosen by Teece and Pisano (1994) in emphasising and arguing for the importance of firms developing new capabilities to adapt to changing conditions. Teece and Pisano (1994) defined dynamic capabilities as 'firms' ability to integrate, build and reconfigure internal and external competences to address rapidly changing environments'.

The concept of dynamic capabilities as understood by Teece et al. (1997) is based on two facets which are the focal points of the concept. Firstly, the *'dynamic'* aspect refers to the ability to quickly adapt and renew the competence basis to keep up with competition. This is the groundwork required for companies to offer innovative solutions in fast-moving, non-predictable and technologically changeable markets. Second is the aspect of management skills, which emphasises the central role of strategic management in developing, adapting, integrating and reconfiguring the competence and knowledge base of a company. Their ideas on competition based on dynamics and speed have been raised previously by other authors. For example, Stalk and Shulman (1992) argue that company success depends on anticipation of market trends and a quick response to changing customer needs. Therefore, they claim that competition is becoming less like chess and more like an interactive video game.

The literature on dynamic capabilities varies in its delineation of what constitutes and causes dynamic capabilities (Thomas, Pollock & Gorman 1999). In their review of dynamic capabilities, Wang and Ahmad (2007) synthesise the conceptual debates and identify the commonalties of dynamic capabilities. The result is a classification of dynamic capabilities into three component factors which define dynamic capabilities: the adaptive capability, the absorptive capability and the innovative capability (Wang & Ahmed 2007). Although correlated, these three components are conceptually distinct (Wang & Ahmed 2007). Adaptive capability is about aligning organisations' internal organisational factors with external environmental factors, and therefore focuses on organisations' ability to adapt themselves in a timely fashion to environmental change through flexible resource management and adequate alignment of resources and capabilities (Wang & Ahmed 2007). Absorptive capability is concerned with learning and absorbing external knowledge, and making it available for internal use. Hence, this category stresses the importance of organisational learning and integration of knowledge to keep up with environmental changes. Innovative capability refers to organisations' innovative potential; hence, it focuses on organisations' ability to develop new products and/or markets. According to Wang and Ahmad (2007), no empirical study has been undertaken so far that examines these three main components of dynamic capabilities.

### 2.5.2. The dynamic capability perspective as an improvement on the resource-based view to explain competitive advantage

The introduction of the DCP has enhanced the resource- based view's explanation of how to gain SCA in several ways. Firstly, while the RBV outlines the importance of specific resources, and argues that the existence of these gives companies competitive advantage, it does not explain how these resources actually contribute to competitive advantage. It fails to explain the mechanism that links resources and product markets (Priem 2001) to competitive advantage (Williamson 1999). Research on dynamic capabilities has begun to explore these transformational mechanisms (Wang & Ahmed 2007). Secondly, the DCP overcomes the criticism aimed at the RBV that it is static. For developing and implementing sustainable competitive advantages, firms often have to make specific, irreversible commitments (Ghemawat & del Sol 1998). On the one hand, irreversible and specific commitments enhance stability and equilibrium and assumed voluntary development by companies entering defined strategic paths. On the other hand, committing to specific and irreversible investments reduces firms' flexibility by determining the strategic paths for development and reducing the strategic alternatives available to a company (Leonard-Barton 1992). In the turbulent contemporary environment, companies with specific commitments are, therefore, in danger of being restricted by their specialised resources and capabilities (Ghemawat & del Sol 1998). In dynamic contemporary markets, sustainable competitive advantage is unlikely to prevail if it is not constantly renewed (D'Aveni & Gunther 1994; Eisenhardt & Martin 2000). The RBV fails to address the constant market dynamism and firm evolution over time (Wang & Ahmed 2007).

The DCP addresses this shortcoming. Dynamic capabilities can be regarded as ‘ultimate organizational capabilities that are conducive to long term performance’ (Wang & Ahmed 2007).

The dynamic capabilities and, therewith, the competitiveness of a company are determined by three factors: firstly, strategic paths, which refer to the availability of a spectrum of strategic options for a company and the path dependency of strategic options (Leonard-Barton 1992); secondly, the resource position of a company, which refers to tangible but especially intangible assets; finally, organisational processes in terms of management skills, patterns of behaviour, thinking and learning (Teece, Pisano & Shuen 1997).

In general, dynamic capabilities enable SCA by focusing on strategy-relevant processes in companies and trying to improve responsiveness in a fast-changing environment. According to Teece and Shuen (1997), these ‘dynamic capabilities’ reflect a company’s ability to achieve new and innovative forms of competitive advantage given path dependencies and market positions. In this view, the company’s competitive advantage lies mainly in its dynamic capabilities, which refer to the capacity to build, renew and reconfigure capabilities and competences so as to achieve congruence with the changing business environment (Kylaheiko, Sandstrom & Virkkunen 2002). In the DCP, IT can contribute to competitive advantage by enabling and supporting the building, renewing and reconfiguration of organisational capabilities and competences. Chapter 3 discusses in greater detail how IT can contribute to competitive advantage by enabling dynamic capabilities.

## 2.6. SUMMARY

The purpose of this chapter was to discuss the main dependent variable of this research: competitive advantage. The search for explanations of competitive advantage has a long tradition. The chapter has offered an overview of the different conceptions of competitive advantage. Accordingly, three notions of competitive advantage were identified: a relative position, superior performance, and an inimitable prolonged benefit (sustainable competitive advantage). This discussion will form the basis for development of the conceptual foundation and the measurement of the dependent variable of this research.

The chapter also reviewed the different perspectives on the sources and causes of competitive advantage. These are the industrial organisations view, the RBV, and the DCP on competitive advantage. The next chapter will draw on this background discussion to review the literature on IT and competitive advantage, which has more or less paralleled the theoretical developments on the sources of competitive advantage. Together, Chapters 2 and 3 lay the background theoretical foundation for the conceptual framework to be introduced in Chapter 4.

After the main dependent variable of this research—competitive advantage—has been discussed, and different perspectives to explain its source have been investigated, the next chapter (Chapter 3: Perspectives on IT and Competitive Advantage) moves on to discuss and delineate the different perspectives on how the independent variable of this research (IT) can be a source of competitive advantage.

# Chapter 3

# PERSPECTIVES ON IT AND COMPETITIVE ADVANTAGE

*'Information technology and business are becoming inextricably interwoven. I don't think anybody can talk meaningfully about one without the talking about the other'*
*(Bill Gates)*[3]

## 3.1. INTRODUCTION

The perspectives on competitive advantage in general are discussed in Chapter 2 of this thesis. Chapter 3 examines further the specific literature on IT and competitive advantage. Firstly, the chapter provides an overview of the different research perspectives on IT and competitive advantage. Secondly, research on IT and competitive advantage from the resource-based view (RBV) is discussed. Although, research on IT and competitive advantage from the RBV offers important insights into IT's ability to leverage organisational resources and to generate competitive advantage (Ravichandran & Lertwongsatien 2005), it does not investigate how IT can contribute to the dynamic capabilities of organisations. Research on IT's ability to contribute to competitive advantage through enabling dynamic capabilities is, therefore, presented in the third section of this chapter. Finally, conclusions drawn from the prevailing research on IT and competitive advantage are presented.

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[3] (BillGatesMicrosoft.com Accessed 20.03.2009)

## 3.2. Overview of Perspectives on IT and Competitive Advantage

Previous research concerned with IT and competitive advantage has investigated how and to what extent the application of IT can lead to competitive advantage. These studies have included investigating IT's impact on firm performance, inventory reduction, productivity enhancement, profitability improvement, process enhancement and other measures of organisational performance. Many IT researchers distinguish between the terms information technology (IT) and information systems (IS). IT processes, transmits and stores information and is asset-based, whereas IS represents a mixture of assets and capabilities around the productive use of IT (Wade & Hulland 2004). IT researchers mainly use IT to refer to the asset-based technology resources. In contrast, the term IS is primarily used to refer to the more comprehensive mixture of IT, capabilities and organisational assets that enable IT to support individual, group and business goals. Hence, IS has a broader focus and incorporates not only IT but also integrated software that uses IT to support individual, group and business goals as well as managerial and transformational IT capabilities. This study uses the generic term IT to include both IT and IS.

Scholars have investigated the relationship between IT and competitive advantage from a variety of perspectives. This has led to a variety of diverse conceptual, theoretical and analytic approaches within research into IT business value (Melville, Kraemer & Gurbaxani 2004). Conceptually, research has investigated either firm performance or competitive advantage as the common dependent variable. The common independent variables vary from financial measures of IT investments to IT systems, IT capabilities and IT support for core competences. Theoretically, scholars have most commonly either based their research on the *economic perspective*, or drawn from one of the three major theories of strategic management—the *strategic perspective* (Porter 1985a), the *resource-based view* (RBV) (Barney 1991; Prahalad & Hamel 1990) or the *dynamic capabilities perspective* (DCP) (Teece, Pisano & Shuen 1997). Table 3.1 below provides an overview of the different perspectives within IT and competitive advantage research and the subsequent sections discuss the literature under each view in some detail.

**Table 3-1: Perspectives on IT and Competitive Advantage**

| | Economic | Strategic | Resource-based | Dynamic capability |
|---|---|---|---|---|
| Key argument | IT investments directly affect firm performance | IT can be used to shape the external environment of organisations | IT has to support organisational resources, capabilities and competences | IT has to enable organisational dynamic capabilities |
| Informing theory | Economic production functions | Industrial organisations view | Resource-based theory | Dynamic capability view |
| Common dependent variable | Firm performance | Competitive advantage | Competitive advantage | Competitive advantage or availability of competitive actions repertoire |
| Common independent variable/s | IT investments | IT's potential to increase bargaining power, strengthen entry barriers and deter competitive rivalry | IT resources, IT capabilities, IT support for core competences | IT resource flexibility, IT capabilities, IT support for core competences |
| Seminal References | Hitt & Brynjolfsson (1996); Brynjolfsson (1993, 2003) | McFarlan (1984); Porter & Millar (1985) | Wade & Hulland (2004); Ravichandran & Lertwongsatien (2005) | Pavlou (2006); Sambamurthy et al. (2003) |
| Findings | Unequivocal findings on the IT–firm performance relationship | Only explains short-term competitive advantages | IT can lead to competitive advantage if it forms complementarities with other firm resources | IT can enable dynamic capabilities |
| Comment | Firm performance as a dependent variable only measures financial performance | Even if specific IT can give short-term advantage, external environmental advantage erodes over time and IT can be copied | Studies many find positive relationships between IT and competitive advantage | Not all studies explicitly mention the DCP |

## 3.3. ECONOMIC PERSPECTIVE ON IT AND FIRM PERFORMANCE

A number of studies have been conducted to analyse the relationship between IT and economic performance. These studies draw from an economic perspective on firm performance and mostly apply economic theories of production as a fundamental framework (Bakos & Kemerer 1992; Bharadwaj, Bharadwaj & Konsynski 1999; Hitt & Brynjolfsson 1996; Tam 1998). The economic theory of production is based on the proposition that a production function links a firm’s input to its output and the cost of each marginal input should equal the marginal output produced by this input (Hitt & Brynjolfsson 1996). Following this logic, research on IT and firm performance seeks to investigate whether firms that spend more on IT gain a higher profitability through IT investment ratios. Input parameters often include costs of IT infrastructure investments, human resource costs (including training costs) or general spending of the IT department. Output is mostly measured by a firm’s financial performance of profitability or stock returns. The results of these studies were mixed and the empirical evidence for IT effects on firm performance from an economic perspective remains generally inconclusive (Zhang & Lado

2001). Some studies found no positive and sometimes even a negative relationship between investments in IT and firm performance (Barua, Kriebel & Mukhopadhyay 1991; Carr 2003; Strassman 1990) while other studies did find evidence of positive relationship between IT investments and firm performance (Barua, Kriebel & Mukhopadhyay 1995; Bharadwaj, Sambamurthy & Zmud 1999; Hitt & Brynjolfsson 1996).

Some articles suggest that IT increases productivity and consumer value, but does not change business profitability (Hitt & Brynjolfsson 1996). These inconsistent findings were previously discussed in the consideration of the so-called '*productivity paradox*' (Brynjolfsson 1993). The '*productivity paradox'* is an assumption that IT investments contribute negatively to productivity. Byrnjolfsson's (1993) often cited article 'The productivity paradox of information technology' examines previous studies that investigate the impact of IT investments on economy-wide productivity and the productivity of IT capital in service and manufacturing. Explanations for this productivity paradox have included mismeasurement of inputs and outputs, time lags between IT investment and performance output due to learning and adjustment, redistribution of benefits within the industry and mismanagement of developers and users of IT (Barua & Lee 1997; Brynjolfsson 1993, 2003). Looking more closely at the data, Brynjolfsson (1993) assumes that the 'productivity paradox' is mainly due to problems with measuring quality changes and valuing new products (e.g. increased variety, improved timeliness of delivery and personalised customer service) in productivity statistics. Brynjolfsson (1993) therefore suggests that IT researchers look beyond the conventional productivity measurement techniques.

Barua, Kriebel and Mukhopadhyay (1995) reviewed previous studies and found that other researchers have utilised a 'web of intermediate level contributions', such as product quality, inventory turnover, labour hours, impact on business processes, to investigate the effects of IT on organisational performance. Barua, Kriebel and Mukhopadhyay (1995) believe that these 'lower level impacts' can affect organisational / higher level performance measures and include factors like inventory turnover, relative quality and price, capacity utilisation and new products. This is consistent with Chan's (2000) demand to incorporate qualitative, individual and group level measures into IT value research. This will not only assist in investigating the impact of IT investments on organisational performance and viewing the organisational system as a black box, but will also include the impact of IT on organisational structure and processes in the research (Chan 2000).

Carr (2003) reviewed IT investments and their impact on the financial performance of companies and asserted that investments in IT do not provide any strategic advantages to firms at all since the commercial IT infrastructure in most enterprises is nearing perfection (Carr 2003). According to Carr (2003), the efficient utilisation of standardised software packages like ERP (Enterprise Resource Planning), or CRM (Customer Relations Management) systems such as SAP, or standard network services (such as broadband LAN) is essential for the survival of a company, but creates only a small chance to differentiate in competition. On Carr's view, when IT lost its potential to create sustainable competitive advantage, it became essential to sustain competition but inconsequential to strategy; thus the risk it creates becomes more significant than the advantages it provides (Carr 2003). In another article he even announces the end of corporate computing, as IT becomes a general purpose technology and offers the potential for considerable economies of scale since its supply can be consolidated (Carr 2003). Following these statements, a wide debate arose and many articles were published around the world among practitioners and academics expressing a range of opinions on the topic. Even though most of the recent articles seem to attest to a strong relationship between IT and improvements in economic performance (Indjikian & Siegel 2005), there is no clear evidence for a direct relation between investment in IT assets and firm performance.

In summary, studies drawing from the economic perspective that have examined the relationship between IT and firm performance and tried to measure the effects of IT investments on a company's profitability and productivity mostly on an aggregate level have produced equivocal results (Brown, Gatian & Hicks 1995; Hitt & Brynjolfsson 1996; Mukhopadhyay, Kekre & Kalathur 1995). Some of the reasons for such equivocal results are mismeasurement, lack of clarity and consistency in the definition of the dependent variable, and lack of a cumulative line of research. In addition, the economic perspective line of IT and competitive advantage research tends to consider the organisational context as a black box—an assumption that is inherently flawed and has been challenged by a number of researchers. Therefore, although the economic perspective helps to identify the relevance of investing in base IT resources, it does not provide a full understanding or explanation of the process of gaining IT business value. As a result, scholars have sought alternative explanations, such as the strategic perspective (Bakos & Treacy 1986; McFarlan 1984; Porter 1985b) which is discussed below.

## 3.4. STRATEGIC PERSPECTIVE ON IT AND FIRM PERFORMANCE

As competitive advantages are influenced by many variables, isolating the direct impact of IT investments on competitive advantage seems difficult to realise. Many IT researchers question the direct link between IT, firm performance and competitive advantage and argue for indirect links between IT and competitive advantage. Therefore, a number of researchers (Bakos & Treacy 1986; McFarlan 1984; Porter 1985b) approach the IT value research from the strategic perspective and draw from the theories of strategic management (Porter 1980b). These studies predominantly examine how IT can be utilised to alter and manipulate a firm's external competitive forces and the structure of the industry, and also how IT can enable a firm to create a superior position in the industry in which it operates. IT's potential to increase a firm's bargaining power over its buyers and suppliers, to deter competitive rivalry and to toughen entry barriers were main areas of investigation (Bakos & Treacy 1986; McFarlan 1984; Porter 1985b;

Stalk, Evans & Shulman 1992). IT research founded in the industrial economic perspective, therefore, focuses on advantages of IT utilisation in regards to possibilities to shape the external environment. As such, most of these IT researchers have argued how firms can use (or have actually used) IT to manipulate market forces or how IT can support a firms' competitive strategy directly by either reducing its cost or differentiating its offerings.

The major limitation of these studies arises because external environmental advantages erode over time due to imitations of strategies and the possibility of copying IT applications. Furthermore, as IT becomes increasingly standardised, any strategic advantage that derives solely from its usage will erode. Therefore, many IT researchers have turned their interest from focusing on the external environment and IT spent towards a focus on the internal environment as an alternative means to investigate IT-enabled competitive advantage. This internal IT research perspective draws from the RBV. Perspectives on IT and competitive advantage from the RBV are discussed in the following section.

## 3.5. The Resource-Based View of IT and Competitive Advantage

The resource-based view (RBV) has been utilised to examine IT and competitive advantage and to explain the '*productivity paradox'* regarding the strategic impacts of IT (Clemons & Row 1991; Feeny & Willcocks 1998; Ravichandran & Lertwongsatien 2005; Wade & Hulland 2004). It has been recognised as a cogent framework with which to evaluate the strategic value of IT (Santhanam & Hartono 2003). Furthermore, the RBV enables the investigation of the different impacts of IT resources, capabilities and competences on competitive advantage (Wade & Hulland 2004). Since this current PhD research draws heavily from this theory, we will review with greater detail the previous works on IT and competitive advantage from the perspective of RBV theory. The section begins with an overview of the resource-based concepts of IT and competitive advantage and moves on to discuss two streams of RBV thought: resource necessity; and the IT intangibles perspective.

### 3.5.1. Overview of the resource-based view of IT and competitive advantage

Three key concepts are used in the IT and competitive advantage literature that draw from the RBV: IT resources, IT capabilities and IT support for core competences. However, the IT literature is not always consistent on what is regarded as an IT resource, IT capability or IT support for core competence. Classifications in IT research range from using simple terminology such as the terms IT resources / IT asset (e.g. (Ross, Beath & Goodhue 1996) to describing all IT-related constructs to more sophisticated classifications that differentiate between input-based resources, transformational and managerial capabilities and output-based competences (e.g. (Ravichandran & Lertwongsatien 2005; Wade & Hulland 2004). This is, indeed, similar to the use of concepts in the generic resource-based literature, in which the terms resources, capabilities and competences are often used interchangeably—as discussed in detail in section 2.2 of Chapter 2.

The precise definitions of IT resources, IT capabilities and IT support for core competences vary throughout the IT literature. The choice of terminology often serves the purpose of a particular researcher. For instance, early researchers that investigated IT from the RBV focused on IT resources and their impact on competitive advantage, which led to the *resource necessity perspective* (Clemons & Row 1991). These researchers did not recognise the role of higher order IT capabilities or IT support for core competences. Subsequent works addressed the shortcomings of previous studies and tended to distinguish between different dimensions of IT. The concept of transformational or managerial IT intangibles was given the term IT capabilities by Feeny and Willcocks (1998). They stated that to achieve competitive advantage companies need nine core IT capabilities, including architecture planning, business system thinking, informed buying and a variety of technical, business and interpersonal skills for IT personnel. Armstrong and Sambamurthy (1999) included in this list IT capabilities conceptualised through IT and business knowledge of senior leadership. Other researchers have also included output-focused IT support for core competences, conceptualised through IT support for core competences (Ravichandran & Lertwongsatien 2005).

Overall, however, research on the RBV of IT and competitive advantage has explored two major themes: firstly, IT's ability to produce complementarities with organisational resources as a source of competitive advantage; secondly, IT's intangible aspects, such as managerial or personnel skills, and how they can leverage IT resources to create competitive advantage. Table 3.2 presents a summary of the different research studies conducted from the RBV on IT. The following sections will discuss the findings, contributions, differences and similarities among these major studies presented in Table 3.2.

**Table 3-2: Research on Resource-Based View of IT and Competitive Advantage**

| Author | Approach | Findings | CA as DV | IT resource complementarities | IT intangibles |
|---|---|---|---|---|---|
| **Clemons & Row (1991)** | Conceptual | IT is a strategic necessity and by itself does not lead to SCA. Nonetheless, IT can leverage other strategic resources. | x | x | |
| **Duncan (1995)** | Empirical | Empirical study in the insurance industry reveals positive impact of IT infrastructure flexibility on business value measures. Also incorporates measures for IT outsourcing. Full model could not been tested in the study. Insurance industry focus. | x | | x |
| **Mata (1995)** | Conceptual | Drawing from the RBV, logical arguments are used to suggest that managerial IT skills are the only resource that leads to SCA. | x | | x |
| **Andreu & Ciborra (1996)** | Conceptual | Focuses on IT's role in organisational learning and discusses how IT supports developing capabilities and competencies within a firm. | | | x |
| **Ross et al. (1996)** | Conceptual | Argues on a conceptual level that firms need three IT assets (IT human resources, technology, relationships) which in combination with IT processes can lead to SCA. | x | | x |
| **Powell & Dent-Micallef (1997)** | Empirical | Although IT is a strategic necessity, it cannot by itself produce SCA. Rather, IT is able to leverage organisational competences to achieve SCA. | x | x | |
| **Feeny & Willcocks (1998)** | Conceptual | To achieve SCA companies need nine IT capabilities. These capabilities include architecture planning, business system thinking, informed buying and a variety of technical, business and interpersonal skills for IT personnel. | x | | x |
| **Armstrong & Sambamurthy (1999)** | Empirical | Business and IT knowledge of senior leadership has a positive impact on the sophistication of IT infrastructures. | | | x |
| **Bharadwaj et al. (1999)** | Empirical | Offer a distinction between resources and capabilities based on RBV theories and empirically examines six IT capabilities. | | | x |
| **Broadbent et al. (1999)** | Empirical | Study found more sophisticated IT infrastructures in firms that often change their products. | | | x |
| **Bharadwaj (2000)** | Empirical | Firm performance of firms with higher IT capability is found to be higher than that of firms with lower IT capability. IT capability construct developed. | x | | x |
| **Santhanam & Hartono (2003)** | Empirical | Firms with superior IT capability have superior firm performance. Builds on and empirically confirms the work of Bharadwaj 2000. | x | | x |
| **Tippins & Sohi (2003)** | Empirical | Organisational learning positively mediates the relationship between IT support for core competences and firm performance | x | | x |
| **Tallon & Kraemer (2004)** | Empirical | Strategic alignment positively mediates the effect of IT capabilities on firm performance. IT capabilities are operationalized as IT infrastructure flexibility. | x | | x |
| **Wade & Hulland (2004)** | Review | Research review: Integrates various RBV constructs into one framework, consisting of outside-in, spanning and inside-out capabilities. | x | x | x |
| **Ray et al. (2005)** | Empirical | IT resources and IT capabilities do not explain variations in process performance unless they are tacit, socially complex and firm-specific. | x | x | x |
| **Ravichandran & Lertwongsatien (2005)** | Empirical | IT capability, which depends on IT resources, is positively related to IT support for core competences. IT support for core competences explain variations in firm performance. | x | | x |
| **Zhang (2007)** | Secondary Data | Performance improvement from IT arises from indirect effects of IT on firm-specific knowledge, vertical integration and related diversification that complement IT. | x | | x |
| **Tangpong (2008)** | Conceptual | Considers RBV and prisoner's dilemma perspective to revisit the IT productivity paradox. Then argues for a dynamic interplay among firms, competitors and IT vendors, which profit the most from IT investments. | x | | x |

## 3.5.2. IT resource complementarities and competitive advantage

The beginnings of IT research using the RBV can be attributed to the early 1990s with the '*strategic necessity hypothesis*' (Clemons & Row 1991). The strategic necessity hypothesis argues that IT is essential to a firm, but on its own is a commodity-like resource that is necessary, but neither unique nor difficult to imitate. Therefore, IT resources alone generally do not lead to SCA. The implications of the strategic necessity view of competitive advantage for IT research according to some researchers are based in the potential of IT to possess *VRIN* (valuable, rare, imperfectly inimitable and non-substitutable) attributes. IT resources, such as networks and databases, are a necessity for organisations to compete in the business, but can be easily acquired from the factor market (Mata, Fuerst & Barney 1995).

In the strategic necessity perspective, IT resources are necessary, but not sufficient for SCA. Others have sought to explain how firms can achieve competitive advantage by managing their IT resources to form complementary relationships to develop VRIN attributes for organisational resources. What makes IT a source of SCA for firms is its ability to leverage differences in strategic resources (Clemons & Row 1991). Firms that manage to utilise IT to leverage structural differences, such as the quality and organisation of key resources or vertical integration and diversification, will be able to achieve competitive advantage from their IT (Clemons & Row 1991). In other words, IT by itself is necessary to compete in the business but does not provide SCA. IT can be a source of competitive advantage if it leverages firms' strategic resources through complementary relationships with other firm assets, business processes, capabilities or competences. In their study, Powell and Dent-Micallef (1997) focused on the retail industry and IT's ability to leverage other intangible, complementary human and business resources. The results were similar to the findings of Clemens and Row (1991) and supported the strategic necessity hypothesis of IT and the notion of the indirect effects of IT on competitive advantage through intangible, complementary human and business resources (Powell & Dent-Micallef 1997).

This logic of resource complementarities has been adopted by many researchers and argues that organisations that complement IT with other organisational resources have a better chance of defending their IT-derived competitive advantage against competitors (Bharadwaj 2000; Clemons & Row 1991; Feeny & Willcocks 1998; Mata, Fuerst & Barney 1995; Tippins & Sohi 2003). IT alone does not impact firm performance, but a number of firms have been seen to gain SCA when they used IT to leverage other organisational resources (Powell & Dent-Micallef 1997). Some studies that have investigated IT from the RBV consider the 'prisoners dilemma' (game theory) and theoretical argue that IT vendors gain the greatest benefits from IT investments, not the investing firms (Tangpong 2008). Other studies have used secondary data to argue for performance improvement from IT investments which arise from the indirect effects of IT on firm-specific knowledge, vertical integration and related diversification that complement IT (Zhang 2007).

Ray et al. (2005) empirically assessed the role of IT on the customer performance process and found that IT resources do not explain variations in process performance unless they are tacit, socially complex and firm-specific. In so far as organisational resources and processes are often unique, this further complicates imitation of the blending of IT with organisational resources (Bharadwaj 2000). This interaction is typically analysed in the IT research literature using multiplicative terms in statistical analyses to examine whether the presence of one resource enhances the value of another (Ravichandran & Lertwongsatien 2005). Powell and Dent-Micallef (1997), for example, measured the effect of complementarities between human resource practices and IT use on retail store performance with interaction terms. Another conceptual approach is the work of Ross, Beath and Goodhue (1996), who define three IT assets (human resources, technology and relationships) and argue that these IT assets, in combination with IT processes, could lead to SCA. The results of their study enhance the notion of its complementary impact on firm performance. Ross, Beath and Goodhue (1996) used the term IT assets to denote assets, personnel and relationship assets, and IT processes to refer to IT planning, delivery, and operations and support processes. They focused on how the interplay between IT assets and IT processes creates business value. Bharadwaj (2000) adopted a similar categorisation but included IT infrastructure (physical IT assets), IT human resources (technical and managerial skills) and IT-enabled intangibles (knowledge assets, customer orientation and synergy) as IT resources.

This classification ignores the different levels of IT resources. Rather than being on the same level as IT infrastructure and IT human resource skills, IT-enabled intangible organisational resources are enabled through the former two resources (Bharadwaj 2000). Consistent with the findings of previous scholars (Clemons & Row 1991; Powell & Dent-Micallef 1997), IT is found to only affect firm performance if it is embedded, so that it can provide sustainable resource complementarities with firms' intangible organisational resources (Bharadwaj 2000). Furthermore, IT human resources can be seen as a transformational and managerial capability that enables IT infrastructure to produce IT intangibles. Categorising all three constructs in the same level under the label of IT resources neglects the relationship among them, and thus lessens the explanatory power of the research.

### 3.5.3. IT intangibles and competitive advantage

To gain a better insight into the relationship between IT and competitive advantage some researchers developed the theory to include IT intangibles in their research models (e.g. (Mata, Fuerst & Barney 1995). IT intangibles are unique sets of hard to duplicate managerial, personnel and transformational capabilities of IT. IT intangibles leverage IT functionality to support organisational resources, capabilities, competences and/or business processes (Ravichandran & Lertwongsatien 2005). The notion of IT intangibles is often captured in terms of IT capabilities or IT support for core competences. In their conceptual work, Mata, Fuerst and

Barney (1995) used the RBV framework to discuss the impact of several IT resources and IT intangibles (access to capital, proprietary technology, technical IT skills and managerial IT skills) on competitive advantage. As a result Mata, Fuerst and Barney (1995) argued that only managerial IT skills lead to SCA.

The notion of IT intangibles, such as managerial IT skills, as important transformational and managerial capabilities of the IT department was also considered by Feeny and Willcocks (1998). Their work was practitioner-focused and not directly linked to the RBV. Nevertheless, they discussed nine core IT capabilities required by a company to transform IT resources into SCA. The four categories of IT capabilities that Feeny and Willcocks (1998) mapped were: *business and IT vision*; *delivery of IT services*; *design of IT architecture*; *and other core IS capabilities* (Feeny & Willcocks 1998). Another empirical study around the same time from Bharadwaj et al. (1999) proposed a distinction between IT resources and IT capabilities based on the RBV arguments (Amit & Schoemaker 1993; Grant 1991). The IT capability concept was defined as an organisation-wide concept consisting of six constructs: *IT business partnerships, external IT linkages, business IT strategic thinking, IT business process integration, IT management* and *IT infrastructure* (Bharadwaj, Sambamurthy & Zmud 1999). Their study contributed to a better understanding of the IT capability construct and provided a conceptual and empirical basis for the proposed IT capability dimensions. In further studies, Bharadwaj (2000) examined the link between IT capabilities and firm performance. Companies that exhibit higher IT capabilities were found to have higher firm performance (Bharadwaj 2000).

Armstrong and Sambamurthy (1999) looked at IT assimilation in firms and the influence of senior leadership and IT infrastructures. The results provided evidence that the business and IT knowledge of the senior IT leadership has a positive impact on IT assimilation (Armstrong & Sambamurthy 1999). Another conceptual work which is loosely based on the RBV comes from Andreu and Ciborra (1996), who focus their attention on the role of IT in organisational learning and core capability development. Although their work is only loosely based on the resource-based view and is not primarily intended to measure dynamic capabilities, the notion of IT's ability to support organisational learning and development of core capabilities is an important idea which gained more attention in the 2000s (Andreu & Ciborra 1996). More recently, Tippins and Sohi (2003) examined the relationship between IT support for core competences, organisational learning and firm performance. Their empirical study among 271 manufacturing firms demonstrated that organisational learning played a significant role in mediating the effects of IT competency on firm performance.

While the above mentioned works all addressed elements of the RBV, Ravichandran and Lertwongsatien (2005) integrated IT resources, IT intangibles and competitive advantage in one framework. Their framework of IT resources, IT capabilities and IT support for core competences overcame the fragmentation of prior research. This allowed them to investigate the relationships among these constructs. The contribution of Ravichandran and Lertwongsatien's (2005) work was not only that the relationships among IT resources, IT capabilities and IT support for core competences were examined, but their study also enabled investigation of the impacts of complementarities on firm performance. To promote a better understanding of the role of IT in organisational processes and resources, Ravichandran and Lertwongsatien (2005) examined IT support for core competences as the ability to acquire, deploy and leverage IT functionality in combination or co-presence with other resources to shape and support business processes and/or other organisational competences. IT support for core competences was measured to examine the coherence between IT activities and firm priorities (Ravichandran & Lertwongsatien 2005). The results of this study supported the prior research findings and contributed to the field in several ways. Firstly, the study confirmed that variation in firm performance can be explained by the degree to which firms use their IT to support their competences. Secondly, the study found that the extent to which companies are able to build IT support for their organisational competences is dependent on IT functional capabilities, such as IT planning sophistication, system development and IT operations capability. Finally, the assumption that IT functional capabilities are dependent on IT resources was confirmed.

While it does not explicitly refer to the RBV, the IT alignment literature also reflects the above discussed perspective of resource complementarities as well as many aspects of IT capabilities. According to the IT alignment literature, IT activities and resources need to be directed towards areas of strategic importance of the firm (Luftman 2003). Aligning IT resources/capabilities/competences with the strategic core competences of a firm enhances complementarities effects. This can be achieved by mutual coherence between IT priorities and firm strategies. This strategic alignment has been on the top issues in the IT field and there is little doubt about its importance (Luftman 2003; Yolande, Rajiv & Jason Bennett 2006). Henderson and Venkatraman (1993) argument that failures in maximising the advantages of IT investment is due to lack of alignment between IT strategy and business strategy. It shows that the issue of strategic alignment is of importance and it becomes more and more so as organizations have to adapt to changes in their environment. Alignment across business and IT areas is hard to achieve and once aligned environmental changes can soon lead to misalignment again as business strategies and technology evolves (Luftman 2003). The Dynamic Capability perspective of IT and competitive advantage in the next section as well as the concept of adaptive IT capability in chapter 4 indirectly discusses how IT can contribute to a better alignment by being able to adapt fast to organizational changes. Hence, enabling faster re-alignment of business and IT and, therefore, be a source of competitive advantage.

In sum, the RBV of IT and competitive advantage enables researchers to look inside organisations to investigate IT's impact on competitive advantage. Hence, the RBV of IT and competitive advantage overcomes the prior limitations of research based on the economic and strategic perspectives. It provides useful insight into IT's ability to generate competitive advantage through supporting organisational resources, capabilities, competences and/or business processes. IT can contribute to competitive advantage and enable SCA if it forms intangible complementary relationships with organisational features. In particular, if IT is leveraged by unique idiosyncratic IT intangibles—such as personnel, managerial or transformational capabilities—it can be a source of SCA.

As contemporary business environments are often subject to change, once achieved successful complementarities between IT and organisational features must be adapted to accommodate new competitive conditions. The dynamic attributes of IT enable organisations to adapt more successfully to changes in the competitive environment than their competitors and, hence, can be a source of SCA (Sambamurthy, Bharadwaj & Grover 2003; Teece, Pisano & Shuen 1997). However, most of the IT researchers who adopt the RBV have not looked at dynamic attributes even though IT can take on such attributes which can be useful to companies especially when operating in turbulent environments (Jarvenpaa & Leidner 1998). The dynamic capability perspective (DCP) on IT and competitive advantage explores IT's dynamic attributes and provides a new insight into IT beyond its traditional interpretation within the context of the RBV (Wade & Hulland 2004); this contribution is discussed in the following section.

## 3.6. Dynamic Capabilities Perspective on IT and Competitive Advantage

The dynamic capability perspective (DCP) on IT and competitive advantage covers a very broad field. In general, the DCP of IT and competitive advantage captures the ability to utilise IT to enable firms to adapt faster to changes in the external environment than their competitors, hence, providing them with a SCA (Teece, Pisano & Shuen 1997). Despite the fact that most IT researchers have not explicitly drawn from the strategic management literature and thus have not referred to the DCP, some have contributed to an understanding of dynamic capabilities (Fink & Neumann 2007; Overby, Bharadwaj & Sambamurthy 2006; Sambamurthy, Bharadwaj & Grover 2003). The DCP on IT and competitive advantage is similar to the above discussed IT resource complementarities and IT intangibles perspective in that both have their roots in the RBV. The DCP is an enhancement of the RBV (see section 2.3). Hence, the conceptualisation of IT resources, IT capabilities and IT support for core competences is similar in each.

However, the DCP is different from the IT resource complementarities and IT intangibles perspective discussed in the previous chapter in several ways. Firstly, the perceptions of IT's potential to create competitive advantage differ. The IT resource complementarities and IT intangibles perspective locates IT's potential to create competitive advantage in its ability to support and build complementarities with organisational resources, capabilities, competences and/or business processes. In contrast, the DCP of IT and competitive advantage sees the main source of IT-derived competitive advantage in IT's ability to facilitate a firm's adaptation to environmental changes more quickly and more efficiently than its competitors. Secondly, in some studies the DCP of IT and competitive advantage includes another dependent variable: the ability to launch frequent and varied competitive actions (Sambamurthy, Bharadwaj & Grover 2003). Finally, in order to continually enable the building, renewing and reconfiguring of organisational competences, IT not only must provide a foundation for organisational dynamic capabilities, but must also adapt itself to changes in the environment. Hence, this adds the notion of flexibility to IT infrastructure–based constructs.

Pavlou and Sawy (2006) conducted an empirical study with 180 managers in the new product development environment. They found that the influence of IT on competitive advantage was mediated by a specific organisational dynamic capability—resource configurability (coordination competence, absorptive capacity, collective mind and market orientation). All four constructs of resource re-configurability are enhanced by digital options (Pavlou 2004). Digital options refer to digitised enterprise work processes and knowledge systems which enable a business infrastructure that shapes a company's capacity to launch varied and frequent competitive actions (Sambamurthy, Bharadwaj & Grover 2003). Digital options are exhibited within organisations through digitised process reach, digitised process richness, digitised knowledge reach and digitised knowledge richness. Digitised knowledge reach and range support the sensing of external change, whereas digitised process reach and range can be the foundation for response activities (Overby, Bharadwaj & Sambamurthy 2006).

Sambamurthy, Bharadwaj and Grover's (2003) model was conceptual and provided new insights into the value-adding role of IT in terms of enabling a business infrastructure that has the capacity to launch frequent and varied competitive actions, and contributed to our understanding of the interplay of the three dynamic capabilities—digital options, agility and entrepreneurial alertness. Their conceptual work also provided a benchmarking framework to assess the value of IT in three ways. Firstly, firms can assess the value of there IT by the quality of the digital options (IT supports for organisational processes and knowledge systems). Secondly, their notion of an agility construct suggests a measurement of the degree of (IT-enabled) agility in organisations. Lastly, the frequency and variety of competitive actions can be measured (Sambamurthy, Bharadwaj & Grover 2003). Furthermore, Sambamurthy, Bharadwaj and Grover's (2003) work contributes to IT research by highlighting three strategic processes: capability building, entrepreneurial action and co-evolutionary adaptation.

While the literature states that digital options can strengthen firms' ability to deal with change and emphasizes the importance of strategic processes, it does not explicitly address how digital options or IT support for core competence can change in order for the business to keep up with changing requirements. Possessing a broad variety of digital options does enable a broader variety of competitive actions, but digital options have to adapt themselves to changes in the environment to be able to offer innovative competitive action moves. The notion of competitive action moves as a dependent variable gives IT research a good insight into the strategic value of agile IT, but it does not elucidate the effect of IT-enabled organisational agility on competitive advantage.

Research into how IT can support organisational ability to react to environmental change was conceptualised differently by Fink and Neumann (2007). Their concept of IT-enabled organisational agility consists of three constructs: *IT-dependent information agility, IT-dependent strategic agility*, and *IT-dependent system agility*. Using SEM techniques Fink and Neumann (2007) were able to assess several alternative models in parallel, and hence further validate their findings. The best fitting and most valid model in their research was the one that revealed the positive effects of IT personnel capabilities on IT infrastructure capabilities as well as the positive impacts of IT infrastructure capabilities on three constructs of IT-dependent organisational agility: IT-dependent information agility, IT-dependent system agility, and IT-dependent strategic agility.

Using the capacity of SEM to investigate the relationships among several latent variables, Fink and Neumann (2007) found that the three constructs of IT-dependent organisational agility were related to each other. IT-dependent system agility has positive effects on IT-dependent information agility. The ability to adjust IT quickly and efficiently seems to impose a technical constraint on the quality of the information itself. Furthermore, both IT-dependent system agility and IT-dependent information agility demonstrate a positive effect on IT-dependent strategic agility. This reveals that when changes in the business environment occur, enterprises require the ability to adapt their information systems and their utilisation of information resources in accordance with the new information needs (Fink & Neumann 2007).

Furthermore, with the exception of a few studies, the DCP on IT and competitive advantage is silent on the subject of the resources, capabilities and competences that are required to enable IT to enhance organisational dynamic capabilities (Piccoli & Ives 2005). Existing frameworks at the organisational level suggest relationships between capabilities, competences and organisational dynamic capabilities (Wang & Ahmed 2007). In addition, IT researchers have found relationships between concepts of IT capabilities and one organisational dynamic capability: resource configurability (coordination competence, absorptive capacity, collective mind and market orientation)(Pavlou & El Sawy 2006). All four constructs of resource re-configurability were enhanced by the ability of IT to provide a foundation for a variety of competitive actions (Pavlou & El Sawy 2006).

## 3.7. SUMMARY

The relationship between IT and competitive advantage has been the preoccupation of many IT researchers. Some researchers have questioned the direct effects of IT on competitive advantage and have argued for mediating links (Barua, Kriebel & Mukhopadhyay 1995), while others have used the RBV to examine the impact of higher order IT capabilities and IT support for core competences on competitive advantage (e.g. Ravichandran & Lertwongsatien (2005); Wade and Hulland (2004).

Others have examined IT from the DCP (Pavlou & El Sawy 2006). Only a few have investigated how IT can enable the adaptation of products, services, organisational structures as well as business and innovation processes or to enhance knowledge sharing through supporting organisational dynamic capabilities. This perspective assists in understanding competitive advantage in terms of the role of IT as an enabler of a firm's ability to adapt itself to changes in the environment (Pavlou & El Sawy 2006; Sambamurthy, Bharadwaj & Grover 2003). No research on IT and competitive advantage has yet investigated the interlinked drivers of IT capabilities, IT support for core competences and their impact on a higher order IT resource which measures IT's impact on organisational dynamic capabilities. Therefore, the next chapter introduces a theoretical framework that addresses this research gap.

# Chapter 4

# A THEORETICAL FRAMEWORK OF ADAPTIVE IT CAPABILITY AND COMPETITIVE ADVANTAGE FROM THE DYNAMIC CAPABILITY PERSPECTIVE

*"The only constant is change, continuing change, inevitable change that is the dominant factor in society today. No sensible decision can be made any longer without taking into account not only the world as it is, but the world as it will be."*

*(ISAAC ASIMOV)*[4]

## 4.1. INTRODUCTION

The strategic management literature has long been investigating how firms adapt to competitive environments to gain profitable competitive advantage. In the contemporary environment of continual change through hypercompetition, increasing demands from customers and constant technological advancements, firms' capabilities to adapt, renew and reconfigure their competences can be an important source of competitive advantage (Teece, Pisano & Shuen 1997). The dynamic capability perspective (DCP) on strategic management is one of the latest attempts to explain competitive advantage in contemporary environments of hypercompetition (Teece & Pisano 1994). Hence, a recent growing research interest has been to investigate the role of IT in the contemporary environment of hypercompetition from this perspective (Piccoli & Ives 2005). Firms' IT can have a vital impact on their ability to adapt themselves to environmental change (Fink & Neumann 2007; Sambamurthy, Bharadwaj & Grover 2003) and can have a positive impact on competitive advantage (Ravichandran & Lertwongsatien 2005). Hence, the perspective on IT and competitive advantage needs to be refocused from the DCP. Drawing from the broader DCP, this research examines how IT can contribute to competitive advantage through a higher order resource—adaptive IT capability—which is the measure of the degree to which IT can support organisational dynamic capabilities. Furthermore, the

[4] (Assimov 1974)

interlinked drivers that build adaptive IT capability are examined in this research model.

The following sections will discuss the research model in greater detail and investigate each concept separately. Following that, the constructs are brought together in a whole theoretical model and research hypotheses are developed.

## 4.2. THE RESEARCH MODEL

In Chapters 1 and 3 (section 3.7) the research gap in the current literature was identified and explained and the need for more research on how IT can enable organisational dynamic capabilities and lead to competitive advantage was discussed. Even though a few studies were identified that draw from the DCP on IT and competitive advantage in Chapter 3, they do not incorporate the higher order resource of adaptive IT capability and its impact on competitive advantage into one conceptual model. Based on the discussion in Chapters 1, 2 and 3, a dynamic capability–based model of IT and competitive advantage is proposed. The proposed model builds on Ravichandran and Lertwongsatien's (2005) model but incorporates the higher order resource of adaptive IT capability as a mediating factor that relies on a firm's IT capabilities and IT support for core competences (ITSCC). The general structure of the proposed model is depicted in Figure 4.1. Adaptive IT capability enables firms to leverage their capabilities and competences in sensing and responding to changes in the market environment, which then have a positive impact on financial and market performance.

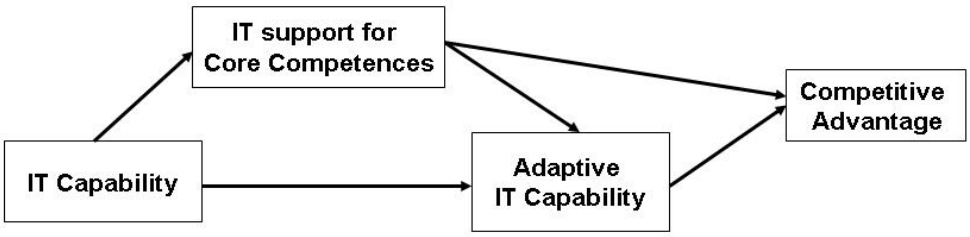


**Figure 4-1: Overview of the Research Model**

The above theoretical framework of this study delineates how this research is positioned within the IT literature. The conceptual model is based on IT and competitiveness of organisations from the resource-based theoretical perspective and its most recent research stream—the DCP. This research draws from the hierarchical categorisation of organisational resources, which is also accepted in the IT literature as discussed in Chapters 2 and 3. The research model incorporates the concepts of IT capabilities, IT support for core competences and competitive advantage. The relationships among these three have been investigated to some extent in prior IT research (Ravichandran & Lertwongsatien 2005). However, that research is limited to the North American context only. The research model presented here includes the concept of adaptive IT capability in the body of knowledge on IT–competitive advantage research. The four theorised concepts (competitive advantage, adaptive IT capability, IT support for core competences and IT capability) on the left side of Table 4.1 below are conceptualised through seven constructs. Table 4.1 provides an overview of the concepts and their constructs in this research model.

**Table 4-1: Constructs of the Research Model**

| Concept | Construct | Definition | Examples | Seminal authors |
|---|---|---|---|---|
| Competitive advantage | | The ability of an organisation to have a market and/or financial advantage relative to its competitors | Edge over competitors in terms of financial performance, profitability and sales growth | Barney 1991; Prahalad & Hamel 1990; Teece, Pisano & Shuen 1997 |
| Adaptive IT capability | | Adaptive IT capability is a higher order resource and refers to IT's ability to enable firms to constantly integrate, build and reconfigure internal and external competences to address changing environments | IT's ability to enhance adapting organisational competences quickly to new products, customers or markets | Teece 1997; Wang & Ahmed 2007; Pavlou 2006 |
| IT support for core competences | IT support for market competence | The ability of IT to support market and functionality related competences of an organisation | IT support for product development, CRM | Ravichandran & Lertwongsatien 2005 |
| | IT support for operational competence | The ability of IT to enable and support business processes and knowledge sharing | IT support for business processes, knowledge sharing | Ravichandran & Lertwongsatien 2005 |
| IT capability | IT personnel capability | The IT and business skills of the IT personnel | Skills to support a variety of ITs and the ability to understand the business environment | Byrd, Lewis & Turner 2004 |
| | IT management capability | The ability to build IT-business partnerships at the operational and strategic levels | Build trusting relationships with business departments, getting top management attention | Byrd, Lewis & Turner 2004; Ravichandran & Lertwongsatien 2005 |
| | IT infrastructure capability | The ability of the IT infrastructure to provide organisation-wide services while being able to add and reconfigure itself easily if needed | The ability to connect to any other IT infrastructure, share any kind of data across the infrastructures and add new components easily | Duncan 1995; Byrd and Turner 2000; Tallon 2008 |

The concept of adaptive IT capability refers to the ability of IT to support the continual integration, building and reconfiguring of organisational competences (Teece, Pisano & Shuen 1997). IT support for core competences is defined in this research model as the ability of IT to support organisational competences, and is conceptualised through the two constructs of IT support for market competence and IT support for operational competence (Ravichandran & Lertwongsatien 2005). IT capabilities in this research model are conceptualised though the constructs of IT infrastructure capability, IT personnel capability and IT management capability (Byrd & Turner 2000; Duncan 1995a; Tallon 2008). Figure 4.2 displays the complete research model and the hypotheses. The following section illustrates how these theorised constructs relate to each other in the theoretical framework of this study and presents the research hypotheses.

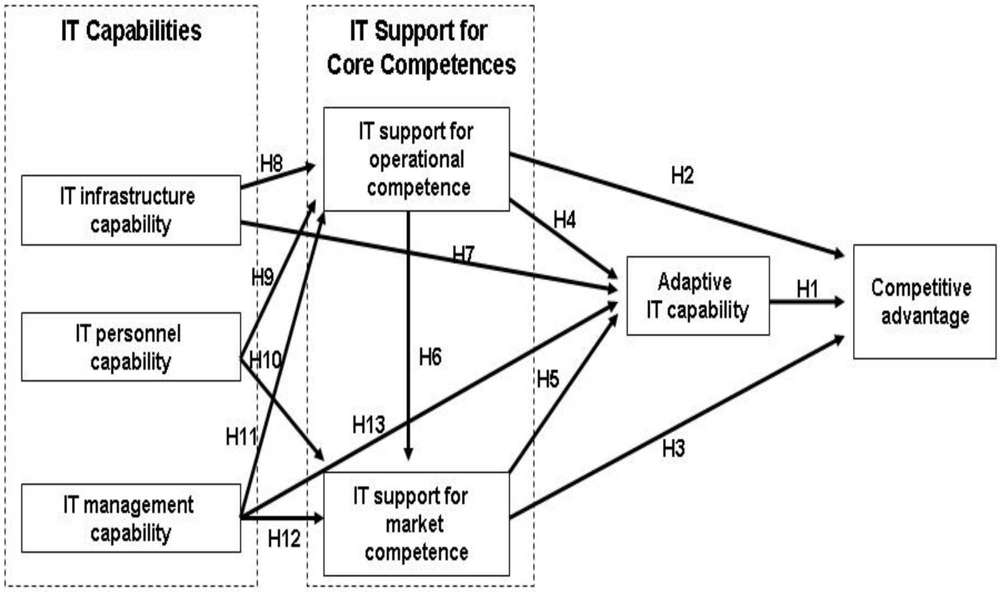


**Figure 4-2: Research Model and Hypotheses**

Figure 4-2 illustrates how the components of the research model are related to each other. The following section examines the relationship between adaptive IT capability and competitive advantage. This is followed by a discussion on the relationships between IT support for core competences and adaptive IT capability and competitive advantage. Finally, the links between the three conceptualised IT capabilities and IT support for core competences and adaptive IT capability are delineated.

## 4.3. ADAPTIVE IT CAPABILITY AND COMPETITIVE ADVANTAGE

Despite the fact that the literature sometimes uses the terms competitive advantage and firm performance interchangeably, and in most cases equates firm performance with financial performance, they are different constructs. In this regard, it is useful to recall that, in contrast to firm performance, competitive advantage is a relational measure based on the competition between different firms (Peteraf 1993; Porter 1980a), is context-specific (Teece & Pisano 1994) and does not definitely and unconditionally lead to superior firm performance or vice versa (Sanders & Premus 2002). Competitive advantage is related to the competitive position of an organisation within its industry and reflects firms' ability to achieve a performance that is greater than the average within their industry (Barney 1991; Porter 1985a).

Within the IT literature two dimensions are used to measure competitive advantage. Firstly, measures for above average operational performance investigate the overall financial performance and profitability of firms (Bharadwaj 2000; Brynjolfsson 1993; Clemons & Row 1991; Huang et al. 2006). Secondly, measures for market performance quantify the ability of firms to generate above average increases in market dimensions, such as market share improvement, increase in customer numbers, or success of products and services (Pavlou & El Sawy 2006; Powell & Dent-Micallef 1997; Ravichandran & Lertwongsatien 2005). In order to capture both sides of competitive advantage, this study defines competitive advantage as above average increases in operational and market-based performances.

### 4.3.1. Adaptive IT capability

The discussion of dynamic capabilities in section 2.5 provided insights into the concepts and building mechanism of dynamic capabilities. In short, no clear classification scheme for dynamic capabilities exists. Following Wang and Ahmed's (2007) classification, three correlated but conceptually distinct component factors of dynamic capability can be identified. The first is *absorptive capacity*, which refers to learning and absorbing external knowledge. The second is *innovative capability* which refers to capturing new product and service development. The third is *adaptive capability*, which refers to an organisation's ability to align itself with environmental changes (Wang & Ahmed 2007). The adaptive IT capability concept within this study focuses on the ability of IT to support firms' dynamic capability in general, and firms' adaptive capability in particular. Hence, the concept of adaptive IT capability reflects the ability of organisations' IT to support changes in firms' products, services, business processes, organisational structures and competences when necessary in order to deal with different situations. IT can support firms' ability to respond to market opportunities and threats (Haeckel 1999). Especially in IT-driven industries, IT's ability to respond to environmental changes can be critical (Sambamurthy, Bharadwaj & Grover 2003). Adaptive IT capabilities can enhance the efficiency of organisational responsiveness to environmental change and therefore might be a potential source of competitive advantage in several ways.

Organisational responsiveness includes adjustment of firms' products and services, the generation of new products and services or the widening of the market scope. It encompasses changes in the reach and range of products and services offered to existing and potential customers (Overby, Bharadwaj & Sambamurthy 2006). IT is the foundation of most business processes, is necessary for organisations' product, services and market scope, and is often deeply embedded within organisational structures (Ravichandran & Lertwongsatien 2005). The ability of an organisation to adapt its products and services and, therewith, its business processes and organisational structures is thus often dependent on the capability of its IT to support these adaptations (Overby, Bharadwaj & Sambamurthy 2006; Zhang 2006).

IT systems which can accommodate changes in knowledge sharing and cross-functional integration of firms' functional departments can provide flexibility of business processes. They support firms' ability to respond quickly to market opportunities and threats, and enable first mover advantages. Hence, adaptive IT capability may potentially be a source of competitive advantage through facilitating firms' ability to adapt to change (Teece, Pisano & Shuen 1997). Furthermore, the value-adding role of IT can be reflected by IT's ability to support a firm in launching a variety of frequent competitive actions (Sambamurthy, Bharadwaj & Grover 2003). Theoretical and empirical studies have revealed that firms that have utilised IT to proactively launch strategic initiatives have gained competitive advantage over their direct competitors (Dehning & Stratopoulos 2003; Sambamurthy, Bharadwaj & Grover 2003; Weill, Subramani & Broadbent 2002). Naturally, this capability of IT is company unique, hard to imitate and definitely heterogeneous.

It can therefore be argued that adaptive IT capability can be a potential source of competitive advantage as a unique, heterogeneous and hard-to-imitate ability of IT to enable firms' dynamic capabilities (Pavlou & El Sawy 2006) and, therewith, provide a foundation for strategic initiatives (Piccoli & Ives 2005; Sambamurthy, Bharadwaj & Grover 2003). Hence, this study states the following hypothesis:

**H1: Adaptive IT capability is positively related to competitive advantage**

## 4.4. IT Support for Core Competences, Adaptive IT Capability and Competitive Advantage

IT support for core competences are higher order resources and reflect the degree to which IT supports organisational competences. The understanding of IT support for core competences in this research is based on the work of Ravichandran and Lertwongsatien (2005) and consists of two constructs: IT support for market competence, and IT support for operational competence. In this research, the influence of IT support for core competences is hypothesised in three ways. First, Ravichandran and Lertwongsatien's (2005) hypothesis of the direct influence of IT support for core competences on competitive advantage is acknowledged. Second, the alternate hypothesis of the indirect influence of IT support for core competences working through adaptive IT capability on competitive advantage is advanced. Third, drawing especially from the organisational competences literature, the relationship between the two dimensions of IT support for core competences—IT support for market competence and IT support for operational competence—is explored.

### 4.4.1. IT support for core competences and competitive advantage: The direct hypothesis

In section 3.5 we argued for the importance of IT to form complementary relationships with organisations' capabilities and competences in order to contribute to SCA. IT support for operational competence reflects IT's potential to activate a variety of organisational competences, such as knowledge management, operational efficiency, cross-functional integration, product development, the innovation process and other business processes. Hence, IT support for operational competence can contribute to competitive advantage by enhancing organisational capabilities and competences (Ravichandran & Lertwongsatien 2005) in several ways.

Firstly, firms' knowledge capital is widely recognised as a unique, inimitable and valuable resource (Prahalad & Hamel 1990). IT can play an important part in knowledge management by encouraging knowledge sharing and organisational learning (McCall, Arnold & Sutton 2008; Tippins & Sohi 2003). Thus, IT support for operational competence can enhance knowledge management and create synergies across functional units. This removes spatial, physical and temporal limitations on communication and knowledge access and may be a source of competitive advantage (Bharadwaj 2000).

Secondly, IT can be used to improve operational efficiency. Several researchers have found positive impacts of IT on productivity improvements (Barua & Lee 1997; Brynjolfsson & Hitt 2003). IT can improve operational efficiency in daily operations, for example, by reducing operational costs, unproductive use of time and unnecessary paperwork, and by automating various value-adding activities (Alter 1999), and can also engender a higher level of labour productivity (Zhang & Lado 2001). Thirdly, IT can enhance cross-functional integration within organisations in three ways. IT can enhance information sharing between different business processes, strengthen coordination abilities and enable collaboration over business processes (Alter 1999) through electronic data interchange (EDI) and the internet (Zhang & Lado 2001). Research on service and manufacturing firms has indicated operational benefits, such as improved productivity, resulting from IT-enhanced cross-functional integration (Koelsch 1990). Fourthly, IT can improve product development and innovation processes. A study by McKinsey discovered IT-enabled development of new products and IT-enabled innovation processes together with scale economies to be the main drivers for IT-derived competitive advantage (Farrell 2003).

Finally, as IT often provides the foundation for other business processes and functions (Lewis & Byrd 2003), it can support business processes in several ways, including business process re-engineering (Tsai 2003). That includes capturing business process information, reducing personnel costs, enabling parallel processes, improving the monitoring of business processes, enhancing decision making, coordination of business processes across distances, coordination of tasks between business processes, and eliminating intermediaries from business processes (Davenport 1993). It is notable, however, that the empirical results of Ravichandran and Lertwongsatien's (2005) study revealed insignificant weights for the construct measuring IT support for operational competence in the measurement model, and thus was dropped in their further structural analysis. Nevertheless, the IT literature provides strong support for such a construct and its positive effect on competitive advantage. Therefore, based on Ravichandran and Lertwongsatien's (2005) call for further empirical studies to re-evaluate whether this construct fits the nomological network of relationships linking IT capabilities, IT support for firms' competences and competitive advantage we hypothesise that:

**H2: IT support for operational competence is positively related to competitive advantage**

IT support for market competence can enhance a firm's ability to systematically capture changes in its external environment and seamlessly exchange strategic and tactical information with its customers and suppliers in response. This ability to sense environmental change (e.g. innovation of competitors, change of customer preferences, new technological abilities or new market segments) gives organisations the chance to respond more quickly to the detected environmental changes than their competitors (Overby, Bharadwaj & Sambamurthy 2006). For example, after detecting a change in customer preferences, launching new products and services to satisfy new consumer needs faster than one's competitors can reduce the time required to market. In order to sense environmental changes, organisations need to generate market intelligence on current and potential future customer needs. A firm's market orientation reflects its ability to generate market intelligence, to spread that intelligence across departments and to coordinate firm-wide responsiveness (Kohli & Devaraj 2004). Market intelligence includes information about competitor actions, consumer preference changes and economic shifts. As the extent of market information often exceeds the capacity of the human mind to process it, IT can enable organisations to make sense of such information (Overby, Bharadwaj & Sambamurthy 2006).

IT can enhance the sensing of environmental changes directly (Haeckel 1999) by raising market intelligence through customer relationship management systems (CRM), decision support systems (DSS) and other information systems. These information systems can be used to analyse customer preferences (e.g. analyse customer use of services on offer) and can enable market segmentation and market analysis—important tasks for any firm wishing to access new markets (Hamel 1994b). For example, customer relationship management systems can enhance the ability to analyse market trends and customer demands (Mahmood & Soon 1991) and to identify customer segments which are most profitable but have not been addressed properly. This provides opportunities for differentiation of products and services and the introduction of flexible pricing strategies, enabling firms to offer products and services which they could not previously due to technological limitations (Rivard, Raymond & Verreault 2006). Furthermore, IT support for market competence can improve customer service through detecting customer requirements, enhancing after-sales service and improving responses to customer enquiries (Mahmood & Soon 1991).

In sum, IT support for market competence enhances organisational market access and the functionally related competences of firms, and can thus be a source of competitive advantage (Ravichandran & Lertwongsatien 2005). Hence, we hypothesise that:

> **H3: IT support for market competence is positively related to competitive advantage**

### 4.4.2. IT support for core competences and competitive advantage: The indirect hypothesis

Although Ravichandran and Lertwongsatien (2005) argued for a direct relationship between IT support for core competences and competitive advantage, the DCP provides sufficient reason to doubt the existence of such a direct relationship. Here a distinction is made between static competences and adaptive competences (referred to in this thesis as adaptive IT capability). While static competences create the necessary base IT support for core competences to enable a firm to reconfigure and rebuild its assets, due to the pervasiveness of IT and its ability to eliminate the trade-off between ‘reach’ and ‘richness’, they can be easy to catch up with, might lack heterogeneity, and might be easily imitated in the long run. Thus, static competences might have limited potency to directly provide a firm with an edge in either its market or operational performance.

IT support for core competences are, however, essential for building adaptive IT. As IT support for core competences enable a wide variety of business process and information sharing options, they can also exhibit an indirect impact on competitive advantage by enhancing organisations’ ability to adapt quickly and efficiently to environmental change (Piccoli & Ives 2005; Sambamurthy, Bharadwaj & Grover 2003). Therefore, it is proposed that the relationship between IT support for core competences (both market and operational) and competitive advantage might be mediated by the higher order resource of adaptive IT capability. The following section discusses several aspects of the impact of IT support for core competences on the higher order resource of adaptive IT capability, and the mediating effects this higher order resource might have on the relationship between IT support for core competences and competitive advantage.

Firstly, in order to adapt IT support to the product–market scope, market orientation is required. IT support for market competence reflects the ability of IT to identify new market segments and analyse customer needs (e.g. through CRM systems). This ability to generate organisation-wide market intelligence creates a foundation from which organisations can leverage to utilise IT to induce more rapid changes in their products and services value chain (Pavlou & El Sawy 2006). Furthermore, IT support for market competence enhances the ability to systematically capture market information and seamlessly exchange response and process information with customers and suppliers (Mendelson 2000). A basic IT support for core competence to sense and exchange market intelligence is an essential prerequisite for a successful reconfiguration of that competence in response to the intelligence gathered.

Secondly, for IT to enable adaptations in relation to products and market demands, it must first support the processes and knowledge sharing activities of organisations. Firms that use IT to capture market intelligence will find it easier to utilise their IT to support the adaptation of their product–market scope (Ravichandran & Lertwongsatien 2005). In other words, if IT already enables market competences it will be easier to support changes in these market competences.

Thirdly, adaptations in products and to market demands require changes in product development processes and information sharing at an organisational level. Hence, adaptive IT capability relies on the ability to acquire, transform and exploit new knowledge as well as the ability to bring the mindsets of a variety of individuals in an organisation in line with each other (McCall, Arnold & Sutton 2008; Ray, Muhanna & Barney 2005) in order to achieve organisation-wide renewal, building and reconfiguring of competences (Andreu & Ciborra 1996). IT systems such as groupware and multimedia systems can increase communication, eliciting tacit knowledge, and can store and structure information (Bharadwaj 2000; Grimaldi, Rippa & Ruffolo 2008). Embedding knowledge in databases and decision support systems enables its efficient transfer across organisations and thus enhances knowledge sharing (McCall, Arnold & Sutton 2008; Sabherwal 1999; Sambamurthy, Bharadwaj & Grover 2003).

IT support for knowledge sharing, cross-functional integration, business and innovation processes enhances the extent of digitised knowledge reach. Firms that possess intranets, databases and knowledge repositories are able to support interactions among individuals for knowledge transfer and sharing, enabling comprehensive codified knowledge accessibility through knowledge databases. Furthermore, advanced knowledge technologies, virtual videoconferencing systems and collaborative tools for knowledge sharing allow companies to activate systems that support the sharing and development of tacit knowledge through the interaction of organisational members. The notion of IT support for knowledge sharing and firms' ability to adapt to change was also examined by Sher and Lee (2004).

In their study of major Taiwanese firms Sher and Lee (2004) suggested that both endogenous and exogenous knowledge can enhance organisations' ability to deal with change significantly through utilisation of several IT applications. These include, first, email, which was found not to be especially effective. Second is document management, which was found to undermine dynamic capabilities. According to Sher and Lee (2004), this is because document management across firms generally involves a great deal of effort in communication and coordination and sometimes can lead to interlocking effects and responsiveness deterioration. Third is powerful online knowledge search, which encourages an overemphasis on knowledge availability and thus reduces the ability of employees to make decisions. Hence, online knowledge searches may impede organisational renewal and could cause organisational inertia; and It was also found to reduce the exploratory power of managing knowledge (Sher & Lee 2004). Finally, knowledge management depends largely on powerful databases, whereas data warehousing in contrast was found to support dynamic capabilities through knowledge management (Sher & Lee 2004). IT support for operational competence can facilitate adaptive IT capability by providing efficient knowledge management systems and enhancing the ability of enterprise units to acquire, assimilate, transform and exploit new knowledge (Pavlou & El Sawy 2006).

Fourthly, firms that build cross-functional and supply chain integration by utilising IT, when confronted with a need to respond to changes in customers, suppliers, technology, internal resources or networks, can unleash the 'power' of this integration to create IT-dependent 'intangible' value. Firms that possess high levels of IT support for business processes, cross-functional integration and knowledge sharing have common, integrated and connected IT-enabled processes. This allows firms to enable information flows across department units, functional units and network partners through integrated enterprise resource planning, supply chain management and customer relationship management systems as well as product and data management (Sambamurthy, Bharadwaj & Grover 2003).Through these means firms can effectively use IT for decision support, analysis and tracking of collected information about transactions, and enables them to utilise this information to re-engineer processes. Mathiassen and Pries-Heje (2006) and Shang and Hsiang (2006) further claim that the use of standardised data and process architecture allow for coordinated, organisation-wide responses to rapidly changing business environments which can then create a potential source of business value. For example, web services allow enterprises to effectively re-use business functionalities and reduce the time required to respond to business challenges.

Fifthly, the ability of organisations to react to environmental change requires coordination competence (Pavlou & El Sawy 2006). High levels of IT support for operational competence underlie organisations' knowledge management, innovation and business processes, and enhance organisations' coordination competence through the ability of IT to process information (Mendelson 2000). This refines the ability of different organisational units to allocate resources, assign tasks and synchronise activities (Pavlou & El Sawy 2006).

Finally, high levels of IT support for core competence (market and operational) provide organisations with a foundation for strategic agility by enabling a wide variety of IT-supported business process and information sharing options (Sambamurthy, Bharadwaj & Grover 2003).

On the basis of the above arguments, the following two hypotheses are offered:

> **H4: IT support for operational competence can contribute significantly to adaptive IT capability**

> **H5: IT support for market competence is positively related to adaptive IT capability**

### 4.4.3. Relationship between IT support for core competences

IT support for operational competence enables organisations not only to improve their efficiency and firm performance; it is also the foundation for other IT-related competences. The ability of IT to enable market competences relies upon the existence of sophisticated IT systems which provide optimal support for business processes. A lack of quality in IT systems can constrain the quality of the information they produce. IT support for market competence relies upon the quality of information extracted from IT systems which support the business processes of a firm (Chen 2001). Customer relationship management systems (CRM), for example, are often based on enterprise resource planning (ERP) systems and generate their market intelligence out of these (Bose 2002; Chen & Popvich 2003). Hence, IT-enabled organisational competences are the foundation of IT support for market competences, and thus the following is hypothesised:

> **H6: IT support for operational competence is positively related to IT support for market competence**

The IT support for core competences (market and operational) discussed above represent higher order resources and are enabled by IT capabilities. Similar to organisation-wide capabilities, IT capabilities in this work represent the abilities, processes and management of the IT department that, together with IT resources create IT support for core competences. Adaptive IT and IT support for core competences are produced through the utilisation of IT infrastructure capabilities, the accumulation of knowledge of IT personnel and the integration of these skills through IT management capabilities. The following section delineates how these capabilities enable IT support for core competences and adaptive IT capability.

## 4.5. IT CAPABILITIES AND ADAPTIVE IT CAPABILITY

IT capabilities refer to an organization's capacity to deploy IT resources, usually in combination with other organisational resources (see Chapter 3, section 2). They can result in improved IT performance (Wang & Ahmed 2007) when organisations utilise them to deploy IT resources together with other complementary organisational resources to form IT support for core competences (Zhang & Lado 2001). In this research, three IT capabilities are identified: IT infrastructure capability, IT personnel capability and IT management capability. The categorisation of IT infrastructure, IT personnel and IT management capabilities into first order IT capability is not without controversy in the IT research. Some authors classify all of these three constructs as IT resources (e.g. (Ravichandran & Lertwongsatien 2005), some only regard IT infrastructure as an IT resource and assign IT personnel skills to the higher order of an IT capability, while others regard both IT infrastructure and IT personnel skills as capabilities (Fink & Neumann 2007).

### 4.5.1. IT infrastructure capability

IT infrastructure capability definitions vary slightly in the literature. Some authors include human resources in the definition (e.g. Broadbent et al. (1999)) whereas others only refer to the technical assets as IT infrastructure and form a separate category for IT human resources (e.g. Fink & Neumann (2007)). For example, Broadbent et al.'s (1999) definition of IT infrastructure is that 'the base foundation of any IT portfolio is the IT infrastructure (both technical and human assets) shared through the firm in the form of reliable services'. Despite such differences, most definitions have a common core. Most commonly, IT infrastructure capability is defined as the ability of IT infrastructure to support and enable the fast design, development and implementation of heterogeneous IT applications, as well as the ability to distribute any type of information (data, text, voice, image or video) across the organisation and beyond (Byrd & Turner 2001b). Further, it refers to the ability of IT infrastructure to support a wide variety of hardware, software and other technologies that can be easily diffused into the overall technological platform (Byrd & Turner 2001b). IT infrastructure is the building block for enterprise-wide IT services and applications.

In this research, the concept of IT infrastructure capability is based on two seminal works by Duncan (1995). Duncan identified IT infrastructure capability through shared and re-usable IT resources and investigated the strategic potential of the flexible IT infrastructure in the insurance industry. The result of Duncan's (1995a) study was a framework for IT infrastructure evaluation, which combines the technological components (platform/networks/data/applications) with flexibility characteristics and types of applied flexibility indicators. Other authors (see Table 4.2) have since used Duncan's (1995) classification.

**Table 4-2: IT Infrastructure Capability Dimensions**

| | Connectivity | Compatibility | Modularity | Others |
|---|---|---|---|---|
| Duncan (1995) | Network connectivity | Platform Compatibility | Modularity | |
| Broadbent et al. (1996) | Communication management | Standards management | Application management | Data management |
| Byrd & Turner (2000; 2001b) | Connectivity | Compatibility | Application functionality | Data transparency |
| Schwager (2000) | Connectivity | Compatibility | Modularity | |
| Byrd, Lewis & Turner (2004) | Connectivity | Compatibility | Modularity | |
| Tallon & Kraemer (2004) | Connectivity | Compatibility | Modularity | |
| Chung et al. (2005) | Integration | | Modularity | |
| | Connectivity | Compatibility | | |
| Bhatt & Grover (2005) | Network connectivity | Network flexibility | | Data integration |
| Bradley (2006) | Integration | | Modularity | |
| Chanopas (2006) | Connectivity | Compatibility | Modularity | Saleability, rapidity, facility, modernity |

Table 4.2 illustrates that three variables have appeared in most studies of IT infrastructure capability. These are connectivity, compatibility and modularity.

This study builds on the above mentioned dimensions and survey items for flexible IT infrastructures developed in the prior research by Duncan (1995) and operationalized by Byrd and Turner (2000) and Tallon and Kraemer (2004). This classification is the most widely used one in IT Research and has been validated many times (Byrd & Turner 2000; Chanopas, Krairit & Khang 2006; Tallon & Kraemer 2004). Therefore, the variables for this research model are:

- Connectivity enables seamless and transparent organisations. Connectivity is measured by the ability of any technology components to attach to any of the other components inside or outside the organisational environment.

- Compatibility allows that data, information and knowledge in the organisation are readily available. Compatibility is measured by the ability to share any type of information across any technology components.

- Modularity is measured by the ability to add, modify and remove any software, hardware or data components of the infrastructure with ease and no major overall impact.

Changes in strategies and business practices demand changes in IT systems. The ability of the IT department to respond quickly and cost-effectively to new system demands is determined by

IT infrastructure capability (Clemons & Row 1991). Capable IT infrastructures are ideally designed to evolve themselves, incorporating emerging technologies and supporting the continual redesign of business and related IT processes (Duncan 1995a). IT infrastructure capability can enable a set of technology resources that provides the foundation for present and future business applications (Duncan 1995a; Earl 1989; Niederman & Brancheu 1991). A highly flexible IT infrastructure, as the foundation of firm-wide IT capacities and business processes, is therefore crucial for building both IT support for core competences and adaptive IT capability (Kayworth, Chatterjee & Sambamurthy 2001). The ability to utilise IT to provide a wide range of services and so to enable organisational competences and dynamic capabilities is dependent on the availability of infrastructure capabilities (Weill, Subramani & Broadbent 2002).

A firm's ability to rebuild its processes relies on the flexibility of the resources available to that firm and its flexibility in applying these resources. In the contemporary business environment, infrastructure flexibility is viewed as a critical organisational competence (Zhang 2006). Possessing a flexible IT infrastructure gives organisations the ability to more easily accommodate changes as required. Highly modular and integrated IT infrastructures make it easier to change or build new IT services for the business. Success in doing so more quickly and easily than one's competitors provides good support for IT's ability to adjust to changes in the product–market scope of organisations (Byrd, Lewis & Turner 2004), therefore supporting adaptive IT capability. Hence, the following hypothesis is stated:

**H7: IT Infrastructure capability is positively related to adaptive IT capability**

Apart from enabling adaptive IT capability, IT infrastructure capabilities are also the foundation for IT support for operational competences. In their study of the impact of IT resources and capabilities on firm performance, Ravichandran and Lertwongsatien (2005) used the IT infrastructure flexibility construct as a precursor to IT support for core competences (market and operational) and found a positive relationship between them. All of this research on IT infrastructure flexibility adds to our knowledge of IT research by showing that IT infrastructure flexibility is a precursor of many critical business and IT capabilities. IT support for operational competences reflects the ability of IT to enable efficient business, innovation and knowledge management processes as well as the cross- functional integration of organisations (Ravichandran & Lertwongsatien 2005). Sophisticated IT infrastructures are required as a foundation for these abilities (Chung et al. 2005). Highly connected and compatible IT infrastructures enable firms to share a variety of IT services across boundaries. Furthermore, highly modular IT infrastructures allow organisations to add and modify applications and data with ease, hence facilitating the combination of IT systems from different departments and across organisational boundaries. Accordingly, highly flexible IT infrastructure capabilities can increase the ability of IT to support organisation-wide business, innovation and knowledge management processes and cross-functional integration of organisations. Therefore, it is hypothesised that:

**H8: IT infrastructure capability is positively related to IT support for operational competence**

Furthermore, one could argue for a strong effect of IT infrastructure capabilities on IT support for market competence. Rather than direct, we argue that positive effects from a well connected and compatible infrastructure on IT support for market competences is indirect through an effective IT support for business processes and crossfunctional integration of firms. One the one hand, in section 4.4.3 we argued that a strong IT support for business processes, operational efficiency, and cross-functional integration is essential to provide IT support for analysing customer needs and market segments and redefine the scope of the business ("*H6: IT support for operational competence is positively related to IT support for market competence*"). On the other hand, in addition in the section above the argument was for positive effects for IT Infrastructure capability on IT support for operational competence (*"H8: IT infrastructure capability is positively related to IT support for operational competence*"). Hence, we argue here that the capability of the IT infrastructure in terms of highly connected and compatible IT services can be regarded as a base capability which further needs the ability to provide effective support for business processes and crossfunctional integration of firms before it can enable an strong support for analysing customer needs, market segments and redefining the scope of the business. Customer relationship management systems (CRM), for example, require not only capable IT infrastructures; further they require enterprise resource planning systems (ERP) to generate their market intelligence out of them (Chen & Popvich 2003).

### 4.5.2. IT personnel capability

The IT skills of the personnel working in the IT department are an intangible capability. On the one hand, highly specialised IT personnel are needed to solve today's complex IT problems, and on the other, IT personnel need general knowledge to cope with changing demands from the business side. IT personnel capability defines the degree to which IT personnel possess the skills and knowledge to perform tasks outside of their original area of training or original domain (Byrd, Lewis & Turner 2004). Knowledge about business processes is required to help the alignment with the business (Byrd, Lewis & Turner 2004). The IT personnel capability construct in this work is mainly based on research from previous studies, especially those of Byrd and Turner (2000). Two variables are examined in this study as part of the IT personnel capability construct: firstly, broad IT knowledge, as the ability of IT personnel to support a wide array of IT services; secondly, business knowledge, as the ability of IT personnel to understand the business environment they support. The variables were selected based on previous research.

Both broad IT knowledge and business knowledge were used in previous research and have been validated many times (Byrd, Lewis & Turner 2004; Tallon & Kraemer 2004).

A broad range of technical knowledge and skills is necessary to deliver data across locations and applications, bridge old and new systems, and to identify technical opportunities emerging from new technologies (Ross, Beath & Goodhue 1996). The increasing rate of change in new technology opportunities requires even more varied and in-depth technical skills (Fink & Neumann 2007). Hence, a broad base of IT knowledge and skills of the IT personnel is essential to develop and maintain capable IT support for the business (Byrd, Lewis & Turner 2004). The business knowledge and skills of the IT personnel are needed to understand and solve business problems. IT personnel do not have to be experts in business knowledge, but to a certain extent they should understand the goals, languages and processes of the organisation (Feeny & Willcocks 1998). The ability to understand organisations' goals, languages and processes improves the support IT personnel can offer the organisation. In sum, a broad range of both IT and business skills and knowledge improves the support that IT can offer to organisational competences. Consequently, IT personnel capability positively influences IT support for core competences (market and operational), and thus the following hypothesis are stated:

**H9: IT personnel capability is positively related to IT support for operational competence**

**H10: IT personnel capability is positively related to IT support for market competence**

In addition to the discussed positive effects of IT personnel capability on IT support for operational competence and IT support for market competence, one could argue that broadly skilled and business savvy IT personnel are an important asset to enable firms' IT to adapt to organisational change. Even though, we acknowledge the arguments of such possible direct effect of IT personnel capability on adaptive IT capability, we further argue for a stronger indirect effect of IT personnel capability on adaptive IT capability through IT support for market and operational competences. Therefore, we do not hypothesize a significant direct effect between IT personnel and adaptive IT capability; rather we examine the indirect effect of IT personnel capability on adaptive IT capability through IT support for market and operational competence (Fink & Neumann 2007). One the one hand we posited a strong direct effect of IT support for operational and market competences on adaptive IT capability in section 4.4.1. On the other hand we also made the case for a positive relationship between IT personnel capability and IT support for operational and market competences above. Fink and Neumann (2007), for example, have conceptually argued and empirically confirmed that the effect of IT personnel capabilities on IT dependent organisational agility is mediated by IT support for organisational business processes. Hence, we argue that the ability to adapt organisations IT to organisational changes requires not only broadly skilled and business sawy IT personnel, rather it also requires the ability of firms' IT to provide support for business processes, cross-functional integration, market segmentation, customer identification and redefining the scope of the business.

### 4.5.3. IT management capability

IT management capability signifies the management of all IT components. IT is probably the least tangible construct of all the IT-related capabilities. Depending on the chosen literature and definition, IT management capability comprises many different areas and different tasks (Bhatt & Grover 2005; Boar 2001; Byrd, Lewis & Bradley 2006; Earl 1989; Feeny & Willcocks 1998; Niederman & Brancheu 1991; Ravichandran & Lertwongsatien 2005; Sambamurthy, Bharadwaj & Grover 2003; Willcocks, Feeny & Olson 2006). This study is concerned with the key factors that influence organisations' IT ability to adapt to change. Hence, the selected IT management capabilities where those, which have been proposed by previous researcher to have a direct impact on IT's ability to deal with change. In this study, two important variables of IT management capability are examined. These are: strategic IT management and IT–business partnerships.

*Strategic IT management* refers to strategic foresight concerning business and IT developments. This involves framing the key issues which affect the organisation; scanning the organisational environment and forecasting for trends; and envisioning possible and desirable outcomes for the organisation (Hines 2006). Furthermore, strategic IT management has to ensure continuous business support from top management in order to enable alignment of business and IT strategies. Hence, strategic IT management encompasses three interrelated tasks: Business strategic foresight, IT management strategic foresight and ensuring business support from top management.

Firstly, in order to keep up with the speed of transitions, companies have to spot new business opportunities and threats as soon as possible to have sufficient time to react appropriately to such changes in the business environment (El Sawy et al. 1999). Changes in the business environment (e.g. new markets, laws, network opportunities or threads) can lead to a new or changing demand for firm resources, capabilities and competences. As IT systems are an integral part of nearly every business function (Sambamurthy, Bharadwaj & Grover 2003), new business environments often require new IT support for core competences. Business strategic foresight is, therefore, an important process for IT management to be able to anticipate changes in the business environment early enough for IT management to take appropriate actions.

Foresight concerning business developments enables an organisation to explore marketplaces, detect areas of marketplace ignorance, and determine opportunities for actions. It is essential to provide optimal IT support for existing competences and to be able to anticipate the necessary development of new IT support for core competences before they are formally developed by the business side. A continual scanning of the business environment and the ability to evaluate the impact of changing business environments on firms' IT systems (Sambamurthy, Bharadwaj & Grover 2003) improve IT systems' ability to support and, if necessary, adapt products, services and business processes.

Secondly, like the business environment, the IT environment is also exposed to change. New IT opportunities or threats need to be spotted and evaluated as soon as possible for firms to be able to anticipate and respond to change. New IT capabilities can enable new IT support for core competences, and thus enable better IT support for organisational competences. This can lead to new competitive advantages for firms. IT management strategic foresight involves the task of predicting and anticipating developments in the IT and business environments (Sambamurthy, Bharadwaj & Grover 2003). Strategic foresight about IT developments gives IT management the ability to anticipate IT changes and demands before they are formulated from the business side, as well as suggesting new IT-enabled opportunities for the business. A continual scanning of the IT environment, together with the ability to evaluate the impact of new IT capabilities on the business landscape, can enhance IT systems' ability to support and adapt organisational competences and business process agility (Tallon 2008).

Finally, to ensure that the knowledge obtained from business and IT strategic foresight is utilised to implement necessary changes in the IT system, it is essential to ensure business support from top management. The IT and in particular the strategic alignment literature has pointed out the importance to integrate business and IT strategy (Venkatraman 1994). IT can have impacts on firm strategies and firm strategies have influence on IT implications (Bakos & Treacy 1986; Feeny & Willcocks 1998). IT that is managed by the senior management level has a higher chance of receiving ongoing support from management, and thus is better able to implement effective IT support for business processes, products, services and information sharing (Ravichandran & Lertwongsatien 2005). Business management need the ability to envision how IT can contribute to business value and the ability to integrate IT planning with the firm's business strategies (Bharadwaj, Sambamurthy & Zmud 1999). Firms which have developed clear visions about the role of IT and the connections between IT and their core value propositions have often pioneered revolutionary innovations with IT (McKenney 1995).

*IT-Business partnerships* ensure that the knowledge obtained from strategic foresight contributes to value-adding implementations in the form of improved support for products, services or business processes, organisations also need the operational abilities of business and IT departments to constructively work together towards mutually understanding partnerships (Feeny & Willcocks 1998; Rockard & Short 1989; Ross, Beath & Goodhue 1996). The variable 'IT–business partnerships' represents the quality of these partnerships (Ross, Beath & Goodhue 1996). IT–business partnerships include mutual trust and free information flow between the business units and the IT department, as well as shared knowledge and organisational links (Henderson 1990). IT–business partnerships, as the ability of business and IT units to constructively work together in mutually understanding and beneficial partnerships, can have a positive impact on the ability of IT to support and adapt organisational competences, such as IT's support for product and service development, business and innovation processes or knowledge sharing. High levels of trust in IT–business partnerships enable business and IT executives to work together to solve business problems through IT (Rockart & Short 1989), allowing IT to be a facilitator of change (Piccoli & Ives 2005; Tallon 2008).

In sum, IT management capability can have a positive influence on IT support for core competences and on IT's ability to support change, and to reconfigure and renew organisational competences. Hence, the following hypotheses are stated:

> **H11: IT management capability is positively related to IT support for operational competence**
>
> **H12: IT management capability is positively related to IT support for market competence**
>
> **H13: IT management capability is positively related to adaptive IT capability**

## 4.6. SUMMARY

The purpose of this chapter was to introduce a theoretical framework for the adaptive IT capability construct and its impact on the competitiveness of firms. This was undertaken to cover the research gaps identified in Chapter 3 and to provide a research model which can be used to answer the research questions. Therefore, the first part of this chapter provided an overview of the conceptual framework of this research. Then the concepts of the research model were introduced. These concepts were brought together in a theoretical framework and research hypotheses were stated. Chapter 5 discusses the research methodology which was used to empirically examine the theoretical framework and test the research hypotheses.

# Chapter 5

# METHODOLOGY

*'The degree to which the construct has been captured by the developed research instrument is determined by how rigorously rules and attributes have been applied and the skills with which they are applied.'*
*(Churchill 1979)*

## 5.1. INTRODUCTION

The previous chapters have outlined the theoretical foundations of the research (Chapters 2 and 3) and established a sound research model (Chapter 4). This chapter will discuss the methodology of this research. Prior to developing and operationalizing a research instrument, a researcher has to think about the information he/she actually requires for the research. Hence, before a work plan for data collection and analysis can be developed, it must be ensured that the obtained data will be measuring what it is supposed to measure. A research design is a structure that ensures that the data obtained from the research is able to answer the research question as unambiguously as possible. A research design is therefore concerned with the logical analysis of the problem, not the logistical method of data collection (De Vaus 2001). The following sections outline the design of this study. First, the reason for the positivistic theory to be chosen as the epistemological base for this research is discussed (section 5.2). Second, an overview of the methodological considerations of this research is provided (section 5.3). The design of the research instrument is explained in section 5.4, followed by a description of the sample design in section 5.5. Lastly, the data collection is discussed in section 5.6.

## 5.2. EPISTEMOLOGICAL CHOICE

Epistemology is the theory of knowledge. It is the theory of how we know what we know, and how we have knowledge of the world around us (Lewis-Beck, Bryman & Liao 2004). The word epistemology is derived from the Greek words *episteme* (knowledge) and *logos* (reason). Epistemological choices depend on beliefs based on a particular view of the world and human life, in turn grounded in a specific standpoint. Epistemology expresses itself through beliefs regarding the nature of knowledge and relates to the strategies by which a theory gathers knowledge (Grix 2004). Hence, it determines the research design, data collection and analysis. Most social studies researchers believe either in the interpretivistic or the positivistic paradigm. The primary difference between the two can be found in answering the question of whether the methodologies of the physical sciences can be applied to the study of social phenomena. The paradigm derived from the physical sciences is known as positivism. A main principle of positivist theory is the view that the external world is structured and all parts of the universe are subject to uniformity and determined relationships (Flood 1989). The opposing paradigm is known as interpretivism (Kumar 2005). Interpretivism postulates that social scientists need to seize the subjective meaning of social action. This requires a strategy for knowledge generation that respects the differences between people and the objects of social science (Bryman 2001). Both paradigms have their own values, terminologies, methods and techniques for understanding social phenomena. The paradigm a researcher believes in derives from his understanding of the world. Even though it might change over time due to personal insights, it does determine the mode of inquiry.

The positivistic view has often been utilised in information systems research. However, it is not free from limitations and critique and, therefore, calls for a more interpretive approach have been made (Stone 1990). In IT research, the positivistic view is the dominant one, accounting for 81% of the published empirical research (Chen & Hirschheim 2004). Positivistic, quantitative, cross-sectional and survey-oriented research is especially dominant in US journals, though not so in European journals (Chen & Hirschheim 2004). As with most studies within the IT research field, this study draws from a positivistic perspective. To obtain knowledge according to the positivistic theory through observation, a scientific method called the inductive method is utilised. The inductive method is a process of undertaking observations of a small group of similar events, specimens or subjects to develop general principles about a specific subject (Neuman 2006). Hence, this research started with abstract conceptualisation and the development of the conceptual theoretical framework outlined in Chapter 4. The theoretical research framework developed consists of hypotheses, expressed by formal propositions and quantifiable through measurement of variables. These will be empirically tested utilising the methodology discussed in this chapter and analysed in Chapters 6, 7 and 8. The findings will then be the basis for broader statements about the subjects examined. Hence, the knowledge contribution of this positivistic research consists of propositions that are verifiable through the cumulative observations of empirical research (Collis et al. 2003).

## 5.3. METHODOLOGICAL CONSIDERATIONS

The purpose of this section is to outline the common approaches to research on IT and competitive advantage and to discuss the methodological choice for this research. Academics from a wide variety of research backgrounds have investigated IT and its contribution to and impact on competitive advantage (Brynjolfsson 2003; Piccoli & Ives 2005; Wade & Hulland 2004). Hence, a diversity of research perspectives exists, with different approaches, meta-theoretic assumptions and paradigms on the research topic. The broad field of IT and competitive advantage research has been approached from a range of disciplines, including management science, computer science, information systems, organisation science, behavioural science and economics. This blend of research fields has resulted in a mix of research methodologies and approaches in IT and competitive advantage research.

### 5.3.1. Overview of data collection methods

It is not possible to determine the appropriate methodology par excellence. Methodological issues need to be resolved within a particular research setting. Most research methods can be utilised in both positivistic and interpretivistic research designs, although some are more appropriate to one research paradigm than the other. In the positivistic research paradigm, the four most common methods are the cross-sectional study, the experimental study, the longitudinal study and the survey (Collis et al. 2003). The experimental study concept involves the manipulation, via an experiment, of an independent variable and observation of the impact on the dependent variable. Experiments can be conducted in either a laboratory or the real world in a systematic way, which allow to draw conclusions (Lewis-Beck, Bryman & Liao 2004). This research method poses several limitations for the purposes of this PhD research. Chief among them are the fact that it would be difficult to gain access to a huge number of companies to manipulate the independent variables, and it would not be possible to eliminate all of the other effects that might influence the dependent variable. Therefore, the experiment is not a suitable method for this research.

The main purpose of a cross-sectional study is to obtain information on variables within the same time frame (Collis et al. 2003; De Vaus 2001) (e.g. comparing success factors of companies in different countries). Often descriptive and exploratory studies are cross-sectional. The main limitations of cross-sectional studies can be found in their inherent constriction to investigate phenomena at a specific point of time. This restricts the ability of cross-sectional studies to investigate causal processes that occur over time (Babbie 2007).

The longitudinal study, in contrast, is designed to look at variables in the same context over a period of time (Collis et al. 2003; De Vaus 2001) (e.g. investigating the change of success factors of companies over a 10-year period). Many in-depth interviews and field research projects involving direct observation are naturally longitudinal. While the longitudinal study is often the best way to study changes over time, it has its limitations also. Longitudinal studies can be more difficult in the case of quantitative studies such as large-scale surveys (Babbie

2007), especially anonymous surveys, as it is difficult to draw the same sample again for subsequent studies.

This current PhD research aims to determine the nature of the relationships among different constructs in the context of Australian medium- and large-sized companies within a given time frame. These constructs have been identified and operationalized through an extensive literature review of previous research. An appropriate method to quantify these measures and test the hypotheses is either the survey or structured interviews. The written survey can be subdivided into the subcategories of the traditional paper survey and the internet survey. If not further specified written surveys refer to both the paper survey and the internet survey. The section below discusses the survey (paper- and web-based) and structured interview as possible research methods for this research and argues for the web-based survey as the most appropriate method of data collection for this study.

### 5.3.2. Possible methods of inquiry for data collection

Three methods of quantitative data collection could be useful for this study: the written survey, the web-based survey and the interview. A scientific survey should be prepared, conducted and protocoled in a systematic way, so that it is clear in which environment and under what circumstances the data were collected so that the results can be reproduced (Collis et al. 2003). The three different methods of data collection (interview, written and internet survey) each have advantages and disadvantages and the following points where taken into account in considering which to choose. Interviews, written surveys (paper- and internet-based) vary in a number of ways (Kumar 2005).

First, the suitability of questions depends on the mode of inquiry. In interviews participants can make enquiries if they do not understand the question, whereas in written surveys the questions have to be worded carefully because the participants do not have this opportunity (Blaikie 2000; Neuman 2006). Participants of written surveys have the chance to stop the survey at any point and ask their colleagues for advice if they cannot answer the question themselves directly (Kumar 2005).

Second, the methods of inquiry vary in the ways in which filters can be utilised. Through filters the survey procedure can be controlled, especially the order and selection of questions (Sarantakos 2005). Filters can be utilised in all forms of a survey, the main difference in their usage being the complexity and amount of useable filters (Collis et al. 2003). In paper surveys, in order not to overstrain the participants, the amount and complexity of filters is limited. Careful design of internet surveys can handle a number of filters, without the participant even noticing. In interviews, specially trained interviewers can handle a higher complexity and number of filters. A limitation can arise with paid interviewers, in so far as they might choose inappropriate filters to finish the interview earlier (Sarantakos 2005).

Third, in relation to the above mentioned problems with inquiries and filters, the layout of written surveys must be well designed so that participants can understand the filters, questions and answer possibilities (Neuman 2006). Hence, useability issues will require more effort and time in written surveys (especially internet surveys).

Fourth, especially with regard to data about companies and managers themselves, anonymity is a concern. Although anonymity and nondisclosure can be assured in all methods, it can be realised either by using two envelopes or by conducting web surveys. Respondents might be reluctant to answer sensitive questions asked by an interviewer (Babbie 2007).

Fifth, interviews generate the issue of interviewer effects (Denzin & Lincoln 2000). Interviewer effects can be both positive and negative in nature. Negatively the participant can be misguided and/or misunderstood by the interviewer. Positively, the interviewer can ensure that all questions are answered, which is especially important with long questionnaires and in cases where the participant has no personal interest in participating in the survey (Sarantakos 2005).

Sixth, both methods vary in convenience for the participants and the researchers. In the case of interviews the participant must agree to an appointment time. Written surveys, in contrast, can be filled out, stopped and restarted at the respondent's leisure (Neuman 2006). Written surveys in addition are not geographically based; no travel is required to meet all participants (Neuman 2006).

Seventh, recent studies investigating the difference in data collection methods between computerised and written surveys have discovered that both survey methods yielded similar outcomes in scale, internal reliability and descriptive statistics, but that the computerised survey was significantly better with regards to completeness of the questions (Wu & Newfield 2007).

Last, as data from both interviews and paper surveys have to be entered into a computer before they can be analysed via statistical programs, data entry can cause errors. Internet surveys can limit that problem, as the data is automatically transferred into a data file.

In summary, all methods of quantitative data collection—the interview, the paper-based and internet survey—have their advantages and disadvantages (Kumar 2005). The purpose of this current research is to measure various constructs, from the IT and business side. The participants can be defined as senior managers (CEOs, CIOs, and senior IT managers). This group normally operates under time pressures and as data analysis requires a large number of answers from across Australia, it would be hard to arrange interview appointments with a sufficiently large number of participants. Therefore, the method of written surveys is more time efficient, convenient and easier to implement when using senior management participants.

Furthermore, since the questions relate to a wide spectrum of business and IT variables, it is beneficial that participants of written surveys have the chance to stop and ask their colleagues, specialists or subordinates for advice on the questions (Babbie 2007). Furthermore, as the survey includes sensitive questions about companies' capabilities, confidentiality and nondisclosure issues, and the written survey method again seems most appropriate. Last, to choose between the two different options for written surveys, the paper-based or the internet-based survey, the claims of an expected higher rate of completion of the survey and for the elimination of the possibility of data entry errors speak in favour of an internet-based survey. Therefore, considering all the points discussed above, a written internet survey is the appropriate data collection method for this research.

## 5.4. INSTRUMENT DESIGN

In order to quantify the research model, it has to be operationalized through a research instrument. The rigorous development of a reliable and valid research instrument minimises the measurement error. One way of achieving a low measurement error is to draw from existing, already validated instrument development frameworks and research instruments. The instrument development of this study followed a research plan recommended by (Churchill 1979). Churchill (1979) introduced a research plan with an eight-step procedure. The steps of this process (specify the domain of constructs, generate a sample of items, collect data, purify measures, collect new data, assess reliability, assess validity and develop norms) were adopted and slightly modified. The first three phases of the process of instrument development are explained in the following sub- sections. These are:

- Section 5.4.1: Specify the domain of constructs
- Section 5.4.2: Generate a sample of items
- Collect data (Pre-Survey Instrument Validation)
    - Section 5.4.3: Panel of expert survey
- Purify Measures
    - Section 5.4.4: Pilot study and instrument fine tuning
- Collect new data
    - Section 5.5: Sample design
    - Section 5.6: Data collection

Chapter 7 is devoted to the remaining three steps.

### 5.4.1. Step 1: Specify the domain of constructs

In order to develop an accurate and valid research instrument it is necessary to define the domain of constructs and generate a sample of items to capture the specified domain. To specify the domain of constructs, one must clarify what is included and what is excluded in the definition of the construct (Churchill 1979). It would not have been possible to include all variables that relate to IT, the dynamic capabilities of firms and competitive advantage. Therefore, an extensive review of the IT literature led to the definition of the concepts of IT capabilities (infrastructure, personnel and managerial), IT support for core competences (market and operational), adaptive IT capabilities and competitive advantage. These concepts are the basis for the research model and are defined in Chapter 4.

### 5.4.2. Step 2: Generate a sample of items

After the domain of the constructs was well defined, the constructs were explored by identifying existing research instruments and developing a pool of items out of them. Drawing from already existing and validated research instruments ensures that measurement error is kept at a minimum, and pooling a representative sample of items contributes further towards validity. An extensive literature review was conducted to identify variables which had been utilised previously to measure the concepts. Useful items from these variables were extracted. Criteria for selection included how well the items had performed in previous surveys and how relevant they were for this research. This led to an initial pool of 68 items for the defined research constructs (see Appendix B for a complete overview of pooled items). The pooled instrument contained seven variables:

- IT infrastructure capability
- IT personnel capability
- IT management capability
- Adaptive IT capability
- IT support for market competence
- IT support for operational competence
- Competitive advantage

This initial pool of items was further modified through discussions with research supervisors to ensure the relevance of each item in relation to the construct they operationalised and to identify precise wording for the items. The following section discusses the pooling of each construct succinctly.

***IT infrastructure and IT personnel capability***

The first two variables, IT infrastructure capability and IT personnel capability, were largely derived from previous research (Byrd, Lewis & Turner 2004; Byrd & Turner 2000). Table 5.1 below displays the pooled items for the IT infrastructure capability and Table 5.2 for the IT personnel capability construct.

**Table 5-1: Generated Items for IT Infrastructure Capability**

| Variable | Item | Source | Factor loading |
|---|---|---|---|
| Connectivity | Our Company has a high degree of system interconnectivity? | Tallon & Kraemer (2004) | 0.84 |
| | Our systems are sufficiently flexible to incorporate electronic links to external parties? | | 0.82 |
| | Data is captured and made available to everyone in the company in real time? | | 0.77 |
| Compatibility | Our user interfaces provide transparent access to all platforms and applications? | Tallon & Kraemer (2004) | 0.87 |
| | Our company makes extensive use of middleware to integrate key enterprise applications? | | 0.68 |
| Modularity | Reusable software modules are widely used throughout our system development group? | Tallon & Kraemer (2004) | 0.76 |
| | Functionality can be quickly added to critical applications based on end-user requests? | | 0.91 |
| | Our company can easily handle variations in data formats and standards? | | 0.8 |

**Table 5-2: Generated Items for IT Personnel Capability**

| Variable | Item | Source | Factor loading |
|---|---|---|---|
| Broad IT Knowledge | Our IT personnel are cross trained to support other IT services outside their domain? | Byrd &Turner (2001) | 0.46 |
| | Our IT personnel are skilled in multiple programming languages? | Byrd, Lewis & Turner (2004) | not reported |
| | Our IT personnel are skilled in multiple microcomputer operating systems? | | |
| | Our IT personnel are knowledgeable about our IT products and delivery/logistics system? | Byrd &Turner (2001) | 0.54 |
| Business Knowledge | Our IT personnel are knowledgeable about the key success factors in our organisation? | Byrd &Turner (2001) | 0.64 |
| | Our IT personnel understand the business environments they support? | | 0.54 |

Table 5.1 and 5.2 above illustrate the pooled items and their factor loadings from previous research. The sample of items from these constructs have been utilised and validated in a number of previous studies (Broadbent, Weill & Neo 1999; Byrd, Lewis & Turner 2004; Byrd & Turner 2000, 2001a, 2001b; Duncan 1995; Lee, Trauth & Farwell 1995). Hence, the items were not changed, rather we let the Panel of experts (section 5.4.3) rate on the appropriateness of the items.

### *IT management capability*

The items of the IT management capability construct were mainly derived from the work of Ravichandran and Lertwongsatien (2005) and Duncan (1995a). A few items were added through discussion with the research supervisors and logical reasoning. For the *strategic IT management* variable two items were added ('*is IS management always informed about up-to-date business developments?'* and '*Does IS management know about and follow the latest development in the business environment?*'). This was done because we believe, that these items capture the important task of business foresights of IT management. Furthermore for the *business IT partnerships* variable the item *'Our IS management is able to interpret business problems and develop solutions'* was added as we believe IT management's ability to interpret business problems and develop solutions is an important to improve the quality of IT business partnerships. Finally, the wording of the items was adjusted for two reasons. Firstly, to be consisted all over the questionnaire and, secondly, the items had to be to fit a 5-point likert scale. Table 5.3 below displays the pooled items and the conducted changes to adjust them to our research instrument.

## Table 5-3: Generated Items for IT Management Capability

| Construct | Original item | Source | Factor Loading | Comment | Adjusted item (step 2) |
|---|---|---|---|---|---|
| Strategic IT Management | Is IS Management always informed about up-to-date business developments? | OWN | | Wording adjusted to scale | Our IT management knows about the latest development in business |
| | Does IS Management know about and follow the latest development in the Business environment? | OWN | | | Our IT management follows the latest developments in business |
| | Does the firm support an IS unit dedicated to evaluate and integrate emerging technologies? | Duncan (1995a) | not reported | Adjusted | Our IT Management is evaluating chances and risks from emerging technologies |
| | IS executives play an important role in organizational planning? | Duncan (1995a) | | Combined and wording adjusted | IT management contributes to our business strategy |
| | Is the CIO integrated into corporate strategic planning? | Duncan (1995a) | | | |
| | Top management has communicated to the firms stakeholders a commitment to exploiting IS as a strategic resource? | Duncan (1995b) | 0.46 | Adjusted | We manage IT strategically |
| | Top business management directly influences IS planning? | Duncan (1995a) | not reported | adapted wording from different scale | IT initiatives are managed at the top levels of our organization |
| | IS planning is initialized by senior management; senior management participation is very high? | Ravichandran & Lertwongsatien (2005) | 0.78 | | |
| Business- IT partnerships | There is a high degree of trust between our IS department and business units? | Ravichandran & Lertwongsatien (2005) | 0.85 | | There is a high degree of trust between our IT department and business units |
| | Critical information and knowledge that affect IT projects are shared freely between business units and IS department? | Ravichandran & Lertwongsatien (2005) | 0.75 | | Critical information and knowledge that affect IT projects are shared freely between business units and IS department |
| | Our IS department and business units understand the working environment of each other very well? | Ravichandran & Lertwongsatien (2005) | 0.83 | | Our IT department and business units understand the working environment of each other very well |
| | The goals and plans for IT projects are jointly developed by both the IS department and our key IT vendors and service providers? | Ravichandran & Lertwongsatien (2005) | 0.76 | | The goals and plans for IT projects are jointly developed by both the IT department and the business units |
| | Our IS management is able to interpret business problems and develop solutions | OWN | | Changed | Our IT management is able to interpret business problems and develop solutions |
| | Conflicts between IS departments and business units are rare and few in our organization? | Ravichandran & Lertwongsatien (2005) | 0.77 | | Conflicts between IT departments and business units are rare and few in our organization |
| | We get timely information from our IT Vendors and service providers to respond to our IT needs in a timely and effective manner? | | 0.82 | | We get timely, relevant and accurate information from our IT vendors and service providers to respond to our IT needs |
| | A very trusting relationship exists between the IS department and our key IT vendors and service providers? | | 0.88 | | We have trusting partnerships with our key vendors and service providers |

### *IT support for core competences*

The concept of IT support for core competence measures the degree to which IT can support firms' core competences. Two variables were conceptualised to capture this IT support. Firstly, IT support for market competence encompassing the ability of IT to support the market access of firms as well as functional competences (see chapter 4). Secondly, IT support for operational competence measuring the ability of IT to support the operational competences of companies. Items to operationalise these two variables were mainly pooled from previous validated research instruments (Gregor et al. 2004; Ravichandran & Lertwongsatien 2005; Rivard, Raymond & Verreault 2006; Tallon & Kraemer 2004). The items were either taken directly from previous research instruments and reworded to fit the 5 point likert scale of our research instrument, adjusted to better measure the variable under investigation, or added as a result of logical reasoning. The source and factor loadings of the items derived from previous literature as well as the adjusted pooled items are presented in Table 5.4 below.

Firstly, the construct of IT support for market competence was operationalized with five items. Four out of these five were derived from Ravichandran and Lertwongsatien's (2005). These were (1) '*To what extent is IT used to identify new market segments?', (2) To what extent is IT used to redefine the scope of our business?*, (3) *'To what extent is IT used to identify groups of customers whose needs are not being met?'* and (4) *'To what extent is IT used to increase the speed of responding to business opportunities/ threats?'.* The items had to be reworded to make them consisted throughout the questionnaire and to fit the utilized 5-pont likert scale. Even though, one item ('*Our IT is utilized to produce our products /services*') was formulated by logical reasoning, the underlying logic was derived from previous research operationalisations (Ravichandran & Lertwongsatien 2005; Rivard, Raymond & Verreault 2006; Tallon & Kraemer 2004).

Secondly, the construct of IT support for operational competence was operationalized by seven items (see Table 5.4 below). (1) The item '*Out IT is supporting our strategic business processes'* derived from several discussion with the supervisors. The main logic behind this item is based on the theory that few business processes are of strategic importance within a firm. IT that is able to support these critical business processes is likely to provide competitive advantage for an organization. (2) The item '*Our IT is improving our operational efficiency*' was derived and compiled from a research instrument consisting six items '*ICT contributed to transactional business benefits (savings in supply chain management, reducing operating costs, reducing communicating costs, avoiding the need to increase the workforce, increasing return to financial assets, enhancing employee productivity)*' (Gregor et al. 2004). These six items were compiled into one to generate a more parsimonious measure. (3) The item '*Our IT supports our innovation processes'* was derived from Rivard's et al. (2006) original instrument *'IT support for innovative differentiation (R&D expenditures for product development, R&D expenditures for process innovation, emphasis being ahead of competition, rate of product innovations)'* and also compiled into one measure. (4) '*Out IT supports our product development*' and (5) '*Our IT supports crossfunctional integration in our firm'* were pooled from Ravichandran and Lertwongsatien (2005) and the wording adjusted to be consisted throughout the questionnaire. Finally (6) '*Our IT supports knowledge sharing in the company'* and (7) '*Our IT supports our organisational learning'* are originated from Rivard et al. (2006) and split into two separate one, because we believe that knowledge sharing and organisational learning, whilst interlinked, are separate topics.

**Table 5-4: Generated Items for IT support for Core Competences**

| | Original item | Source | Factor Loading | Comment | Adjusted item (step 2) |
|---|---|---|---|---|---|
| IT support for Market Competences | To what extent is IT used to identify new market segments? | Ravichandran & Lertwongsatien (2005) | 0.78 | reworded | Our IT supports identifying market segments |
| | To what extent is IT used to redefine the scope of our business? | | 0.71 | | Our IT is utilized to redefine the scope of our business |
| | To what extent is IT used to identify groups of customers whose needs are not being met? | | 0.74 | | Our IT supports analysing customer needs (i.e. products, preferences, pricing and quality) |
| | To what extent is IT used to increase the speed of responding to business opportunities/ threats? | | 0.72 | | Our IT is utilized to increase the speed of responding to business opportunities/ threats |
| | | OWN | | | Our IT is utilized to produce our products /services |
| IT support for Operational Competence | | OWN | | | Our IT is supporting our strategic business processes |
| | ICT contributed to transactional business benefits:<br>- savings in supply chain management<br>- reducing operating costs<br>- reducing communicating costs<br>- avoiding the need to increase the workforce<br>- increasing return to financial assets<br>- enhancing employee productivity | Gregor et al. (2004) | not provided | compiled and adjusted | Our IT is improving our operational efficiency |
| | IT support for innovative differentiation:<br>- R&D expenditures for product development<br>- R&D expenditures for process innovation<br>- emphasis being ahead of competition<br>- rate of product innovations | Rivard et al. (2006) | 0.83-0.86 | compiled and adjusted | Our IT supports our innovation processes |
| | To what extent is IT used to develop new products /services? | Ravichandran & Lertwongsatien (2005) | 0.78 | | Out IT supports our product development |
| | To what extent is IT used to integrate internal business units? | | 0.65 | reworded | Our IT supports crossfunctional integration in our firm |
| | IT support for knowledge and skills of employers | Rivard et al. (2006) | not provided | adjusted and split in two items | Our IT supports knowledge sharing in the company |
| | | | | | Our IT supports our organizational learning |

### *Adaptive IT Capability*

To measure the construct of adaptive IT capability the focus was on the ability of firms' IT to quickly respond to changes in firms' competences. The items generated encompass the ability of firms' IT to respond quickly to market- and product-related changes as well as the ability of IT to quickly build, adapt or renew the internal business processes and structures of a company. Altogether 14 items were utilized to operationalize the adaptive IT capability construct (see Table 5.5) and were operationalized in several ways.

Firstly, the items for the adaptive IT capability construct are in eight cases items from the IT support for core competences construct, which have been adjusted to measure how adaptable (dynamic IT support for core competences) this static IT support is (see chapter 4, particular section 4.4.2). In particular the items '*Our IT supports knowledge sharing in the company', 'Our IT supports organisational learning', ' Our IT supports our product development', 'Our IT supports our strategic business processes'* and '*Our IT supports crossfunctional integration in our firm*' from the IT support for operational competence construct, as well as the item '*Our IT is utilized to produce our products and services'* from the IT support for operational competence construct were rephrased to that they measure the ability to adjust this static support in a dynamic environment. As a result the following seven items were developed: '*Our IT is able to adapt quickly to changes in knowledge sharing in the company', 'Our IT is able to adapt quickly to changes in organisational learning. 'Our IT is able to adapt quickly to changes which can become necessary when the firm changes it's Products or Services', 'Our IT is able to develop new products and services', Our IT is able to adapt quickly to changes in the product development', 'Our IT is able to adapt strategic business process reengineering'* and '*Our IT is able to adapt quickly to changes in the crossfunctional integration of our firm'*.

Secondly, a literature research identified four items (see Table 5.5) which provide a measure for IT's ability to support organisational change (Ravichandran & Lertwongsatien 2005). Two items ('*To what extent is IT used to reengineering business processes?*' and '*To what extent is IT used to enhance business process flexibility?*') were reworded and compiled into one item. This was done because we believed, that adapting the reengineering of business processes and enhancing the business process flexibility are similar and so a more parsimonious, compiled item ('*Our IT is able to enhance business process flexibility*') was utilized in our research instrument. Furthermore, the items '*To what extent is IT used to define new markets?*' and '*To what extent is IT used to determining customer requirements (i.e. products, preferences, pricing and quality)?* were identified in the literature (Ravichandran & Lertwongsatien 2005) and reworded to achieve consistency across the questionnaire and to make the appropriate for a 5 point likert scale. As a result, the following items were utilized for the research instrument: '*Out IT is able to identify new market segments*' and '*Our IT is able to identify new customer needs*'.

**Table 5-5: Generated Items for Adaptive IT Capability**

| Original item | Source | Factor Loading | Comment | Adjusted item (step 2) |
|---|---|---|---|---|
| Adaptability measure for "Our IT supports knowledge sharing in the company" | Adaptability measure of IT support for core competence item | | | Our IT is able to adapt quickly to changes in knowledge sharing in the company |
| Adaptability measure for "Our IT supports organisational learning" | | | | Our IT is able to adapt quickly to changes in organisational learning |
| Adaptability measure for "Our IT is utilized to produce our products and services" | | | | Our IT is able to adapt quickly to changes which can become necessary when the firm changes it's Products or Services |
| Adaptability measure for "Our IT is utilized to produce our products and services" | | | | Our IT is able to develop new products and services |
| Adaptability measure for "Our IT supports our product development" | | | | Our IT is able to adapt quickly to changes in the product development |
| Adaptability measure for item "Our IT supports our strategic business processes" | | | | Our IT is able to adapt strategic business process reengineering |
| Adaptability measure for "Our IT is able to adapt quickly to changes in the crossfunctional integration of our firm" | | | | Our IT is able to adapt quickly to changes in the crossfunctional integration of our firm |
| To what extent is IT used to reengineering business processes? | Ravichandran & Lertwongsatien (2005) | 0.78 | compiled and adjusted | Our IT is able to enhance business process flexibility |
| To what extent is IT used to enhance business process flexibility? | | 0.78 | | |
| To what extent is IT used to define new markets? | | 0.8 | wording | Out IT is able to identify new market segments |
| To what extent is IT used to determining customer requirements (i.e. products, preferences, pricing and quality)? | | 0.66 | wording | Our IT is able to identify new customer needs |
| | OWN | | | Our IT is able to adapt quickly to changes which can become necessary when the firm addresses changes in the market and customer demands |
| | OWN | | | Our IT is able to adapt quickly to changes which can become necessary because of competitors actions |
| | OWN | | | Our IT is able to adapt quickly to changes which can become necessary when the firm redesigns its business processes and organisational structures |

Finally, three items were specifically developed through logical reasoning and several discussions with the research supervisors to measure IT ability to support organisational ability to adapt to change (see Table 5.5). These items are (1) a measure how IT can support changes in market and customer demands (‘*Our IT is able to adapt quickly to changes which can become necessary when the firm addresses changes in the market and customer demands’*). (2) Companies often have to adapt quickly to competitor actions (e.g. new pricing strategies, products, etc.). Hence, the item (‘*Our IT is able to adapt quickly to changes which can become necessary because of competitors actions’*) was put forward. (3) Changes in products, services, entering new markets or global merger and acquisitions often demand changes in organisational processes and structures. Hence the item ‘*Our IT is able to adapt quickly to changes which can become necessary when the firm redesigns its business processes and organisational structures’* was utilized in the adaptive IT capability construct.

### *Competitive Advantage*

Finally, the items for competitive advantage were taken over from a previous study (Powell & Dent-Micallef 1997) in the IT field that measured competitive advantage, in order to make this study more comparable. Ravichandran and Lertwongsatien (2005) have used similar items and obtained factor loadings with their adjusted items from 0.75-0.90. The items are displayed in Table 5.6 below.

**Table 5-6: Generated Items for Competitive Advantage**

| Original item | Source | Factor Loading |
|---|---|---|
| Over the past 3 years, our financial performance has exceeded our competitors | Powell and Dent Micalleff (1997) | not provided |
| Over the past 3 years, we have been more profitable than our competitors | | |
| Over the past 3 years, our sales growth has exceeded our competitors | | |

The measurement items for competitive advantage are all relational measures that assess the relative position in financial performance, profitability and sales growth of an organisation in comparison to the competitors.

All items, except those from the IT infrastructure capability and IT personnel capability construct, were then scrutinised through a panel of expert survey to ensure that they measured what they were supposed to measure.

### 5.4.3. Step 3: Panel of experts survey

The purpose of this step was to further improve the validity of the instrument through consulting experts in the field and asking their opinion regarding the relevance of the items. The panel of experts consisted of 40 IT/IS academics that were known for their research in the competitive advantage and IT area. They were identified through a literature search. An online survey was set up and the panel of experts was asked to rate each item from '1: Not relevant' to '5: Highly relevant' to measure the constructs. Additionally, the experts were encouraged to provide further feedback concerning the items. An email invitation containing a plain language statement, together with an online link to the draft questionnaire, was sent to the panel of experts. The invitation email and plain language statement are displayed in Appendices B, C and D. From the 40 approached, 14 academics replied. This amounted to a response rate of 35%, which was considered reasonable for this kind of study. The experts came from a variety of universities and had a range of experiences and research backgrounds. This variety improved the quality of the feedback on the research instrument. To determine whether these experts were in agreement and to check whether the data obtained were valid, the inter-judge reliability of the data from the panel of experts survey was calculated. The inter-observer reliability is measures of agreement among the different observers, in this case the experts. A popular way of doing this is by calculating the correlation-coefficient between different experts (Litwin 1995).

The correlation coefficient was calculated by importing the Judges' responses into SPSS. The correlation between each item (judges rating on each instrument question) of a pair of judges was calculated and the average of the item-correlation for each pair of judges obtained. Table 5.1 illustrates the inter-observer reliability of the panel of experts survey for each pair of judges.

**Table 5-7: Inter-Judge Reliability**

| | R1 | R2 | R3 | R4 | R5 | R6 | R7 | R8 | R9 | R10 | R11 | R12 | R13 | R14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R1 | 1.00 | | | | | | | | | | | | | |
| R2 | 0.47 | 1.00 | | | | | | | | | | | | |
| R3 | 0.51 | 0.59 | 1.00 | | | | | | | | | | | |
| R4 | 0.29 | 0.39 | 0.31 | 1.00 | | | | | | | | | | |
| R5 | 0.53 | 0.65 | 0.56 | 0.43 | 1.00 | | | | | | | | | |
| R6 | 0.56 | 0.67 | 0.49 | 0.51 | 0.74 | 1.00 | | | | | | | | |
| R7 | 0.54 | 0.47 | 0.41 | 0.31 | 0.63 | 0.74 | 1.00 | | | | | | | |
| R8 | 0.53 | 0.58 | 0.59 | 0.41 | 0.71 | 0.81 | 0.70 | 1.00 | | | | | | |
| R9 | 0.48 | 0.48 | 0.49 | 0.40 | 0.67 | 0.64 | 0.49 | 0.80 | 1.00 | | | | | |
| R10 | 0.44 | 0.37 | 0.35 | 0.30 | 0.53 | 0.51 | 0.39 | 0.34 | 0.30 | 1.00 | | | | |
| R11 | 0.56 | 0.36 | 0.41 | 0.41 | 0.61 | 0.51 | 0.62 | 0.60 | 0.67 | 0.37 | 1.00 | | | |
| R12 | 0.47 | 0.51 | 0.41 | 0.45 | 0.60 | 0.54 | 0.56 | 0.52 | 0.52 | 0.49 | 0.56 | 1.00 | | |
| R13 | 0.47 | 0.58 | 0.60 | 0.25 | 0.59 | 0.60 | 0.67 | 0.61 | 0.44 | 0.41 | 0.46 | 0.47 | 1.00 | |
| R14 | 0.51 | 0.60 | 0.65 | 0.44 | 0.51 | 0.68 | 0.51 | 0.67 | 0.61 | 0.38 | 0.48 | 0.34 | 0.62 | 1.00 |

**F= 6.56 p= 0.00**

The correlation-coefficient ranges between 0 and 1, and the higher the correlation-coefficient the higher their observers’ overall agreement on the variables. A correlation coefficient of 0.3 means there is a weak positive association between the two rater, a correlation of 0.6 and above stands for strong association (Selvanathan et al. 2004).

Table 5.7 reveals agreements rating from weak to strong among the experts, indicating the reliability and stability of their judgements. With an F value of 6.56 and a significant p-value of $p = 0.01$ all correlations between experts were significant.

Despite the fact that overall the academics displayed high levels of agreement (4.25 averages on a 5-point Likert scale) over the proposed research model; a few suggestions were offered to improve the instrument. Several discussions with the research supervisors accompanied the analysis of the panel of experts’ feedback. Items that rated at an average of below 4 out of 5 on the Likert scale were specially scrutinised as they did not withstand the panel of experts’ confirmation. Three options were considered for each item. Firstly, the item was left how it is. Secondly, if the experts suggested improvements for the item, the item was reworded. Thirdly, if the item had low average agreement score of the lowest score in the construct the item was deleted. This was done to obtain a more parsimonious instrument. Table 5.2 provides an overview of the significant instrument changes that resulted from the panel of experts survey.

**Table 5-8: Instrument Improvements after Panel of Experts Survey**

| Construct | Before POE | Average | ACTION TAKEN |
|---|---|---|---|
| IT management capability | Our IT management knows about the latest developments in business | 4.36 | Replaced with new item: ‘Our IT management is up to date with the business developments’ |
| | Our IT management follows the latest developments in business | 3.50 | |
| | Conflicts between IT departments and business units are rare and few in our organisation | 2.64 | Deleted due to: not relevant |
| | We get timely, relevant and accurate information from our IT vendors and service providers to respond to our IT needs | 2.86 | Deleted |
| | We have trusting partnerships with our key vendors and service providers | 2.93 | |
| Adaptive IT capability | Our IT is able to identify new market segments | 3.57 | Deleted: Questions are least relevant in measuring variable |
| | Our IT is able to identify new customer needs | 3.71 | |
| | Our IT is able to adapt strategic business process re-engineering | 3.64 | Deleted |
| IT support for operational competence | Our IT supports our organisational learning | 4.36 | Deleted, because knowledge sharing is a sub-question of organisational learning and more relevant to IT |

Most instrument changes occurred in the IT management construct (see Table 5.2 above). The first two items—'*Our IT management knows about the latest developments in business*' and '*Our IT management follows the latest developments in business'*—were combined. This was done in response to the comments on these items, which indicated that knowing and following the latest developments in business are closely linked. As a result, the two items were rephrased into the statement: '*Our IT management is up to date with business developments*'. Three other items from the IT management construct were dropped due to low average agreement scores (2.64–2.93 out of 5) (see Table 5.2 above). These were: 1. '*Conflicts between IT departments and business units are rare and few in our organisation*'; 2. '*We get timely, relevant and accurate information from our IT vendors and service providers to respond to our IT needs'*; and 3. *'We have trusting partnerships with our key vendors and service providers'*. From the adaptive IT capability construct three items were removed as they had a low average agreement score (3.57–3.71 out of 5). These were: 1. *'Our IT is able to identify new market segments'; 2. 'Our IT is able to identify new customer needs'*; and 3. '*Our IT is able to adapt to strategic business process reengineering'*. From the IT support for operational competence construct one item was dropped: '*Our IT supports our organisational learning*'. This was done because we realised through the feedback comments that knowledge sharing is a subset of organisational learning. Organisational learning encompasses many attributes, one of which is knowledge sharing. Without knowledge sharing, no organisational learning can take place. The IT support for knowledge sharing can be measured, whereas organisational learning encompasses organisational culture and many other non-IT related attributes. Hence, the item '*Our IT supports our knowledge sharing*' was retained, and the item '*Our IT supports our organisational learning*' was dropped. A complete overview of the panel of experts' feedback and the modification of the items is attached in Appendix F.

After defining the domain of the constructs, pooling variables from previously validated research instruments and strengthening their validity through a panel of experts survey, the research instrument can be seen to adequately measure the research construct and to have sufficient content validity. A pilot study was then conducted to determine whether the research instrument was actually interpreted in the way it was designed to be by the target audience—the sample population.

### 5.4.4. Step 4: Pilot study and instrument finetuning

The next step was to test the soundness of the research instrument in order to further improve its quality. The significance of this pilot test was to find out what meaning potential respondents ascribed to the terms used and what context they applied when considering their answers. This provided insights into the respondents' thought processes and allowed us to ensure that questions were understood in the way they were intended. The pilot test was conducted via face-to-face discussion with two chief information officers (CIOs). The questionnaire was presented to the participants and they were asked to outline how they understood and interpreted the questions and whether they had any difficulties in answering them. Overall, the interviewees confirmed that the questions were clearly stated, that they understood them well, though they did suggest some wording changes in certain items. The participants also offered further feedback from the practitioner perspective and proposed deletion of several items. After analysing the feedback obtained from these interviews, the research instrument was further modified in order to obtain higher validity. The changes implemented are illustrated in Table 5.3 below.

**Table 5-9: Changes to Instrument after Pilot Study**

| Construct | Before pilot study | Action taken |
|---|---|---|
| IT management | IT initiatives are managed at the top levels of our organisation | Deleted |
| Adaptive IT capability | Our IT is able to enhance strategic business process flexibility | Deleted |
| IT support for market competence | Our IT is utilised to increase the speed of product and service delivery | Deleted |

Apart from a few wording changes to make the instrument more comprehensible for CIOs, Table 5.3 above presents the actions taken in response to the feedback provided by the CIOs. Three items were deleted because the interviewees rated them either as not suitable or already captured by other items of the same construct. Firstly, from the IT management construct, the item '*IT initiatives are managed at the top level of our organization*' was deleted. Secondly, from the adaptive IT capability construct, the item '*Our IT is able to enhance strategic business process flexibility*' was deleted. Thirdly, from the IT support for market competence construct, the item '*Our IT is utilised to increase the speed of product and service delivery*' was deleted. The research instrument was now ready for the main survey.

## 5.5. SAMPLE DESIGN

In empirical research, it is crucial to design a sample which can reflect the same results as would be found in the population (De Vaus 2002). Designing a suitable and representative sample involves three interrelated aspects; the sampling frame, the sample selection criteria, and the sample size (Fowler 1993).

### 5.5.1. Sampling frame

One way of examining subjects is to collect information from every subject in a group. This can be difficult or impossible to realise, especially for large groups. It is therefore much easier and more practical to utilise the principle of random sampling. This principle entails the collection of information from a representative subset of this group and drawing conclusions from the subset about the whole group. In order to be representative, the subset must reflect the characteristics of the whole group (De Vaus 2002). To ensure the study is comparable to other studies in this area, a literature review was conducted to identify the sampling frame of similar studies and compare it with our own. The results are shown in Table 5.4 below.

**Table 5-10: Comparison of Sampling Frames from Previous Studies**

| Author | Method | Industry | Firm Size | Country |
|---|---|---|---|---|
| Armstrong & Sambamurthy (1999) | Mail survey | Manufacturing, transportation, utilities, retail, banking, financial services, petroleum, food, insurance | Medium and large | USA |
| Bharadwaj (2000) | Secondary data | | | |
| Bhatt & Grover (2005) | Mail survey | Manufacturing | Large (annual revenue US$50–140 billion) | USA |
| Bradley (2006) | Online survey | Healthcare | All | USA |
| Byrd & Turner (2000) | Mail survey | All | Large | USA |
| Mahmood & Soon (1991) | Structured interview | All, Fortune 500 | Large (Fortune 500) | USA |
| Pavlou (2006) | Online survey | New product development firms | Medium and large | Not specified |
| Powell & Dent-Micallef (1997) | Mail survey | Retail Industry | Large | USA |
| Ravichandran & Lertwongsatien (2005) | Mail survey | All, except education and government | Large (Fortune 1000) | USA |
| Ray et al. (2005) | Mail survey | Life and health insurance industry | Medium and large (over 100 employees) | USA/ Canada |
| Tallon (2000) | Mail survey | Single line of business firms | Large | USA |
| Vogel (2005) | Mail survey | All (except government related) | Large:<br><1k employees: 10%<br>1k–10k employees: 47%<br>> 10k employees: 53% | USA |
| Huang et al. (2005) | Mail survey | Most, finance and insurance excluded | Firms listed on the Taiwan stock market | Taiwan |

The comparison of sampling frames from similar studies in Table 5.4 above indicates three interesting features of sampling frames from previous studies. Firstly, some studies included a wide variety of industries in their sample frames (Armstrong & Sambamurthy 1999; Byrd & Turner 2000; Mahmood & Soon 1991; Ravichandran & Lertwongsatien 2005; Vogel 2005). Only a few studies focused on a specific industry segment (Bhatt & Grover 2005; Bradley 2006; Pavlou & El Sawy 2006; Powell & Dent-Micallef 1997; Ray, Muhanna & Barney 2005). Secondly, the most common sizes of investigated firms were medium and large. Finally, nearly all studies were conducted in North America, especially in the USA.

This study seeks to examine the concepts of IT capabilities, IT support for core competences and adaptive IT capabilities and their influence on the competitiveness of firms. These concepts are recognised as being important in nearly all industries, and hence all industries were included in the sample selection for this study. The main difference between the sampling frame of this study and those used in previous studies (see Table 5.4) is the geographic distribution of companies. Most previous studies set their sampling frames to the North American continent (USA and Canada). The sampling frame of this research will be Australian companies. As with the size of the companies in the sampling frame, to make this research more comparable and to act within the research tradition, the common approach within previous studies of focusing the investigation on medium- and large-sized organisations (see Table 5.4) was adopted for this research. However, it should be noted that North America and Australia have different classification regimes on what constitutes medium and large organisations. Drawing from the ANZIC (Australian and New Zealand Industry Classifications) from the Australian Bureau of Statistics[5], the sampling frame was set to include large companies with 200 employees or more. As number of employees is not the only means of determining business size, medium-sized companies with annual revenues of more than AUD$10 million were included into the selection. Regardless of the fact that according to the classification of the Australian Bureau of Statistics, medium-sized companies are those with 20–200 employees, only companies with more than 75 employees actually made the AUD$10 million revenue thresholds in the selected sample.

### 5.5.2. Sample size

It is vital to put some serious thought into the minimum necessary sample size before starting a survey. On the one hand, in general the margin of error decreases with an

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[5] For ABS ANZIC Classification see:

http://www.abs.gov.au/ausstats/abs@.nsf/productsbytopic/97452F3932F44031CA256C5B00027F19?OpenDocument increasing sample size (it is an inverse relationship). On the other hand, the bigger the sample is, the more cost-intensive the research will be (De Vaus 2001). Therefore, it is important to determine the MRSS (minimum required returned sample sized) and from that basis to calculate or estimate the actual sample size of the organisations to be contacted (De Vaus 2001). The MRSS and the response rate obtained are dependent on many factors. Following Collis et al. (2003) two main considerations were taken into account.

Firstly, the desired method of statistical analysis has to be considered when determining the MRSS. As with the MRSS for data analysis, Bartlett et al. (2001) state that for factor analysis it should not fall below 100 and the ratio of independent variable to observations in multiple regression analysis should not fall below five. Based on experience, the expected variability within the sample and the results should be taken into account. Even though, there seems to be agreement among scholars, that the larger the sample size for SEM, the higher the statistical power (Weston & Gore 2006), there does not seem to be a clear agreement among scholar as how large the MRSS has to be to perform SEM analysis. Nevertheless, there are several indicators that should be taken into account when using SEM. These include (1) the desired statistical power, (2) test for close versus exact fit and (3) the complexity of the model (Weston and Gore 2006). Research by MacCallum, Bowne and Sugawara (1996) examined the impact of sample size on the statistical power of covariance structure models (e.g. SEM). Their research also considered the complexity of models through degrees of freedom assessment and the desired fit assessment (close versus exact fit). This research study desires to test Hypothesis at a 95% confidence interval. Furthermore, the fit statistics which will be later utilized to determine if the research model represent the collected data in an appropriate way assume an close fit (RMSEA, CFI, RMR, etc.), rather than exact fit. Last, the research model of this research will have more than 100 degrees of freedom (see also chapter 7). Considering these issues, research on required sample size indicate that a sample of 200 will be appropriate (MacCallum, Browne & Sugawara 1996).

Secondly, the tradition in the particular research area regarding appropriate sample size should give some indication of the required MRSS. A literature review was conducted and the results are listed in Table 5.5 below.

**Table 5-11: Comparison of Sample Sizes from Previous Studies**

| Study | Method | Sample Size | Responses | % |
|---|---|---|---|---|
| Armstrong & Sambamurthy (1999) | Mail survey | 1120 | CIO / IT Mgmt: 235<br>CEO: 265 | 21% |
| Bhatt & Grover (2005) | Mail survey | 1200 | 202 | 17% |
| Bradley (2006) | Online survey | 1000 | 243 | 24% |
| Byrd & Turner (2000) | Mail survey | 1000 | 207 | 21% |
| Fink & Neumann (2007) | Mail survey | 8000 | 361 | 5% |
| Lertwongsatien (2000) | Mail survey | 758 | 70 | 9% |
| Pavlou (2006) | Online survey | 547 | 170 | 31% |
| Powell & Dent-Micallef (1997) | Mail survey | 250 | 65 | 26% |
| Ravichandran & Lertwongsatien (2005) | Mail survey | 710 | 129 | 18% |
| Ray et al. (2005) | Mail survey | 800 | 104 | 13% |
| Tallon (2000) | Mail survey | 542 | 367 | 68% |
| Vogel (2005) | Mail survey | 159 | 89 | 56% |
| Huang et al. (2005) | Mail survey | 271 | 155 | 57% |

The comparison of previous studies outlined in Table 5.5 above indicates that on average the studies gained around 175 responses. These studies mainly used sample sizes ranging from 159 to 1120 and often gained response rates of around 20–30%. Because previous studies were conducted in a different geographical region, using different databases, the comparison with previous studies suggested that it would be reasonable to aim for a response rate of around 180 based on research tradition.

When estimating the MRSS, both the preferred method of data analysis (SEM), which requires around 200 responses (see above), and the research tradition of an average of 175 responses were taken into consideration. This estimation of MRSS is also in line with more general statements of Hair et al (2006), Tabachnick and Fidell (2007) and Bartlett et al. (2001) which all regard a sample size of 200 as appropriate.

Hence, the required MRSS was set at 200 respondents. Having set the MRSS at 200, the initial sample size was estimated. While the prior research displayed a respectable response rate ranging from 5% to 57% (see Table 5.5), it was acknowledged that empirical evidence indicates web surveys typically generate lower response rates (Ballard

& Prine 2002; Crawford, Couper & Lamias 2001; Fink & Neumann 2007; Peszynski & Molla 2008). Even though, it is noted that Pavlou (2006) and Bradley (2006) did receive reasonable responses rates with web surveys. As outlined by Ballarad and Prine (2002) in most cases web surveys receive smaller response rates. Hence, a higher sample size was selected to ensure that even at a low response rate the desired MRSS would be achieved. A sample size of 3500 was thus considered to be appropriate to achieve the desired responses of 200.

### 5.5.3. Respondents selection criteria

After the sampling frame and sample size were determined, the next task was to identify the most appropriate types of respondents from the company. A Senior IT executive, such as a CIO or senior IT manager, is usually regarded as an appropriate respondent (Bhatt & Grover 2005; Huber & Power 1985). Senior IT executives are expected to be well versed in organisational capabilities pertaining to IT, as well as in the business issues facing companies. In cases where the desired respondent was not contactable and only one respondent per unit was solicited, according to Huber and Power (1985), the next most informed respondent is an appropriate substitute. As CEOs are perceived to be knowledgeable about all of the major issues in their company, in cases where there was no contact information available for a senior IT executive, the CEO would be contacted. To avoid conflicts or multiple respondents from one company, only one contact per company was selected.

To ensure that this research adhered to the tradition of previous studies and that the results could be compared to similar studies, a literature review was conducted. The results are presented in Table 5.6 below.

**Table 5-12: Respondents Selection Criteria**

| Author | Respondent | Comments | Database |
|---|---|---|---|
| Armstrong & Sambamurthy (1999) | CIO and Chief Executives | Different questions for CIO and CEO | Cross Listing firms from: Fortune 500, Service Fortune 500 Business Week 1000 with the IS Executive Database and Standard and Poor's Register of Executives |
| Bhatt & Grover (2005) | CIO and Senior IT Executives | CIO knows organisational capabilities as well as competitive advantage of company | Marketing vendor |
| Bradley (2006) | CIO or Senior IT Manager | Health Information and Management System Society | Healthcare Forum Database |
| Byrd & Turner (2000) | CIO and senior IT Managers | Fortune 1000 | Directory of Top Computer Executives |
| Lertwongsatien (2000) | CIO and Senior IT Managers (only job titles as follows: CIO,VP, director MIS) | Fortune 1000 Information week 500 | Directory of Top Computer Executives |
| Mahmood & Soon (1991) | CEO | Small sample size | |
| Pavlou (2006) | New product development managers | | PDMA Conference (http://www.pdma.org/2002/) |
| Powell & Dent-Micallef (1997) | CEO | Personal phone call before sending out survey | |
| Ravichandran & Lertwongsatien (2005) | CIO and Senior IT Managers | Fortune 1000 | Directory of Top Computer Executives |
| Ray et al. (2005) | IT Manager and Customer Service | Different questions | Dun & Bradstreet |
| Tallon (2000) | CIO, CEO, Strategic planners | Fortune 500 firms | Hoovers list www.hoovers.com |
| Vogel (2005) | CIO | Winners of the 2002 and 2003 CIO 100 award. Mainly public firms | CIO Magazine |
| Huang et al. (2005) | Top Executive | Firms listed on the Taiwan stock market | Taiwan Intelligence Capital Investigation Project |

The results of the literature review (see Table 5.6 above) indicated that the respondent selection was consistent with those of previous studies with CEOs and/or CIOs/senior IT managers perceived as being the most knowledgeable about the issues concerned.

The next task was to identify lists that could be potentially representative of such a frame and to select the list that was most appropriate for this study. The selection criteria for the lists included completeness of the list in the form of contact addresses and required sample size. As most previous studies in this field were conducted in North America, the Directory of Top Executives was a frequently utilised source in these studies (see Table

5.6 above). Unfortunately, this list does not feature Australian companies. Therefore a special database of Australian companies had to be found. As it was decided to conduct an online survey, another selection criterion on the list was the existence of email addresses, not only mail addresses. Databases, like the Impact 500 or the Dun & Bradstreet database either did not contain email addresses or only contained those of CEOs and not CIOs. After a lengthy search, a large business database provider—IncNet Australia—was identified and a list of 3,500 records was rented. The marketing agency selected the 3,500 records according to the selection criteria of this study (all industries with companies of >20 employees). In the category of large companies (>200 employees) all datasets were obtained. In the category of medium-sized companies (21–200 employees) a random selection of companies was provided by IncNet. In the year 2003–2004, the overall population of large companies (>200 employees) in Australia was 2,799 and of medium-sized companies (21–200 employees) was 44,890 (ABS 2007).

## 5.6. DATA COLLECTION

Surveys over the internet can be conducted in a number of ways, mainly either through email and/or via a web page. Firstly, there is the email survey, whereby an email was sent out to the participant. The participants can directly reply to the email and no further step is necessary. Secondly, there is the web-based online survey, whereby a web page was built that includes the survey and usually sends out an email with a link to that web page. While email surveys have the advantage of being easy to construct and that it is easy to contact the participants via email, they have the disadvantage that participants have to reply to the email, and therefore their anonymity and nondisclosure cannot be guaranteed. The advantage of web-based surveys is that anonymity can be ensured because the participants do not have to disclose their email addresses, as they fill out the survey on the web page and simply click the submit button. Therefore, in this research the survey was conducted via a web page, and an email containing a link to the survey web page was sent to participants. This method ensured the anonymity of the participants, and enabled to use the efficiency of email to contact participants.

The main survey was conducted via an online questionnaire. No advantages / disadvantages or any implications to this research could be identified with using specific online survey software. Hence, the decision on the technical implementation and the technical hosting and administration of the online survey was left to the Web officer of RMIT School of Business IT. The questionnaire was not constructed through online survey software; rather it was built as a webpage using HTML and XML. An email invitation (see Appendix G) containing a plain language statement (see Appendix H) and an online link to the questionnaire (see Appendix I) were sent out to 3,500 CIOs and CEOs of Australian companies. A typical response rate in this kind of survey with senior executives is about 5–10%. It is a crucial part of every survey to obtain an acceptable response rate. To achieve the desired 5–10% response rate, the survey sought to encourage and motivate the addressed CIOs/CEOs to participate. The participants were addressed personally in the invitation email and after three weeks a reminder email was sent, leading to another flow of responses. The first wave yielded 133 respondents, the second yielded 117 respondents. Two months after the first invitation email was sent the survey was closed. A total of 250 responses were received, which is equivalent to a response rate of around 7.1%.

## 5.7. SUMMARY

This chapter discussed the methodology that was used to measure the framework described in Chapter 3. First, the overall research design was outlined. The research design argued for the positivist theory as the epistemological choice, and the survey as the appropriate data collection method for this research. Second, the instrument development process was delineated, which, in order to minimise measurement errors, followed a well known framework developed by Churchill (1979). Third, the sample design was outlined, and the sampling size, frame and selection criteria were explained and justified. Finally, the chosen data collection method was explained. The following chapter will investigate the collected data.

# Chapter 6

# DATA ANALYSIS I: DATA CLEANING

## 6.1. INTRODUCTION

Before commencing validation of the research instrument and conducting multivariate analysis with structural equation modelling, the data were examined, prepared and explored in section 6.2. This process was conducted for three reasons. The first was to minimise the potential for measurement error and to validate the soundness of the data. The second reason was to verify that the data satisfied the requirements (such as normality, Multicollinearity, content validity, internal consistency reliability and construct validity) of the multivariate techniques later utilised. Multivariate analysis refers to all statistical techniques that simultaneously analyse multiple variables within a single analysis; therefore, any simultaneous analysis of more than two variables can be loosely considered multivariate analysis (Hair et al. 2006). Multivariate analysis comprises powerful techniques that allow greater insight into data and create more knowledge than their univariate or bi-variate predecessors. Furthermore, an overview of the respondents profiles with which the research model and its hypotheses will be tested and evaluated is presented in section 6.3.

## 6.2. DATA EXAMINATION AND PREPARATION

To examine and prepare the data several steps were undertaken, which are illustrated in Table 6.1 below. Firstly, a data screening and cleaning exercise was conducted (section 6.2.1) to recode the survey data and detect inconsistencies. Secondly, the missing values were analysed (section 6.2.2) to delete non-applicable items and cases, and to utilise imputation methods for the remaining data. Thirdly, the normality of the data was assessed (section 6.2.3). Fourthly, outliers and Multicollinearity were identified and treated (section 6.2.4). Finally, to ensure that the data collected represent a generalisation of the population, the non-response bias was estimated (section 6.2.5).

**Table 6-1: Overview of Data Examination and Preparation**

| Overview of data examination and preparation steps | | |
|---|---|---|
| **Steps** | **Section** | **Action** |
| 1 | 6.1.2 | Data recoding |
| 2 | | Data screening |
| 3 | 6.1.3 | Analysis of "user-missing" data |
| 4 | | Identifying pattern of "system missing" data |
| 5 | | EM imputation for "system missing" data |
| 6 | 6.1.4 | Normality test |
| 7 | 6.1.5 | Outlier identification |
| 8 | | Multicollinearity check |
| 9 | 6.1.6 | Non-response bias test |

### 6.2.1. Data screening and cleaning

Data screening and cleaning were executed in several steps. Firstly, the data were imported electronically from the online survey into an Excel file. There the data were sorted according to date and time. Secondly, an identifier was given, so that each respondent had a unique identification. Thirdly, the data formats and variable names were adjusted, so that they could be imported into statistical software packages such as SPSS. Finally, the data were checked for invalid respondents—that is, if the characteristics of the sample matched the characteristics of the defined population. The two characteristics checked were the company size and the position of the respondent. Twenty-one cases that did not match the defined sample frame (see Chapter 5, section 5.5.1 for sample frame) were deleted. From the 250 received responses 229 were used in further analysis.

### 6.2.2. Missing value analysis

The next step was to check for missing data. The missing data were dealt with by referring to a four-step process outlined by Hair et al. (2006). The first step is to determine the type of missing data, as '*user-missing'* versus '*system-missing'*. The second step is to identify and delete 'user-missing' data >5% in cases and items. The third step is to diagnose the randomness of 'system-missing' data. The final step is to decide on an appropriate imputation method. These four steps are further discussed in the following paragraphs.

The **first step** in dealing with missing data is to determine the type of missing data involved. Assessment of the extent and patterns of missing data allows discovering whether the missing data are concentrated in specific cases or questions. For this reason, percentages of variables and cases with missing data were calculated. The aim was to determine if the amount of missing data per variable or case was low enough not to warrant further treatment or to affect the results of the study. Altogether, 422 out of 12,366 data points (3.4%) were missing. Two kinds of missing data were identified, as either 'system-missing' or 'user-missing' data (Hair et al. 2006; Lewis-Beck, Bryman & Liao 2004). 'System-missing' refers to questions that have not been answered by the participant. This could be due to a variety of reasons such as failure to complete the whole questionnaire, overlooking answer fields, or privacy and nondisclosure concerns, especially in response to the competitive advantage questions. 'User-missing' refers to missing values which are the results of the research design (Allison 2002). If the research instrument includes skip patterns, not applicable options or 'don't know' choices (Hair et al. 2006), some respondents are likely to opt for those answers, which results in user-missing data.

While the online questionnaire used in the current study had a 5-point Likert scale, it also included a sixth, 'not applicable', option. As the questions cover a wide range of IT and organisational related questions, there is always the chance that either the respondent could not answer the question or the question did not apply to the organisation. The 'not applicable' option was therefore added to each question to minimise the risk of obtaining inaccurate responses from participants (Barua et al. 2004). The 'not applicable' answer can also be considered as an indicator of either an irrelevant question or a respondent who did not belong to the sample frame. This kind of missing data is called 'user-missing' data, because respondents deliberately opt for the 'not applicable' option. Hence, data cleaning was performed separately for 'user-missing' data ('not applicable' answers) and 'system-missing' data.

### *Missing value analysis for 'user-missing' data*

The **second step** involves the identification and deletion of 'user-missing' data. Altogether 149 out of 12,366 data points (1.2%) were identified as 'user-missing' data. Although the literature argues for the necessity of treating missing data, there appears to be neither clear criteria nor a well established norm on how to do so. Some proposed remedies include deletion of all 'user-missing' cases (list wise deletion), pair wise deletion or imputation using known strategies (Hair et al. 2006; Lewis-Beck, Bryman & Liao 2004). Therefore, to determine the most appropriate methods to handle 'user-missing' data, an email was sent to well known IT researchers asking for their advice on this issue. Five answers were received (see Appendix J). While the researchers varied in their proposed remedies for treating 'user-missing' data, most of them agreed on the necessity of treating 'system-missing' and 'user-missing' data separately.

Based on the recommendations in the literature (Hair et al. 2006), the advice of experts and reinvestigating the meaning of the 'not applicable' option in the questionnaire, the following strategy for treatment of user-missing data was followed. High percentages of 'not applicable' responses per case identify participants who did not fit the desired characteristics of the sample and were the result of error of inclusion in the sample frame. High percentages of 'not applicable' responses in items identify questions which were either irrelevant or which the users could not answer. Therefore, a decision was made to delete all cases and items with more than 5% 'user-missing' data. The threshold of 5% was set after examining the data, revisiting the questions with 'user-missing' data and referring to proposed thresholds in the literature (Tabachnick & Fidell 2007). This led to the deletion of 15 cases and four items. The deleted items are displayed in Table 6.2 below.

**Table 6-2: Deleted Items Due to 'User-Missing' Data**

| Construct | ID | Item | % 'NA' |
|---|---|---|---|
| IT personnel capability | 2B | Our IT personnel are skilled in multiple programming languages | 9.7% |
| IT support for operational competence | 6D | Our IT supports our product development | 8.7% |
| Adaptive IT capability | 8C | Our IT is able to develop new products and services | 8.2% |
| | 9C | Our IT is able to adapt quickly to changes in product development | 7.2% |

After completing the above process, the remaining data contained no case or item with more than 5% 'user-missing' data. The next issue was how to treat items that had 0-5% 'user-missing' data. The amount of non-applicable answers to these Items was below 5%, but there were respondents who found the item not applicable. Deleting these items/cases as well might cause a biased result. The 95% of correct answers would have been lost. Therefore, items and cases with 0-5% 'user-missing' data in the dataset were not deleted.

To ensure that this method did not cause any bias, a cross-check was conducted at the end of the instrument validation process. The purpose of the cross-check was to verify that the deleted items were not applicable for the analysis and would have failed the instrument validation process regardless. Therefore, at the completion of the instrument validation process, the process was repeated with different versions of 'user-missing' data handling. The result was that the above chosen option produced the best valid instrument. All the items displayed in Table 6.2 would have failed the instrument validation process anyhow.

### *Missing value analysis for 'system-missing' data*

After the data were cleaned of items and cases with more than 5% 'user-missing' data, 'system-missing' data were considered for treatment. Following Hair et al.'s (2006) suggested process, the amount of 'system-missing' data was identified. Out of 12,366 data points (2.2%), 273 were 'system-missing' data. Since no firm guideline exists for an appropriate level of exclusion, Hair et al.'s (2006) rule of thumb to delete cases above 10% and variables above 15% missing values was followed. Checking the data, no case or variable was within this margin, therefore no case or item deletion was conducted.

The **third step** in dealing with missing data is to diagnose the randomness of the missing data process. There are two kinds of randomness in missing data: missing completely at random (MCAR) and 'missing at random' (MAR) (Hair et al, 2006). Data that is 'system-missing' without any discernible pattern are called 'missing completely at random' (Hair et al. 2006). Data that are MCAR are not subject to any underlying process that determines that the data are missing and, therefore, the 'system-missing' data do not lend to bias in the observed variable (Allison 2002). Data that are missing randomly within subgroups, but which manifest differences between the subgroups of missing data, are called 'missing at random' (MAR) (Hair et al. 2006). The subgroups with 'system-missing' data and without 'system-missing' data can be identified (Allison 2002). To diagnose the level of randomness in the 'system-missing' data process, the data were split into two samples—one containing no 'system-missing' data at all, and the other containing 'system-missing' data. To find out if significant difference between the datasets existed, the construct means of these two sub samples were compared using an independent sample t-test (Tabachnick & Fidell 2007). The t-test results are displayed in Table 6.3 below.

**Table 6-3: Independent Sample t-test for 'System-Missing' Data**

| Construct | t | p | Mean Difference | Std. Error Difference |
|---|---|---|---|---|
| Mean IT capability | -0.25 | 0.80 | -0.02 | 0.07 |
| Mean IT support for core competence | -1.35 | 0.18 | -0.12 | 0.09 |
| Mean adaptive IT capability | -1.26 | 0.21 | -0.14 | 0.11 |
| Mean competitive advantage | -2.32 | 0.02 | -0.30 | 0.13 |

The results presented in Table 6.3 above illustrate that there is no significant difference between the missing data for the IT capability, IT support for core competence and adaptive IT capability constructs. Nevertheless, there exists a significant difference between the two sub samples for the competitive advantage construct. Hence, the pattern of missing data was identified as not MCAR.

The **final step** was to identify a remedy for dealing with the missing data. Possible remedies depend on the classification of the data into MAR or MCAR. There are many possible remedies for MCAR data, such as case/list wise deletion, pair wise deletion and several imputation methods (Case substitution, Hot and Cold Desk Imputation, Mean substitution and Regression-based approaches) (Hair et al. 2006; Lewis-Beck, Bryman & Liao 2004). These remedies cannot be used for MAR and the non-random missing data pattern, because any deletion and substitution with the above mentioned imputation methods can create bias in the data (Hair et al. 2006).

The 'system-missing' data of this research were identified as not MCAR. Therefore, only MAR and non-random techniques could be applied as a remedy for the missing data issue within this study. The literature suggests the modelling-based imputation approach (EM imputation) as the best representation of original distribution of values with least bias, as other methods produce bias in the data (Allison 2002; Hair et al. 2006; Tabachnick & Fidell 2007). SPSS 16 was used for the EM imputation of the 'system-missing' data. SPSS 16 produced a new data sheet with the imputed missing values, which was then used for further analysis.

### 6.2.3. Test for normality

Normality is a term used to indicate that the data are normally distributed. Normal distributions take the form of a bell-shaped curve. The standard normal distribution is one with a mean of 0 and a standard deviation of 1. It is a benchmark distribution for many statistical assumptions (Groebner & Shannon 1990; Lewis-Beck, Bryman & Liao 2004). Normality is a key assumption of multivariate data analysis (Hair et al. 2006). Hence, it will be tested in the following section.

Kurtosis, skewness and their standard errors are common descriptive statistics that measure the shape of the distribution. Skewness refers to the skew of a distribution (Groebner & Shannon 1990). A skew is the tilt (or lack of it) in a distribution. There are two types of skewness: negative (right) skew and positive (left) skew. Negative (right) skew exists if the tail points to the right, and is the more common type. Less common is left skew, where the tail points to the left. Kurtosis refers to the peakiness of a distribution and measures the relationship between a distribution's tails and its most numerous values. A positive kurtosis indicates a higher peak than the normal distribution; a negative kurtosis indicates a flatter distribution than the normal distribution (Everitt 2006). Even though kurtosis can lead to an underestimation of variance, with bigger samples (200+) this risk is reduced (Tabachnick & Fidell 2007). A commonly used rule-of-thumb test for normality is to run descriptive statistics to obtain skewness and kurtosis. The results are then divided by the standard errors. Skewness and kurtosis should be within the +2 to -2 range when the data are normally distributed (Lewis-Beck, Bryman & Liao 2004). A few authors use the more lenient +3 to -3 for kurtosis (Hair et al. 2006). The results of the normality test are displayed in Table 6.4 below.

**Table 6-4: Results of Normal Distribution Test**

| Item | Mean | Std. Dev. | Skew. | Kurt. | | Item | Mean | Std. Dev. | Skew. | Kurt. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1B | 3.72 | 0.93 | -0.39 | -0.48 | | 4D | 3.75 | 0.84 | -0.59 | -0.10 |
| 1C | 3.62 | 0.87 | -0.65 | 0.10 | | 4E | 4.12 | 0.66 | -0.65 | 1.21 |
| 1D | 3.24 | 1.11 | -0.15 | -1.01 | | 5A | 3.30 | 0.87 | -0.37 | -0.10 |
| 1E | 2.88 | 1.09 | 0.20 | -0.83 | | 5B | 3.06 | 0.90 | -0.04 | -0.65 |
| 1G | 3.10 | 1.11 | -0.25 | -1.01 | | 5C | 3.56 | 0.94 | -0.51 | -0.46 |
| 1H | 3.19 | 1.00 | -0.28 | -0.79 | | 5D | 3.71 | 0.99 | -0.68 | 0.08 |
| 1I | 3.26 | 0.93 | -0.24 | -0.80 | | 6A | 4.00 | 0.77 | -0.67 | 0.48 |
| 2A | 3.51 | 0.98 | -0.53 | -0.69 | | 6B | 4.10 | 0.69 | -0.88 | 2.38 |
| 2C | 3.60 | 0.86 | -0.54 | -0.18 | | 6C | 3.90 | 0.77 | -0.34 | -0.22 |
| 2D | 4.06 | 0.72 | -0.74 | 0.97 | | 5E | 3.86 | 0.80 | -0.60 | 0.15 |
| 2E | 3.87 | 0.78 | -0.41 | -0.08 | | 6F | 3.87 | 0.81 | -0.42 | -0.21 |
| 2F | 3.93 | 0.73 | -0.44 | 0.22 | | 8A | 3.39 | 0.92 | -0.50 | -0.24 |
| 3A | 4.06 | 0.74 | -0.70 | 1.15 | | 8B | 3.50 | 0.88 | -0.54 | -0.26 |
| 3B | 3.95 | 0.73 | -0.77 | 1.03 | | 8D | 3.45 | 0.88 | -0.42 | -0.40 |
| 3C | 3.58 | 1.03 | -0.35 | -0.72 | | 8E | 3.50 | 0.90 | -0.38 | -0.41 |
| 4E | 3.74 | 0.98 | -0.42 | -0.53 | | 9A | 3.53 | 0.91 | -0.58 | -0.16 |
| 3F | 3.72 | 1.07 | -0.57 | -0.50 | | 9B | 3.41 | 0.94 | -0.31 | -0.54 |
| 3G | 3.84 | 0.84 | -0.47 | -0.21 | | 9D | 3.48 | 0.87 | -0.40 | -0.27 |
| 3H | 3.88 | 0.85 | -0.69 | 0.54 | | 9E | 3.61 | 0.79 | -0.49 | 0.11 |
| 3I | 3.82 | 0.86 | -0.64 | 0.39 | | 11A | 3.54 | 0.91 | -0.13 | -0.41 |
| 4A | 3.77 | 0.79 | -0.54 | 0.39 | | 11B | 3.54 | 0.90 | -0.14 | -0.35 |
| 4B | 3.66 | 0.80 | -0.55 | -0.07 | | 11C | 3.49 | 0.91 | -0.09 | -0.38 |
| 4C | 3.53 | 0.91 | -0.32 | -0.56 | | | | | | |

Table 6.4 demonstrates that all values for the items fall within the range of the rigorous level of -1 to +1 for skewness. All but one item meet the proposed level of -2 to +2 for kurtosis (Lewis-Beck, Bryman & Liao 2004). Only one item (6B) 'Our IT is improving our operational efficiency' (kurtosis = 2.38) is outside of the -2 to +2 range for kurtosis. Nevertheless, it meets the more lenient -3 to +3 range for kurtosis (Hair et al. 2006). Furthermore, the underestimation of variance with positive kurtosis diminishes with large sample sizes (100+) (Tabachnick & Fidell 2007). Therefore, all variables can be considered to be normally distributed.

### 6.2.4. Outliers and Multicollinearity

Outliers exist on a univariate and multivariate level. Univariate outliers can be identified visually by looking at histograms, Q-Q plots, steam-leaf diagrams or by using the SPSS outlier report, which is probably the easiest and most reliable method. As the range of values in most questions was on a 5-point Likert scale, the values ranged from 1 to 5. Hence, univariate outlier identification did not make much sense. In contrast, multivariate outlier identification seemed more useful. Multivariate outlier detection with Mahalonbis distance was conducted (Tabachnick & Fidell 2007), which calculated the M2/df (Mahalonbis distance divided by degrees of freedom) for each construct separately (Hair et al. 2006). There does not appear to be a strict recommendation for a threshold. However, (Hair et al. 2006) propose an M2/df threshold of between 2.5 and 4.0 as the limit. The M2/df threshold depends on sample size, with larger samples allowing a larger value (Hair et al. 2006). Furthermore, it appears that researchers use their own discretion to determine which cases to regard as multivariate outliers and which to regard as correct variance. However, the decision has to be taken in context depending on each variable and case (Hair et al. 2006). Choosing a low threshold could lead to the deletion of too many cases, and hence could cause bias or data wastage. Too high a threshold, on the other hand, could mean that multivariate outliers are not identified, thus biasing the results as well. We decided to choose 3.5 to be the threshold for the 214 cases. This threshold resulted in 15 detected multivariate outliers. Every case identified as a multivariate outlier was scrutinised. In some cases the respondents of the outliers' cases used the comment box to explain why their response might differ from the mean. These comments provided helpful insights and, as a result, 11 cases were identified as true outliers and deleted. This reduced the data to 203 cases.

Multicollinearity exists if two or more independent variables measure the same thing. Even though items from the same construct are supposed to be correlated, as they intend to measure the same underlying construct, a correlation higher than 0.90 between any item can cause statistical problems (Tabachnick & Fidell 2007, p. 82). To assess Multicollinearity item–item correlations were calculated between all items (Tabachnick & Fidell 2007, p. 82) ( see Appendix K). No Multicollinearity item was identified.

### 6.2.5. Estimating non-response bias

The research design is based on the assumption that it is possible to generalise from the sample to the population. As with most survey data, there is always a degree of non-response, as not all addressed participants return the questionnaire. Non-response may cause sample bias and problems of generalisation of research findings to the population. One method for analysing non-response bias is according to date of reply. This can be done by sending a follow-up letter to the sample and comparing responses from the first wave to those from the second wave (Collis et al. 2003). Participants who respond later to the questionnaire are assumed to have similar characteristics to non-respondents. Comparing the characteristics of early respondents to those of late respondents will identify a non-response bias (Collis et al. 2003; Lewis-Beck, Bryman & Liao 2004).

There is no accepted norm regarding the characteristics that can be used to compare early with late respondents. However, the literature suggests that respondents who are more interested in the survey respond earlier than others, hence leading to non-response bias based on differences in interest (Lewis-Beck, Bryman & Liao 2004). Thus, variables which might affect willingness and interest to participate in this survey were identified. Since this research examines the impact of IT capabilities and IT support for core competences on adaptive IT capabilities and their impact on competitive advantage, companies with higher levels of IT capability, IT support for core competence or adaptive IT capability might be expected to be more interested in participating in the survey than companies with lower levels. Therefore, several variables which could lead to an interest bias within the sample population were identified. Firstly, respondents who had a higher IT capability might be more likely to respond, in so far as they might be proud of their capability and might want to see if it impacts on other factors such as IT support for core competence and adaptive IT capability. Secondly, CIOs/CEOs from firms with higher levels of IT support for core competence might be more willing to participate than others. Finally, respondents from firms that had identified the importance of adaptive IT capabilities might be more willing to respond, thus biasing the result. In sum, the variables selected to estimate the non-response bias were:

- Average mean of IT capability
- Average mean of IT support for core competence
- Average mean of adaptive IT capability
- Average mean of competitive advantage

The sample was split into two sub samples. The first sub sample contains the first 30 (circa 15%) responses; the second sub sample contains the last 30 responses (circa 15%) from the survey. The statistical test to compare the sub samples was a two-samples independent t-test at a 5% significance level. The results of the independent samples t-test are displayed in Table 6.5 below.

**Table 6-5: Independent Sample t-test for Non-Response Bias**

| Independent sample t-test for non-response bias | | | | |
|---|---|---|---|---|
| **Construct** | **t** | **p** | **Mean Difference** | **Std. Error Difference** |
| Mean IT capability | 0.39 | 0.70 | 0.05 | 0.13 |
| Mean IT competence | 1.11 | 0.27 | 0.17 | 0.15 |
| Mean adaptive IT capability | 1.11 | 0.27 | 0.23 | 0.21 |
| Mean competitive advantage | 1.37 | 0.18 | 0.30 | 0.22 |

The results of the independent sample t-test to check for non-response bias depicted in Table 6.5 above reveal no significant difference between the first and second wave of responses at a 95% confidence interval for the chosen characteristics. Therefore, even if there is a non-response bias, it is not significant enough to bias the data or deter generalisation from the sample to the population.

Furthermore, the data was examined for common method bias. Common method bias may occur from data that is collected only via one method or only at one point of time (Straub, Boudreau & Gefan 2004). This data could share variance that is not due to the related research model or any other casual relationship, but simple related to the method of data collection. Several methods are proposed to test for common method bias in the literature. The most widely used one is Harman's single factor test (Podasakoff et al. 2003). This method examines the unrotated factor solution of an exploratory factor analysis. The underlying logic is that common method bias can be detected if either a) one factor accounts for the majority of the covariance between the measures or b) a single factor will emerge from the factor analysis (Aulakh & Gencturk 2000; Greene & Organ 1973; Podasakoff et al. 2003). An exploratory factor analysis was conducted to examine the possibility of common method bias of the research (see Table 7.5). The test found no significant bias in the data set that were due to survey methodology

## 6.3. PROFILE OF RESPONDENTS

The following section discusses the demographic attributes of the organisations that participated in this study. The sampling frame for this study consists of CEOs/CIOs from medium-sized and large Australian organisations across all industries. Large Australian organisations are defined in this study as those with more than 200 employees; medium-sized Australian organisations are those with fewer than 200 employees. The concepts of IT capabilities, IT support for core competences and adaptive IT capabilities are expected to be similar across all industries. Hence, all industries excepting government and defence were included in the sampling frame. The industry and size profiles of the organisations that participated in this study are displayed in Table 6.6 below.

**Table 6-6: Industry and Size Profiles of Survey Respondents**

| | Company size | | | | Company size | | |
|---|---|---|---|---|---|---|---|
| **Industry** | **Large** | **Medium** | **Total** | **Industry** | **Large** | **Medium** | **Total** |
| Communication | 8 | 1 | 9 | Hospitality | 3 | 2 | 5 |
| Construction | 6 | 1 | 7 | Logistic | 10 | 1 | 11 |
| Education | 10 | | 10 | Manufacturing | 36 | 6 | 42 |
| Electricity, Gas, Water | 9 | 2 | 11 | Other/ not specified | 28 | 7 | 35 |
| Financial services | 16 | 5 | 21 | Property | 8 | 1 | 9 |
| Health services | 14 | 6 | 20 | Trade | 12 | 11 | 23 |
| | | | | Total | 160 | 43 | 203 |

From the 203 organisations that replied to the survey and passed the data cleaning, 160 were large organisations, and 43 medium-sized ones (see Table 6.6 above). Furthermore, Table 6.6 illustrates that the respondents came from all industries. The biggest group came from the manufacturing segment (42 out of 203 respondents), followed by trade (23 out of 203 respondents), financial (21 out of 203), health services (20 out of 203), electricity, gas and water (11 out of 203), logistics (11 out of 203), education (10 out of 203), communication and property (9 out of 203), construction (7 out of 203), and hospitality (5 out of 203). Out of 203 respondents, 35 either did not fit into the industry classification scheme or did not answer the question.

The primary focus of the sample selection was on the CIO of an organisation; CEOs were included only when a CIO contact address was not available. In the latter case, it was assumed that CEOs were equally well informed about the state of the IT-enabled dynamic capabilities and competitive advantage as the CIOs. Figure 6-1 displays the breakdown by position of the respondents.

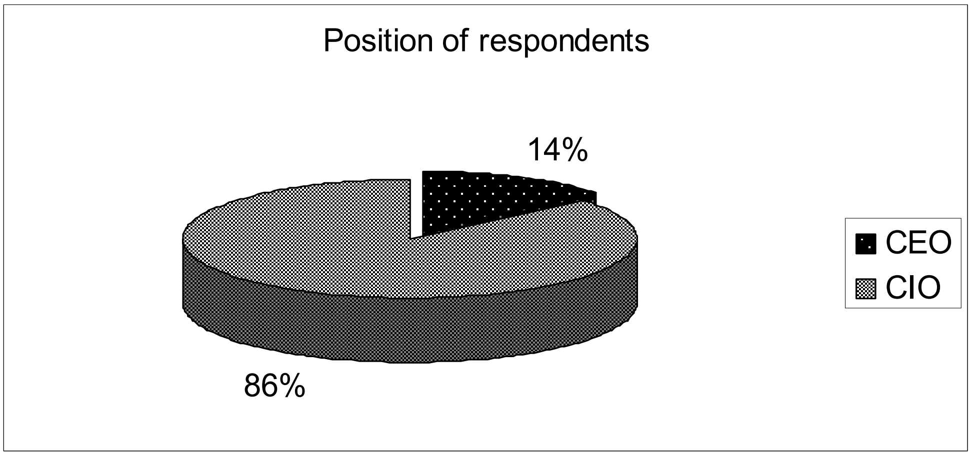


**Figure 6-1: Job Profile of Respondents**

Of the 203 respondents, 86% hold the position of CIO and 14 the position of CEO (see Figure 6-1).

## 6.4. SUMMARY

The purpose of this chapter was to examine the data obtained from the online survey and to prepare this data for further analysis. As the objective of the further data analysis was to employ both univariate and multivariate statistics, the data were examined for several characteristics. Table 6.7 below illustrates this procedure and the steps taken.

**Table 6-7: Summary of Data Preparation**

| Summary of data examination and preparation | | | | | | |
|---|---|---|---|---|---|---|
| See | Problems encountered | Action | Results | Deletions | | Total cases |
| | | | | Case | Item | |
| 6.1.2 | Data from online survey has an invalid format for statistical programs | Data recoding | Data can be imported into statistical programs | | | 250 |
| | Data contained invalid responses | Data screening | Deleting invalid responses | 21 | | 229 |
| 6.1.3 | Data was missing | Analysis of "user-missing" data | Deleting "user missing" data > 5% | 15 | 4 | 214 |
| | | Identifying pattern of "system missing" data | "system missing" data is MAR or non random missing | | | 214 |
| | | EM imputation for "system missing" data | Complete EM imputed data file | | | 214 |
| 6.1.4 | Distribution of Data unclear | Normality test | Data can be considered normal distributed | | | 214 |
| 6.1.5 | Possibility of Outliers | Outlier identification | 15 multivariate outliers detected, comments identified 11 cases as outliers | 11 | | 203 |
| | Possibility of Multicollinearity | Multicollinearity check | No Multicollinearity detected | | | 203 |
| 6.1.6 | Possibility of Non-response bias | Non-response bias test | Generalization from the sample to the population is possible | | | 203 |

In step one, the data were recoded so that they could be imported into statistical packages, where they were screened and 21 invalid responses deleted in step two. The missing data analysis of ‘user-missing’ data in step three led to the deletion of 15 cases and four items. The remaining 214 items were scanned for ‘system-missing’ data in step four, and imputation methods in step five ensured a complete dataset. In step six the normality assumptions were tested and normally distributed data confirmed. The Multicollinearity check in step seven did not find any Multicollinearity items. To eliminate outliers, step eight identified and deleted 11 outliers. Finally, in step nine the non-response bias of the remaining 203 cases was tested negatively and, as a result, generalisation from the sample to the population was deemed to be possible. Finally, the profile of the respondents was presented in section 6.3.

In summary, the section above examined and prepared the data obtained for further data analysis. From the 250 cases obtained, 47 were deleted and it was ensured that the remaining 203 cases reflected the desired sample selection (see Chapter 5), did not contain missing data, were normally distributed, free from outliers and Multicollinearity, and could be used to generalise from the sample to the population. These data are used for further multivariate analysis.

# Chapter 7

# INSTRUMENT VALIDATION AND MEASUREMENT MODEL

## 7.1. INTRODUCTION

The extent to which the collected data are an accurate representation of the theorised latent constructs is often characterised as the rigour of the research design (Straub, Boudreau & Gefan 2004). Correct measurement of the theorised constructs is a vital part of scientific research. However, measurement error as the most common error in scientific research is almost unavoidable. In IT research, as with all social research disciplines, it is difficult to locate the truth; yet by following a rigorous research process the error of measurement can be reduced to an acceptable level. Therefore, appropriate methods to minimise the measurement error need to be adopted. In order to follow a rigorous research process, the validation of the research instrument is important. While there is a long history within the philosophy of science, validation of positivistic research instruments to understand the basic principles of the scientific method for discovering truth is mainly a late 20th century interest (Straub, Boudreau & Gefan 2004).

The following sections describe the pragmatic use of scientific methods to test the validity and reliability of the instrument and to ensure that the research adopts both intellectual soundness and good IT research practice. To achieve this goal, two seminal guidelines are followed, one on instrument validation in general (Churchill 1979) and the other on IT positivistic research validation in particular (Straub, Boudreau & Gefan 2004). Churchill's (1979) framework for measuring and constructing valid studies has been the basis for many instrument validation processes in IT research. For rigorous research, the instrument must be checked for reliability and validity (Churchill 1979; Straub, Boudreau & Gefan 2004). Reliability measures the extent to which the instrument is reliable in measuring the same results on repeated occasions. Validity checks if the instrument is measuring what it is supposed to measure (De Vaus 2001). In order to produce a valid and reliable research instrument, recommendations from the research literature (Churchill 1979; Straub, Boudreau & Gefan 2004) were followed. Assessments of content, construct, convergent and discriminant validity as well as of internal consistency reliability were conducted. Further validity of the instrument was assessed through exploratory and confirmatory factor analysis.

## 7.2. CONTENT VALIDITY

Content validity is concerned with the question of whether the instrumentation includes a sufficiently representative number of items to ensure that all ways to measure the content of a construct are covered (Kumar 2005; Sarantakos 2005; Straub, Boudreau & Gefan 2004). This can be achieved through literature reviews and drawing from existing, validated and accepted instruments. Interviews with experts are another way to support content validity. Content, or as it is sometimes called, face validity exists if the items look 'right' and the sample is appropriate (Churchill 1979). The literature review in Chapter 3 discussed previous research that had contributed to our knowledge of IT, dynamic capabilities and competitive advantage. Drawing from this theoretical background, a research model which investigates the impact of IT resources, IT capabilities, IT support for core competences and adaptive IT capabilities on a firm's desire to achieve competitive advantage was developed in Chapter 4. The item development process in Chapter 5 (see also Appendix B) delineated how items were either pulled from existing frameworks discussed in the literature, generated based on the theorised research model, or produced through a panel of experts survey. The above process ensures that the instrument developed for this study has sufficient content validity.

## 7.3. MEASURE PURIFICATION

An important assumption in positivistic research is that the research instrument contains constructs which consist of items that have an equal amount of common core and ensure an operationalisation that minimizes the systematic error (Churchill 1979). A clearly defined item development process (see section 5.3) must ensure that the content validity has provided a pool of items that theoretically should operationalise the constructs. Recommended instrument validation procedures, however, call for purification of the measure before moving on to assessing construct validity through factor analysis methods (Churchill 1979; Straub, Boudreau & Gefan 2004). Purifying the instrument increases the reliability of the research instrument and ensures that so-called 'garbage items'—items that do not have the same core and do not measure the same thing, and therefore would produce additional dimensions in factor analysis—are deleted (Churchill 1979). This increases the accuracy of measurement while also ensuring that the construct measures the same thing, even though different participants were surveyed (Straub, Boudreau &

Gefan 2004). To purify the measurement, the measurement error was assessed through reliability analysis.

Assessing the measurement errors within constructs is called reliability analysis (Kumar 2005). From a broader philosophical viewpoint, reliability is concerned with finding measures that reflect the 'true scores' that express the phenomenon of interest (Straub, Boudreau & Gefan 2004). Reliability is independent for every construct and, therefore, has to be calculated differently for each construct. Of the six different techniques (split-half, test-retest, alternative forms, inter-rater, unidimensional, and internal consistency) that can be used to assess reliability (Straub, Boudreau & Gefan 2004), internal consistency reliability analysis was adopted in this research (see Appendix L for a discussion of alternate reliability assessments). This choice was made because internal consistency reliability assesses whether the instrument itself is consistent, that is, if respondents answer consistently across all items of a construct (Neuman 2006). The recommended and most commonly used statistic to assess internal consistency reliability are item-scale correlations and the estimation of Cronbach's alpha (Churchill 1979).

According to Churchill (1979), Cronbach's alpha should be the first measure calculated to measure the quality of an instrument. Cronbach's alpha and item-to-total correlation (hereafter referred to as item-scale) have to be calculated for each construct separately. Low values of alpha indicate that the items capture the construct poorly (Churchill 1979). The value of alpha is also dependent on the number of items, with a greater number of items per construct yielding higher alphas (Churchill 1979). The literature varies in its definition of acceptable threshold levels for alphas. The threshold for this study was set at 0.75. The second measure to assess internal consistency reliability is item-scale correlations. Item-scale are sometimes referred to as item-to-total correlations and measure how each items correlate with the other items in their construct (Churchill 1979). Low correlation between items is an indicator that the items do not represent the same construct, and hence are producing measurement error and unreliability (Churchill 1979). Conversely, high values (>0.95) are suspect as they indicate the possibility that respondents have not responded objectively. This could be because items are grouped together and respondents remember the answers (Straub, Boudreau & Gefan 2004). Similar to the alpha value, the optimal threshold for item-scale values is a question of judgement. The item-scale for this item was set at 0.4, a threshold comparable to that used in studies in IT (Palvia (1996). Item-scales and Cronbach's alpha were calculated for each construct separately. Three items were deleted due to low item-scale values (see Table 7.1 below).

**Table 7-1: Item Deletion Due to Low Reliability**

| Construct | ID | Item | Item scale | Cronbach alpha after deletion |
|---|---|---|---|---|
| IT infrastructure capability | 1F | Our company makes extensive use of middleware to integrate key enterprise applications | 0.26 | 0.79 |
| IT personnel capability | 2C | Our IT personnel are skilled in multiple operating systems | 0.36 | 0.77 |
| IT management capability | 3B | Our IT management evaluates chances, opportunities and risks from emerging technologies | 0.39 | 0.79 |

Table 7.1 above displays the three items which had item-scale values of below 0.4. This clearly indicates that these items do not share a common core with the other items of their respective constructs and were therefore dropped. From the IT infrastructure capability construct the item '*Our company makes extensive use of middleware to integrate key enterprise applications'* had an item-scale of 0.26. This clearly indicated that this item did not have a common core with the other items of IT infrastructure capability. From the IT personnel capability construct, the item *'Our IT personnel are skilled in multiple operating systems*' shows an item-scale value of 0.36, which suggests that this item did not share a common core with the other items of IT personnel capability. The third item that had an item-scale value below the 0.4 threshold was '*Our IT management evaluates chances, opportunities and risks from emerging technologies'* out of the IT management capability construct.

After completing the above process, the research instrument was reduced to 38 items from seven constructs. Table 7.2 and Table 7.3 below illustrate the remaining items, their item-scale values and the Cronbach's alpha values of the constructs.

**Table 7-2: Final Item Reliability Score I**

| | Item | | Item-scale | Cronbach's alpha |
|---|---|---|---|---|
| IT infrastructure capability | 1IIFB | Our company has a high degree of system interconnectivity | 0.49 | 0.79 |
| | 1IIFC | Our system is sufficiently flexible to incorporate electronic links to external parties | 0.50 | |
| | 1IIFD | Data is available to everyone in the company in real time | 0.52 | |
| | 1IIFE | Our user interfaces provide transparent access to all platforms and applications | 0.50 | |
| | 1IIFG | Legacy systems within our firm do NOT hamper the development of new IT applications | 0.48 | |
| | 1IIFH | Functionality can be quickly added to critical applications | 0.60 | |
| | 1IIFI | Our company can easily handle variations in data formats and standards | 0.52 | |
| IT personnel capability | 2HRFA | Our IT personnel are cross-trained to support other IT services outside their domain | 0.49 | 0.77 |
| | 2HRFD | Our IT personnel are knowledgeable about our IT products | 0.55 | |
| | 2HRFE | Our IT personnel are knowledgeable about the key success factors in our organisation | 0.62 | |
| | 2HRFF | Our IT personnel understand the business environments they support | 0.60 | |
| IT management capability | 3SMCA | Our IT management is up to date with business developments | 0.47 | 0.79 |
| | 3SMCG | IT management contributes to our business strategy | 0.48 | |
| | 3SMCI | We manage IT strategically | 0.56 | |
| | 4OMCA | There is a high degree of trust between our IT department and business units | 0.41 | |
| | 4OMCB | Critical information and knowledge that affect IT projects are shared freely between business units and the IS department | 0.62 | |
| | 4OMCC | Our IT department and business units understand the working environments of each other | 0.49 | |
| | 4OMCD | The goals and plans for IT projects are jointly developed by both the IT department and the business units | 0.56 | |
| IT support for market competence | 5SMCA | Our IT supports identifying market segments | 0.57 | 0.76 |
| | 5SMCB | Our IT is utilised to redefine the scope of our business | 0.64 | |
| | 5SMCC | Our IT supports analysing customer needs (i.e. products, preferences, pricing and quality) | 0.57 | |
| | 5SMCD | Our IT is utilised to produce our products/services | 0.43 | |
| IT support for operational competence | 6SOCA | Our IT supports our strategic business processes | 0.65 | 0.85 |
| | 6SOCB | Our IT is improving our operational efficiency | 0.74 | |
| | 6SOCC | Our IT supports our innovation processes | 0.63 | |
| | 6SOCE | Our IT supports knowledge-sharing in the company | 0.66 | |
| | 6SOCF | Our IT supports cross-functional integration in our firm | 0.64 | |

**Table 7-3: Final Reliability score II**

| | | | | |
|---|---|---|---|---|
| Adaptive IT capability | 8AMAA | Our IT is able to adapt quickly to changes in the market and customer demands | 0.82 | 0.94 |
| | 8AMAB | Our IT is able to adapt quickly to changes in the firm's products or services | 0.82 | |
| | 8AMAD | Our IT is able to adapt quickly to changes which can become necessary because of competitors' actions | 0.78 | |
| | 8AMAE | Our IT is utilised to increase the speed of responding to business opportunities/threats | 0.76 | |
| | 9AOAA | Our IT is able to adapt quickly to changes in business processes and organisational structures | 0.81 | |
| | 9AOAB | Our IT is able to adapt quickly to changes in knowledge-sharing in the company | 0.73 | |
| | 9AOAD | Our IT is able to adapt quickly to changes in the cross-functional integration of our firm | 0.72 | |
| | 9AOAE | Our IT is able to enhance strategic business process flexibility | 0.79 | |
| Competitive advantage | 11CAA | Over the past three years, our financial performance has exceeded our competitors | 0.89 | 0.93 |
| | 11CAB | Over the past three years, we have been more profitable than our competitors | 0.91 | |
| | 11CAC | Over the past three years, our sales growth has exceeded our competitors | 0.78 | |

## 7.4. Assessing Construct Validity through Exploratory Factor Analysis

After ensuring the content validity and reliability of the research instrument in the previous section, this section is concerned with assessing the construct validity of the research instrument. The reason why reliability was assessed first is that reliability is necessary for construct validity, but not vice versa (Straub, Boudreau & Gefan 2004). Whereas reliability is concerned with assessing the degree of reliability of the construct, construct validity examines whether the construct actually measures what it is intended to measure (Sarantakos 2005). A research instrument has construct validity if the items that are considered together actually 'fit' together and capture the essence of a construct and are different from other constructs (Straub, Boudreau & Gefan 2004).

Straub et al. (2004) present six different validity components to assess construct validity: convergent, discriminant, factorial, nomological, predictive, and common method bias/method halo. Convergent validity exists if items of the same construct converge and show high correlations to each other. Discriminant validity measures whether a construct differs sufficiently from another construct (Lewis-Beck, Bryman & Liao 2004). In contrast to convergent validity, which is a measurement within constructs, discriminant validity is concerned with measurement between constructs. Factorial validity is the favoured concept in IT research (Straub, Boudreau & Gefan 2004) and can assess both convergent and discriminant validity (Lewis-Beck, Bryman & Liao 2004). Possible techniques for measuring factorial validity are either MTMM (Multi-Trait Multi-Method Matrix) or factor analysis. MTMM seems to be the preferred technique within the field when more than one research method is used, whereas factor analysis appears to be the more commonly used technique when a single method is employed (Straub, Boudreau & Gefan 2004). Since this research has only used one research method, the common practice was followed and factor analysis techniques were thus used to assess factorial validity.

### 7.4.1. Overview of factor analysis

To examine the underlying structure among the items of the measurement model, an interdependence technique called factor analysis[6] was employed (Hair et al. 2006; Lewis-Beck, Bryman & Liao 2004). In contrast to dependence techniques, which seek to predict a relationship between the independent and the dependent variable, interdependence techniques seek to identify structures, and therefore consider all variables, dependent and independent, simultaneously (Hair et al. 2006). Hence, factor analysis does not assume any structure or dependence relationship among variables. It is used to reduce the number of theorised items to a smaller number of factors for modelling purposes.

Two main approaches exist for creating and testing the measurement model: exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). EFA takes an exploratory approach and seeks to discover model structures among items without considering theorised models, and should be used to empirically derive the initial set of factors for the construct (Lewis, Templeton & Byrd 2005). The exploratory approach is especially useful if the relationship between the observed and latent variables is not directly apparent, due to introduction of new research models, or applying research models in different environments (Byrne 2001; Hair et al. 2006). In contrast, CFA assumes that the research is built on previously theorised items. CFA is used to determine whether the measured items confirm the expected loadings on factors based on pre-established theory (Byrne 2001). This study uses a mixture of pre-established research constructs and new or adapted constructs in order to answer the research questions. Hence, examination of the measurement model in the following section begins with the exploratory approach of EFA to identify the structure of the measurement model. In the subsequent sections 7.5–7.9,

[6] Factor analysis is the statistic used to determine if any of the independent variables comprise common underlying dimensions called ‘factors’.

CFA is conducted and fit statistics presented to confirm this measurement model.

### 7.4.2. Exploratory factor analysis

Exploratory factor analysis is applied for two interrelated purposes. The first is to identify the structure of the measurement model and to summarise the items into variables (Kline 2005). To correctly identify the underlying structure of the items, the items are examined to determine whether they are correlated with each other, but are relatively independent of other sets of data (Lewis-Beck, Bryman & Liao 2004). Then, the contribution of each item to the factor, called factor loading, is identified. The second aims to make the data more parsimonious for subsequent multivariate analysis by reducing the number of items into a smaller number of parsimonious items (Hair et al. 2006; Lewis-Beck, Bryman & Liao 2004).

Prior to proceeding with EFA, the main assumptions of factor analysis (conceptual and statistical) were assessed. It is vital that the conceptual assumption is met, because even if factor analysis detects interrelations between items, the assumption stipulates that the observed patterns must be conceptually valid and appropriate to the use of factor analysis (Hair et al. 2006). The items in this study were theorised from a conceptual model which had been developed through a methodologically sound process. Hence, the conceptual assumption of factor analysis was met. The statistical assumption of factor analysis includes normality, which was tested during data cleaning (see section 6.2) and the assumption that some underlying structure exists between the items (Hair et al. 2006). To determine the appropriateness of factor analysis for the data, the intercorrelations of the entire correlation matrix were examined using the Bartlett's Test of Sphericity (Hair et al. 2006) and the Kaiser-Meyer-Olkin (KMO) test as proposed by Lewis at al. (2005). The Kaiser-Meyer-Olkin test measures the sampling adequacy, which should be greater than 0.5 for a satisfactory factor analysis to proceed. The statistical Bartlett's Test of Sphericity should be below the 0.05 significance level to indicate that sufficient correlations exist among the items (Hair et al. 2006).

Table 7.4 below illustrates that the KMO test yields an acceptable score of 0.8, and that the significance level of the Bartlett's Test (0.00) indicates that the overall intercorrelations assumptions are met.

**Table 7-4: KMO and Bartlett's Test**

| KMO and Bartlett's Test | | |
|---|---|---|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy | | 0.91 |
| Bartlett's Test of Sphericity | Approx. Chi-Square | 4842.16 |
| | df | 703.00 |
| | p | 0.00 |

The next step involved selection of the factor extraction. The main decision to be made was the choice between principal component analysis (PCA) and common factor analysis (FA). The latter is primarily used to identify factors and dimensions, whereas PCA is mainly used to summarise the items into a minimal number of factors for predictive purposes (data reduction) (Tabachnick & Fidell 2007). According to Hair (2006), both methods display similar results in empirical research. PCA was used in this research, because it is the most commonly used factor extraction method in IT research.

The next decision was to choose between two criteria for abort factoring. Either the number of factors to extract can be specified a priori, or an Eigen value threshold can be set (Tabachnick & Fidell 2007). Since only factors with an Eigen value of greater than 1.0 are considered significant (Hair et al. 2006), the Eigen value was set at a cut-off point of 1.0. Next, the optimal factor rotation method had to be identified (Tabachnick & Fidell 2007). Two main types of rotation methods are available—the oblique rotation methods and the orthogonal rotation methods. The latter are the most widely used and are the preferred mode when the goal of factor analysis is data reduction (Hair et al. 2006). No specific rule was found as a guideline to indicate the most appropriate orthogonal rotation for this research. Nevertheless, Varimax, an orthogonal method, is commonly used and thus was the one chosen for this study. To assess the essential factor loading required to be deemed significant, the sample size must be considered. Smaller samples require higher factor loadings to be considered significant, whereas larger sample sizes require smaller factor loadings. For the sample size of this study (203) a factor loading of 0.4 would be significant at a 95% confidence interval level (Hair et al. 2006).

In summary, in accordance with the literature and with common research practice, the following factor extraction rules were implemented:

- Principal component extraction
- Varimax rotation
- Threshold for factor extraction of Eigen value >1
- Items with cross-loadings (loadings on two or more factors) of > 0.4 were dropped
- Items with a factor loading of less than 0.4 on any factor were dropped

Exploratory factor analysis was conducted for all items of the research instrument together. The results of the initial results of the EFA are displayed in Table 7.5 below.

# Table 7-5: Initial Results of Explorative Factor Analysis

| Construct | Item | | Factors 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|
| IT infrastructure capability | 1IIFB | Our company has a high degree of system interconnectivity | | | | | | | 0.68 | |
| | 1IIFC | Our system are sufficiently flexible to incorporate electronic links to external parties | | | | | | | 0.76 | |
| | 1IIFD | Data is available to everyone in the company in real time | | | | | | | 0.61 | |
| | 1IIFE | Our user interfaces provide transparent access to all platforms and applications | | | | | | | 0.59 | |
| | 1IIFG | Legacy systems within our firm do NOT hamper the development of new IT- Applications | | | | | 0.65 | | | |
| | 1IIFH | Functionality can be quickly added to critical applications | | | | | 0.67 | | | |
| | 1IIFI | Our company can easily handle variations in data formats and standards | | | | | 0.73 | | | |
| IT personnel capability | 2HRFA | Our IT personnel are cross trained to support other IT services outside their domain | | | | | | 0.61 | | |
| | 2HRFD | Our IT personnel are knowledgeable about our IT products | | | | | | 0.73 | | |
| | 2HRFE | Our IT personnel are knowledgeable about the key success factors in our organisation | | | | | | 0.70 | | |
| | 2HRFF | Our IT personnel understand the business environments they support | | | | | | 0.74 | | |
| IT management capability | 3SMCA | Our IT management is up to date with the business development | | 0.51 | | | 0.43 | | | |
| | 3SMCG | IT Management contributes to our business strategy | | 0.70 | | | | | | |
| | 3SMCI | We manage IT strategically | | 0.70 | | | | | | |
| | 4OMCA | There is a high degree of trust between our IT department and business units | | | | | | | | 0.46 |
| | 4OMCB | Critical information and knowledge that affect IT projects are shared freely between business units and IS department | | | | | | | | 0.70 |
| | 4OMCC | Our IT department and business units understand the working environment of each other | | | | | | | | 0.74 |
| | 4OMCD | The goals and plans for IT projects are jointly developed by both the IT department and the business units | | | | | | | | 0.73 |
| IT support for market competence | 5SMCA | Our IT supports identifying market segments | | | | 0.66 | | | | |
| | 5SMCB | Our IT is utilized to Redefine the scope of our business | | 0.41 | | 0.68 | | | | |
| | 5SMCC | Our IT supports analysing customer needs (i.e. products, preferences, pricing and quality) | | | | 0.51 | | | | |
| | 5SMCD | Our IT is utilized to produce our products /services | | | | 0.57 | | | | |
| IT support for operational competence | 6SOCA | Our IT is supporting our strategic business processes | | 0.68 | | | | | | |
| | 6SOCB | Our IT is improving our operational efficiency | 0.42 | 0.59 | | | | | | |
| | 6SOCC | Our IT supports our innovation processes | | 0.54 | | | | | | |
| | 6SOCE | Our IT supports knowledge-sharing in the company | 0.59 | | | | | | | |
| | 6SOCF | Our IT supports cross-functional integration in our firm | 0.60 | 0.46 | | | | | | |
| Adaptive IT capability | 8AMAA | Our IT is able to adapt quickly to changes in the market and customer demands | 0.62 | | | | 0.43 | | | |
| | 8AMAB | Our IT is able to adapt quickly to changes in Firm's Products or Services | 0.63 | | | | 0.42 | | | |
| | 8AMAD | Our IT is able to adapt quickly to changes which can become necessary because of competitors actions | 0.56 | | | 0.45 | | | | |
| | 8AMAE | Our IT is utilized to increase the speed of responding to business opportunities/ threats | 0.56 | | | 0.42 | | | | |
| | 9AOAA | Our IT is able to adapt quickly to changes in Business Processes and Organisational structures | 0.73 | | | | | | | |
| | 9AOAB | Our IT is able to adapt quickly to changes in knowledge sharing in the company | 0.72 | | | | | | | |
| | 9AOAD | Our IT is able to adapt quickly to changes in the crossfunctional Integration of our firm | 0.75 | | | | | | | |
| | 9AOAE | Our IT is able to enhance strategic business process flexibility | 0.72 | | | | | | | |
| Competitive advantage | 11CAA | Over the past 3 years, our financial performance has exceeded our competitors | | | 0.91 | | | | | |
| | 11CAB | Over the past 3 years, we have been more profitable than our competitors | | | 0.91 | | | | | |
| | 11CAC | Over the past 3 years, our sales growth has exceeded our competitors | | | 0.81 | | | | | |

The initial exploratory factor analysis in Table 7.5 above illustrates that a few items did not load correctly on their construct, rather they crossloaded with other items. All crossloading items were deleted. The analysis was performed in an iterative way, until all factor extraction rules were met. Table 7.6 below presents the items that did not load correctly on their theorised factors and thus had to be deleted.

**Table 7-6: Item Deletions after Exploratory Factor Analysis**

| Construct | Item | | Reason |
|---|---|---|---|
| IT management capability | 3SMCA | Our IT management is up to date with business developments | Cross-loading > 0.4 |
| | 3SMCG | IT management contributes to our business strategy | |
| | 3SMCI | We manage IT strategically | |
| IT support for operational management | 6SOCC | Our IT supports our innovation processes | Cross-loading > 0.4 |

Table 7.6 above demonstrates that the three items from the IT management construct ('*Our IT management is up to date with business developments'*, *'IT management contributes to our business strategy*' and '*We manage IT strategically'*) had to be deleted due to cross-loadings of higher than 0.4 on other factors than the theorised IT management capability construct. Furthermore, the item '*Our IT supports our innovation processes*' from the IT support for operational management construct had to be deleted because it cross-loaded and did not load together with the other items of that construct.

The final results of the exploratory factor analysis are presented in Table 7.7 and Table 7.8 below. After four iterations, the items of the research instrument were grouped into eight factors. The IT infrastructure capability construct was theorised to consist of two variables (IT integration and IT modularity). Firstly, IT integration consisted of four items: '*Our company has a high degree of system interconnectivity'*, '*Our systems are sufficiently flexible to incorporate electronic links to external parties*', '*Data is available to everyone in the company in real time*', and '*Our user interfaces provide transparent access to all platforms and applications*'. Secondly, IT modularity consisted of three items: *'Legacy systems within the firm do not hamper the development of new IT applications*', '*Functionality can be quickly added to critical applications', and 'Our company can easily handle variations in data formats and standards*'.

## Table 7-7: Results of Exploratory Factor Analysis I

| | Item | | Factors 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|
| IT infrastructure capability | 1IIFB | Our company has a high degree of system interconnectivity | 0.68 | | | | | | | |
| | 1IIFC | Our system is sufficiently flexible to incorporate electronic links to external parties | 0.75 | | | | | | | |
| | 1IIFD | Data is available to everyone in the company in real time | 0.63 | | | | | | | |
| | 1IIFE | Our user interfaces provide transparent access to all platforms and applications | 0.64 | | | | | | | |
| | 1IIFG | Legacy systems within our firm do NOT hamper the development of new IT applications | | 0.74 | | | | | | |
| | 1IIFH | Functionality can be quickly added to critical applications | | 0.67 | | | | | | |
| | 1IIFI | Our company can easily handle variations in data formats and standards | | 0.68 | | | | | | |
| IT personnel capability | 2HRFA | Our IT personnel are cross-trained to support other IT services outside their domain | | | 0.60 | | | | | |
| | 2HRFD | Our IT personnel are knowledgeable about our IT products | | | 0.70 | | | | | |
| | 2HRFE | Our IT personnel are knowledgeable about the key success factors in our organisation | | | 0.72 | | | | | |
| | 2HRFF | Our IT personnel understand the business environments they support | | | 0.78 | | | | | |
| IT management capability | 4OMCA | There is a high degree of trust between our IT department and business units | | | | 0.48 | | | | |
| | 4OMCB | Critical information and knowledge that affect IT projects are shared freely between business units and the IS department | | | | 0.74 | | | | |
| | 4OMCC | Our IT department and business units understand the working environments of each other | | | | 0.71 | | | | |
| | 4OMCD | The goals and plans for IT projects are jointly developed by both the IT department and the business units | | | | 0.74 | | | | |
| IT support for market competence | 5SMCA | Our IT supports identifying market segments | | | | | 0.74 | | | |
| | 5SMCB | Our IT is utilised to redefine the scope of our business | | | | | 0.81 | | | |
| | 5SMCC | Our IT supports analysing customer needs (i.e. products, preferences, pricing and quality) | | | | | 0.58 | | | |
| | 5SMCD | Our IT is utilised to produce our products/services | | | | | 0.49 | | | |
| IT support for operational competence | 6SOCA | Our IT supports our strategic business processes | | | | | | 0.69 | | |
| | 6SOCB | Our IT is improving our operational efficiency | | | | | | 0.59 | | |
| | 6SOCE | Our IT supports knowledge-sharing in the company | | | | | | 0.55 | 0.40 | |
| | 6SOCF | Our IT supports cross-functional integration in our firm | | | | | | 0.69 | | |

**Table 7-8: Results of Exploratory Factor Analysis II**

| | Item | | Factors 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|
| Adaptive IT capability | 8AMAA | Our IT is able to adapt quickly to changes in the market and customer demands | | | | | | | 0.76 | |
| | 8AMAB | Our IT is able to adapt quickly to changes in the firm's products or services | | | | | | | 0.75 | |
| | 8AMAD | Our IT is able to adapt quickly to changes which can become necessary because of competitors' actions | | | | | | | 0.71 | |
| | 8AMAE | Our IT is utilised to increase the speed of responding to business opportunities/threats | | | | | | | 0.64 | |
| | 9AOAA | Our IT is able to adapt quickly to changes in business processes and organisational structures | | | | | | | 0.64 | |
| | 9AOAB | Our IT is able to adapt quickly to changes in knowledge-sharing in the company | | | | | | | 0.64 | |
| | 9AOAD | Our IT is able to adapt quickly to changes in the cross-functional Integration of our firm | | | | | | | 0.67 | |
| | 9AOAE | Our IT is able to enhance strategic business process flexibility | | | | | | | 0.72 | |
| Competitive advantage | 11CAA | Over the past three years, our financial performance has exceeded our competitors | | | | | | | | 0.92 |
| | 11CAB | Over the past three years, we have been more profitable than our competitors | | | | | | | | 0.91 |
| | 11CAC | Over the past three years, our sales growth has exceeded our competitors | | | | | | | | 0.81 |

The IT support for market competence construct had one item, '*Our IT supports knowledge-sharing in the company*', which cross-loaded just at the 0.4 threshold onto the adaptive IT capabilities construct. As the factor loading was just at the threshold level, the decision over whether to delete this item could not be based on the results of the exploratory factor analysis alone. Several factors were considered. Firstly, the above mentioned item had an item-scale of 0.66 for reliability analysis, the second highest of its construct. Secondly, in the panel of experts survey the item scored an average approval value of 4.4 out of 5. Finally, IT support for knowledge-sharing is a vital task and an important measure of IT support for operational competence in this study. In sum, even though the item '*Our IT supports knowledge-sharing in the company*' had a cross-loading at the threshold level of 0.4, several arguments support its contribution to the IT support for operational competence construct. Hence, the item was not deleted.

The items of IT personnel capability, IT management capability, IT support for market competence, adaptive IT capabilities and competitive advantage constructs loaded as expected on their constructs. In general, the significant loadings of the items on single factors indicate the Unidimensionality of each construct, while the fact that cross-loading items were eliminated supports the discriminant validity. The next section further tests these initial results through confirmatory factor analysis.

## 7.5. ASSESSING CONSTRUCT VALIDITY THROUGH CONFIRMATORY FACTOR ANALYSIS

After identifying the underlying structure using exploratory factor analysis, confirmatory factor analysis (CFA) through structural equation modelling (SEM) was used to assess construct validity through model fit indices (Tabachnick & Fidell 2007). CFA demands the presence of a theoretical framework, and an a priori theory based assumption that defines how each variable loads on each factor and vice versa (Byrne 2001). CFA only examines the link between factors and their measured variables. Hence, CFA represents what is termed a measurement model (Byrne 2001). The measurement model is then evaluated for its '*goodness of fit'* to the sample data by statistical means (Byrne 2001). According to the literature, SEM is the best and most widely accepted procedure for testing both construct validity and the theoretical relationship among constructs (Hair et al. 2006; Kline 2005).

SEM is a family of statistical methods which test complex multivariate research models (Kline 2005). SEM is a combination of factor analysis and multiple regression (Everitt 2006) and can be seen as a hybrid of factor analysis and path analysis (Weston 2006). SEM can use statistical analysis either based on covariance analysis or partial least squares, although covariance-based methods are the best known ones. Hence, the research literature sometimes uses the terms SEM and covariance-based methods synonymously. In this study SEM refers to covariance based SEM. Several operationalisations exist for SEM (LISREL, AMOS, and EQS). This study uses AMOS 16.0.

Apart from the similarities, SEM (sometimes also referred as "second-generation" also exhibits certain differences from "first-generation" multivariate procedures (Byrne 2001; Holmes-Smith 2007). Firstly, SEM employs CFA rather than an exploratory approach to data analysis, and enables better inferential analysis (Hair et al. 2006). Secondly, although hypothesis testing is difficult in most multivariate techniques, SEM offers a less difficult means to test research hypotheses, and enables the analysis of relationships between dependent variables (Kline 2005). Thirdly, SEM enables explicit estimates of error variance parameters, which is not possible in traditional multivariate techniques (Holmes-Smith 2007; Kline 2005).

The SEM method is a powerful multivariate analysis technique which can be used for two purposes. Firstly, similar to factor analysis, SEM provides a parsimonious summary of the interrelationships among variables. Expanding on the potential of EFA, SEM can include

CFA that can test specific hypotheses about the structure of the factor loadings and intercorrelations (Holmes-Smith 2007). Secondly, similar to path analysis, SEM can test hypothesised relationships among constructs with a linear equation system (Weston & Gore 2006).

Both applications mean that the SEM method can simultaneously assess the properties of the underlying measurement model and test the theoretical propositions. For analytical purposes, the SEM method can be separated into two models: the measurement model and the structural model (Byrne 2001). The measurement model is concerned with the variables that are supposed to measure the concept or, in other words, the measurement model represents the CFA model, and shows how the latent variables, or constructs, are represented by their respective indicators. As mentioned above, the SEM method thereby adopts a confirmatory approach. The subsequent structural model in SEM describes the relationships between the latent variables, or constructs. Both models together are called the composite, or full, structural model (Weston & Gore 2006).

The full structural model was modelled and analysed based on a six-stage process described by Hair (2006). The six stages Hair (2006) proposed were:

1. Defining individual constructs
2. Developing the overall measurement model
3. Designing a study to produce empirical results
4. Assessing the measurement model validity
5. Specifying the structural model
6. Assessing structural model validity

Stages 1–3 have already been discussed in Chapters 4 and 5; thus, only an outline of these steps is provided in section 7.5.1 below. Stage 4 is the primary task outlined in this chapter and is discussed in the following sections. Stages 5 and 6 are discussed in Chapter 8.

### 7.5.1. Developing the measurement model in SEM

This chapter focuses on the measurement model, while Chapter 8 will analyse the structural model. The measurement model was developed and assessed according to the first four stages of Hair's (2006) six-stage process described above. The structure of this thesis reflects this process. Hair's process begins with the demand for a good measurement theory to define individual constructs in Stage 1. The full structural model will then only be valid and reliable when the measurement model is based on theory and well defined constructs, so that the subsequent structural model is based on a solid theoretical foundation. Table 7.9 summarises the key issues (Churchill 1979; Straub, Boudreau & Gefan 2004) in SEM model development and how these issues are handled in this study. For a detailed discussion on developing models in SEM refer to Appendices L and M.

**Table 7-9: Summary of Key Issues in SEM Model Development**

| Issue | Action Taken |
|---|---|
| Defining individual constructs | See Chapter 5 for the process of instrument development |
| Determine the type of data (correlation or covariance matrix) to be analysed | As the use of covariance input matrices contains greater information, and provides far more capability, and as statistical impact favours the use of covariance input matrices, covariance matrices are used as input. |
| Treatment of missing data | See Chapter 6 |
| Model Estimation | The choice of the relevant estimation technique is straightforward. Even though previous attempts at SEM started with different estimation techniques, maximum likelihood estimation, hereafter referred to as MLE, is the most commonly used technique in SEM software and is therefore adopted for this study. |
| Choice of SEM software: AMOS (Analysis of Moment Structures), EQS (Equations), Mplus and LISREL AM | As these programs become increasingly similar, the choice of software package to use should be based on preferences and availability (Hair et al. 2006). The software employed for SEM in this research was AMOS, because it was easily available as an addition to SPSS. |
| Model Identification | Model identification refers to the existence of a unique set of parameters consistent with the data. A model 'identified' as a unique solution for the data can be found (Tabachnick & Fidell 2007). |

### 7.5.2. Statistical criteria for assessing the validity of measurement models

After the measurement model was specified and developed in Stages 1–3, the data collected and important decisions regarding its estimation set, the measurement model was ready for Stage 4—the validity assessment of Hair's (2006) process. The main purpose of using SEM to assess the measurement model is to find the most parsimonious model which is well fitting and valid. This section details the necessary tests and the acceptance levels for goodness of fit, convergent validity, discriminant validity and second order confirmatory factor analysis measurement tests. The discussion is generic and serves as the foundation for the actual tests to be conducted and reported in the subsequent sections.

#### *Goodness of Fit*

Whether a measurement model is considered valid is dependent on goodness of fit (GOF) indices. GOF indices indicate how well the model reflects the data, in other words, how well the specified model reproduces the covariance matrix among the indicator items (Hair et al. 2006). There are various GOF indicators, although usually only a couple of which are reported. Generally GOF indicators can be grouped into three categories: absolute measures, incremental measures and parsimonious fit measures. To ensure rigour in the empirical assessment, as suggested in the literature (Ho 2006; Kline 2005) multiple GOF indices are used. The literature is divided over the amount of fit indices that should be reported (e.g. Kline (2005) suggests at least four), which fit indices are most appropriate, as well as the acceptable cut-off threshold (Hair et al. 2006; Kline 2005). Table 7.10 summarises the basics of GOF used in this which are further detailed in Appendix O. Appendix O also acknowledges other popular fit indices which were not used in this study. This study follows the advice by Weston and Gore (2006), MacCallum and Austin (2000), Hu and Bentler (1998), Mcdonald and Ho (2002) and presents the following fit indices: chi-square, normed chi-square, RMSEA, RMR and CFI. In addition to the advice above, Hu and Bentler (1998) recommended against the usage of GFI and AGFI because they are not only insufficiently and inconsistently sensitive to model misspecification, they are also strongly influenced by sample size (MacCallum & Austin 2000). Hence, GFI and AGFI were not used in this study. The chosen GOF indicators and their acceptance level are summarised in Table 7.10.

**Table 7-10: Summary of Goodness of Fit Indices**

| **Category and definition** | **Indicators** | **Description** | **Traditional Acceptable levels (Gore 2006)** |
|---|---|---|---|
| Absolute fit measures indicate the degree to which the proposed model fits/predicts the observed covariance matrix | Chi-Square statistic | Tests if the proposed model fits the collected empirical data | p> 0.05 |
| | Normed Chi-Square | Handles the sensitivity of Chi-Square in complex models and can be used to estimate the parsimony of the model | 1.0 - 2.0 |
| | Root Mean-Square Error of Approximation (RMSEA) | Addresses the issue of error in the approximation of the population via a sample survey. In contrast to the exact fit test of the chi-square, the RMSEA is a measure of discrepancy per degree of freedom | < 0.10 |
| | RMR | RMR is the mean absolute value of the covariance residuals | < 0.10 |
| Incremental fit measures compare the proposed model to some baseline model. Hence, they are also often called comparative fit indices | Comparative Fit index (CFI) | CFI avoids the underestimation of fit often noted in small samples and is the improved version of the often used NFI | > 0.90 |

*Source: (Ho 2006); (Jöreskog & Sörbom 1993); (Holmes-Smith 2007).*

In summary, several GOF indices were presented, encompassing their interpretation and their acceptance level. The chosen GOF indicators are based on the recommendation of Hair (2006), to account for sample size and model complexity. These GOF indicators are a lot more stringent and rigorous than the classic ones employed by Weston and Gore (2006) and are more relevant than those used by Holmes-Smith (2007), as they account for complexity and sample size. Table 7.11 below provides an overview of the GOF measures and their acceptance levels used for this research with a sample size of below 250.

**Table 7-11: Goodness of Fit Measures**

| | | Acceptance level | | | |
|---|---|---|---|---|---|
| **Name** | **Abbreviation** | **Traditional (Gore 2006)** | **Adjusted levels of this CFA** | | |
| Complexity of model (no. variables) | | irrelevant | m<12 | 12<m<30 | m>30 |
| Chi-Square | $x^2$ | P > 0.05 | p>0.05 | p<0.05 possible | not relevant |
| Normed Chi-Square | $x^2$/ df | 1.0 - 2.0 | values close to 1.0 optimal | | |
| Root Mean-Square Error of Approximation | RMSEA<br>LO90<br>PCCLOSE | RMSEA<br>< 0.10 | RMSEA <0.08<br>PCCLOSE >0.05<br>Lo90 =0 (not necessary, but indicates that the test of exact fit is supported) | | |
| RMR | RMR | < 0.10 | n.a. | < 0.08 | < 0.09 |
| Comparative Fit Index | CFI | > 0.90 | > 0.97 | > 0.95 | > 0.92 |

***Convergent validity***

Convergent validity measures whether items of the same variable or construct measure the same thing and, therefore, reveal correlations to each other. In CFA, convergent validity measures whether items of the same latent factor share a proportion of variance (Hair et al. 2006). Convergent validity is, therefore, a direct measure of the extent of the relationship between an observed variable and a latent construct. According to Holmes-Smith (2007), convergent validity is achieved when this relationship, represented by factor loadings, is significantly different from zero. To assess the statistical significance of the factor loading, critical ratios and p-values were calculated for each factor loading. Critical ratios outside the -1.96 to +1.96 z-value range and p-values below p<0.05 indicate factor loadings that are significantly different from zero. This statistical test of the significant factor loading is the key criterion in assessing factor validity (Holmes-Smith 2007).

Furthermore, regression weights, standardised regression weights and squared multiple correlations (SMC) can be calculated to assess convergent validity. Standardised regression weights should be above 0.5, with values of above 0.7 optimal (Hair et al. 2006, pp. 776-7). Squared multiple correlations are squared standardised factor loadings and represent the extent to which a measured variable's variance is explained by a latent factor (Hair et al. 2006). SMC can also be used to assess item reliability. To identify a concrete value for an acceptable level of SMC a literature review was conducted, which yielded no definite threshold level. Hair et al. (2006, pp. 776–7) explicitly comment on the vague handling of SMC values: 'We do not provide specific rules for interpreting these values here because in a congeneric measurement model they are a function of the factor loading estimates. Recall that a congeneric measurement model is one in which no measured variable loads on more than one construct. The rules for the factor loading estimated tend to produce the same results'. Although all authors agree that the higher the SMC, the better the item reflects the latent variable (Anderson & Gerbing 1988; Byrne 2001; Kahn 2006; Kaplan 2000; Kline 2005; Straub, Boudreau & Gefan 2004; Tabachnick & Fidell 2007; Weston & Gore 2006), very few have provided concrete values for an acceptance level. Values below 0.3 indicate that the item is a poor measure of the construct and should be dropped (Holmes-Smith 2007). SMC between 0.3 and 0.5 indicates that the item is a weak but adequate measure of the construct (Holmes-Smith 2007). An SMC of 0.5 calculates to a standardised loading of 0.7, which indicates that the item reflects the construct very well (Hair et al. 2006; Holmes-Smith 2007).

In sum, convergent validity is assessed through a variety of measures: firstly, with standardised regression loadings of higher than 0.5 (Hair et al. 2006); secondly, with significant p-values (at 95% confidence interval) (Anderson & Gerbing 1988; Hair et al. 2006) and critical ratios outside the -1.96 to +1.96 z-range; and finally, SMC values below 0.4 are considered not to hold convergent validity. SMC values between 0.4 and .05 were scrutinised and accepted if all other convergent validity measures were well above the recommended thresholds. SMC above 0.5 were accepted. The standardised factor loadings, the critical ratio, p-value and SMC of each item are displayed for each construct.

#### *Discriminant validity*

Discriminant validity measures to what extent latent variables differ from each other. In contrast to convergent validity, which is a measure within latent variables, discriminant validity is a measure between variables. Discriminant validity is especially important if latent variables and constructs are interrelated. It can be assessed in two ways. Firstly, correlations between different constructs can be calculated. High correlations (above 0.8 or 0.9) between constructs indicate a lack of discriminant validity (Holmes-Smith 2007). Secondly, the average variance extracted for constructs should exceed the square of the correlations between the constructs (Holmes-Smith 2007). In addition to model fit statistics, both discriminant validity measures will be presented for each construct.

#### *Second order confirmatory factor analysis measurement models*

The section above discussed the first order measurement models of the research model. As the main research questions of this study are at a higher order concept level, second order confirmatory factor analysis was employed. The advantages of higher order confirmatory factor analysis are, on the one hand, that they include fewer parameters to be estimated, and that the model represents the underlying structure of the sample data in a more parsimonious way (Byrne 2001). On the other hand, higher order confirmatory factor analysis enables the estimation of the relationships between higher order constructs, rather than only estimating the relationships between variables or lower order constructs. In a second order confirmatory factor analysis, the first order variables are regarded as though they were items.

Similar to one factor, first order confirmatory factor analysis, in second order confirmatory factor analysis, models can either be estimated as a congeneric version with freed error variances and regression weights, or as parallel versions. In the following section, a second order confirmatory factor analysis measurement model of the research model will be estimated and presented. Therefore, sections 7.6.3 and 7.7.3 transfer the one factor confirmatory factor analysis models from 7.7.1 and 7.72 into second order, one factor confirmatory factor analysis measurement models. Model fit statistics and convergent validity will be presented for each second order construct. Subsequently, a full second order confirmatory factor analysis model will be presented together with model fit, convergent and discriminant validity statistics.

## 7.6. Measurement Model for the IT Infrastructure Capability Construct

To assess the construct validity of the domain of the research constructs, CFA was employed for all three constructs separately. Hence, the following sections discuss the measurement model for each construct separately.

### 7.6.1. One factor, congeneric measurement models for IT infrastructure capability variables

The previous section discussed the nature and purpose of measurement models in positivistic research. It also explained two important issues in confirmatory factor analysis: model identification and goodness of fit indices. Congeneric measurement models consist of several unidimensional constructs with all crossloadings assumed to be zero. Unlike parallel models, in congeneric measurement models, indicators are seen as measuring the same latent variable on possibly different scales, with possibly different amounts of precision, and with possibly different amounts of error (Holmes-Smith 2007).
The following section discusses the one factor, congeneric measurement models for each theorised variable consecutively.

#### *IT integration*

The literature has theorised IT integration in two ways: firstly, IT integration as consisting of two variables—IT connectivity and IT compatibility; and secondly, IT integration as only one variable compromising IT connectivity and IT compatibility. In the research instrument development chapter, the latter approach was followed—that is, IT integration is seen as one consolidated variable. This decision was supported by the results of the exploratory factor analysis in the previous chapter. Therefore, the proposed model for IT integration consists of all four items and is shown in Figure 7-1 below, together with the fit statistics in Table 7.12

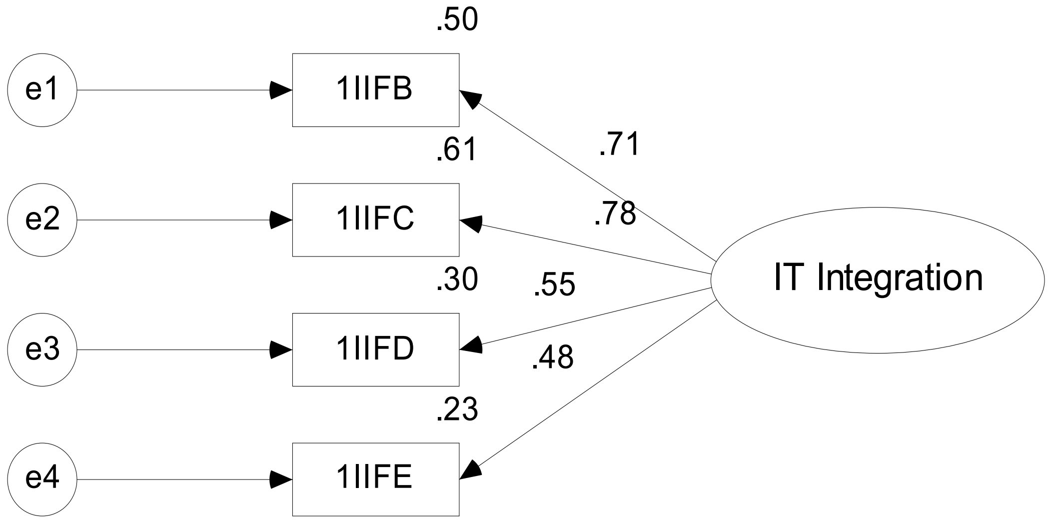


**Figure 7-1: Proposed One Factor, Congeneric Model of IT Integration**

The standardised factor loadings are displayed above the arrows from the latent variable (IT integration) towards the four items. The SMC are presented above the items.

**Table 7-12: Statistics for Proposed One Factor, Congeneric Measurement Model of IT Integration[7][8][9]**

| Model identification | | | Model Fit Statistics | | | | | |
|---|---|---|---|---|---|---|---|---|
| observed variables | = | 4 | $X^2$ | = | 27.11 | CFI | = | 0.86 |
| estimated parameters | = | 13 | $X^2$ / df | = | 13.56 | RMSEA | = | 0.25 |
| df | = | 2 | p | = | 0 | LO 90 | = | 0.17 |
| Model is identified | | | RMR | = | 0.09 | PCLOSE | = | 0 |

**Factor loadings**

(*** = p< 0.001, ** = p< 0.01, * = p< 0.05)

| Item | | Variable | S.E | C.R. | p | SMC | Comment |
|---|---|---|---|---|---|---|---|
| 1IIFB | <- | IT Integration | 0.71 | 7.31 | *** | 0.50 | |
| 1IIFC | <- | IT Integration | 0.78 | 10.56 | *** | 0.61 | |
| 1IIFD | <- | IT Integration | 0.55 | 9.58 | *** | 0.30 | SMC to low |
| 1IIFE | <- | IT Integration | 0.48 | 6.36 | *** | 0.23 | SMC to low |

**Model Fit inadmissible**

[7] SE: Standardised Estimate, also referred to as Standardised Regression Weight or Standardised Path Coefficient

[8] CR: Critical Ratio

[9] SMC: Squared Multiple Correlations

The proposed model for IT integration is identified with two degrees of freedom. The model fit statistics indicate an inadmissible model fit (see Table 7.12 above). All model fit statistics are outside acceptable thresholds. The normed Chi-Square has a value of 13.56, and an acceptable level would be below 2. The statistical test of bad fit is significant (p< 0.00), indicating a significant misfit of the model, CFI (0.86) is below the threshold (0.97) and RMSEA (0.25) is outside the recommended range of 0.05–0.08. This proposed model is clearly a bad fit and must be respecified. The factor loading table shows critical ratios above +/- 1.96, which together with the significant p-values indicates that the factor loadings are significantly different from zero (Holmes-Smith 2007). The squared multiple correlations (or item reliabilities) (Holmes-Smith 2007) are for two items (1IIFD and 1IIFE) below an acceptable level. These items might be the cause of the misfit. To further identify the cause of the misfit two respecification statistics, the standardised residual covariances and the modification indices, were scrutinised. The respecification statistics are presented in Table 7.13 below.

**Table 7-13: Respecification Statistics for IT Integration Model**

| **Standardised residual covariances** | | | | | **Modification Indices** | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1IIFE | 1IIFB | 1IIFC | 1IIFD | | | | MI | Par Change |
| 1IIFE | 0 | | | | e3 | <-> | e4 | 23.8 | 0.33 |
| 1IIFB | -0.77 | 0 | | | | | | | |
| 1IIFC | -0.65 | 0.49 | 0 | | | | | | |
| 1IIFD | 3.18 | -0.74 | -0.42 | 0 | | | | | |
| Association between 1IIFE and 1IIFD is not sufficiently accounted for in the model | | | | | MI proposed covariance between e3 <->e4 to be freed | | | | |

Firstly, residual covariances reveal the error between the model's predicted covariances and the sample covariance matrix. Standardised residual covariances are residual covariances divided by their estimated standard error (Holmes-Smith 2007). According to (Holmes-Smith 2007), these standardised residual covariances are the soundest method for identifying the source of model misspecification. At a α=0.05 significance level, the z-distribution demands values of between -1.96 and +1.96 to indicate a good fit. Larger values of standardised residual covariances of an item pair indicate a misspecification of this item pair (Holmes-Smith 2007). The association between 1IIFD and 1IIFE is large, and thus indicates a misspecification of these items. Secondly, the modification indices are calculated for each non-free parameter and two values are presented, the actual modification indices, hereafter referred to as 'MI', and 'par change', the estimated approximate increase in the covariance if the items were freed to be covaried.

The MI of 23.8 indicates that the Chi-Square would improve in 23.8 units if e3 and e4 were to be covaried; the 0.33 value of the par change is an approximate value for the estimated covariance when these items would be covaried. These statistics provide a clear indication that the Items 1IIFD ('*Data is available to everyone in real time*') and 11FE

('*Our user interfaces provide transparent access to all platforms and applications*') are linked more closely to each other than to the other items of the IT integration variable. Hence, the IT integration model has to be respecified. Respecification statistics should not be used as a sole means to respecify the model. They can indicate a problem associated with the proposed model, but every model respecification has to be based on strong theoretical evidence (Hair et al. 2006). As mentioned above, the IT integration model consists of two interlinked variables: IT connectivity (items 1IIFB and 1IIFC) and IT compatibility (items 1IIFD and 11IIFE). Prior research has either used these variables separately or grouped them together in a consolidated variable called IT integration (see Table 4.2). Based on the results of the exploratory factor analysis, the consolidated variable IT integration was used instead of the two separate variables. The results of the one factor, congeneric measurement model above indicate a poor model fit with the consolidated variable IT integration. The model misfit statistics are consistent with the theoretical analysis, as they indicate that the two IT compatibility items covary more strongly with themselves than with items from IT connectivity. Hence, model respecification is based on theoretical foundations.

According to the literature (Hair et al. 2006; Holmes-Smith 2007), in order to respecify a model, three approaches can be taken. Firstly, items that do not load highly enough on the factor can be deleted. Secondly, items that are found to covary too highly with each other can be linked by freeing the covariation between the error variances. Thirdly, items that covary too highly with some but not all of the items of this model are an indicator of measuring a different factor to the one theorised. A possible remedy is to take these items out of the model and load them onto a new factor. In doing so, it is crucial to ensure the theoretical soundness of the modifications rather than base the modifications on statistical results alone. In other words, theory-driven model modifications are superior to data-driven modifications. As mentioned above, there is some theoretical support (see Table 4.2) for dividing the IT integration measurement model into two factors: IT connectivity (1IIFB and 1IIFC) and IT compatibility (1IFD and 1IIFE). These two variables are discussed below.

***IT connectivity***

The IT connectivity model consists of only two observed variables, and thus the model identification of the congeneric model of IT connectivity failed. This model is not identified. A possible remedy would be to construct a parallel model. Adopting a parallel approach for IT connectivity makes the model solvable. In the parallel model the variances of the error terms and the factor loadings are assumed to be equal. Hence, few parameters have to be estimated and parallel models are more parsimonious. The one factor, parallel model of IT connectivity and its statistics are illustrated in Figure 7-2 and Table 7.14

below.

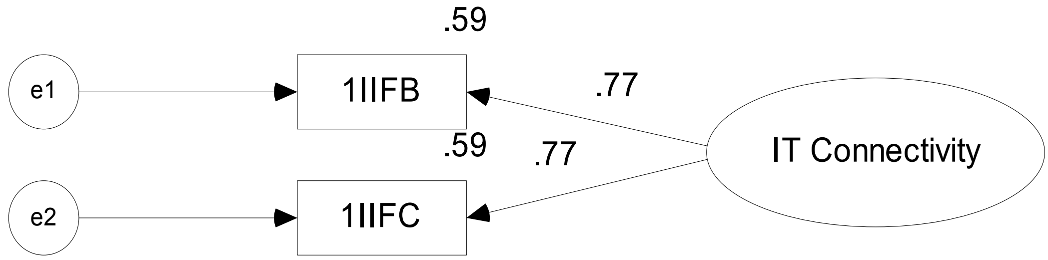


**Figure 7-2: One Factor, Parallel Model of IT Connectivity**

**Table 7-14: Statistics for One Factor, Parallel Model of IT Connectivity**

| **Model identification** | | | **Model Fit Statistics** | | | | | |
|---|---|---|---|---|---|---|---|---|
| observed variables | = | 2 | $X^2$ | = | 1.52 | **CFI** | = | 0.99 |
| estimated parameters | = | 2 | $X^2$ / df | = | 1.52 | **RMSEA** | = | 0.05 |
| df | = | 1 | **p** | = | 0.22 | **LO 90** | = | 0 |
| **Model is identified** | | | **RMR** | = | 0.05 | **PCLOSE** | = | 0.33 |

**Factor loadings**

(*** = p< 0.001, ** = p< 0.01, * = p< 0.05)

| Item | | Variable | SE | CR | p | SMC | Comment |
|---|---|---|---|---|---|---|---|
| 1IIFB | <- | IT Connectivity | 0.77 | 7.31 | *** | 0.59 | Convergent validity holds |
| 1IIFC | <- | IT Connectivity | 0.77 | 10.56 | *** | 0.59 | Convergent validity holds |

**Model Fit excellent**

The parallel model of IT connectivity has an excellent fit (see Table 7.14). All fit statistics are well within acceptable values. Even the statistical test of misfit is not significant (p=0.22) and the statistical fit test of exact fit of RMSEA, the Lo90 value, is significant. The critical ratios of the factor loadings are all significantly different from zero (above 1.96) and the SMC is close to 0.6, meaning that the two items 1IIFB and 1IIFC explain 59% of the variance of the IT connectivity variable. Altogether, the parallel model of IT connectivity has an excellent fit and both items exhibit convergent validity; hence, the model is accepted.

***IT compatibility***

The proposed model for IT compatibility is similar to that for IT connectivity in that it also has only two observed variables. Hence, a congeneric model of IT compatibility would be unidentified and a parallel model for IT compatibility is necessary, which is displayed in Figure 7-3 followed by its statistics in Table 7.15 below.

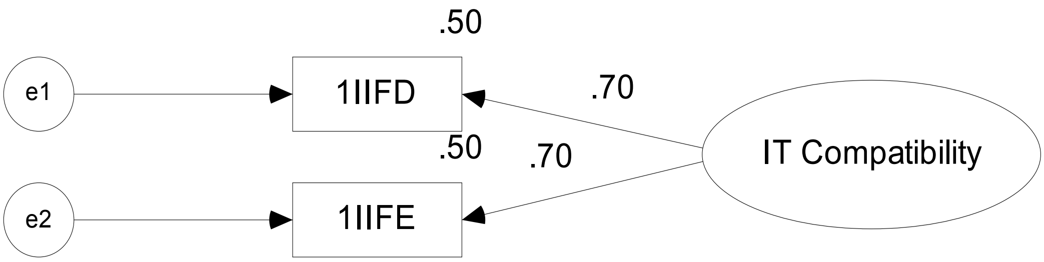


**Figure 7-3: One Factor, Parallel Model of IT Compatibility**

**Table 7-15: Statistics for One Factor, Parallel Model of IT Compatibility**

| Model identification | | Model Fit Statistics | | | | | |
|---|---|---|---|---|---|---|---|
| observed variables | 2 | $X^2$ | = | 0.14 | CFI | = | 1.00 |
| estimated parameters | 2 | $X^2$ / df | = | 0.14 | RMSEA | = | 0.00 |
| df | 1 | p | = | 0.71 | LO 90 | = | 0.00 |
| **Model is identified** | | RMR | = | 0.02 | PCLOSE | = | 0.77 |

**Factor loadings**

(*** = p< 0.001, ** = p< 0.01, * = p< 0.05)

| Item | | Variable | S.E. | C.R. | p | SMC | Comment |
|---|---|---|---|---|---|---|---|
| 1IIFD | <- | IT Compatibility | 0.7 | 12.61 | *** | 0.50 | Convergent validity holds |
| 1IIFE | <- | IT Compatibility | 0.7 | 12.61 | *** | 0.50 | Convergent validity holds |

**Model Fit excellent**

The one factor parallel model of IT compatibility is identified with one degree of freedom and has model fit statistics all within the acceptable range (see Table 7.16). The statistical test of misfit is rejected (p>0.05), RMR and RMSEA are well below the recommended threshold of 0.08, and with LO90 at 0.00 and PCLOSE above 0.05, the model fits with the observed data. Hence, the one factor parallel model for IT compatibility is an excellent fit and is accepted.

***IT modularity***

The proposed model for IT modularity consists of three observed variables. Figure 7-4 below depicts the model graphically and Table 7.16 presents the statistics of the proposed one factor, congeneric model of IT modularity.

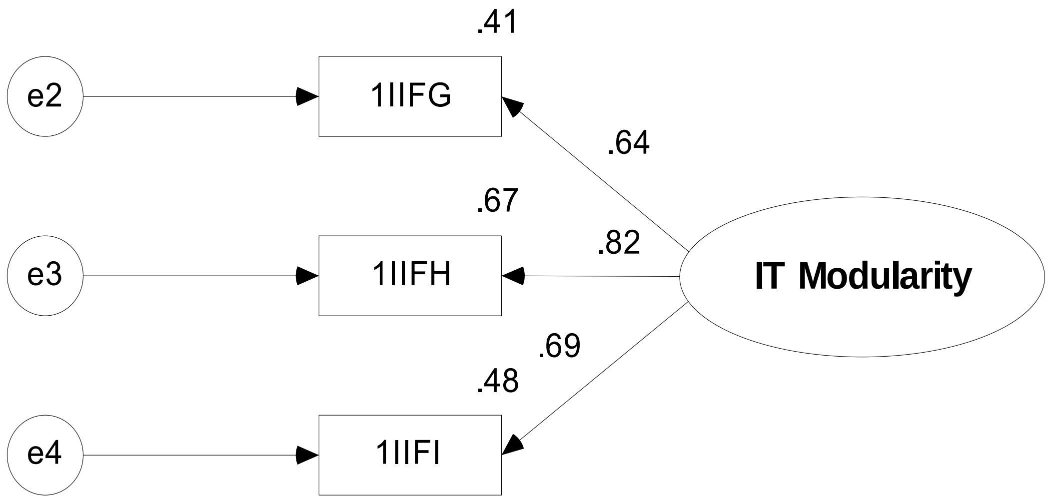


**Figure 7-4: Proposed One Factor, Congeneric Model of IT Modularity**

**Table 7-16: Statistics for Proposed One Factor, Congeneric Model of IT Modularity**

| Model identification | | | Model Fit Statistics | | | | | |
|---|---|---|---|---|---|---|---|---|
| observed variables | = | 3 | $X^2$ | = | 0.00 | CFI | = | 1.00 |
| estimated parameters | = | 6 | $X^2$ / df | = | 0.00 | RMSEA | = | 0.49 |
| df | = | 0 | p | = | 0.00 | LO 90 | = | 0.43 |
| Model is just-identified | | | RMR | = | 0.00 | PCLOSE | = | 0.00 |
| Factor loadings | | | | | | | | |
| (*** = p< 0.001, ** = p< 0.01, * = p< 0.05) | | | | | | | | |
| Item | | Variable | SE | CR | p | SMC | Comment | |
| 1IIFG | <- | IT Modularity | 0.64 | 8.61 | *** | 0.41 | SMC low | |
| 1IIFH | <- | IT Modularity | 0.82 | 10.84 | *** | 0.67 | | |
| 1IIFI | <- | IT Modularity | 0.69 | 9.33 | *** | 0.48 | | |
| Model Fit inadmissible | | | | | | | | |

The model included exactly the amount of data that is necessary to solve the equations. Hence, the model is just-identified (see Table 7.17) While it is possible to produce a unique solution with just-identified models, scientifically they do not make much sense, because zero degrees of freedom imply that the model cannot be rejected (Byrne 2001). Hence, a more suitable approach would be a parallel model. The parallel model was estimated and resulted in model fit statistics which came close, but not close enough, to an acceptable level. To investigate the reasons for the misfit, factor loadings of the congeneric model were investigated. Although the item 1IIFG has a critical ratio of above 1.96 and a loading on IT modularity that is significantly different from zero, the factor loading (SMC of 0.41) is the lowest of the IT modularity variables. The item was thus dropped and the model re-estimated. The final model for IT modularity is displayed in Figure 7-5 below, followed by its statistics in Table 7.17.

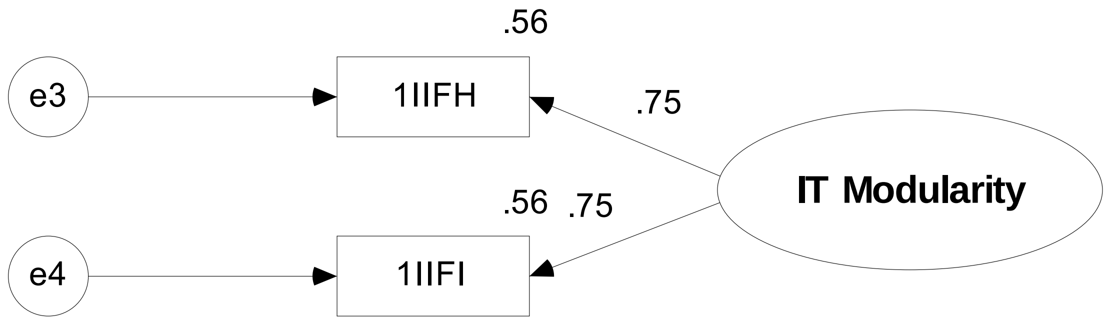


**Figure 7-5: Final One Factor, Parallel Model of IT Modularity**

**Table 7-17: Statistics for Final One Factor, Parallel Model of IT Modularity**

| **Model identification** | | **Model Fit Statistics** | | | |
|---|---|---|---|---|---|
| observed variables | 2 | $X^2$ | = 1.91 | CFI | = 0.99 |
| estimated parameters | 2 | $X^2$ / df | = 1.91 | RMSEA | = 0.07 |
| df | 1 | p | = 0.17 | LO 90 | = 0.00 |
| **Model is identified** | | RMR | = 0.06 | PCLOSE | = 0.27 |

**Factor loadings**

(*** = p< 0.001, ** = p< 0.01, * = p< 0.05)

| Item | | Variable | S.E. | C.R. | p | SMC | Comment |
|---|---|---|---|---|---|---|---|
| 1IIFH | <- | IT Modularity | 0.72 | 13.94 | *** | 0.56 | Convergent validity holds |
| 1IIFI | <- | IT Modularity | 0.72 | 13.94 | *** | 0.56 | Convergent validity holds |

**Model Fit excellent**

The model fit statistics (see Table 7.17) indicate that this model of IT modularity represents the sample data far more accurately than the proposed model. The statistical test of bad fit is rejected with p>0.05, CFI and GFI are with 0.99 (close to a perfect fit of 1.00), RMSEA and RMR are below the thresholds, Lo90 supports with 0.00, and PCLOSE with >0.05, thus indicating a good fit. The factor loadings of the two remaining items, 1IIFH and 1IIFI, are both 0.56, indicating that they account for 56% of the variance in the IT modularity variable. Overall, the final one factor, parallel model of IT modularity has an excellent fit and is accepted.

### 7.6.2. Full measurement model for IT infrastructure capability construct

The construct IT infrastructure capability was theorised to consist of two variables, IT integration and IT modularity, or three variables, IT connectivity, IT compatibility and IT modularity. Theoretically, both versions are valid; hence, factor analysis was utilised to validate which version resembled the sample data the closest. The confirmatory factor analysis of the one factor, congeneric models in the previous section revealed that the three variable solution yields better model-fit statistics; hence this approach was chosen. Because of identification issues with congeneric modelling of one factor solutions, the three variables had to be estimated with a parallel solution in the previous one factor estimation. In the estimation of the construct, a congeneric version of the model is identified and can be estimated. The measurement model of the IT infrastructure capability construct is presented in Figure 7-6, followed by its statistics in Table 7.18 below.

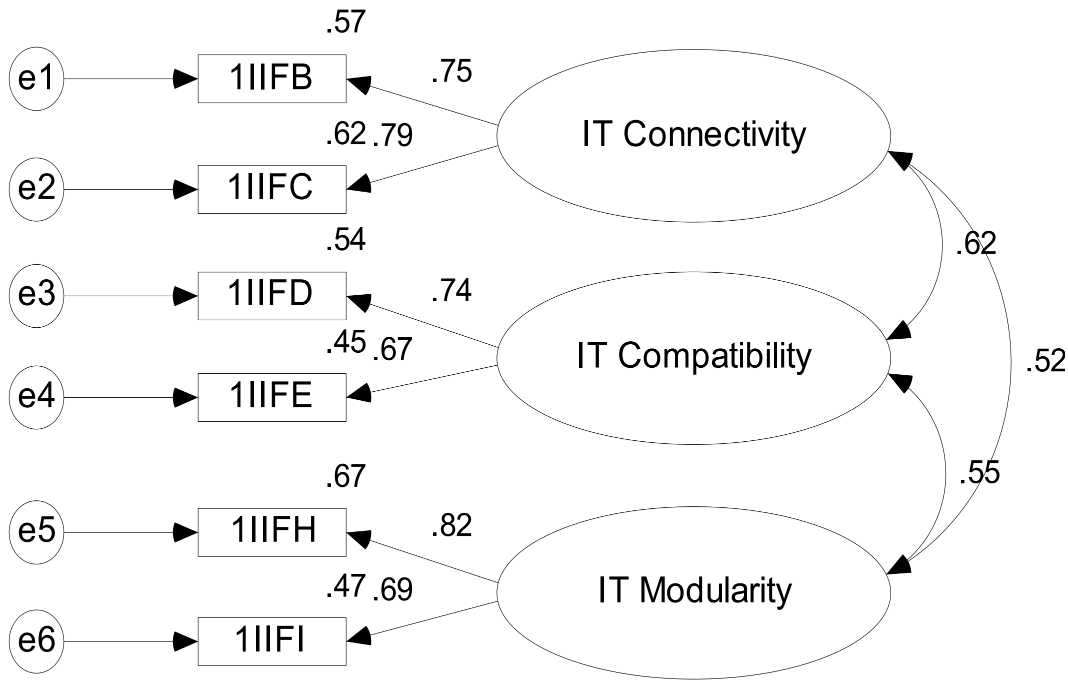


**Figure 7-6: Measurement Model of IT Infrastructure Capability Construct**

**Table 7-18: Statistics for Measurement Model of IT Infrastructure Capability**

| **Model identification** | | | **Model Fit Statistics** | | | | | |
|---|---|---|---|---|---|---|---|---|
| observed variables | = | 6 | $X^2$ | = | 11.68 | **CFI** | = | 0.98 |
| estimated parameters | = | 15 | $X^2$ / df | = | 1.95 | **RMSEA** | = | 0.07 |
| df | = | 6 | **p** | = | 0.07 | **LO 90** | = | 0 |
| **Model is identified** | | | **RMR** | = | 0.02 | **PCLOSE** | = | 0.25 |

**Factor loadings**

(*** = p< 0.001, ** = p< 0.01, * = p< 0.05)

| Item | | Variable | SE | CR | p | SMC | Comment |
|---|---|---|---|---|---|---|---|
| **1IIFB** | <- | IT Connectivity | 0.75 | 9.92 | *** | 0.57 | Convergent validity holds |
| **1IIFC** | <- | IT Connectivity | 0.79 | 10.29 | *** | 0.62 | Convergent validity holds |
| **1IIFD** | <- | IT Compatibility | 0.74 | 9.08 | *** | 0.54 | Convergent validity holds |
| **1IIFE** | <- | IT Compatibility | 0.67 | 8.47 | *** | 0.45 | Convergent validity holds |
| **1IIFH** | <- | IT Modularity | 0.82 | 9.73 | *** | 0.67 | Convergent validity holds |
| **1IIFI** | <- | IT Modularity | 0.69 | 8.56 | *** | 0.47 | Convergent validity holds |

**Model Fit acceptable**

Table 7.18 displays results of measurement model of IT infrastructure capability of the three variables—IT connectivity, IT compatibility and IT modularity—and their covariances. The statistics in Table 7.17 indicate an acceptable fit for the congeneric measurement model. All fit statistics are within the recommended thresholds and the factor loadings are sufficiently high to render the convergent validity of the congeneric measurement model for IT infrastructure capability acceptable. After model fit and convergent validity was established, discriminant validity was calculated to investigate whether the variables measure different things. The results are presented in Table 7.19 below.

**Table 7-19: Discriminant Validity of IT Infrastructure Capability Construct**

| | | **Standardised Regression Weight** | | **Error variance** | **Variance extracted** |
|---|---|---|---|---|---|
| Variable | Item | $\lambda$ | $\lambda^2$ | $\varepsilon$ | $\rho_{vc(\eta)}$ |
| IT Connectivity | 1IIFB | 0.755 | 0.570 | 0.370 | |
| | 1IIFC | 0.788 | 0.621 | 0.280 | |
| | Sum | | 1.191 | 0.650 | 0.647 |
| IT Compatibility | 1IIFD | 0.736 | 0.542 | 0.565 | |
| | 1IIFE | 0.673 | 0.453 | 0.646 | |
| | | | 0.995 | 1.211 | 0.451 |
| IT Modularity | 1IIFH | 0.820 | 0.672 | 0.330 | |
| | 1IIFI | 0.688 | 0.473 | 0.450 | |
| | | | 1.146 | 0.780 | 0.595 |
| | **Correlation of variables** | | | | |
| | | | $\rho$ | | Result (Method I) |
| IT Connectivity | <--> | IT Compatibility | 0.623 | | Discriminant validity holds |
| IT Modularity | <--> | IT Connectivity | 0.521 | | Discriminant validity holds |
| IT Modularity | <--> | IT Compatibility | 0.555 | | Discriminant validity holds |
| | | **Pair wise variable comparison for discriminant validity** | | | |
| | | | $\rho^2$ | **ave** $\rho_{vc(\eta)}$ | Result (Method II) |
| IT Connectivity | <--> | IT Compatibility | 0.388 | 0.549 | Discriminant validity holds |
| IT Modularity | <--> | IT Connectivity | 0.271 | 0.621 | Discriminant validity holds |
| IT Modularity | <--> | IT Compatibility | 0.308 | 0.523 | Discriminant validity holds |

Discriminant validity presented in Table 7.19 above was calculated as explained in the section above in two ways. The correlations of variables must be below 0.85 and the average variance of constructs extracted should exceed the square of the correlations between the constructs (Holmes-Smith 2007). Both methods indicate that the construct of IT infrastructure capability holds discriminant validity.

### 7.6.3. IT infrastructure capability as a second order construct

The first order confirmatory factor analysis conducted in the section above yielded an acceptable measurement model for the IT infrastructure construct. However, it was of interest to examine IT infrastructure capability at a higher level. Therefore, a second order confirmatory factor analysis was conducted. In a second order confirmatory factor analysis, the first order variables (in this case, IT connectivity, IT compatibility and IT modularity) are regarded as though they are items. Their consolidated values from their items are used to estimate the higher order construct of IT infrastructure capability. The graphical presentation of the model is displayed in Figure 7.7 below.

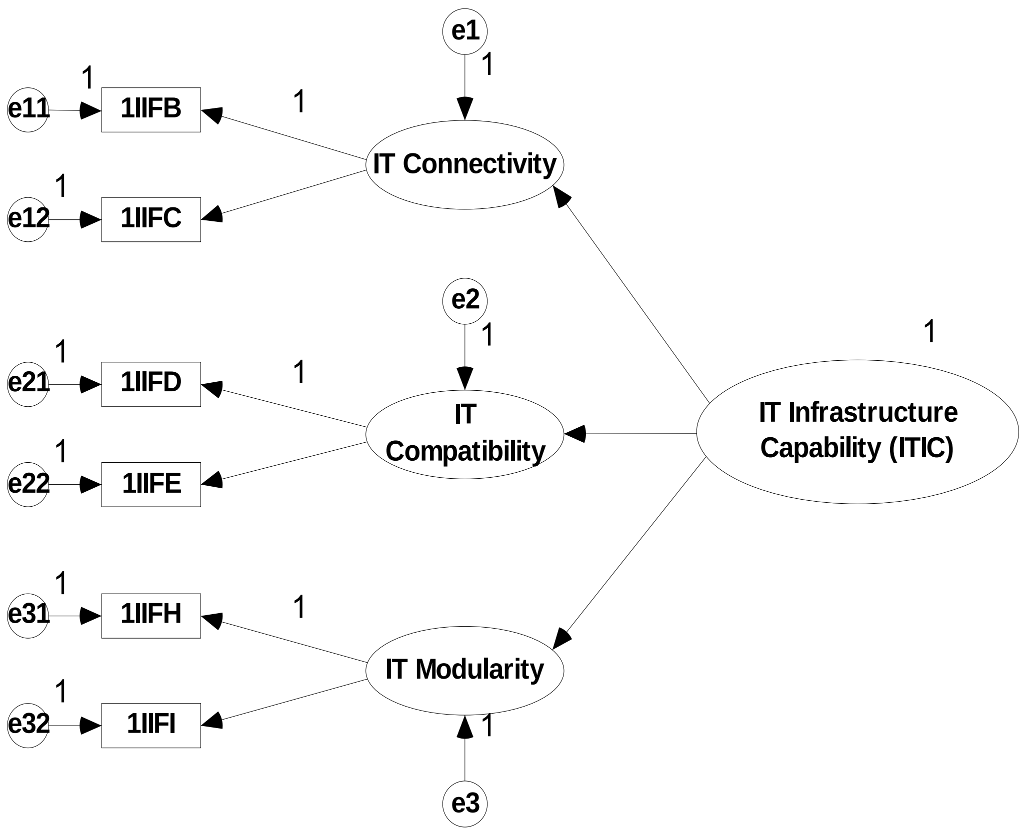


**Figure 7.7: Second Order CFA Measurement Model of IT Infrastructure Capability**

**Table 7-20: Statistics for Second Order Confirmatory Factor Analysis Measurement model of IT Infrastructure Capability**

| Model identification | | | Model Fit Statistics | | | | | |
|---|---|---|---|---|---|---|---|---|
| observed variables | = | 6 | $X^2$ | = | 11.68 | CFI | = | 0.98 |
| estimated parameters | = | 15 | $X^2$ / df | = | 1.95 | RMSEA | = | 0.07 |
| df | = | 6 | p | = | 0.07 | LO 90 | = | 0 |
| Model is identified | | | RMR | = | 0.02 | PCLOSE | = | 0.25 |

**Factor loadings**

(*** = p< 0.001, ** = p< 0.01, * = p< 0.05)

| Item | | Variable | Estimate | SE | CR | p | SMC | Comment |
|---|---|---|---|---|---|---|---|---|
| IT Connectivity | <- | ITIC | 0.54 | 0.76 | 6.60 | *** | 0.59 | Convergent validity holds |
| IT Compatibility | <- | ITIC | 0.67 | 0.81 | 6.87 | *** | 0.66 | Convergent validity holds |
| IT Modularity | <- | ITIC | 0.56 | 0.68 | 6.67 | *** | 0.46 | Convergent validity holds |

**Model Fit acceptable**

The statistics for the second order confirmatory factor analysis measurement model of IT infrastructure capability (ITIC) in Table 7.20 above show an acceptable model fit. The theorised variables—IT connectivity, IT compatibility and IT modularity—were regarded as items and their factor loadings on the IT infrastructure capability construct were scrutinised. All three variables have significant critical ratios and p-values and, therefore, hold convergent validity. The high level of SMC further indicates item reliability. Hence, the second order confirmatory factor analysis model of the IT infrastructure capability construct is accepted.

## 7.7. Measurement Model for IT Personnel Capability Construct

### 7.7.1. One factor, congeneric measurement models for IT personnel capability construct

The IT capability construct was theorised as consisting of two variables: broad IT knowledge and business knowledge. These variables will be tested if they represent the sample data in the following sections. In this section each variable will be tested in one factor confirmatory factor analysis models separately. These one factor models are the basis for the next section, in which the whole measurement model of the IT capability construct will be tested through a second order confirmatory factor analysis.

***Broad IT knowledge***

The variable broad IT knowledge was theorised to contain four items. One item (2HRFB) was dropped due to a high rate of ‘not applicable’ responses. Another item (2HRFC) was dropped during the reliability check. The two remaining items of the broad IT knowledge variable—2HRFA ('*Our IT personnel are cross-trained to support other IT services outside their domain*') and 2HRFD ('*Our IT personnel are knowledgeable about our IT products*')—had to be modelled in a one factor parallel model (see Figure 7-7 because a congeneric model would not have been identified.

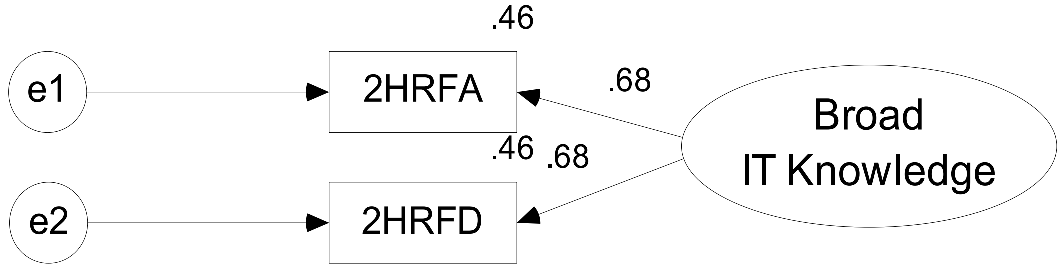


**Figure 7-7: One Factor Parallel Model of Broad IT Knowledge**

**Table 7-21: Statistics for One Factor Parallel Model of Broad IT Knowledge**

| **Model identification** | | | **Model Fit Statistics** | | | | | |
|---|---|---|---|---|---|---|---|---|
| observed variables | = | 2 | $X^2$ | = | 23.1 | **CFI** | = | 0.56 |
| estimated parameters | = | 2 | $X^2$ / df | = | 23.1 | **RMSEA** | = | 0.34 |
| df | = | 1 | **p** | = | 0 | **LO 90** | = | 0.23 |
| **Model is identified** | | | **RMR** | = | 0.18 | **PCLOSE** | = | 0.0 |

**Factor loadings**

(*** = p< 0.001, ** = p< 0.01, * = p< 0.05)

| Item | | Variable | Estimate | SE | CR | p | SMC | Comment |
|---|---|---|---|---|---|---|---|---|
| 2HRFA | <- | Broad IT Knowledge | 0.58 | 0.68 | 11.80 | *** | 0.46 | Convergent validity holds |
| 2HRFD | <- | Broad IT Knowledge | 0.58 | 0.68 | 11.80 | *** | 0.46 | Convergent validity holds |

**Model Fit inadmissible**

The parallel modelled broad IT knowledge variable has an inadmissible fit (see Table 7.21). This could be due to several reasons. To identify these, the modification statistics were further investigated (see Table 7.22).

**Table 7-22: Respecification of Statistics for Broad IT Knowledge**

**Standardised residual covariances**

| | 2HRFD | 2HRFA |
|---|---|---|
| 2HRFD | -2.98 | |
| 2HRFA | 0 | 2.98 |

**Modification Indices**

| Parameters to be estimated | | | MI | Par Change |
|---|---|---|---|---|
| | | e2 | 8.85 | -0.17 |
| | | e1 | 8.85 | 0.17 |
| 2HRFD | <--- | Broad IT Knowledge | 12.8 | -0.21 |
| 2HRFA | <--- | Broad IT Knowledge | 12.8 | 0.21 |

**MI indicate that estimating the error variances and factor loadings improves model fit**

The estimated one factor model for the broad IT knowledge variable had to be a parallel model so that it could be identified. Hence, factor loadings and error variances were set as equal. The respecification statistics in Table 7.22 indicate that freeing/estimating the error variances e2 and e1 would improve the $\chi^2$ with 8.85 points, and freeing/estimating the factor loadings of the two items 2HRFA and 2HRFD on the broad IT knowledge variable would improve the $\chi^2$ an estimated 12.8 points. Hence, a congeneric model of the broad IT knowledge variable seems to have a far better fit than the estimated parallel model. When integrated into a higher order CFA, the congeneric version can be estimated. It was decided to keep the broad IT knowledge variable, despite its bad fit, and to evaluate its fit statistics again when integrated into a second order CFA.

***Business knowledge***

The business knowledge of IT personnel is an important element of IT capabilities. The research instrument measured the business knowledge of IT personnel using two items: 2HRFE (‘*Our IT personnel are knowledgeable about the key success factors in our organisation*’) and 2HRFF (‘*Our IT personnel understand the business environment they support’*). Equivalent to the broad IT knowledge variable discussed above, the business knowledge variable also only consists of two items. Hence, a congeneric one factor model would not be identified and a one factor parallel model had to be estimated. The results are displayed in Figure 7-8 and Table 7.23 below.

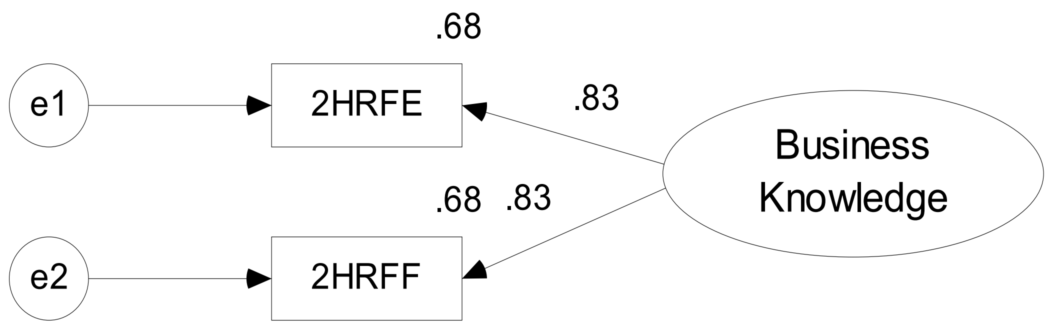


**Figure 7-8: One Factor Parallel Model for Business Knowledge**

**Table 7-23: Statistics for One Factor Parallel Model of Business Knowledge**

| Model identification | | | Model Fit Statistics | | | | | |
|---|---|---|---|---|---|---|---|---|
| observed variables | = | 2 | **$X^2$** | = | 1.75 | **CFI** | = | 0.99 |
| estimated parameters | = | 2 | **$X^2$ / df** | = | 1.75 | **RMSEA** | = | 0.05 |
| df | = | 1 | **p** | = | 0.19 | **LO 90** | = | 0 |
| **Model is identified** | | | **RMR** | = | 0.03 | **PCLOSE** | = | 0.29 |

**Factor loadings**

(*** = p< 0.001, ** = p< 0.01, * = p< 0.05)

| Item | | Variable | Estimate | SE | CR | p | SMC | Comment |
|---|---|---|---|---|---|---|---|---|
| 2HRFE | <- | Business Knowledge | 0.62 | 0.83 | 16.00 | *** | 0.68 | Convergent validity holds |
| 2HRFF | <- | Business Knowledge | 0.62 | 0.83 | 16.00 | *** | 0.69 | Convergent validity holds |

**Model Fit acceptable**

The model fit statistics for the business knowledge variable (see Table 7.22) indicate an acceptable fit, and good factor loadings of the items for the parallel model. Hence, the one factor parallel model for business knowledge is accepted. However, since a congeneric model could not be estimated, it could not be determined at this stage whether a congeneric model might have a better fit than the parallel model. Hence, this decision was carried on to the next stage—the integration of the business knowledge variable into a second order CFA of the IT personnel capability construct (see following section).

### 7.7.2. Full measurement model of the IT personnel capability construct

The construct IT personnel capability was theorised to consist of two variables: broad IT knowledge and business knowledge of IT personnel. Each variable was estimated and fitted in separate one factor parallel measurement models above. In Figure 7-9 below the full measurement model of the IT personnel capability construct is displayed and its statistics are presented in Table 7.24 below.

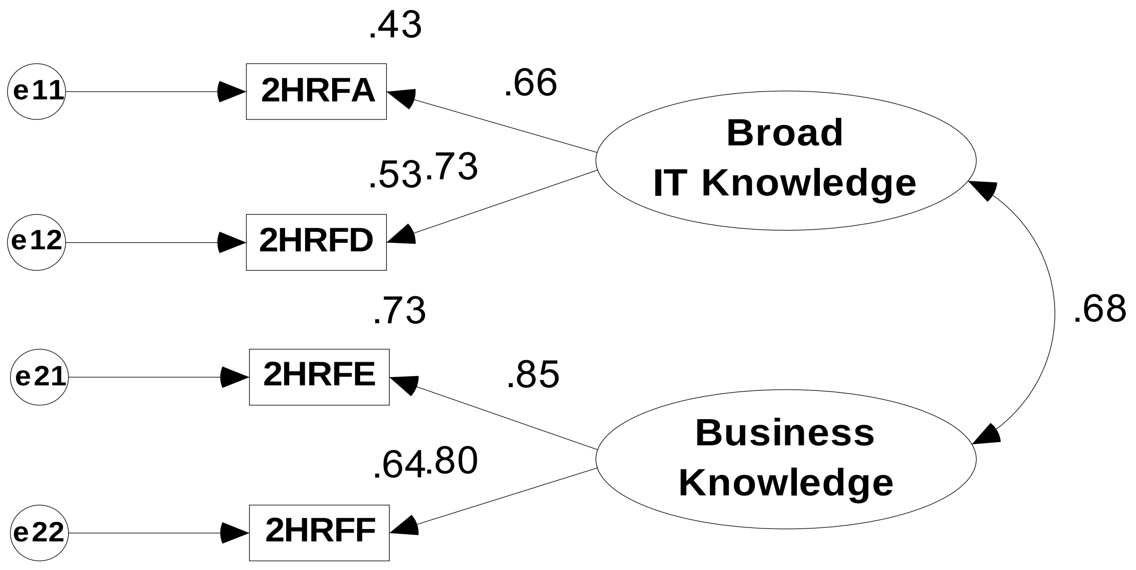


**Figure 7-9: Full Measurement Model for IT Personnel Capability**

**Table 7-24: Statistics for IT Personnel Capability Construct**

| Model identification | | | | Model Fit Statistics | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| observed variables | = | 6 | | $X^2$ | = | 11.68 | CFI | = | 0.98 |
| estimated parameters | = | 15 | | $X^2$ / df | = | 1.95 | RMSEA | = | 0.07 |
| df | = | 6 | | p | = | 0.07 | LO 90 | = | 0 |
| Model is identified | | | | RMR | = | 0.02 | PCLOSE | = | 0.25 |

**Factor loadings**

(*** = p< 0.001, ** = p< 0.01, * = p< 0.05)

| Item | | Variable | Estimate | SE | CR | p | SMC | Comment |
|---|---|---|---|---|---|---|---|---|
| 2HRFA | <- | IT Connectivity | 0.64 | 0.66 | 8.30 | *** | 0.43 | Convergent validity holds |
| 2HRFD | <- | IT Connectivity | 0.53 | 0.73 | 8.85 | *** | 0.53 | Convergent validity holds |
| 2HRFE | <- | IT Compatibility | 0.67 | 0.85 | 11.74 | *** | 0.73 | Convergent validity holds |
| 2HRFF | <- | IT Compatibility | 0.58 | 0.80 | 11.00 | *** | 0.64 | Convergent validity holds |
| **Model Fit acceptable** | | | | | | | | |

The fit statistics for the full measurement model of the IT personnel capability construct presented in Table 7.24 above reveal a well-fitting model with all fit statistics well above the set thresholds. Furthermore, the factor loadings and SMC indicate that all items of the measurement model exhibit convergent validity. After model fit and convergent validity was established, discriminant validity was calculated to identify whether the variables measure different things, the results of which are presented in Table 7.25 below.

**Table 7-25: Discriminant validity of personnel capability construct**

| | | Standardised Regression weight | | Error variance | variance extracted |
|---|---|---|---|---|---|
| **Variable** | **Item** | $\lambda$ | $\lambda^2$ | $\varepsilon$ | $\rho_{vc(\eta)}$ |
| Broad IT Knowledge | 2HRFA | 0.655 | 0.429 | 0.540 | |
| | 2HRFD | 0.730 | 0.533 | 0.240 | |
| | Sum | | 0.962 | 0.780 | 0.552 |
| Business Knowledge | 2HRFE | 0.850 | 0.723 | 0.166 | |
| | 2HRFF | 0.800 | 0.640 | 0.190 | |
| | Sum | | 1.363 | 0.356 | 0.793 |
| | **Correlation of variables** | | | | |
| | | | $\rho$ | | **Result (Method I)** |
| Broad IT Knowledge | <--> | Business Knowledge | 0.68 | | Discriminant validity holds |
| | **Pairwise variable comparison for Discriminant validity** | | | | |
| | | | $\rho^2$ | **ave** $\rho_{vc(\eta)}$ | **Result (Method II)** |
| Broad IT Knowledge | <--> | Business Knowledge | 0.462 | 0.673 | Discriminant validity holds |

Discriminant validity as outlined in Table 7.25 above was calculated as explained in the section above in two ways. The correlations of variables have to be below 0.85 and the average extracted variance of constructs should exceed the square of the correlations between the constructs (Holmes-Smith 2007). Both methods indicate that the construct of IT infrastructure capability holds discriminant validity. Thus, the full measurement model of the IT personnel capability construct is accepted.

### 7.7.3. IT personnel capability as a second order construct

Derived from an extensive literature review outlined in Chapter 3, the research model presented in Chapter 4 theorised IT personnel capability as a second order construct. The measurement model of the IT personnel capability construct in the section above is the basis for the second order construct of IT personnel capability which is displayed in Figure 7-10 below.

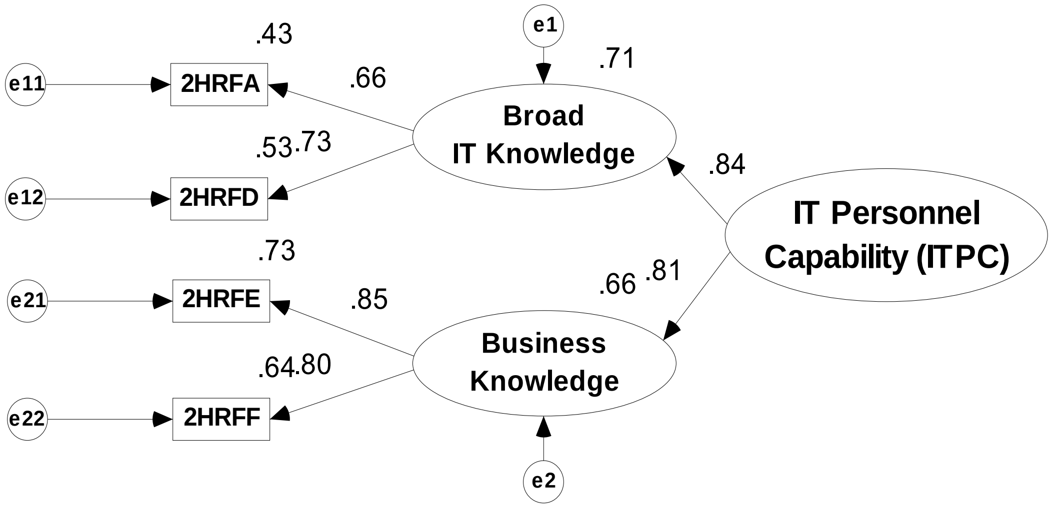


**Figure 7-10: IT Personnel Capability as a Second Order Construct**

**Table 7-26: Statistics for Second Order IT Personnel Capability Construct**

| **Model identification** | | | **Model Fit Statistics** | | | | | |
|---|---|---|---|---|---|---|---|---|
| observed variables | = | 4 | $X^2$ | = | 0.158 | **CFI** | = | 1 |
| estimated parameters | = | 19 | $X^2$ / df | = | 0.158 | **RMSEA** | = | 0.76 |
| df | = | 1 | **p** | = | 0.69 | **LO 90** | = | 0 |
| **Model is identified** | | | **RMR** | = | 0.002 | **PCLOSE** | = | 0.76 |

**Factor loadings**

(*** = p< 0.001, ** = p< 0.01, * = p< 0.05)

| Item | | Variable | Estimate | SE | CR | p | SMC | Comment |
|---|---|---|---|---|---|---|---|---|
| Broad IT Knowledge | <- | ITPC | 0.54 | 0.84 | 10.28 | *** | 0.71 | Convergent validity holds |
| Business Knowledge | <- | ITPC | 0.54 | 0.81 | 10.28 | *** | 0.66 | Convergent validity holds |

**Model Fit acceptable**

The second order measurement model for the IT personnel capability construct could not be identified in the congeneric version; hence, it was estimated as a parallel model. The model fit statistics in Table 7.26 above indicate an excellent-fitting model with sufficient convergent validity for each item of the model. Therefore, the second order measurement model for IT personnel capability is accepted.

## 7.8. MEASUREMENT MODEL FOR IT MANAGEMENT CAPABILITY

The construct IT management capability was theorised in the research model presented in Chapter 4 to consist of three variables: *IT–business partnerships*, *strategic IT management foresight* and *strategic IT management*. All items of strategic IT management and strategic IT management foresight had to be dropped in the data preparation (section 6.2) and instrument validation (section 7.2) phases. Hence, the IT management capability construct only consists of the IT–business partnership variable.

The variable IT–business partnership, now referred to as IT management capability, was theorised as consisting of five items. Item 4OMCE passed the internal consistency check, but was found to have cross-loadings in the EFA in the previous chapter, so was deleted. The first estimation of the measurement model indicated that the item 4OMCA had a too low SMC, and hence did not meet the convergent validity criterion and was deleted. The three remaining items are 4OMCB (‘*Critical information and knowledge that affect IT projects are shared freely between business units and the IS department*’), 4OMCC (‘*Our IT department and business units understand the working environments of each other’*), and 4OMCD (‘*The goals and plans for IT projects are jointly developed by the IT department and business units’*). Figure 7-11 displays the IT management construct

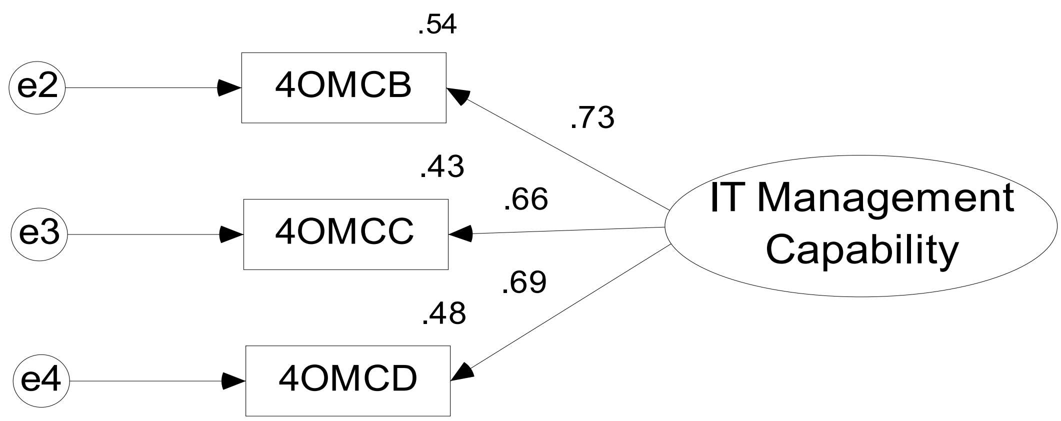


**Figure 7-11: One Factor Congeneric Model of IT Management Capability**

**Table 7-27: Statistics for One Factor Congeneric Model of IT Management Capability**

| Model identification | | | Model Fit Statistics | | | | | |
|---|---|---|---|---|---|---|---|---|
| observed variables | = | 3 | $X^2$ | = | 0.558 | CFI | = | 1 |
| estimated parameters | = | 4 | $X^2$ / df | = | 0.28 | RMSEA | = | 0 |
| df | = | 2 | p | = | 0.76 | LO 90 | = | 0 |
| **Model is identified** | | | RMR | = | 0.016 | PCLOSE | = | 0.84 |

**Factor loadings**

(*** = p< 0.001, ** = p< 0.01, * = p< 0.05)

| Item | | Variable | Estimate | SE | CR | p | SMC | Comment |
|---|---|---|---|---|---|---|---|---|
| 4OMCB | <- | IT Management Capability | 0.59 | 0.73 | 14.60 | *** | 0.54 | Convergent validity holds |
| 4OMCC | <- | IT Management Capability | 0.59 | 0.66 | 14.60 | *** | 0.43 | Convergent validity holds |
| 4OMCD | <- | IT Management Capability | 0.59 | 0.69 | 14.60 | *** | 0.48 | Convergent validity holds |

**Model Fit acceptable**

Figure 7-11 illustrates the IT management capability parallel model, followed by the statistics for this model presented in Table 7.27. The model fit is acceptable, and the factor loadings are close to explaining 50% of the variance in the IT management capability variable. Hence the measurement model for IT management capability is accepted.

## 7.9. Measurement Model of the IT Support for Core Competences Constructs

### 7.9.1. IT support for market competence

The support and enabling function IT can provide for companies' market competences is part of the IT support for market competence construct. The variable IT support for market competence was theorised as consisting of four items. The proposed model is illustrated in Figure 7-12 below.

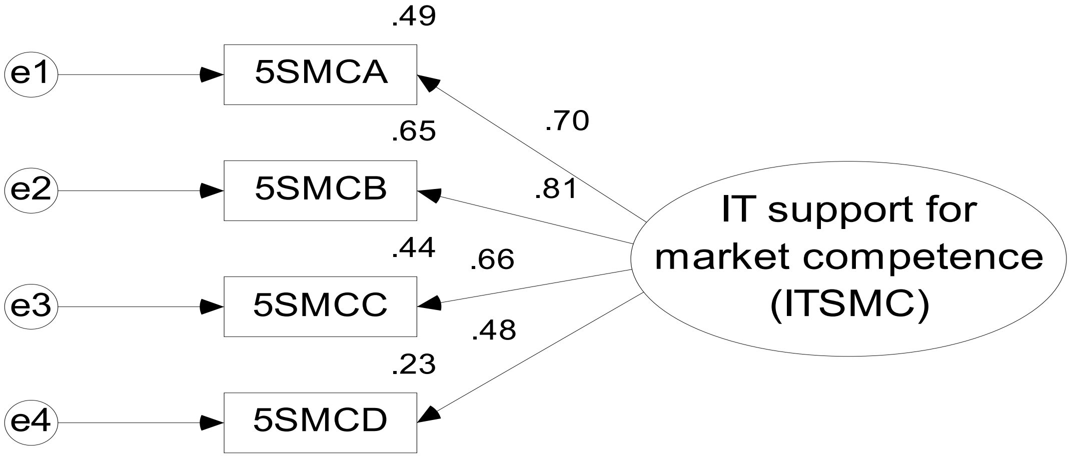


**Figure 7-12: One Factor Congeneric Model of IT Support for Market Competence**

**Table 7-28: Statistics for One Factor Congeneric Measurement Model of IT Support for Market Competence**

| Model identification | | | Model Fit Statistics | | | | | |
|---|---|---|---|---|---|---|---|---|
| observed variables | = | 4 | $X^2$ | = | 0.15 | CFI | = | 1 |
| estimated parameters | = | 9 | $X^2$ / df | = | 0.15 | RMSEA | = | 0 |
| df | = | 1 | p | = | 0.7 | LO 90 | = | 0 |
| Model is identified | | | RMR | = | 0.0 | PCLOSE | = | 0.76 |

**Factor loadings**

(*** = p< 0.001, ** = p< 0.01, * = p< 0.05)

| Item | | Variable | SE | CR | p | SMC | Comment |
|---|---|---|---|---|---|---|---|
| 5SMCA | <- | ITSMC | 0.70 | 7.19 | *** | 0.49 | Convergent validity holds |
| 5SMCB | <- | ITSMC | 0.81 | 8.58 | *** | 0.65 | Convergent validity holds |
| 5SMCC | <- | ITSMC | 0.66 | 6.58 | *** | 0.44 | Convergent validity holds |
| 5SMCD | <- | ITSMC | 0.48 | 8.61 | *** | 0.23 | Convergent validity FAILS |

**Model Fit inadmissible**

The model statistics for the IT support for market competence variable are displayed in Table 7.28 above. The model fit statistics indicate a good fit of the model and the sample data. All indicators are well inside the thresholds. RMSEA and LO90 of 0.00 and PCCLOSE of above 0.5 indicates that the claim for exact fit is supported. Furthermore, a p-value of 0.81 is clearly insignificant with a value above the 0.05 threshold. The factor loadings of 5SMCA, 5SMCB, 5SMCC are well above the recommended 0.3 threshold. Item 5SMCD (‘*Our IT is utilised to produce our products and services*’), however, has an SMC of only 0.23. This indicates that statistically speaking the item is not internally consistent with the other items. Hence, it was deleted and a new measurement model estimated. The final measurement model is displayed in Figure 7-13 below.

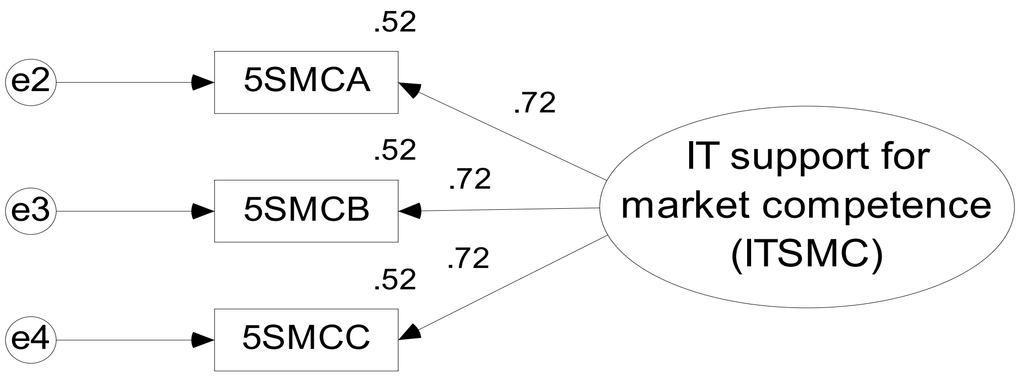


**Figure 7-13: Final One Factor Measurement Model for IT Support for Market Competence**

**Table 7-29: Statistics for Final One Factor Measurement Model for IT Support for Market Competence**

| **Model identification** | | | **Model Fit Statistics** | | | | | |
|---|---|---|---|---|---|---|---|---|
| observed variables | = | 3 | $X^2$ | = | 2.23 | **CFI** | = | 0.99 |
| estimated parameters | = | 11 | $X^2$ / df | = | 1.12 | **RMSEA** | = | 0.02 |
| df | = | 1 | **p** | = | 0.33 | **LO 90** | = | 0 |
| **Model is identified** | | | **RMR** | = | 0.03 | **PCLOSE** | = | 0.49 |

**Factor loadings**

(*** = p< 0.001, ** = p< 0.01, * = p< 0.05)

| **Item** | | **Variable** | **SE** | **CR** | **p** | **SMC** | **Comment** |
|---|---|---|---|---|---|---|---|
| 5SMCA | <- | ITSMC | 0.72 | 15.34 | *** | 0.52 | Convergent validity holds |
| 5SMCB | <- | ITSMC | 0.72 | 15.34 | *** | 0.52 | Convergent validity holds |
| 5SMCC | <- | ITSMC | 0.72 | 15.34 | *** | 0.52 | Convergent validity holds |

**Model Fit excellent**

The final measurement model for IT support for market competence in Figure 7-134 indicates an excellent fit in Table 7.29 above. All model fit statistics are well above the thresholds. Furthermore, the SMC of the items are all above the 0.3 threshold, indicating convergent validity for each item. Hence, the model is accepted.

### 7.9.2. IT support for operational competence

Organisational competences have to be supported, and are sometimes enabled by IT. The variable IT support for operational competence measures this support. The proposed model of IT support for operational competence was theorised to consist of four items. The proposed model is depicted in Figure 7-14 below.

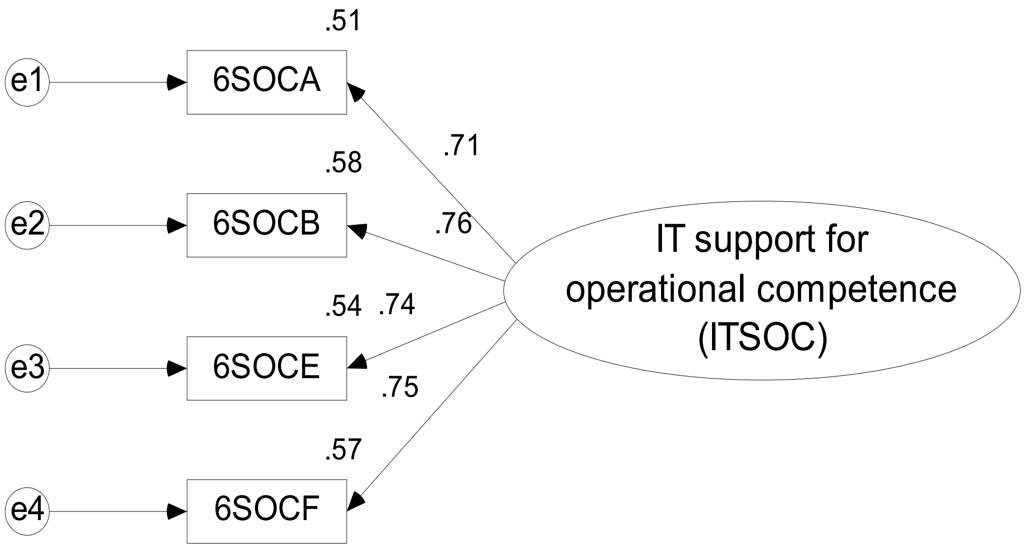


**Figure 7-14: Proposed One Factor Congeneric Model of IT Support for Operational Competence**

**Table 7-30: Statistics for Proposed One Factor Congeneric Model of IT Support for Operational Competence**

| Model identification | | | Model Fit Statistics | | | | | |
|---|---|---|---|---|---|---|---|---|
| observed variables | = | 4 | $X^2$ | = | 27.9 | CFI | = | 0.92 |
| estimated parameters | = | 9 | $X^2$ / df | = | 14 | RMSEA | = | 0.253 |
| df | = | 1 | p | = | 0 | LO 90 | = | 0.175 |
| **Model is identified** | | | RMR | = | 0.03 | PCLOSE | = | 0 |

**Factor loadings**

(*** = p< 0.001, ** = p< 0.01, * = p< 0.05)

| Item | | Variable | Estimate | SE | CR | p | SMC | Comment |
|---|---|---|---|---|---|---|---|---|
| 6SOCA | <- | ITSOC | 0.55 | 0.71 | 10.72 | *** | 0.51 | Convergent validity holds |
| 6SOCB | <- | ITSOC | 0.52 | 0.76 | 11.72 | *** | 0.59 | Convergent validity holds |
| 6SOCE | <- | ITSOC | 0.59 | 0.74 | 11.19 | *** | 0.54 | Convergent validity holds |
| 6SOCF | <- | ITSOC | 0.61 | 0.75 | 11.49 | *** | 0.57 | Convergent validity holds |

**Model Fit inadmissible**

The factor loadings on the right-hand side of Table 7.30 above indicate that all items load well on the IT support for operational competence variable. However, the model fit statistics on the left-hand side of Table 7.30 tell a different story. The proposed model of IT support for operational competence is a clear misfit. All fit statistics indicate that the model does not represent the sample data in an appropriate way. To investigate the reasons for this misfit, respecification statistics were estimated which are presented in Table 7.31 below.

**Table 7-31: Respecification Statistics for Operational Competence**

| Standardised residual covariances | | | | | Modification Indices | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 6SOCF | 6SOCE | 6SOCB | 6SOCA | | | | MI | Par Change |
| **6SOCF** | 0 | | | | e3 | <--> | e4 | 12.06 | 0.086 |
| **6SOCE** | 1.101 | 0 | | | e2 | <--> | e4 | 6.787 | -0.054 |
| **6SOCB** | -0.77 | -0.205 | 0 | | e1 | <--> | e3 | 9.396 | -0.075 |
| **6SOCA** | -0.244 | -1.068 | 1.162 | 0 | e1 | <--> | e2 | 12.826 | 0.073 |

The standardised residual covariances in Table 7.31 above indicate that the covariance between 6SOCF (‘*Our IT supports cross-functional integration of the firm*’) and 6SCOCE (‘*Our IT supports knowledge-sharing in the company*’) is not represented correctly by the proposed model of IT support for operational competence. The modification indices on the right hand sight of Table 7.31 further indicate that covarying these items would increase the $\chi^2$ an approximate 12.06 points and the correlation would be 0.086. Even though other items also correlate, this correlation is the highest; hence, it was dealt with first. Upon further investigation of the standardised residual covariances and the modification indices it is obvious that the item 6SMCE covaries not only with 6SOCF, but also with other items of the model. Hence, the item 6SMCE was deleted and the resulting final model of IT support for operational competence is displayed in Figure 7-15 below.

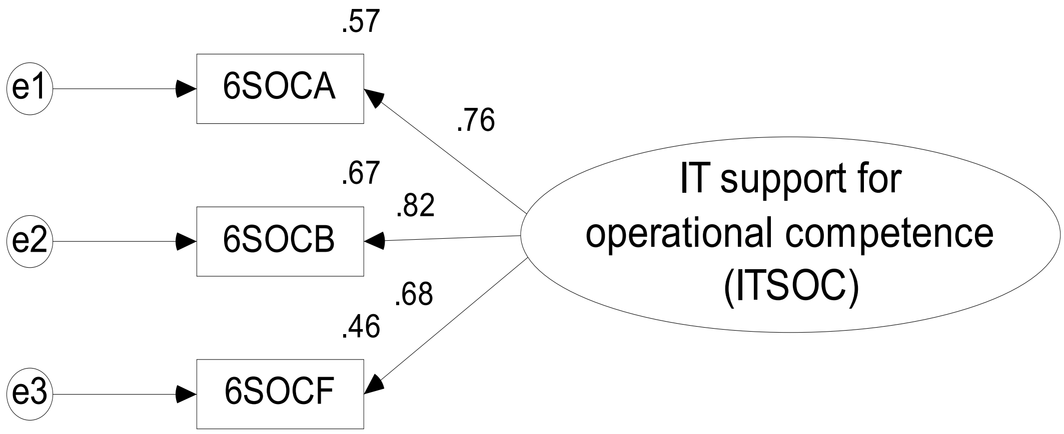


**Figure 7-15: Final One Factor Congeneric Model for IT Support for Operational Competence**

**Table 7-32: Statistics for Final One Factor Congeneric Measurement Model of IT Support for Operational Competence**

| **Model identification** | | | **Model Fit Statistics** | | | | | |
|---|---|---|---|---|---|---|---|---|
| observed variables | = | 3 | $X^2$ | = | 1.99 | **CFI** | = | 0.99 |
| estimated parameters | = | 4 | $X^2$ / df | = | 1 | **RMSEA** | = | 0 |
| df | = | 2 | **p** | = | 0.36 | **LO 90** | = | 0 |
| **Model is identified** | | | **RMR** | = | 0.02 | **PCLOSE** | = | 0.53 |

**Factor loadings**

(*** = p< 0.001, ** = p< 0.01, * = p< 0.05)

| Item | | Variable | Estimate | SE | CR | p | SMC | Comment |
|---|---|---|---|---|---|---|---|---|
| 6SOCA | <- | ITSOC | 0.56 | 0.76 | 16.00 | *** | 0.57 | Convergent validity holds |
| 6SOCB | <- | ITSOC | 0.56 | 0.82 | 16.00 | *** | 0.67 | Convergent validity holds |
| 6SOCF | <- | ITSOC | 0.56 | 0.68 | 16.00 | *** | 0.46 | Convergent validity holds |

**Model Fit excellent**

The statistics for the final model of IT support for operational competence in Table 7.32 above indicate an excellent-fitting model, with p=0.70 well above the significance level of 0.05. Furthermore, GFI, CFI, RMSEA and Lo90 indicate exact fit, and PCCLOSE above 0.5 supports this even further. In addition to a good fit, all factor loadings show good values of SMC. Hence, the model of IT support for operational competence is accepted.

## 7.10. MEASUREMENT MODEL OF THE ADAPTIVE IT CAPABILITY CONSTRUCT

The adaptive IT capabilities construct was theorised to consist of eight items. Figure 7-16 below displays the proposed one factor congeneric measurement model for adaptive IT capability.

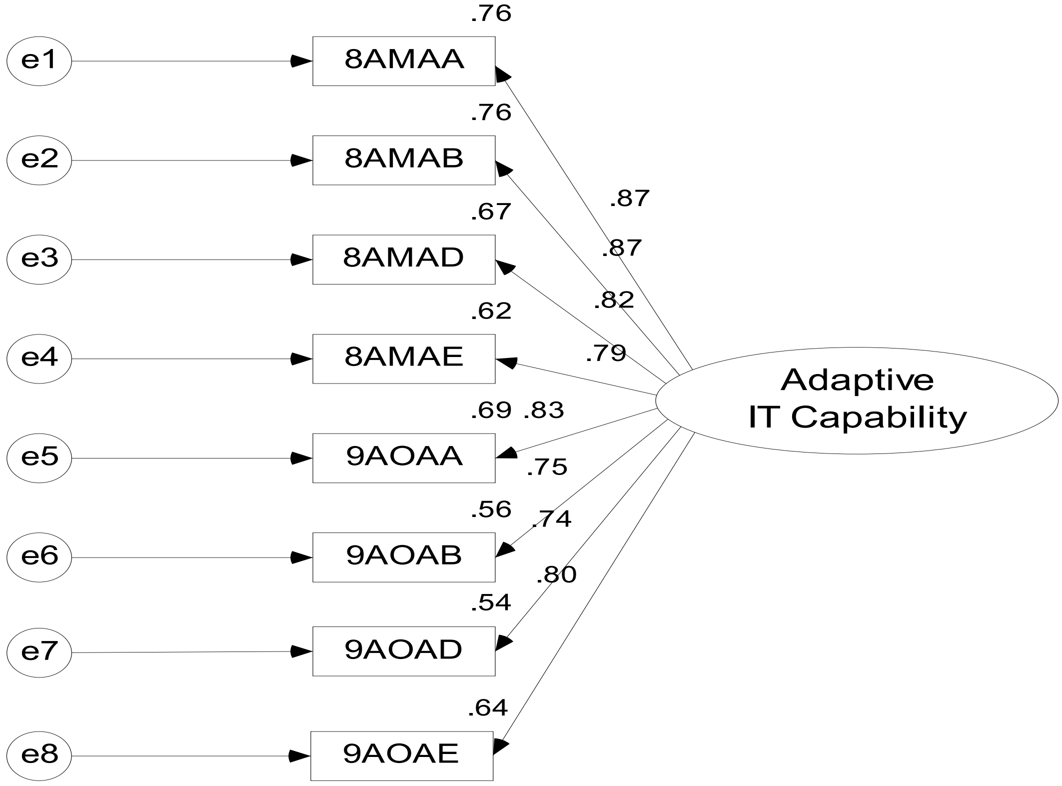


**Figure 7-16: Proposed One Factor Congeneric Model for Adaptive IT Capability**

**Table 7-33: Statistics for Proposed One Factor Measurement Model of Adaptive IT Capability Construct**

| Model identification | | | Model Fit Statistics | | | | | |
|---|---|---|---|---|---|---|---|---|
| observed variables | = | 8 | $X^2$ | = | 125.30 | CFI | = | 0.918 |
| estimated parameters | = | 25 | $X^2$ / df | = | 6.27 | RMSEA | = | 0.161 |
| df | = | 20 | p | = | 0.00 | LO 90 | = | 0.135 |
| Model is identified | | | RMR | = | 0.36 | PCLOSE | = | 0 |

Factor loadings

(*** = p< 0.001, ** = p< 0.01, * = p< 0.05)

| Item | | Variable | Estimate | SE | CR | p | SMC | Comment |
|---|---|---|---|---|---|---|---|---|
| 8AMAA | <- | Adaptive IT capability | 0.80 | 0.87 | 15.50 | *** | 0.76 | Convergent validity holds |
| 8AMAB | <- | Adaptive IT capability | 0.76 | 0.87 | 15.50 | *** | 0.76 | Convergent validity holds |
| 8AMAD | <- | Adaptive IT capability | 0.72 | 0.82 | 14.00 | *** | 0.67 | Convergent validity holds |
| 8AMAE | <- | Adaptive IT capability | 0.71 | 0.79 | 13.20 | *** | 0.62 | Convergent validity holds |
| 9AOAA | <- | Adaptive IT capability | 0.75 | 0.83 | 14.30 | *** | 0.69 | Convergent validity holds |
| 9AOAB | <- | Adaptive IT capability | 0.70 | 0.75 | 12.20 | *** | 0.56 | Convergent validity holds |
| 9AOAD | <- | Adaptive IT capability | 0.64 | 0.74 | 12.00 | *** | 0.54 | Convergent validity holds |
| 9AOAE | <- | Adaptive IT capability | 0.63 | 0.80 | 13.55 | *** | 0.64 | Convergent validity holds |

Model Fit inadmissible

The statistics for the above displayed measurement model for adaptive IT capability construct in Table 7.33 indicate a clear misfit of the model. Hence, respecification statistics were calculated and the results are presented in Table 7.34 below.

**Table 7-34: Standardised Residual Covariances for Adaptive IT Capability**

Standardised residual covariances

| | 9AOAD | 8AMAA | 8AMAB | 8AMAD | 8AMAE | 9AOAA | 9AOAB | 9AOAE |
|---|---|---|---|---|---|---|---|---|
| 9AOAD | 0 | | | | | | | |
| 8AMAA | -0.606 | 0 | | | | | | |
| 8AMAB | -0.569 | 0.836 | 0 | | | | | |
| 8AMAD | -0.232 | 0.076 | 0.341 | 0 | | | | |
| 8AMAE | -0.741 | -0.072 | -0.263 | 0.906 | 0 | | | |
| 9AOAA | 0.089 | -0.143 | -0.066 | -0.822 | 0.103 | 0 | | |
| 9AOAB | 1.11 | -0.563 | -0.544 | -0.318 | -0.119 | 1.084 | 0 | |
| 9AOAE | 1.99 | -0.405 | -0.672 | -0.151 | 0.034 | 0.31 | 0.225 | 0 |

**Table 7-35: Modification Indices for Adaptive IT Capability**

| Modification Indices | | | MI | Par Change |
|---|---|---|---|---|
| e1 | <--> | e7 | 6.14 | -0.05 |
| e2 | <--> | e7 | 5.35 | -0.05 |
| e2 | <--> | e1 | 27.52 | 0.08 |
| e4 | <--> | e7 | 5.00 | -0.06 |
| e4 | <--> | e3 | 11.50 | 0.07 |
| e5 | <--> | e3 | 12.23 | -0.07 |
| e6 | <--> | e7 | 9.07 | 0.08 |
| e6 | <--> | e1 | 5.54 | -0.05 |
| e6 | <--> | e2 | 5.11 | -0.05 |
| e6 | <--> | e5 | 14.41 | 0.09 |
| e8 | <--> | e7 | 38.44 | 0.13 |
| e8 | <--> | e2 | 10.33 | -0.05 |

The respecification statistics presented in Table 7.34 and Table 7.35 above show high standardised residual covariances for a couple of items. This implies that the model does not represent the data correctly. A couple of corrective measures were thus performed. Firstly, the items 8AMAA ('*Our IT is able to adapt quickly to changes in the market and customer demands*') and 8AMAB ('*Our IT is able to adapt quickly to changes in the firm's products or services*') both measured similar things. Changes in market and customer demands would lead to changes in products and services. Hence, the items 8AMAA and 8AMAB were covaried. Secondly, the item 8AMAD ('*Our IT is able to adapt quickly to changes which can become necessary because of competitors' actions'*) showed high residual covariances with two items: 8AMAE ('*Our IT is utilised to increase the speed of responding to business opportunities/threats*') and 9AOAA ('*Our IT is able to adapt quickly to changes in business processes and organisational structures'*). Reacting to competitors' actions nearly always means changes in business processes and organisational structures. Hence, the items 8AMAD and 8AMAE were covaried. Finally, the items 9AOAB ('*Our IT is able to quickly adapt to changes in knowledge-sharing in the company*') and 9AOAE ('*Our IT is able to enhance strategic business process flexibility*') indicated a misfit. Hence, they were deleted. The resulting final measurement model for adaptive IT capability is illustrated in Figure 7-17 below.

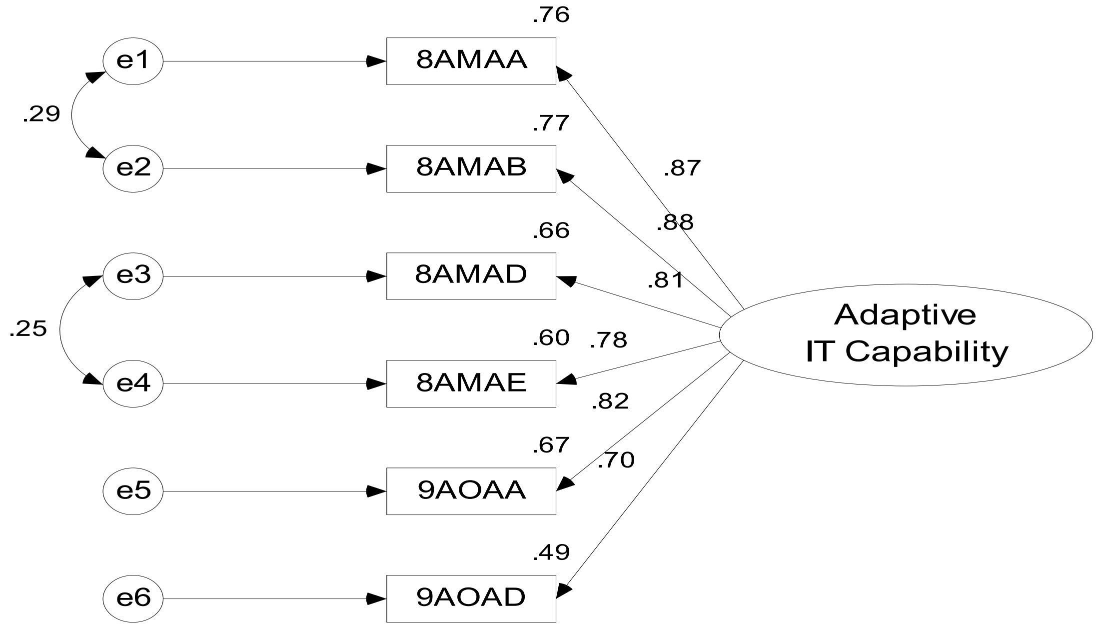


**Figure 7-17: Final One Factor Congeneric Measurement Model for Adaptive IT Capability**

**Table 7-36: Statistics for Final One Factor Congeneric Measurement Model of Adaptive IT Capability**

| Model identification | | | Model Fit Statistics | | | | | |
|---|---|---|---|---|---|---|---|---|
| observed variables | = | 8 | $X^2$ | = | 125,30 | CFI | = | 0.918 |
| estimated parameters | = | 25 | $X^2$ / df | = | 6,27 | RMSEA | = | 0.161 |
| df | = | 20 | p | = | 0,00 | LO 90 | = | 0.135 |
| **Model is identified** | | | RMR | = | 0,36 | PCLOSE | = | 0 |

**Factor loadings**

(*** = p< 0.001, ** = p< 0.01, * = p< 0.05)

| Item | | Variable | E | S.E. | C.R. | p | SMC | Comment |
|---|---|---|---|---|---|---|---|---|
| 8AMAA | <- | adaptive IT capability | 0,80 | 0,87 | 15,50 | *** | 0,76 | Convergent validity holds |
| 8AMAB | <- | adaptive IT capability | 0,76 | 0,87 | 15,50 | *** | 0,76 | Convergent validity holds |
| 8AMAD | <- | adaptive IT capability | 0,72 | 0,82 | 14,00 | *** | 0,67 | Convergent validity holds |
| 8AMAE | <- | adaptive IT capability | 0,71 | 0,79 | 13,20 | *** | 0,62 | Convergent validity holds |
| 9AOAA | <- | adaptive IT capability | 0,75 | 0,83 | 14,30 | *** | 0,69 | Convergent validity holds |
| 9AOAB | <- | adaptive IT capability | 0,70 | 0,75 | 12,20 | *** | 0,56 | Convergent validity holds |
| 9AOAD | <- | adaptive IT capability | 0,64 | 0,74 | 12,00 | *** | 0,54 | Convergent validity holds |
| 9AOAE | <- | adaptive IT capability | 0,63 | 0,80 | 13,55 | *** | 0,64 | Convergent validity holds |

**Model Fit inadmissable**

The statics for the final one factor congeneric measurement model displayed in Table 7.36 above indicate an acceptable model fit and convergent validity (SMC above 0.3 for each item). Hence, this measurement model for the adaptive IT capability construct is accepted.

## 7.11. MEASUREMENT MODEL FOR COMPETITIVE ADVANTAGE

The competitive advantage construct was theorised as consisting of three items. Two of these three items measure financial performance (10CAA) and profitability (10CAB) while the third measures (10CAC) sales growth. The graphic representation of the proposed model is displayed below in Figure 7-18

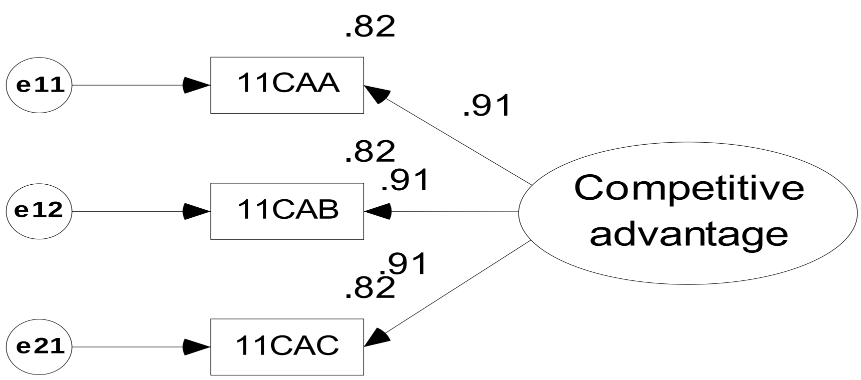


**Figure 7-18: One Factor Proposed Model of Competitive Advantage**

**Table 7-37: Statistics for One Factor Proposed Model of Competitive Advantage**

| **Model identification** | | | **Model Fit Statistics** | | | | | |
|---|---|---|---|---|---|---|---|---|
| observed variables | = | 3 | $X^2$ | = | 82.26 | **CFI** | = | 0.86 |
| estimated parameters | = | 2 | $X^2$ / df | = | 20.00 | **RMSEA** | = | 0.31 |
| df | = | 4 | **p** | = | 0.00 | **LO 90** | = | 0.25 |
| **Model is identified** | | | **RMR** | = | 0.04 | **PCLOSE** | = | 0 |

**Factor loadings**

(*** = p< 0.001, ** = p< 0.01, * = p< 0.05)

| Item | | Variable | Estimate | SE | CR | p | SMC | Comment |
|---|---|---|---|---|---|---|---|---|
| 11CAA | <- | Competitive advantage | 0.82 | 0.91 | 14.21 | *** | 0.82 | Convergent validity holds |
| 11CAB | <- | Competitive advantage | 0.82 | 0.91 | 14.21 | *** | 0.82 | Convergent validity holds |
| 11CAC | <- | Competitive advantage | 0.82 | 0.91 | 14.21 | *** | 0.82 | Convergent validity holds |

**Model Fit inadmissible**

The statistics of the proposed model of competitive advantage presented in Table 7.37 reveal an inadmissible model fit. To identify possible sources of misfit, respecification indices were calculated and these are presented in Table 7.38 below.

**Table 7-38: Respecification Statistics for Competitive Advantage**

**Standardised residual covariances**

| | 11CAA | 11CAB | 11CAC |
|---|---|---|---|
| 11CAA | 0.05 | | |
| 11CAB | 1.08 | -0.15 | |
| 11CAC | -0.59 | -0.50 | 0.10 |

**High standardised residual covariance between 11CAA and 11CAB indicates possible misspecification of model**

**Modification Indices**

| | | | MI | Par Change |
|---|---|---|---|---|
| e2 | <--> | e1 | 54.518 | 0.101 |
| e3 | <--> | e1 | 18.518 | -0.059 |
| e3 | <--> | e2 | 9.489 | -0.042 |

**MI indicate that covarying error items will improve the model**

The high standardised residual covariances between the items 11CAA and 11CAB indicate a source of misfit (see Table 7.38). This claim is supported by the modification indices on the right-hand side of Table 7.38. The MI between the error terms of 11CAA (‘*Over the past three years, our financial performance has been outstanding*’) and 11CAB (‘*Over the past three years, we have been more profitable than our competitors*’) are correlated higher to each other than to the third item, 11CAC (‘*Over the past three years, our sales growth has exceeded our competitors*’). From a theoretical perspective the first two items (11CAA and 11CAB) measure performance, whereas the third item, 11CAC, measures sales growth. Hence, the misspecified correlation between 11CAA and 11CAB is justifiable. 11CAA and 11CAB were covaried. The result is the final model, illustrated in Figure 7.20 and statistics in Table 7.39 below.

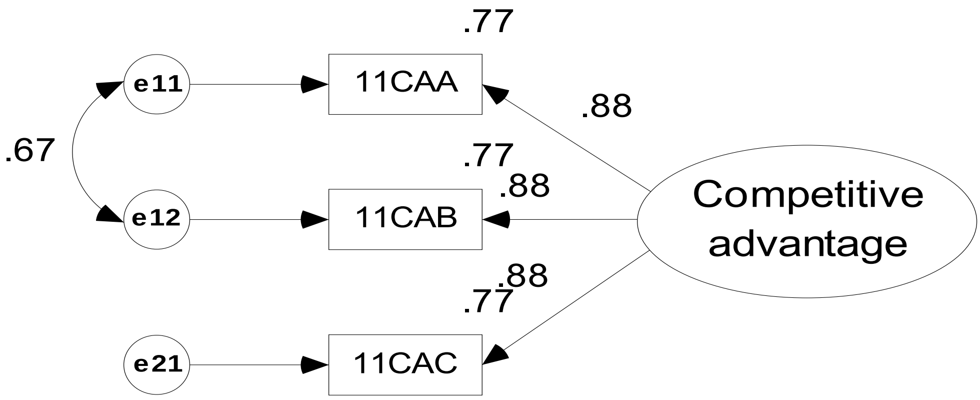


**Figure 7.20: Final One Factor Parallel Model of Competitive Advantage**

**Table 7-39: Statistics for Final One Factor Parallel Measurement of Competitive Advantage**

| **Model identification** | | | **Model Fit Statistics** | | | | | |
|---|---|---|---|---|---|---|---|---|
| observed variables | = | 3 | $X^2$ | = | 0.08 | **CFI** | = | 1 |
| estimated parameters | = | 3 | $X^2$ / **df** | = | 0.84 | **RMSEA** | = | 0 |
| df | = | 1 | **p** | = | 0.77 | **LO 90** | = | 0 |
| **Model is identified** | | | **RMR** | = | 0.00 | **PCLOSE** | = | 0.82 |

**Factor loadings**

(*** = p< 0.001, ** = p< 0.01, * = p< 0.05)

| Item | | Variable | Estimate | SE | CR | p | SMC | Comment |
|---|---|---|---|---|---|---|---|---|
| 11CAA | <- | Competitive advantage | 0.45 | 0.88 | 17.55 | *** | 0.77 | Convergent validity holds |
| 11CAB | <- | Competitive advantage | 0.45 | 0.88 | 17.55 | *** | 0.77 | Convergent validity holds |
| 11CAC | <- | Competitive advantage | 0.45 | 0.88 | 17.55 | *** | 0.77 | Convergent validity holds |
| **Model Fit acceptable** | | | | | | | | |

According to the model fit statistics in Table 7.39 above the final one factor parallel model of competitive advantage has an acceptable model fit and all items hold convergent validity. Hence, the final one factor parallel model of competitive advantage is accepted.

## 7.12. FULL CFA MEASUREMENT MODEL

The sections above have discussed each construct separately and have delineated the one factor congeneric measurement models. These models constitute the input into the full measurement model presented in this section. The proposed full CFA measurement model of this research is illustrated in Figure 7-19 below.

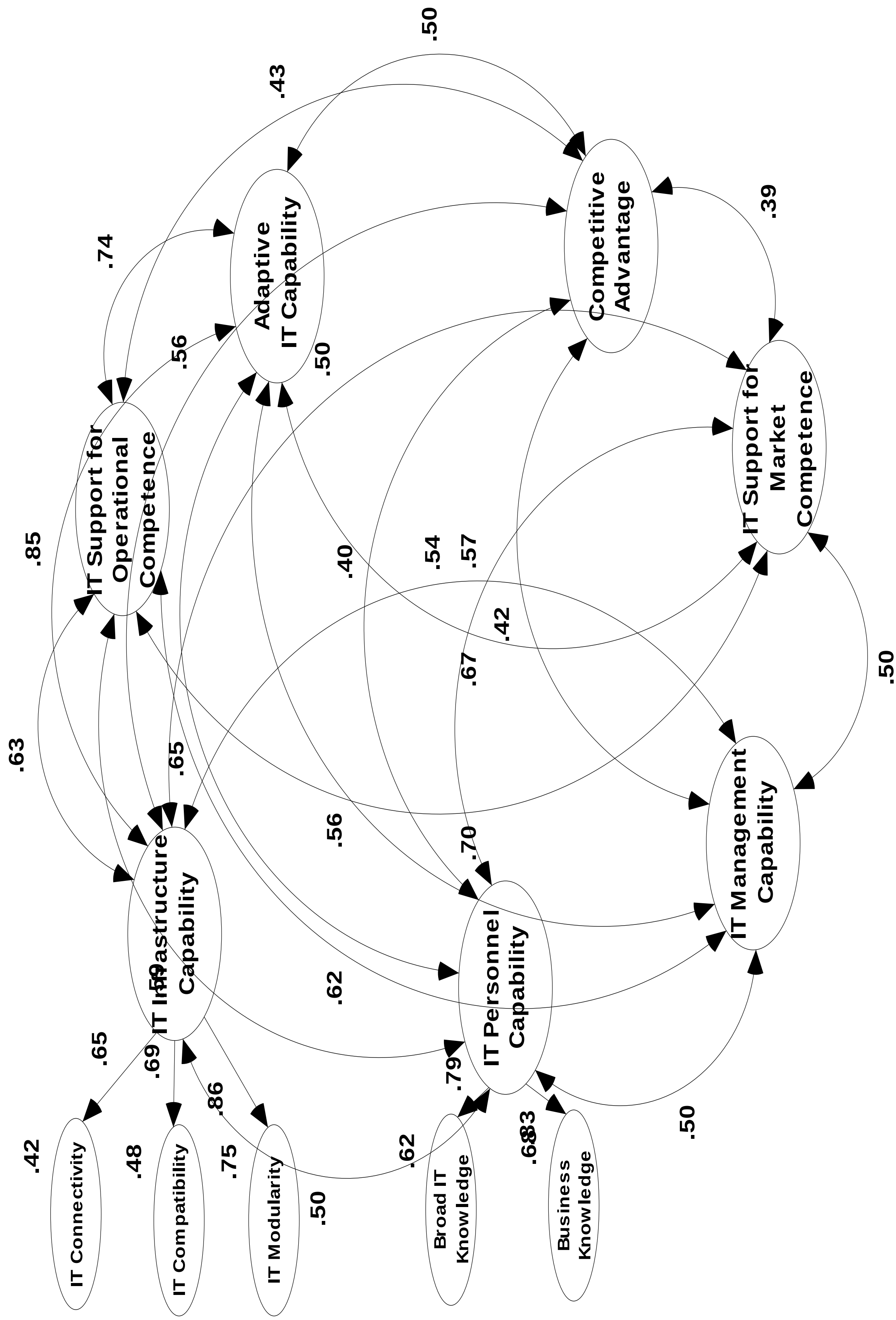


**Figure 7-19: Proposed Full CFA Measurement Model**

**Table 7-40: Statistics for Proposed Full CFA Measurement Model**

| Model identification | | | Model Fit Statistics | | | | | |
|---|---|---|---|---|---|---|---|---|
| **observed variables** | = | 28 | $X^2$ | = | 474.04 | **CFI** | = | 0.95 |
| **estimated parameters** | = | 130 | $X^2$ / df | = | 1.48 | **RMSEA** | = | 0.05 |
| **df** | = | 321 | **p** | = | 0.00 | **LO 90** | = | 0.04 |
| | | | **RMR** | = | 0.04 | **PCLOSE** | = | 0.59 |
| **Model is identified** | | | **Model fit acceptable** | | | | | |

The statistics for the full CFA measurement model summarised in Table 7.40 above indicate an acceptable fit for the full CFA measurement model. The CFI is with 0.95, well above the 0.92 threshold, the RMSEA with 0.05, well below the 0.08 threshold, and the PCLOSE value is above 0.05. The discriminant validity for the full measurement model is displayed in Table 7.41 and Table 7.42 below.

**Table 7-41: Discriminant Validity I for Proposed Full Measurement Model**

| | | | ρ | Result (Method I) |
|---|---|---|---|---|
| IT support for market competence | <--> | Competitive advantage | 0.39 | Discriminant validity holds |
| Competitive advantage | <--> | Adaptive IT capability | 0.50 | Discriminant validity holds |
| IT support for operational competence | <--> | Adaptive IT capability | 0.74 | Discriminant validity holds |
| IT infrastructure capability | <--> | IT support for operational competence | 0.63 | Discriminant validity holds |
| IT infrastructure capability | <--> | IT personnel capability | 0.50 | Discriminant validity holds |
| IT management capability | <--> | IT personnel capability | 0.50 | Discriminant validity holds |
| IT support for market competence | <--> | IT management capability | 0.50 | Discriminant validity holds |
| IT support for operational competence | <--> | Competitive advantage | 0.43 | Discriminant validity holds |
| IT infrastructure capability | <--> | Competitive advantage | 0.56 | Discriminant validity holds |
| Competitive advantage | <--> | IT personnel capability | 0.40 | Discriminant validity holds |
| Competitive advantage | <--> | IT management capability | 0.42 | Discriminant validity holds |
| IT infrastructure capability | <--> | Adaptive IT capability | **0.85** | **Discriminant validity fails** |
| Adaptive IT capability | <--> | IT personnel capability | 0.65 | Discriminant validity holds |
| Adaptive IT capability | <--> | IT management capability | 0.56 | Discriminant validity holds |
| IT support for operational competence | <--> | IT personnel capability | 0.60 | Discriminant validity holds |
| IT support for market competence | <--> | Adaptive IT capability | 0.67 | Discriminant validity holds |
| IT support for operational competence | <--> | IT support for market competence | 0.70 | Discriminant validity holds |
| IT infrastructure capability | <--> | IT support for market competence | 0.50 | Discriminant validity holds |
| IT support for market competence | <--> | IT personnel capability | 0.58 | Discriminant validity holds |
| IT support for operational competence | <--> | IT management capability | 0.62 | Discriminant validity holds |
| IT infrastructure capability | <--> | IT management capability | 0.54 | Discriminant validity holds |

Table 7-42: Discriminant Validity II for Proposed Full Measurement Model

| | | | $\rho^2$ | ave $\rho_{vc(\eta)}$ | **Result (Method II)** |
|---|---|---|---|---|---|
| IT support for market competence | <--> | Competitive advantage | 0.154 | 0.644 | Discriminant validity holds |
| Competitive advantage | <--> | Adaptive IT capability | 0.249 | 0.652 | Discriminant validity holds |
| IT support for operational competence | <--> | Adaptive IT capability | 0.543 | 0.636 | Discriminant validity holds |
| IT infrastructure capability | <--> | IT support for operational competence | 0.397 | 0.689 | Discriminant validity holds |
| IT infrastructure capability | <--> | IT personnel capability | 0.253 | 0.689 | Discriminant validity holds |
| IT management capability | <--> | IT personnel capability | 0.251 | 0.742 | Discriminant validity holds |
| IT support for market competence | <--> | IT management capability | 0.252 | 0.520 | Discriminant validity holds |
| IT support for operational competence | <--> | Competitive advantage | 0.187 | 0.703 | Discriminant validity holds |
| IT infrastructure capability | <--> | Competitive advantage | 0.310 | 0.705 | Discriminant validity holds |
| Competitive advantage | <--> | IT personnel capability | 0.163 | 0.758 | Discriminant validity holds |
| Competitive advantage | <--> | IT management capability | 0.177 | 0.594 | Discriminant validity holds |
| IT infrastructure capability | <--> | Adaptive IT capability | **0.723** | **0.639** | **Discriminant validity fails** |
| Adaptive IT capability | <--> | IT personnel capability | 0.421 | 0.691 | Discriminant validity holds |
| Adaptive IT capability | <--> | IT management capability | 0.310 | 0.528 | Discriminant validity holds |
| IT support for operational competence | <--> | IT personnel capability | 0.354 | 0.742 | Discriminant validity holds |
| IT support for market competence | <--> | Adaptive IT capability | 0.448 | 0.578 | Discriminant validity holds |
| IT support for operational competence | <--> | IT support for market competence | 0.496 | 0.628 | Discriminant validity holds |
| IT infrastructure capability | <--> | IT support for market competence | 0.247 | 0.630 | Discriminant validity holds |
| IT support for market competence | <--> | IT personnel capability | 0.331 | 0.683 | Discriminant validity holds |
| IT support for operational competence | <--> | IT management capability | 0.382 | 0.578 | Discriminant validity holds |
| IT infrastructure capability | <--> | IT management capability | 0.287 | 0.580 | Discriminant validity holds |

Table 7.41 above illustrates the discriminant validity for the proposed full measurement model. The correlations between the adaptive IT capability and the IT Infrastructure capability constructs reached the threshold of 0.85. Furthermore, the average variance extracted between these two constructs was lower than the squared correlations. Hence, discriminant validity failed. To investigate this issue, the correlations between the three variables of IT infrastructure capability and adaptive IT capability were scrutinized. The correlations between the variables of IT infrastructure and adaptive IT capability construct revealed a high correlation between the IT modularity variable and the adaptive IT capability construct. Therefore, the IT modularity variable was deleted and the full measurement model re-estimated (see Figure 7-202 below)

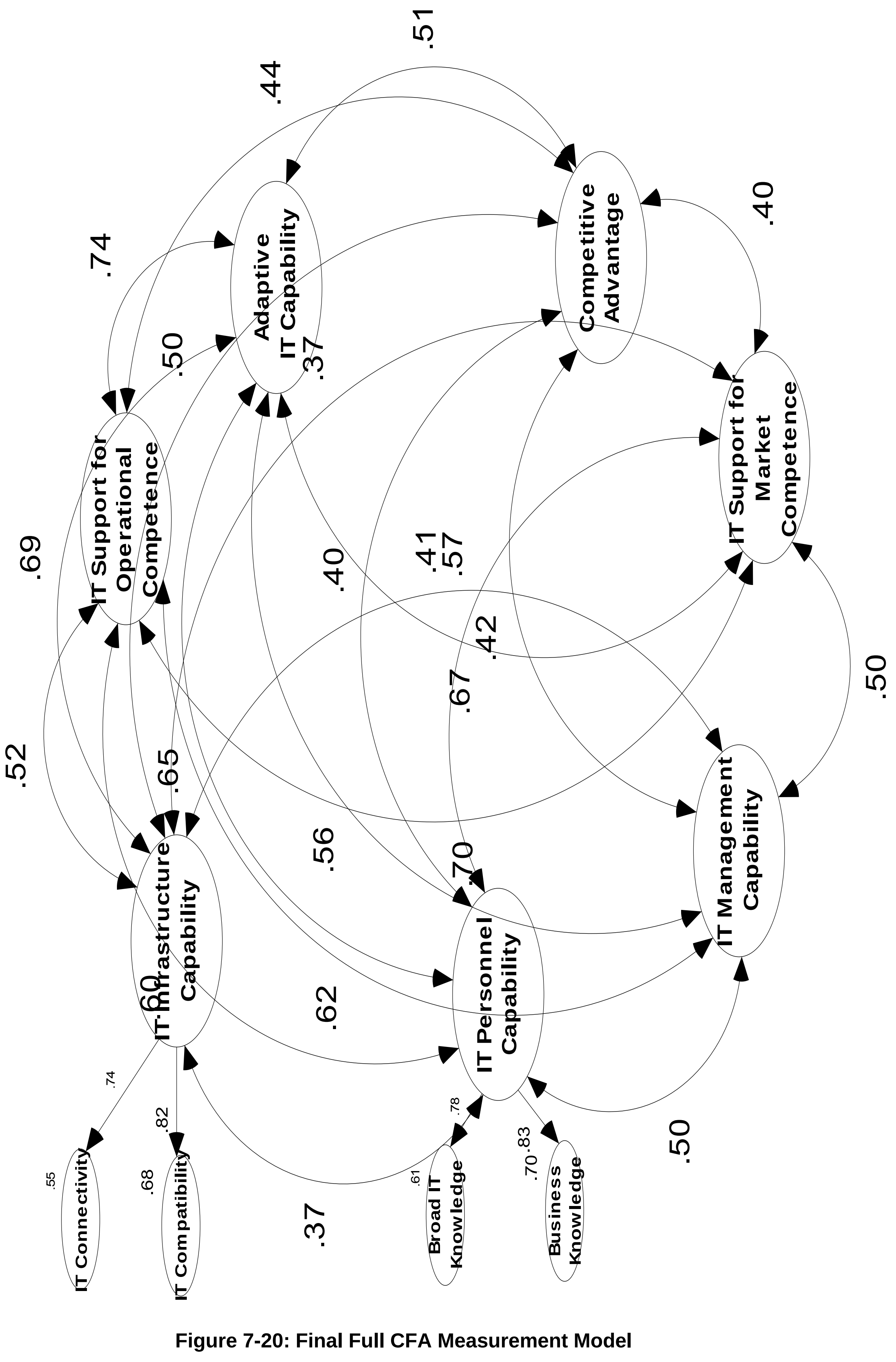


**Figure 7-20: Final Full CFA Measurement Model**

**Table 7-43: Statistics for Final Full CFA Measurement Model**

| Model identification | | | Model fit statistics | | | | | |
|---|---|---|---|---|---|---|---|---|
| observed variables | = | 26 | $X^2$ | = | 429.40 | CFI | = | 0.95 |
| estimated parameters | = | 80 | $X^2$ / df | = | 1.58 | RMSEA | = | 0.05 |
| df | = | 271 | p | = | 0.00 | LO 90 | = | 0.04 |
| | | | RMR | = | 0.43 | PCLOSE | = | 0.26 |
| Model is identified | | | Model fit acceptable | | | | | |

The model fit statistics presented in Table 7.43 above indicate a well-fitting full CFA model with all fit statistics above the recommended thresholds. The discriminant validity was re-estimated and the results are displayed in Table 7.44 and Table 7.45 below.

**Table 7-44: Discriminant Validity I Final Model**

| | | | ρ | Result (Method I) |
|---|---|---|---|---|
| IT support for market competence | <--> | Competitive advantage | 0,40 | Discriminant validity holds |
| Competitive advantage | <--> | Adaptive IT capabilty | 0,51 | Discriminant validity holds |
| IT support for operational competence | <--> | Adaptive IT capability | 0,75 | Discriminant validity holds |
| IT infrastructure capability | <--> | IT support for operational competence | 0,52 | Discriminant validity holds |
| IT infrastructure capability | <--> | IT personnel capability | 0,37 | Discriminant validity holds |
| IT management capability | <--> | IT personnel capability | 0,50 | Discriminant validity holds |
| IT support for market competence | <--> | IT management capability | 0,50 | Discriminant validity holds |
| IT support for operational competence | <--> | Competitive advantage | 0,45 | Discriminant validity holds |
| IT Infrastructure capability | <--> | Competitive advantage | 0,50 | Discriminant validity holds |
| Competitive advantage | <--> | IT personnel capability | 0,40 | Discriminant validity holds |
| Competitive advantage | <--> | IT management capability | 0,42 | Discriminant validity holds |
| IT infrastructure capability | <--> | Adaptive IT capability | 0,69 | Discriminant validity holds |
| Adaptive IT capability | <--> | IT personnel capability | 0,63 | Discriminant validity holds |
| Adaptive IT capability | <--> | IT management capability | 0,55 | Discriminant validity holds |
| IT support for operational competence | <--> | IT personnel capability | 0,60 | Discriminant validity holds |
| IT support for market competence | <--> | Adaptive IT capability | 0,69 | Discriminant validity holds |
| IT support for operational competence | <--> | IT support for market competence | 0,70 | Discriminant validity holds |
| IT infrastructure capability | <--> | IT support for market competence | 0,37 | Discriminant validity holds |
| IT support for market competence | <--> | IT personnel capability | 0,57 | Discriminant validity holds |
| IT support for operational competence | <--> | IT management capability | 0,62 | Discriminant validity holds |
| IT infrastructure capability | <--> | IT management capability | 0,41 | Discriminant validity holds |

**Table 7-45: Discriminant Validity II Final Model**

| | | | $\rho^2$ | ave $\rho_{vc(\eta)}$ | Result (Method II) |
|---|---|---|---|---|---|
| IT support for market competence | <--> | Competitive advantage | 0.163 | 0.644 | Discriminant validity holds |
| Competitive advantage | <--> | Adaptive IT capability | 0.261 | 0.753 | Discriminant validity holds |
| IT support for operational competence | <--> | Adaptive IT capability | 0.561 | 0.737 | Discriminant validity holds |
| IT infrastructure capability | <--> | IT support for operational competence | 0.269 | 0.645 | Discriminant validity holds |
| IT infrastructure capability | <--> | IT personnel capability | 0.135 | 0.645 | Discriminant validity holds |
| IT management capability | <--> | IT personnel capability | 0.245 | 0.742 | Discriminant validity holds |
| IT support for market competence | <--> | Business IT Partnerships | 0.252 | 0.520 | Discriminant validity holds |
| IT support for operational competence | <--> | Competitive advantage | 0.199 | 0.703 | Discriminant validity holds |
| IT infrastructure capability | <--> | Competitive advantage | 0.248 | 0.661 | Discriminant validity holds |
| Competitive advantage | <--> | IT personnel capability | 0.159 | 0.758 | Discriminant validity holds |
| Competitive advantage | <--> | Business IT Partnerships | 0.175 | 0.594 | Discriminant validity holds |
| IT infrastructure capability | <--> | Adaptive IT capability | 0.473 | 0.696 | Discriminant validity holds |
| Adaptive IT capability | <--> | IT personnel capability | 0.401 | 0.792 | Discriminant validity holds |
| Adaptive IT capability | <--> | Business IT Partnerships | 0.307 | 0.629 | Discriminant validity holds |
| IT support for operational competence | <--> | IT personnel capability | 0.354 | 0.742 | Discriminant validity holds |
| IT support for market competence | <--> | Adaptive IT capability | 0.476 | 0.679 | Discriminant validity holds |
| IT support for operational competence | <--> | IT support for market competence | 0.496 | 0.628 | Discriminant validity holds |
| IT infrastructure capability | <--> | IT support for market competence | 0.136 | 0.587 | Discriminant validity holds |
| IT support for market competence | <--> | IT personnel capability | 0.324 | 0.683 | Discriminant validity holds |
| IT support for operational competence | <--> | Business IT Partnerships | 0.383 | 0.578 | Discriminant validity holds |
| IT infrastructure capability | <--> | Business IT Partnerships | 0.168 | 0.537 | Discriminant validity holds |

The discriminant validity calculation in Table 7.45 above indicates that the respecified full measurement model has sufficient discriminant validity. No construct-to-construct correlation is above the 0.85 threshold (Hair et al. 2006) and the average variance extracted from each pair of constructs is greater than their squared correlations. Therefore, discriminant validity could be ascertained. Having deleted the IT modularity variable, the congeneric measurement model of the IT infrastructure capability construct has to be rechecked if it still fits and exhibits convergent validity. The new two factor congeneric model is displayed Figure 7-21 below.

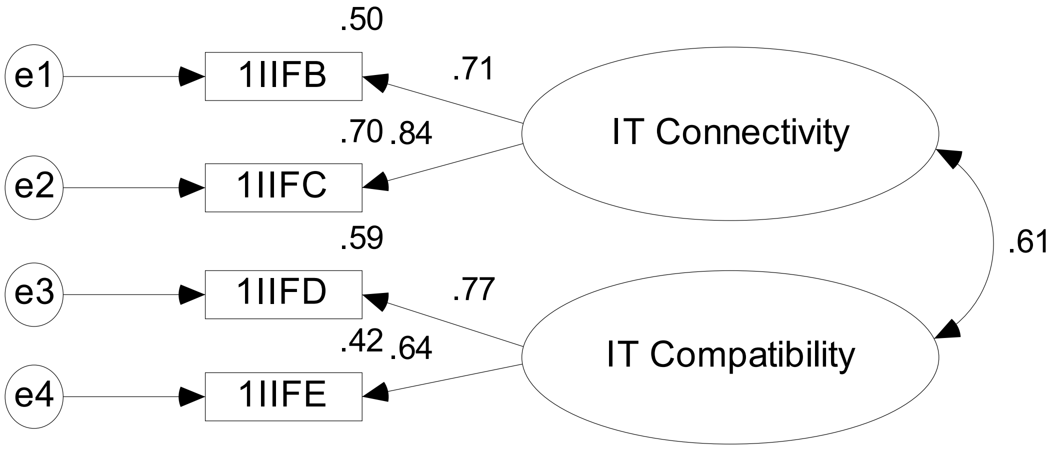


**Figure 7-21: Re-estimated IT infrastructure capability measurement model**

**Table 7-46: Statistics of re-estimated IT infrastructure capability measurement model**

| **Model identification** | | **Model Fit Statistics** | | | | | |
|---|---|---|---|---|---|---|---|
| observed variables | 4 | $X^2$ | = | 0.028 | **CFI** | = | 1 |
| estimated parameters | 9 | $X^2$ / df | = | 0.028 | **RMSEA** | = | 0 |
| df | 1 | **p** | = | 0.86 | **LO 90** | = | 0 |
| **Model is identified** | | **RMR** | = | 0.002 | **PCLOSE** | = | 0.896 |

**Factor loadings**

(*** = p< 0.001, ** = p< 0.01, * = p< 0.05)

| Item | | Variable | S.E. | C.R. | p | SMC | Comment |
|---|---|---|---|---|---|---|---|
| 1IIFB | <- | IT Connectivity | 0.71 | 8.79 | *** | 0.50 | Convergent validity holds |
| 1IIFC | <- | IT Connectivity | 0.84 | 9.92 | *** | 0.70 | Convergent validity holds |
| 1IIFD | <- | IT Compatibility | 0.77 | 8.60 | *** | 0.59 | Convergent validity holds |
| 1IIFE | <- | IT Compatibility | 0.64 | 7.67 | *** | 0.42 | Convergent validity holds |

**Model Fit acceptable**

The statistics of the re-estimated IT infrastructure capability measurement model in Table 7.46 above indicates that the IT infrastructure capability construct exhibits acceptable model fit and convergent validity after the IT modularity variable was deleted. Hence, the full CFA measurement model is accepted and is ready to be transformed into a structural model.

## 7.13. SUMMARY

The purpose of this chapter was to validate the research instrument through a rigorous scientific process, called instrument validation. Therefore, internal consistency reliability was assessed in section 7.2, followed by exploratory factor analysis in section 7.3. The factorial validity of the measurement model was estimated and optimised through structural equation modelling (SEM) in sections 7.4–7.11. SEM was used to assess the convergent and discriminant validity of all constructs and of the whole measurement model. As a result, the final full measurement model depicted in section 7.11 was developed which exhibits both sufficient convergent and discriminant validity as well as acceptable model fit statistics. This full measurement model will be used in the following chapter to build the structural model and to test the research hypothesis.

# Chapter 8

# RESEARCH FINDINGS AND DISCUSSION

*'It is not the strongest species who survive nor the most intelligent,*
*but the ones most responsive to change'*
*(Charles Darwin)*[10]

## 8.1. INTRODUCTION

The purpose of this chapter is to present and discuss the key findings of this dissertation. It attempts to answer the research questions by analysing and investigating the results of the data analysis (descriptive and analytic).

This PhD study has argued that adaptive IT capability and its antecedent factors positively contribute to and significantly influence competitive advantage. Based upon this argument, a theoretical framework was presented and discussed in the earlier chapters. Instrument validation has further refined the research instrument. Discussion of the research findings are presented as follows. Firstly, because the relationship between IT and competitive advantage is complex and context-sensitive, it cannot be understood without considering the organisational context in which it takes place. An overview of the organisational context within which this study takes place is provided in section 8.2 through a descriptive analysis of the research constructs. Secondly, the structural relationships within the developed theoretical framework are assessed and the hypotheses tested in section 8.3. Thirdly, the findings of this PhD study are discussed in section 8.4, and, finally, a summary is provided in section 8.5.

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[10] (van Marrewijk & Werne 2003)

## 8.2. DESCRIPTIVE FINDINGS

This section provides an overview of the extent of IT capabilities, IT support for core competences and adaptive IT capability among Australian organisations. The validated measurement model presented in section 7.12 is the foundation for the descriptive analysis of adaptive IT capability and its antecedent factors.

### 8.2.1. Overview of IT capabilities and IT support for core competences among Australian organisations

The purpose of this section is to empirically examine the extent of the IT-based constructs among Australian organisations. The variables that were developed to measure the IT constructs were discussed in Chapters 4 and 5 above. The measurement scale was a 5-point Likert scale (1: 'totally disagree' – 5: 'totally agree'). Figure 8-1 below provides an overview of the extent of IT-based constructs among Australian organisations.

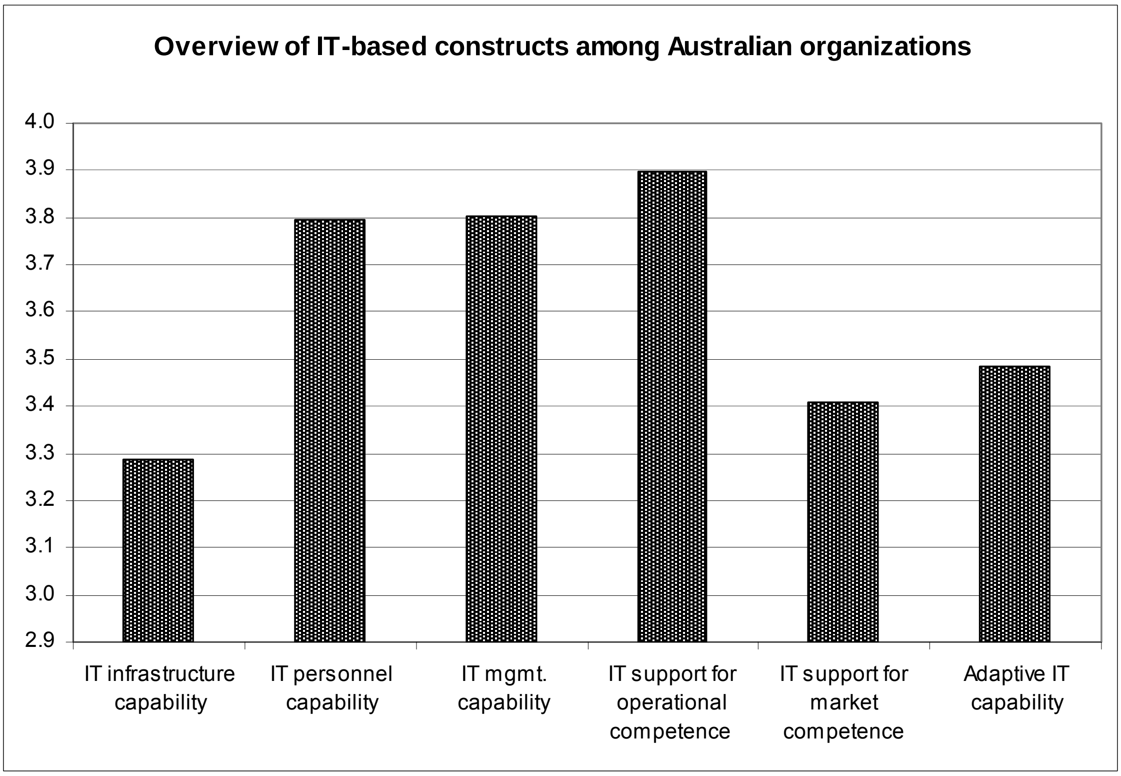


**Figure 8-1: Overview of IT Constructs among Australian Organisations**

The results in Figure 8-1 reveal that all constructs are above the scale medians. The highest average means are from the constructs of IT support for operational competence, IT personnel capability, and IT management capability. This is particularly noteworthy, as IT personnel capability has been found to have the highest effects on IT success variables in prior studies (Byrd & Turner 2001b). Interestingly, the mean for IT support for operational competence (3.9) is much higher than the mean for IT support for market competence (3.4). Australian organisations appear to utilise their IT far more to support business processes and cross-functional integration than for market-related tasks, such as identifying customer needs and market segments. On the other hand, the IT infrastructure capability of the surveyed firms had the lowest mean value. To further investigate these constructs, the effects of company size on the constructs are examined and discussed in the following section.

Before examining each indicator of the IT construct separately, the effect of company size was analysed. Figure 8-2 below depicts the effect of the demographic variable on the constructs.

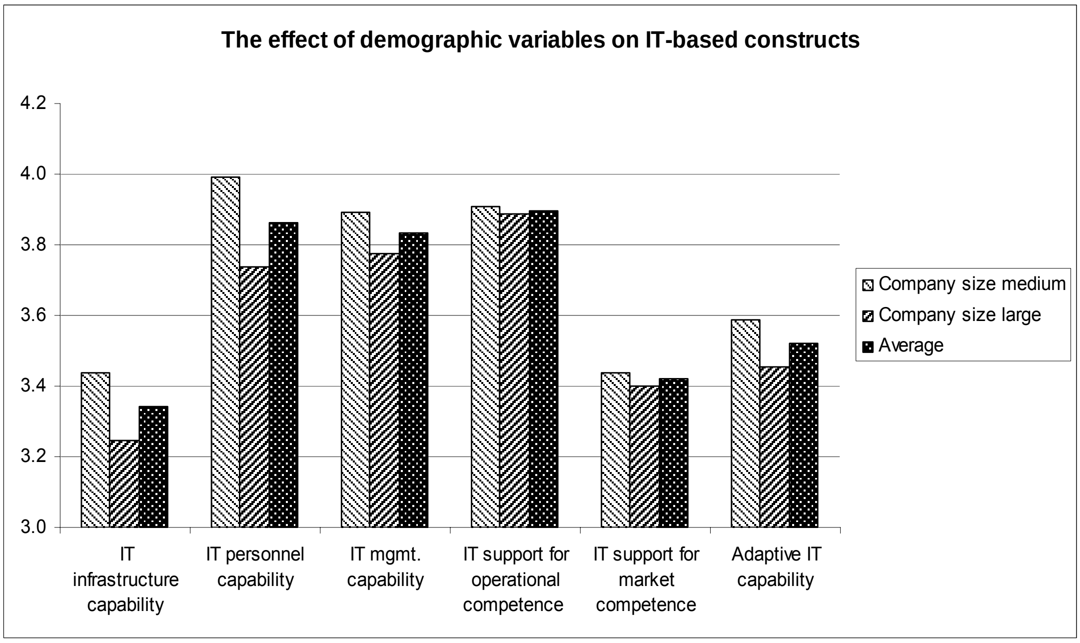


**Figure 8-2: The Effect of Company size**

Figure 8-2 above illustrates the difference in means of company size. All constructs indicate that medium-sized Australian companies have higher levels of IT capabilities and IT support for core competences than large companies. The differences are especially noticeable with IT infrastructure and IT personnel capability as well as the adaptive IT capability construct. The results of an independent sample t-test of the company size are displayed in Table 8.1 below.

**Table 8-1: Independent Sample t-test on Company Size**

| | Mean | t | p | Mean difference | Std. error |
|---|---|---|---|---|---|
| **IT infrastructure capability** | 3.30 | 1.65 | 0.09 | 0.19 | 0.11 |
| **IT personnel capability** | 3.81 | 2.55 | 0.01 | 0.25 | 0.10 |
| **IT mgmt. capability** | 3.81 | 1.25 | 0.21 | 0.12 | 0.09 |
| **IT support for operational competence** | 3.89 | 0.10 | 0.92 | 0.01 | 0.13 |
| **IT support for market competence** | 3.41 | 0.33 | 0.74 | 0.04 | 0.12 |
| **Adaptive IT capability** | 3.48 | 1.05 | 0.29 | 0.13 | 0.13 |

The independent sample t-test summarised in Table 8.1 above revealed that IT infrastructure capability is statistically affected by organisational size ($p<0.1$). A possible explanation is that large organisations may have less integrated and connected IT due to a higher degree of specialisation and complexity in their IT infrastructure. The integration of the data and functionality with transparent access to platforms and applications, and the compatibility of applications across platforms, is most likely far more complex in larger organisations. This could be the reason for the higher IT infrastructure capability among medium-sized organisations in comparison to large organisations.

The mean difference in IT personnel capability between medium and large organizations is highly significant ($p<0.05$). This could be due to the fact that large organisations often have more complex IT systems (see above) and require IT personnel with more specialised IT knowledge. Medium-sized organisations, on the other hand, are more likely to have fewer IT personnel and more broadly trained IT personnel. IT employees in smaller organisations are required to handle a broader variety of jobs and often substitute for each other, therefore, performing tasks outside their original area of training. Understanding the business environment can enable IT personnel to develop business-relevant IT solutions, and improve the flexibility and time-to-market of IT systems (Ravichandran & Lertwongsatien 2005). Apart from the necessity to substitute for each other, IT personnel in medium-sized organisations may possess better business knowledge because their organisation is less complex and thus easier to understand. Furthermore, medium-sized organisations might have shorter and better communication channels, thus improving the business knowledge of their IT personnel. None of the other constructs (IT management capability, IT support for operational competence, IT support for market competence or adaptive IT capabilities) were influenced by company size at a statistically significant level.

In sum, Australian organisations have average levels of IT infrastructure capability, IT support for market competence and adaptive IT capabilities, but fairly good levels of IT personnel capability, IT management capability and IT support for market competence. Furthermore, the constructs IT infrastructure capability and IT personnel capability were affected by company size.

### 8.2.2. Adaptive IT capability

The extent to which Australian companies exhibit adaptive IT capabilities is represented in Figure 8-3 below.

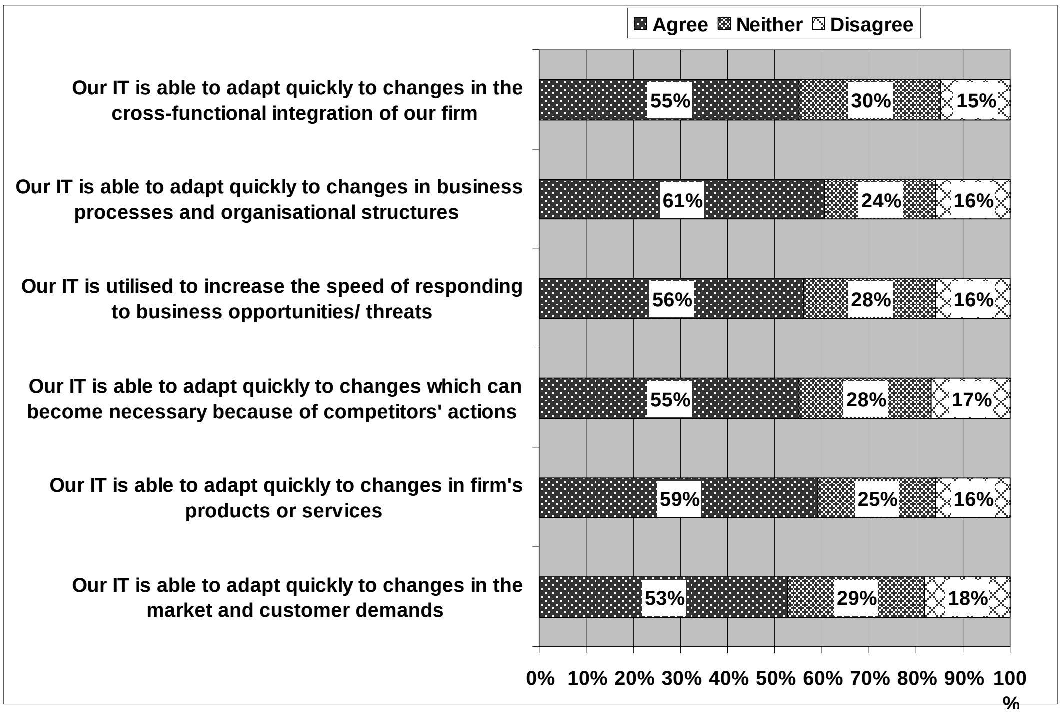


**Figure 8-3: Adaptive IT Capability**

Responding to competitors' actions and adapting to business opportunities and threats involve several tasks, which were rated separately by the respondents (see Figure 8-3) Firstly, 53% of respondents stated that their IT was able to respond quickly to changes in customer and market demands. Secondly, adaptations often included the development of new products and services; 59% of respondents believed that their IT is able to support change or the development of new products and services. Thirdly, new products and services often included changes in organisations' cross-functional integration, business processes or organisational structures. Furthermore, 55% of respondents regarded their IT as being able to adapt quickly to changes in cross-functional integration, while 61% saw their IT as able to adapt quickly to changes in the firm's processes and organisational structures. Finally, 55% of respondents regarded their IT as able to deal with any changes resulting from competitors' actions, and 56% claimed to utilise their IT to increase the speed of response to business opportunities and threats.

### 8.2.3. IT support for core competences

To gain a better insight into IT support for core competence, the construct of IT support for core competences was separated into IT support for market competences and IT support for operational competences. The extent of these competences among Australian organisations is displayed in Figure 8-4 below.

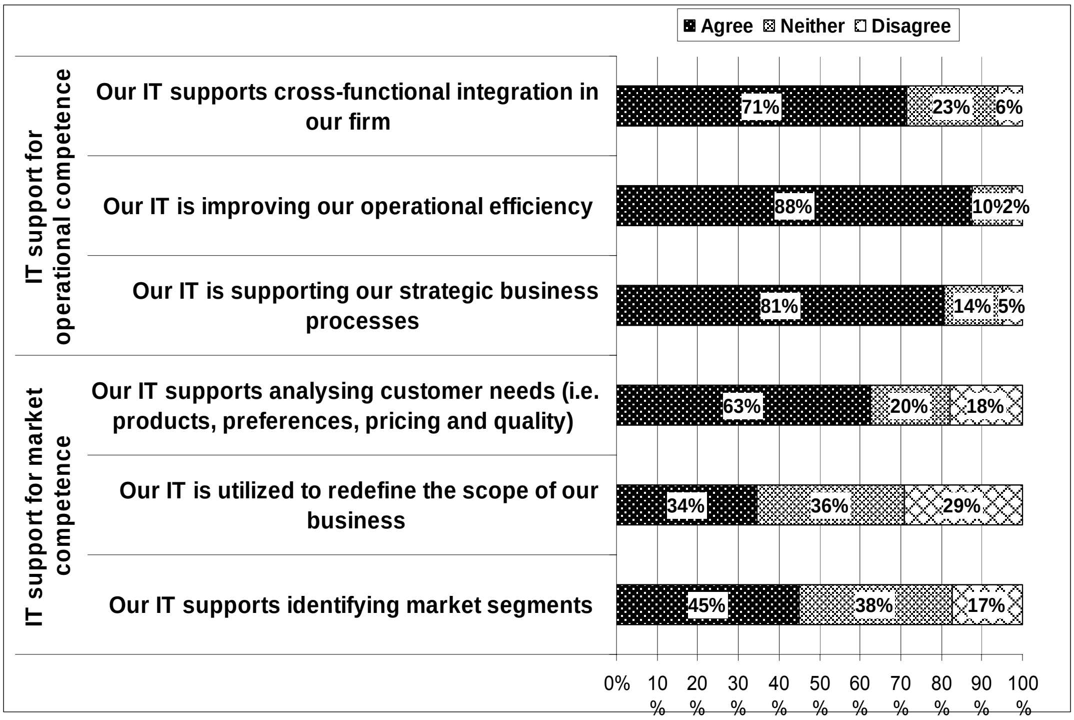


**Figure 8-4: IT Support for Core Competences**

The degree to which IT can support organisational competences as delineated in Figure 8-4 above differed between the two variables examined. Firstly, the ability to support operational competences was rated high overall, ranging from 71% to 88% agreement. IT was found to be supporting the cross-functional integration in 71% of companies. Furthermore, 81% of respondents declared that IT was supporting their strategic business processes and 88% stated that their IT was improving their operational efficiency. Secondly, the ability of IT to support market competences, while still rating high overall, was lower than the previously discussed ability of IT to support operational competences. Only 35% of respondents regarded their IT as being able to redefine the scope of their business. Identifying new market segments and analysing customer needs are essential tasks in contemporary customer-focused business environments, and IT can provide vital support for these tasks, Nevertheless, only 45% of respondents attested to utilising their IT to support the identification of new market segments, and 63% to utilising their IT to analyse customer needs.

Hence, the ability of IT to support firms' competences varies in regard to the task performed. While IT provides good support for operational competences, such as supporting business processes, improving efficiency or cross-functional integration, Australian companies rated the ability of their IT to redefine the scope of their business and to support the identification of new customers and market segments as somewhat mediocre.

## 8.2.4. IT capability

***Extent of IT capabilities among Australian organisations***

The status of IT infrastructure capabilities among Australian companies is illustrated in Figure 8-5 below.

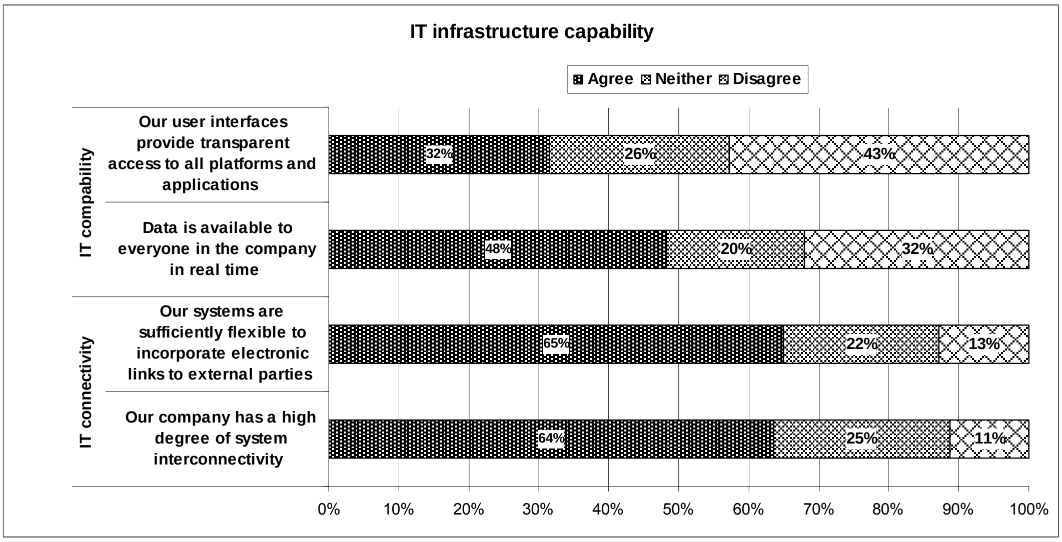


**Figure 8-5: IT Infrastructure Capability**

The four different items that measured IT infrastructure capability varied from 65% approval for system flexibility to incorporate electronic links, to only 32% approval for the use of transparent user interfaces. Although only around half of the organisations stated that their data were available across the whole organisation in real time, Australian companies seem to have a high percentage of IT interconnectivity, enabling them to link IT infrastructure components together and to establish links to external parties. This enables them to connect their IT infrastructure to other organisations, thus contributing to organisational adaptability. One of the main issues related to the capability of IT infrastructure among Australian organisations seems to be the ability to share and access data across the organisation (Figure 8-5). Many organisations use a variety of heterogeneous systems. The use of middleware to integrate key enterprise applications or user interfaces that provide transparent access to all platforms and applications are possible remedies to integrate these heterogeneous systems. Only less than one third of the sample organisations claimed to have transparent access to all platforms and applications (see Figure 8-5).

The skills and knowledge of IT personnel have gained in importance as their value has risen in modern organisations (Chung et al. 2005). In order to support today's organisations, IT personnel need to possess a broad knowledge base of both IT and business (Chung et al. 2005). Broad IT knowledge indicates that the IT personnel are able to support a variety of IT services as well as being knowledgeable about IT products. The analysis of the data yielded insights into the knowledge and skills of IT personnel in Australian companies, which are displayed in Figure 8-6 below.

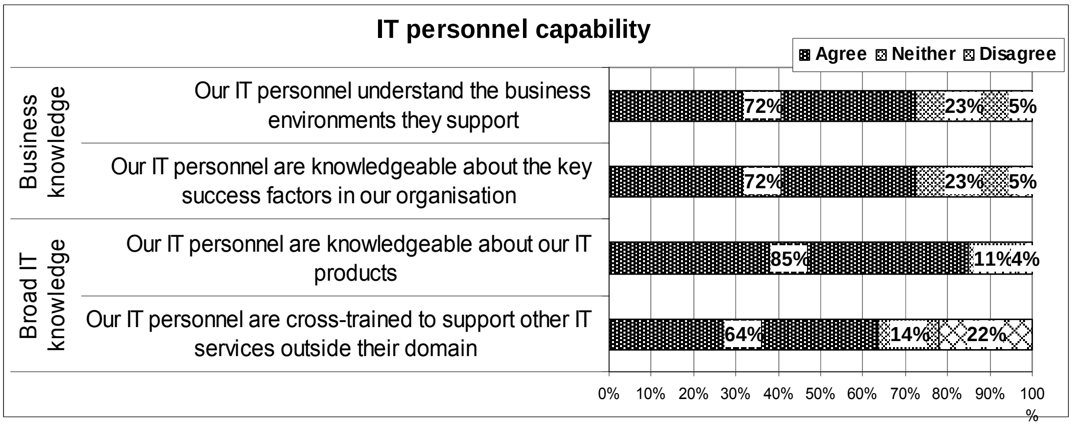


**Figure 8-6: IT Personnel Capability**

Nearly 85% of the sample organisations stated that their IT personnel were knowledgeable about their IT products, and 64% agreed that their IT personnel were able to support other IT services outside their domain.

In order to provide optimal support for the business, IT personnel must be able to understand the business environment they support, and develop appropriate IT solutions (Chung et al. 2005). The study investigated the business knowledge of IT personnel and discovered that in 72% of organisations, IT personnel understood the business environment they supported and were knowledgeable about the key success factors for their organisation. Figure 8-6 indicates a relatively high IT personnel capability for Australian organisations, which enables these organisations to better support changes in business processes.

Furthermore, IT–business partnerships are essential to enable IT to support the building, renewal and reconfiguration of firms' competences. Figure 8-7 below shows the extent of IT management capability among Australian organisations.

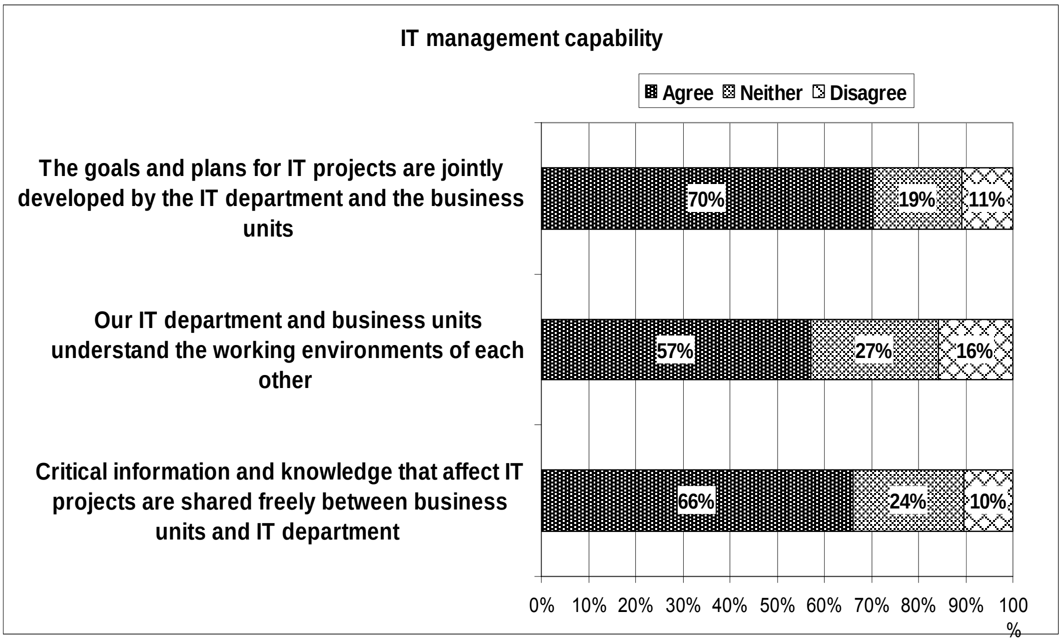


**Figure 8-7: IT Management Capability**

Overall, Australian organisations exhibit a high degree of IT management capability (see Figure 8-7 above). Positive agreement on IT management–related questions varied among the respondents from 57% to 70%. Even though mutual understanding of the working environments between business and IT units could only be found in 57% of Australian organisations, other topics in IT management capability rated higher. Over two thirds of respondents agreed that, firstly, critical information and knowledge that affects IT projects were shared freely between business units and the IT department (66%). The goals and plans for IT projects were jointly developed by the IT department and the business units (70%).

In sum, while the respondents rated the overall degree of IT capabilities among Australian organisations as high, a number of issues remain. Found mainly in terms of the capability of IT infrastructure, these included those of transparent access to and availability of data and applications across all platforms.

### 8.2.5. Summary of descriptive findings

The purpose of this descriptive section was to provide an understanding of the background environment of this research. The context for this research is that of the presence of adaptive IT capability and its antecedent factors (IT capabilities and IT support for core competences) among medium-sized and large Australian organisations. The empirical results of this study illustrated the current extent of IT capabilities, competences and adaptive IT capability among Australian organisations. On the one hand, high levels of IT personnel and management capability as well as of IT support for operational competence were discovered. On the other hand, IT infrastructure capability, IT support for market competence and adaptive IT capabilities were found to be at mediocre levels. As far as a comparison with overseas studies is possible, the performance of Australian organisations was found to be comparable to that of overseas organisations.

## 8.3. STRUCTURAL MODEL AND HYPOTHESIS TESTING

In this section the measurement model will be used as the foundation to assess the conceptual representation of the relationships among constructs. The structural model represents the theory with a set of structural equations and is usually depicted in a visual diagram (Hair et al. 2006). The estimation of the structural model and constructing the visual diagram were performed by utilising structural equation modelling (SEM). SEM is a powerful technique to conduct structural analysis of the relationships among constructs, and was discussed in Chapter 7 in more detail.

Structural models are assessed within SEM in regard to four issues. Firstly, the theoretical model should reproduce the observed covariance matrix well. This is estimated by overall and relative model fit statistics (Kline 2005). The model fit statistics and the chosen threshold levels for this research were discussed in greater detail in Chapter 7. In the following section, these model fit statistics are utilised to assess how well the structural model reproduces the observed covariance matrix, and hence represents the sample data (Byrne 2001). Secondly, to further assess the validity of the structural model, it is compared to the measurement model (Hair et al. 2006). Similar fit statistics for measurement and structural models indicate an acceptable structural model (Hair et al. 2006). Thirdly, the variance explained, measured by SMC, indicates the percentage of the variance of the dependent variable which is explained by the structural model (Weston & Gore 2006). SMC are presented for each latent variable in the section below. Finally, the significance and direction of the hypothesised paths, depicted by one-headed arrows on a path diagram, are calculated and the size, direction and significance of the structural parameter are estimated. The strengths of the paths are another indicator for the fit of a structural model, and these are presented in the section below.

In sum, well-fitting models with significant paths in the theorised directions and good percentages of explained variance (SMC) are supported. SEM should be used with research models that are based on a strong theoretical foundation. Theoretical plausibility checks, as Hair et al. (2006) call them, are therefore necessary to determine whether the estimated relationships make theoretical sense. The theoretical relationships of the structural model of this study are built upon an extensive review of the literature and are discussed in Chapter 4 above. Hence, the theoretical plausibility check has been met. The validation of the developed research instrument was performed in the previous chapter and as a result a valid measurement model was produced. This measurement model is the basis for assessing the proposed structural research model.

In addition to the theorised paths of the research model, two covariances were specified to improve the model fit. These are: (1) the covariance between IT infrastructure capability and IT personnel capability; and (2) the covariance between IT personnel capability and IT management capability. Both are based on solid theoretical ground. Prior IT literature has argued for these IT capabilities to be interrelated (Byrd & Turner 2001a; Fink & Neumann 2007). It is plausible that IT personnel with business skills and broad IT knowledge can have positive effects on the connectivity and compatibility of IT infrastructure as well as improving the quality of IT–business partnerships. In contrast, highly connected and compatible IT infrastructures as well as extensive IT–business partnerships require broadly skilled and business-sawy IT personnel. Hence, the conducted covariations are not solely based on statistics; they are also supported by conceptual arguments. The resulting full structural model is displayed in Figure 8-8 below, followed by its statistical estimates in Table 8.2 below.

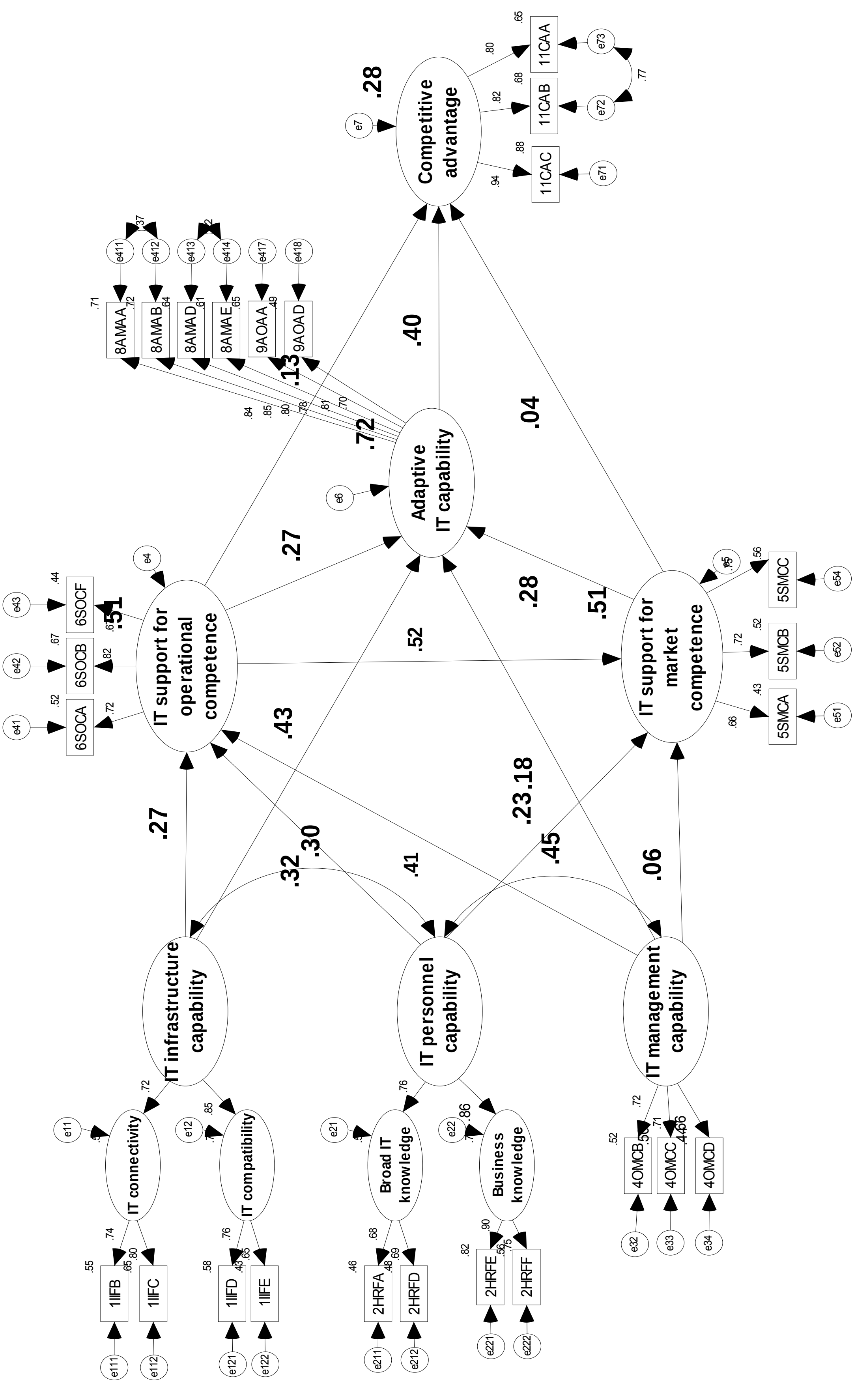


**Figure 8-8: Full Research model**

**Table 8-2: Model Fit Statistics for Structural Model**

| Model fit statistics | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Acceptance level | | | | Results | | |
| | | | items | | 12-30 | > 30 | | | |
| **$X^2$** | = | 457.25 | **$X^2$ / df** | = | < 2.0 | | **$X^2$ / df** | = | 1.65 |
| **df** | = | 277 | **CFI** | = | > 0.95 | > 0.92 | **CFI** | = | 0.94 |
| **p** | = | 0 | **RMSEA** | = | < 0.08 | | **RMSEA** | = | 0.06 |
| **items** | = | 26 | **LO 90** | = | close to 0 | | **LO 90** | = | 0.05 |
| | | | **PCLOSE** | = | > 0.05 | | **PCLOSE** | = | 0.12 |

The thresholds for the model fit indices were discussed in greater detail in Chapter 7 above. In short, the normed Chi-Square should be below 2.0, and the normed Chi-Square of the structural model is 1.65—well inside this level. The CFI should be above 0.92 with a model of over 30 items and above 0.95 with a model of over 12 items with the adjusted model fit values. The structural model depicted above consists of 26 items and has a CFI of 0.94. The rigorous acceptance level for 12-30 items is CFI >0.95. Although it does not exactly meet the more rigorously adjusted CFI for 12–30 items, it is very close to the 30 items category. Furthermore, the structural model meets the thresholds stipulated in the literature which suggests even 0.90 as an acceptable level for CFI (Weston & Gore 2006). Hence, the CFI of 0.94 was accepted. The RMSEA should be below 0.08, with Lo90 close to 0 and PCLOSE above 0.05. The structural model fit statistics meet these thresholds. In sum, the structural model was assessed and the statistics for the full structural model indicate an acceptable model fit with all model fit indices well inside the recommended thresholds of the literature (Hair et al. 2006; Weston & Gore 2006). Furthermore all but one (CFI) indices met the rigorous acceptance level of this study (see Table 8.2 above). The CFI met the recommended threshold by Weston and Gore (2006) and was very close the rigorous threshold of this study. Hence the model was accepted.

To further validate the full structural model it was compared to the measurement model. Measurement models always provide same or better fit statistics, because they have more paths and less degrees of freedom (Hair et al. 2006). The structural model cannot fit any better than the measurement model and, therefore, the comparison to the measurement model provides a useful assessment of the validity of the structural model (Hair et al. 2006). If the model fit of a measurement model is not significantly better than that of a more parsimonious structural model, the latter is to be preferred (Hair et al. 2006). The difference of CFI and RMSEA between the structural and the measurement model is 0.01. The difference of normed Chi-Square between the structural and measurement model equals 0.07. This indicates that the structural model will not improve to any noteworthy extent if all covariations between the constructs are to be added, as was done in the measurement model. As the structural model contains fewer paths to be estimated and more degrees of freedom, it is more parsimonious, and hence to be preferred.

To examine the extent of variance explained for the four dependent variables (IT support for operational competence, IT support for market competence, adaptive IT capabilities and competitive advantage) the SMC was estimated. Table 8.3 below displays the SMC for the four dependent variables.

**Table 8-3: Variance Explained**

| Variance explained | SMC |
|---|---|
| **IT support for operational competence** | **0.52** |
| **IT support for market competence** | **0.51** |
| **Adaptive IT capability** | **0.72** |
| **Competitive advantage** | **0.28** |

Table 8.3 above indicates that the structural model explains 28% of the variance in competitive advantage, 72% of the variance in adaptive IT capability, and around 50% of the variance in the two IT support for core competences constructs. This signifies that the structural model represents the observed sample data well, and thus the variance explained assessment further supports the validity of the structural model. The final assessment for the structural model is to examine the strength of the paths within the model. Table 8.4 below illustrates the strengths of the structural paths.

**Table 8-4: Structural Paths**

| | | | Estimate | SE | CR | P |
|---|---|---|---|---|---|---|
| IT support for operational competence | <--- | IT infrastructure capability | 0.30 | 0.27 | 2.59 | 0.010 |
| IT support for operational competence | <--- | IT management capability | 0.35 | 0.41 | 3.85 | *** |
| IT support for operational competence | <--- | IT personnel capability | 0.35 | 0.33 | 2.75 | 0.006 |
| IT support for market competence | <--- | IT support for operational competence | 0.61 | 0.52 | 4.02 | *** |
| IT support for market competence | <--- | IT management capability | 0.06 | 0.06 | 0.59 | 0.554 |
| IT support for market competence | <--- | IT personnel capability | 0.30 | 0.23 | 1.95 | 0.052 |
| Adaptive IT capability | <--- | IT support for market competence | 0.33 | 0.28 | 2.85 | 0.004 |
| Adaptive IT capability | <--- | IT support for operational competence | 0.37 | 0.27 | 2.22 | 0.026 |
| Adaptive IT capability | <--- | IT infrastructure capability | 0.66 | 0.44 | 4.08 | *** |
| Adaptive IT capability | <--- | IT management capability | 0.21 | 0.18 | 2.02 | 0.044 |
| Competitive advantage | <--- | Adaptive IT capability | 0.38 | 0.40 | 3.18 | 0.001 |
| Competitive advantage | <--- | IT support for market competence | 0.04 | 0.03 | 0.28 | 0.777 |
| Competitive advantage | <--- | IT support for operational competence | 0.18 | 0.13 | 0.97 | 0.332 |

From the 13 theorised structural paths, nine are significant at a 95% confidence interval. This supports the overall assessment of the structural model as an acceptable representation of the sample data. Therefore, the structural model was accepted and the research hypotheses can be tested.

The developed research model and the hypotheses are illustrated in Figure 8-9 below. Table 8.4 above delineates the strengths of the research hypotheses.

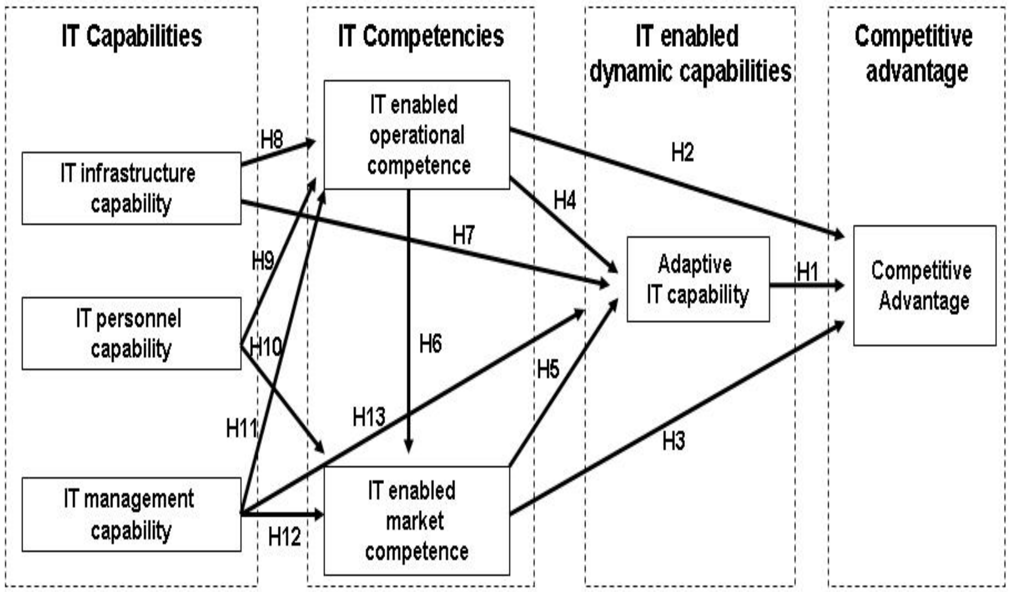


**Figure 8-9: Research Model and Hypotheses**[11]

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[11] Insignificant paths are presented by dotted lines.

**Table 8-5: Hypothesis Testing**

| (p<0.05=*, p<0.01=**, p<0.001=***) | Path Coeff. | p | Supported? |
|---|---|---|---|
| H1: Adaptive IT capability is positively related to competitive advantage | 0.38 | ** | Yes |
| H2: IT support for operational competence is positively related to competitive advantage | 0.18 | n.s. | No |
| H3: IT support for market competence is positively related to competitive advantage | 0.04 | n.s. | No |
| H4: IT support for operational competence is positively related to adaptive IT capability | 0.37 | * | Yes |
| H5: IT support for market competence is positively related to adaptive IT capability | 0.33 | ** | Yes |
| H6: IT support for operational competence is positively related to IT support for market competence | 0.61 | *** | Yes |
| H7: IT infrastructure capability is positively related to adaptive IT capability | 0.66 | *** | Yes |
| H8: IT infrastructure capability is positively related to IT support for operational competence | 0.3 | * | Yes |
| H9: IT personnel capability is positively related to IT support for operational competence | 0.35 | ** | Yes |
| H10: IT personnel capability is positively related to IT support for market competence | 0.3 | * | No |
| H11: IT management capability is positively related to operational competence | 0.35 | *** | Yes |
| H12: IT management capability is positively related to market operational competence | 0.06 | n.s. | No |
| H13: IT management capability is positively related to adaptive IT capability | 0.21 | * | Yes |

Nine out of the 14 hypotheses are significant at a 95% confidence interval (see Figure 8-9 and Table 8.5 above). A higher degree of adaptive IT capability is highly positively related to competitive advantage as theorised in the research model. In contrast, the two hypotheses which stated a significant positive relationship between IT support for core competences and competitive advantage—'*H2: IT support for operational competence is positively related to competitive advantage*' and '*H3: IT support for market competence is positively related and can contribute significantly to competitive advantage*'—are not supported. Hence, no direct significant relationship between constructs of IT support for core competence and competitive advantage could be found in this study.

The construct of adaptive IT capability was theorised to be influenced, firstly, by the two IT support for core competence constructs (IT support for operational competence and IT support for market competence) directly; secondly, by two IT capability constructs (IT infrastructure capability and IT management capability) both directly and indirectly via IT support for core competences (IT support for operational competence and IT support for market competence); and finally, by IT personnel capability indirectly via IT support for operational competence. One hypothesis of IT management capability ('*H12: IT management capability is positively related to market operational competence*') was not significant and thus not supported.

# 8.4. DISCUSSION

## 8.4.1. Adaptive IT capability and competitive advantage

This study began by arguing that while there has been a lot of emphasis in the literature on the importance of dynamic capabilities for contemporary organisations on the one hand, and a lot of research on IT and competitive advantage on the other hand, the role of IT in achieving competitive advantage through enabling organisational dynamic capabilities has been underemphasised. Dynamic capabilities are complex routines and can be unique, heterogeneous and hard-to-imitate (Eisenhardt & Martin 2000). They can also be a source of competitive advantage (Teece, Pisano & Shuen 1997). Following Wang and Ahmad's (2007) classification this study focused on how IT can enhance adaptive capabilities. Hence, IT's potential to be a source of competitive advantage was analysed by scrutinising IT's role in enhancing firms' ability to adapt products, services and organisational structures, as well as business and innovation processes. These issues are addressed by the higher order resource of adaptive IT capability.

Adaptive IT capability was found to have a significant impact on competitive advantage, and so H1 ('*Adaptive IT capability is positively related and can contribute significantly to competitive advantage'*) was accepted. Overall, the theoretical framework developed in this PhD study explained 28% of the variance in market and financial performance of firms in comparison to their competitors. To compare the results of this study with those of previous studies on IT and competitive advantage, Table 8.6 below illustrates a comparison of variance explained for the competitive advantage construct from similar studies.

**Table 8-6: Comparison of Variance Explained**

| Author | Findings | Variance explained |
|---|---|---|
| Powell & Dent Micallef (1997) | Although IT is a strategic necessity, it cannot by itself produce SCA. Rather, IT is able to leverage organisational competences to achieve SCA | 17% |
| Tallon & Kraemer (2004) | Strategic alignment positively mediates the effect of IT capabilities on firm performance. IT capabilities are operationalised as IT infrastructure flexibility | 15% |
| Chung et al. (2005) | Builds on Byrd and Turner (2001) and includes mass customisation | 29% |
| Ravichandran & Lertwongsatien (2005) | IT capability, which depends on IT resources, is positively related to IT support for core competences. IT support for core competences explain variations in firm performance | 29% |

The variance explained by similar studies ranges from 15% to 29% (see Table 8.6). In their study Powell and Dent-Micallef (1997) argued that IT alone does not provide sustained performance advantages. However, companies that were able to utilise IT to leverage intangible, complementary human and business resources (e.g. supplier relationships, flexible culture and integrating IT in strategic planning) were able to gain advantages from IT (Powell & Dent-Micallef 1997). Powell and Dent-Micallef's (1997) theoretical model was tested with firms in the retail industry and explained 17% of the variance in competitive advantage.

Similar results were obtained by Tallon and Kraemer (2004). They examined the mediating impact of strategic alignment on the relationship between IT infrastructure flexibility and firm performance. Their model was empirically tested, and explained 15% of the variance in firm performance and found significant impacts of strategic alignment (measured through IT support for critical business activities) on the IT–competitive advantage relationship (Tallon & Kraemer 2004).

Another study that investigated IT's ability to leverage organisational capabilities was conducted by Chung et al. (2005). This study examined IT's ability to improve business performance indirectly by enhancing mass customisation (Chung et al. 2005). The model explained 29% of the variance in business performance, the dependent variable. IT infrastructure flexibility was found to have a positive effect on firms' ability to enable mass customisations, which was found to positively impact on business performance.

Further arguments for IT's ability to leverage organisational competences have been proposed by Ravichandran and Lertwongsatien (2005), who investigated the effect of a higher order IT resources (IT support for core competence) which measures IT's ability to support the influence of organisational competences on competitive advantage. Their model also incorporated IT capabilities (such as IT planning sophistication, system development capability, IT support maturity, and IT operations capability) as well as measures for IT personnel, IT infrastructure capability and IT partnership quality as antecedent factors of IT support for core competence. This theoretical model was empirically examined and explained 29% of the variance in competitive advantage (Ravichandran & Lertwongsatien 2005).

All of these results from previous studies are similar to the results of this PhD, in regard to IT's ability to have a positive effect on firms' output variables. The above displayed results of this study support the theoretical background outlined in Chapters 2, 3 and 4 which argues for IT's potential to influence competitive advantage by supporting business competences, in particular organisational dynamic capabilities. Overall, the research model explained 28% of the variance of competitive advantage, which can be placed within the range of comparable studies.

These results are further in accordance with other IT research which reasons that IT can have a positive effect on firms' market and financial performance if it complements firms' resources, capabilities, competences and processes (Bharadwaj 2000; Clemons & Row

1991; Wade & Hulland 2004). However, this research extends this notion by arguing that firms not only need the static support of IT for their competences (Ravichandran & Lertwongsatien 2005) but also the ability to renew and adapt their IT support to match new environmental settings (Pavlou & El Sawy 2006; Sambamurthy, Bharadwaj & Grover 2003). These findings are similar to that of Pavlou and El Sawy (2006), who discovered positive effects of IT on resource configurability and found that IT can support coordination competence, absorptive capability, collective mind and market orientation. Further, when mediated by functional competences of new product development, resource re-configurability exhibited positive effects on competitive advantage.

Furthermore, this PhD study extends the findings of Pavlou and El Sawy (2006) in a number of ways. Firstly it adds to their work by introducing a higher order IT resource which can measure the extent to which IT enables organisational dynamic capabilities. Secondly, it examines the direct and indirect effects of a variety of antecedent IT factors (such as IT infrastructure capability, IT personnel capability, IT management capability, IT support for operational and market competences) which can enhance IT's ability to support firms' dynamic capabilities. Lastly, this research contributes further by comparing the effect of both static and adaptable IT support for business. Adaptive IT capability was found to impact more positively to competitive advantage than static IT support for firm competences. IT support for firm competences can have a significant effect on competitive advantage if it is able to adapt to changes in firms' business processes and cross-functional integration. Adaptive IT capability together with a wide variety of IT support options for business processes, services and products allows firms to proactively launch strategic initiatives, hence staying ahead of competitors in the race for first mover advantages. Thus, this study also provides empirical support for Sambamurthy et al.'s (2003) and Piccoli and Ives's (2005) conceptual arguments that IT-enabled strategic initiatives can be a source of competitive advantage.

Furthermore, the findings are in accordance with the DCP on strategic management. In the DCP the potential for competitive advantage lies in firms' capacity to build, renew and reconfigure their resources, capabilities and competences so as to achieve congruence with a changing business environment (Eisenhardt & Martin 2000; Kylaheiko, Sandstrom & Virkkunen 2002; Teece, Pisano & Shuen 1997). Chapter 2 outlined the importance for firms to be able to adjust their internal resources in order to deal with environmental change. Wang and Ahmad (2007) have argued conceptually for the positive effects of adaptive, absorptive and innovative capabilities on competitive advantage. According to Wang and Ahmad (2007), no empirical study has yet been found that examines these three main components of dynamic capabilities. This PhD study has examined and positively tested IT's ability to support adaptive capabilities. Furthermore, the results of this PhD study support the argument that new sources of competitive advantage extend beyond simple competences (Collis 1994). Adaptive IT capability as a complex, heterogeneous higher order resource was found to provide firms with an edge over competitors in financial and market performance. Furthermore, IT support for functional competences might provide short-term advantage to companies if they manage to align their IT support with organisational strategy, goals and objectives, but these advantages can erode quickly. Adaptive IT capability has the potential to continuously influence and shape organisational resources, capabilities and competences and, therefore, might be of competitive value for longer periods of time.

In sum, the results of this study indicate that IT can be a source of competitive advantage by providing firms with the ability to adapt themselves more quickly than their competitors to environmental changes, hence supporting and extending prior works on DCP (Eisenhardt & Martin 2000; Teece, Pisano & Shuen 1997).

### 8.4.2. IT support for core competences, adaptive IT capability and competitive advantage

This PhD study has theorised the influence of IT support for core competences in three ways: (1) a direct influence on competitive advantage; (2) an indirect influence through adaptive IT capability; and (3) a relationship between IT support for core competences.

To acknowledge existing theory direct relationships between IT support for core competences (market and operational) and competitive advantage were hypothesised (Ravichandran & Lertwongsatien 2005). IT support for operational competence was theorised to have a significant positive effect on competitive advantage (‘*H2: IT support for operational competence can have a positive effect on competitive advantage*’). IT support for market competence was theorised to have a positive effect on competitive advantage (‘*H3: IT support for market competence is positively related and can contribute significantly to competitive advantage*’). The hypothesis test in section 8.3 revealed a positive but not statistically significant effect of IT support for market competence and IT support for operational competence on competitive advantage. These findings do not necessarily contradict the existing theorisations of positive relationships between IT support for core competences and competitive advantage. Rather, they could indicate that the effect of IT support for core competences on competitive advantage is indirect and mediated by the intermediary higher order resource of adaptive IT capability as theorised in Chapter 4.

In order to extend the existing theory, and based on an extensive literature review and the conceptual model developed, the indirect effect of IT support for core competences on competitive advantage through adaptive IT capability was theorised. The theoretical framework presented in Chapter 4 has argued from the DCP for both direct and indirect effects of IT support for core competence on competitive advantage. IT support for core competence was theorised as a necessary base competence for higher order adaptive IT capability. Hence, the argument was for a positive influence of IT support for core competence on adaptive IT capability and for indirect effects of IT support for core competence on competitive advantage through adaptive IT capability. The hypothesis testing illustrated that the two constructs that measure IT support for core competence had significant positive relationships with adaptive IT capability. Both hypotheses *('H4: IT support for operational competence is positively related to adaptive IT capability*' and '*H5: IT support for market competence is positively related to adaptive IT capability*') are significant at the 95% confidence interval, with H5 even more significant at the 99% confidence interval level. Hence, in this PhD study, IT support for core competences (market and operational) were found to have a significant effect on adaptive IT capability.

Furthermore, as adaptive IT capability was established to have a significant effect on competitive advantage, this could be an indicator that the effects of IT support for operational competence and IT support for market competence on competitive advantage are mediated by adaptive IT capabilities. Mediating effects occur when a third variable intervenes (mediates) between two other related constructs and facilitates the relationship between them (Hair et al. 2006). To further investigate the structural relationships of the model, and especially to examine the possible mediating effects discussed above, indirect and total effects were estimated, and are presented in Table 8.7 below.

**Table 8-7: Standardised effect of IT Support for Core Competences on Competitive Advantage**

| | direct | indirect | total |
|---|---|---|---|
| IT support for operational competence | 0.13 | 0.18 | 0.32 |
| IT support for market competence | 0.04 | 0.11 | 0.15 |
| Adaptive IT capability | 0.40 | | 0.40 |

Table 8.7 above indicates that, apart from the direct effects, several strong indirect effects can be observed in the structural model. The two constructs that represent IT support for core competences (IT support for operational competence and IT support for market competence) have, apart from their direct effects, also indirect effects on competitive advantage. The standardised indirect effect of IT support for operational competence on competitive advantage is 0.18; and from IT support for market competence on competitive advantage it is 0.11. Even though the hypothesised relationship of IT support for operational competence on competitive advantage was not found to be significant, it exhibits recognisable total effects on competitive advantage (see Table 8.7 above). IT support for operational competence has a standardised total effect on competitive

advantage of 0.32. IT support for market competence was not found to have a direct significant effect on competitive advantage and also the total effect this construct shows on competitive advantage is considerably low (0.15).

Finally, the significance levels for the indirect effects were calculated using bias- corrected bootstrapping (see Table 8.8 below). According to the literature, the bias- corrected bootstrapping method is more reliable for testing indirect effects and mediation than the Sobel test or the Baron and Kenny (1986) method (Cheung & Lau 2008).

**Table 8-8: Significance Levels for Indirect Effects (bias-corrected bootstrapping method)**

| | **Indirect effect on competitive advantage p-value** |
|---|---|
| IT support for operational competence | 0.08 |
| IT support for market competence | 0.03 |

Table 8.8 displays the p-value of the indirect effects. IT support for operational competence has a significant indirect effect on competitive advantage at the 90% confidence interval, whereas IT support for market competence has a significant effect on competitive advantage at a 95% confidence interval.

In sum, examining the effects of IT support for firms' competences on competitive advantage revealed three insights. Firstly, although no direct significant relationships between IT support for operational competence and competitive advantage could be discovered, the results indicate that IT support for operational competence influences competitive advantage indirectly though adaptive IT capability. Secondly, IT support for market competence was not found to affect competitive advantage directly at any significant level, but nevertheless has a significant indirect effect on competitive advantage. Finally, all results above indicate that the higher order resource adaptive IT capability is mediating the relationship between IT support for core competences (market and operational) and competitive advantage.

The results above indicate that rather than influencing competitive advantage directly, IT support for core competences (market and operational) are exhibiting their impact on competitive advantage indirectly through enabling a wide variety of business processes and information-sharing options which enable IT to support firms in adapting to changes in the environment. These insights confirm and extend previous studies in several ways.

Firstly, high levels of IT support for market competences have been theorised to provide firms with the opportunity to generate market intelligence (such as identifying new market segments and customer needs) through capturing, exchanging and processing market information with customers and suppliers (Mendelson 2000). Market intelligence enables firms to more rapidly introduce changes in their services and products or to launch new service and product initiatives faster than their competitors (Pavlou & El Sawy 2006). This study has confirmed these arguments by revealing that high levels of IT support for market competences strengthen IT's ability to assist firms to introduce changes quickly to or design new products and services (H5 was thus supported). Furthermore, this study has extended the argument by revealing that a basic IT support for core competence to sense and exchange market intelligence is necessary to successfully reconfigure that competence in response to the intelligence gathered.

Secondly, the research model of this PhD study theorised that firms with higher levels of IT support for operational competence have IT that supports cross-functional and supply chain integration, as well as highly integrated and connected digitised business processes. This study revealed that this integration allows firms to respond more rapidly to changes in networks, suppliers or customers. Furthermore, the results indicate that cross-functional integrated business processes through integrated enterprise resource planning systems, supply chain management, customer relationship and data management allow information flows across department boundaries and enable organisations to re-engineer business processes based on this information. This is in line with prior research which has argued that standardised data and process architecture can be a potential source of business value by allowing coordinated, organisation-wide responses to environmental changes (Mathiassen & Pries-Heje 2006; Shang & Hsiang 2006).

Thirdly, prior research has argued that the ability of organisation-wide renewing, building and reconfiguring of competences can be strengthened through knowledge-sharing which brings the mindsets of a variety of individuals in an organisation together (McCall, Arnold & Sutton 2008; Ray, Muhanna & Barney 2005). Building on the notion outlined in the paragraph above, cross-functional integration and IT-supported business processes allow information flows across departmental boundaries, hence enhancing knowledge-sharing. Based on these arguments this research theorised that IT support for cross-functional integration enhances knowledge-sharing and thereby strengthens firms' ability to renew, rebuild and reconfigure their competencies. The construct that measures IT support for cross-functional integration was found to have a significant positive impact on the ability of IT to support changes in product, service, customer and market demands (thus, H5 was supported). Hence, previous research was confirmed and extended. Several IT applications can facilitate cross-functional integration and knowledge-sharing. Knowledge-sharing can be enhanced by imbedding structured information in database and decision support systems so that it can be transferred across organisations (McCall, Arnold &

Sutton 2008; Sabherwal 1999; Sambamurthy, Bharadwaj & Grover 2003). Furthermore, groupware and multimedia systems can increase communication, extract tacit knowledge, and store and structure information (Bharadwaj 2000; Grimaldi, Rippa & Ruffolo 2008).

Fourthly, based on prior studies, this study has theorised that IT can support firms' ability to adapt to changes by enhancing firms' coordination competence (Pavlou & El Sawy 2006). High levels of IT support for operational competence support knowledge management and business processes. In line with the IT literature it was theorised that this support strengthens the ability of IT to process information and thus enhances coordination competence (Mendelson 2000). The results of this PhD study demonstrated significant relationships between IT support for operational competence and the ability of firms to adapt to change, hence confirming prior empirical works (Pavlou & El Sawy 2006).

In sum, the results of this PhD are in accordance with the DCP of IT and competitive advantage which argues for IT's potential to create competitive advantage through not only supporting static competences, but also by enhancing firms' ability to reconfigure their resources, capabilities and competences (Pavlou & El Sawy 2006) and to provide a basic competence from which a variety of competitive actions can be launched (Sambamurthy, Bharadwaj & Grover 2003). In addition to confirming previous arguments in the IT literature regarding IT's ability to leverage organisational competences, this study extends on the findings of the previous research by arguing for and revealing positive empirical evidence indicating that IT's strategic potential derives from its ability not only to support functional competences which can be copied in the long run, lack heterogeneity, and thus might have limited potency to directly provide firms with an edge over its competitors, but moreover to enable firms to adapt themselves to environmental change.

The findings of this PhD study on IT support for core competences and competitive advantage are novel as they explicate IT's effect on firms' ability to generate an edge over competitors in terms of market and financial performance, not only through previously argued static business support (Ravichandran & Lertwongsatien 2005) but through an even stronger indirect influence facilitated by the ability to adapt the business support to keep up with changes in the environment. Hence, this study extends on the previous research which has empirically explored the link between how IT can support businesses and firms' performance/competitive advantage (Chung et al. 2005; Powell & Dent-Micallef 1997; Ravichandran & Lertwongsatien 2005; Tallon & Kraemer 2004) by arguing that IT support for businesses must not only provide the optimal support for today's business demands, but also be able to adapt this support as is necessary. In doing so, this study also extends on studies from DCP on IT and competitive advantage which have theorised links between IT and firms' ability to reconfigure their resources (Pavlou & El Sawy 2006) or IT and firms' ability to proactively launch a variety of competitive actions (Sambamurthy, Bharadwaj & Grover 2003) by including IT support for business competences and its antecedent IT capabilities into the concepts.

### 8.4.3. IT capabilities, IT support for core competences and adaptive IT capability

Section 8.4.2 above discussed the direct positive effect of IT support for core competences (market and operational) on adaptive IT capability. This section discusses how adaptive IT capability is influenced by several IT capabilities either directly or indirectly via IT support for core competences (market and operational).

The standardised effects within this PhD study of the three IT capabilities on the higher order resource adaptive IT capability are displayed in Table 8.9 below.

**Table 8-9: Standardised Effects of IT Capabilities on Adaptive IT Capability12**

| IT Capabilities Effects on Adaptive IT Capability | | | | |
|---|---|---|---|---|
| | Direct Effects | | Indirect effects | |
| | S.E. | p | S. E. | p |
| IT personnel capability | | | 0.20 | 0.06 |
| IT management capability | 0.18 | 0.04 | 0.19 | 0.06 |
| IT infrastructure capability | 0.44 | <0.01 | 0.11 | 0.07 |

Overall, all three IT capabilities were found to impact on the ability of IT to enhance firms' adaptive capability (Table 8.9). IT infrastructure capability has the highest standardised effect on adaptive IT capability, followed by IT management capability and IT personnel capability. The direct and indirect effects of the three IT capabilities on adaptive IT capability are discussed succinctly below.

***Direct effects of IT capabilities on adaptive IT capability***

Adaptive IT capability was theorised to be directly positively influenced by IT infrastructure capability ('*H7: IT infrastructure capability is positively related to adaptive IT capability*') and IT management capability ('*H13: IT management capability is positively related to adaptive IT capability*'). The structural model and hypothesis testing outlined in Chapter 7 revealed that both hypotheses were supported at a 95% confidence interval. Hence, this PhD study states that the compatibility and connectivity of IT infrastructure and the quality of IT–business partnerships both have a significant positive effect on the ability of IT to

[12] Significance levels of indirect effects calculated through bias corrected bootstrapping

support firms' dynamic capabilities.

These results support previous arguments on the potential of IT infrastructure to enhance IT's ability to adapt to changes in business processes, customer demands or in the business environment generally. Duncan (1995) has stated that IT infrastructures are ideally designed to evolve in line with emerging technologies and to support the continual redesign of business and IT-related processes. IT infrastructure flexibility must be able to handle increased customer demands without increased costs (Weill, Subramani & Broadbent 2002). Earl (1989) and Niederman and Brancheu (1991) have also argued that IT infrastructure capability can facilitate a foundation for present and future business applications as well as be a base for firm-wide IT capabilities and business processes, and therefore is crucial to the building of IT support for core competences and adaptive IT capability (Kayworth, Chatterjee & Sambamurthy 2001). In addition, high levels of IT infrastructure capability were theorised to provide a wide range of IT services and can support a wide range of business services (Weill, Subramani & Broadbent 2002). To provide firms with the ability to adapt IT support for business processes and cross-functional integration IT infrastructure capability is vital. IT infrastructure capability can be a critical attribute of IT when firms need to adapt themselves to changes in the environment (Zhang 2006).

The confirmed positive link between IT infrastructure capability and adaptive IT capability, in combination with confirmed positive links between adaptive IT capability and competitive advantage identified in this PhD study (see sections 8.4.1 and 8.4.2), supports the argument for a indirect impact of IT infrastructure capability on competitive advantage via the higher order resource of adaptive IT capability. This rationale further extends the arguments from studies on IT capabilities which suggest that the capability of a firm's IT infrastructure, such as speed of implementation or flexibility, can influence vital aspects of business processes and performance in the contemporary environment (Allen & Boynton 1991; Venkatraman 1994), and that infrastructure flexibility could be the most critical factor within IT infrastructures (Allen & Boynton 1991). Furthermore, this study extends the work of Duncan (1995) who argues that the flexibility of IT infrastructure is an important source of competitive advantage. Her empirical study in the insurance industry included measures of IT flexibility such as configuration, compatibility and integration rules as well as access standards and connectivity measures for IT infrastructure components. Duncan (1995) found that business value measures were positively related to IT infrastructure flexibility (Duncan 1995a).

In addition to IT infrastructure capability, the research model presented in Chapter 4 also attested to positive and statistically significant effects of IT management capability on adaptive IT capability. The research development process described in Chapter 5 and the instrument validation outlined in Chapter 7 narrowed down the three theorised constructs of IT management capability (IT management strategic foresight, IT–business partnerships and strategic IT management), so that only the IT–business partnerships variable represented the IT management capability construct in the hypothesis testing. IT–business partnerships as the ability of IT and business units to constructively work together in mutually understanding partnerships was found to have a significant positive effect on adaptive IT capability. The results of this study confirm previous arguments that high levels of trust in IT–business partnerships enhance IT's ability to support change by allowing executives from both the IT and business sides to effectively work together and also enable fast and efficient use of IT to solve business problems (Piccoli & Ives 2005; Tallon 2008). Hence, IT management capabilities can have a positive effect on firms' ability to deal with change (Tallon 2008).

### *Indirect effects of IT capabilities on adaptive IT capability*

IT Capabilities were theorized in chapter 4 to have indirect effects on adaptive IT capability through IT support for core competences. These indirect effects encompass a variety of direct and indirect effects from IT capabilties on IT support for core competences and adaptive IT capability. The indirect effects are displayed in Table 8.9. Adaptive IT capability and IT support for core competences were theorised to be positively influenced by IT capabilities (infrastructure, personnel and management) in several ways.

Firstly, IT infrastructure capability was theorised to have, in addition to the direct effect on adaptive IT capability, an indirect effect on adaptive IT capability through IT support for operational competence. Hence, IT infrastructure capability was hypothesised to have a positive effect on IT support for operational competence and the following hypothesis was stated *('H8: IT infrastructure capability is positively related to IT support for operational competence'*). The structural model testing presented in Chapter 7 supported this hypothesis with a 95% confidence interval. Therefore, this PhD study concludes that the ability of firms' IT infrastructure to attach to any of the other components inside and outside the organisational environment, and its ability to share any kind of information across any technology component, positively influences the support that IT can provide for business processes as well as cross-functional integration. IT infrastructure capability can be the foundation of many business applications and can positively impact IT support for business process and cross-functional integration. This is consistent with the theoretical arguments of Ravichandran and Lertwongsatien (2005), which could not, however, be empirically confirmed in their research, because the construct that measures this IT support lacked validity in their measurement model. Nevertheless, calls have been made for further empirical evidence and theoretical support to explore whether IT support for business processes and cross-functional integration fits within the nomological network of relationships linking IT capabilities, IT competencies and competitive advantage (Ravichandran & Lertwongsatien 2005). This PhD study has addressed this call by empirically examining the construct of IT support for operational competence to positively conclude that such a construct does, indeed, fit into the nomological network of IT capabilities, IT support for core competences and competitive advantage.

Secondly, IT personnel capability was theorised to have a positive influence on IT support for core competences (market and operational) and, hence, to indirectly influence adaptive IT capability. Therefore, two research hypotheses were formulated: '*H9: IT personnel capability is positively related to IT support for operational competence'*, and *'H10: IT personnel capability is positively related to IT support for market competence'*. This chapter assessed these hypotheses through a structural model and as a result H9 was supported with a 99% confidence interval and H10 was by a 95% confidence interval. In addition to these direct effects in section 4.5.2 we argued for strong indirect effects of IT personnel capability on adaptive IT capability through IT support for market and operational competence. Table 8.9 above indicates that IT personnel capabilities indeed exhibit significant indirect effect on adaptive IT capability on a 90% confidence interval. Hence, the results of this study lead to the conclusion that the broad technical skills and business knowledge of IT personnel on the one hand have a statistically significant effect on the support that IT can provide for business processes, operational efficiency and cross-functional integration. Furthermore, on the other hand the results of this study indicate that the broad technical skills and business knowledge of IT personnel also have a statistically non-significant effect on the support IT can provide for analysing customer needs and markets.

These results confirm and extend the findings of the previous research on IT personnel, such that both the broad IT knowledge and knowledge of the business languages, goals and processes of IT personnel were found to have the potential to improve the support that IT can offer the business. Additionally, a higher level of IT personnel knowledge of the language, goals and processes of an organisation is regarded to further improve alignment with the business (Byrd, Lewis & Turner 2004). The discovered indirect effect of broadly skilled and business savvy IT personnel on IT's ability to adapt organisations through IT support for organisational business processes is to some degree similar to prior findings in the IT literature (Fink & Neumann 2007). So, we argue that the ability to adapt organisations IT to organisational changes requires not only broadly skilled and business savvy IT personnel, rather it also requires the ability of firms' IT to provide support for business processes, cross-functional integration, market segmentation, customer identification and redefining the scope of the business. Doing so the results of this PhD study further extend the existing knowledge on IT personnel capabilities as they provide arguments and evidence that better and broader business and IT knowledge among IT personnel are able to strengthen the ability of IT to adapt to environmental changes indirectly. Expecting expert knowledge of business issues from IT personnel would be unrealistic, but to a certain extent IT personnel should understand the goals, processes and languages of the business they support (Feeny & Willcocks 1998). Furthermore, broadly skilled IT personnel can better bridge old and new systems, deliverer data across locations and applications, and identify technical opportunities from new technologies (Ross, Beath & Goodhue 1996).

Thirdly, IT management was theorised not only to have a direct effect on adaptive IT capability but in addition to exhibit an indirect effect on adaptive IT capability through IT support for core competences (market and operational). Hence, in addition to H13, which proposed the direct effect of IT management on adaptive IT capability, the following two hypotheses were proposed: '*H11: IT management capability is positively related to IT support for operational competence*', and '*H12: IT management capability is positively related and can contribute significantly to IT support for market operational competence*'. The hypothesis testing disclosed that only H11 can be supported at a 99% confidence interval, whereas H12 was statistically not significant[13].

Therefore, the results of this study indicate that the quality of IT–business partnerships has a statistically significant effect on the support IT can provide for business processes, operational efficiency and cross-functional integration. Furthermore, the results of this PhD study point to a non-significant relationship between the quality of IT–business partnerships and the support that IT can provide for analysing customer needs and markets. These results confirm previous theorised frameworks on the IT–business partnerships effect on IT support for operational competence (Ravichandran & Lertwongsatien 2005).

### *Effects on IT support for market competence*

The ability of organisations IT to support identifying customer needs, market segments and redefining the scope of the business was theorized in this study to be influenced by several variables directly and indirectly. Three direct influences on IT support for market competence were hypothesized: '*H6: IT support for operational competence is positively related to IT support for market competence*', '*H10: IT personnel capability is positively related to IT support for market competence*, '*H12: IT management capability is positively related and can contribute significantly to IT support for market operational competence'*. Furthermore, an indirect effect of IT infrastructure capability on IT support for market

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[13] H12 is discussed in the section below in greater detail

competence was theorized in section 4.5.1. Table 8.10 provides an overview of the effects on IT support for market competence.

**Table 8-10: Effects on IT Support for Market Competence**

| Effects on IT support for market competence | | | | |
|---|---|---|---|---|
| | Direct Effects | | Indirect effects | |
| | SE | p | SE | p |
| IT support for operational competence | 0.52 | 0.01 | - | - |
| IT personnel capability | 0.23 | 0.05 | 0.17 | 0.12 |
| IT management capability | 0.06 | 0.55 | 0.21 | 0.02 |
| IT infrastructure capability | - | - | 0.14 | 0.08 |

Firstly, the separation of IT support for core competences into market and operational support allowed this study to assess the relationship between these two IT support for core competences. The research model theorised a positive relationship between IT support for operational competences and IT support for market competences. Hence, H6 was stated (‘*H6: IT support for operational competence is positively related to IT support for market competence*’). The hypothesis test presented in Table 8.10 above revealed a significant positive effect of IT support for operational competence on IT support for market competence (99% confidence interval). This result confirmed the assumption that IT support for business and innovation processes, knowledge-sharing and cross-functional integration also enhances IT’s ability to support firms’ products, services and the analysis of customer needs and markets. The ability to analyse markets and customers, for example, requires organisations to share information across departments or extract them from IT systems that support business processes (ERP systems such as SAP) (Bose 2002; Chen 2001; Chen & Popvich 2003).

Secondly, IT personnel capability was theorised to have a positive influence on IT support for market competence. Therefore, the research hypothesis was formulated *‘H10: IT personnel capability is positively related to IT support for market competence’*. This chapter assessed these hypotheses through a structural model and as a result H10 was supported by a 95% confidence interval. The results of this study indicate that the broad technical skills and business knowledge of IT personnel have an effect, which is statistically significant at 95% confidence interval, on the support IT can provide for analysing customer needs and markets. This is in line with Ravichandran and Lertwongsatien (2005) who discussed such a relationship before.

Thirdly, this study hypothesized direct positive effects of IT management capability on IT support for market competence and H12 was stated (‘*H12: IT management capability is positively related and can contribute significantly to IT support for market operational competence*’). The hypothesis test in Table 8.10 above indicates that such a relationship is statistically insignificant. Hence, H12 was rejected and the results of this study provide no evidence for a direct positive effect between the quality of IT-business partnerships and the ability of IT to support the identification of new market segments, analysing customer needs and redefining the scope of the market. Instead, this study revealed another interesting insight. IT management capability has a strong and statistically significant indirect effect on IT support for market competence through IT support for operational competence (see Table 8.10 above). Hence, this study states, that the ability of IT to support the market access of a company is not directly affected by the quality of IT business partnerships. Rather, these partnerships can have a strong effect on IT's ability to support market access competences of a company, if they can help to leverage existing IT support for business processes and cross-functional integration into optimal IT support for analysing customer needs, market segments and ideally redefining the scope of the business.  This notion is to some extent in line with the arguments of Ravichandran and Lertwongsatien (2005) for the indirect effects of these IT personnel traits on IT support for market competences. In their study Ravichandran and Lertwongsatien (2005) argued for indirect effects of IT personnel capability on IT support for core competencies through a variety of other IT capabilities (such as IT planning, system development, IT support, IT operations).

Finally, in section 4.5.1 we argued that rather than directly, IT infrastructure capability influences IT support for market competence indirectly through IT support for operational competence. The indirect effects delineated in Table 8.10 supports this argument. The indirect effect of IT infrastructure capability on IT support for market competence is significant on a 90% confidence interval. Hence, for firms' IT to provide optimal support for analysing customer segments, market needs and redefining the scope of the business it does not only need a capable IT infrastructure, it further need the ability of supporting business processes and cross-functional integration of firms. This is in line with literature which argues that CRM systems are often build on and require sophisticated ERP systems to unleash their full potential (Bose 2002; Chen & Popvich 2003).

#### *Relationship between IT Capabilties*

Finally, in addition to the proposed research model from Chapter 4, two covariances were specified. Firstly, in order to support a highly connected and compatible IT infrastructure, broad IT skills are essential. IT personnel capabilities can be transformational mechanisms which enable IT infrastructure capabilities (Fink & Neumann 2007). Furthermore, the ability of IT personnel to support a wide variety of IT services has a positive effect on the integration of IT infrastructure. Hence, the constructs IT infrastructure capability and IT personnel capability were covaried (Byrd & Turner 2001a), and strong effects between the two were measured (standardised effect of 0.32). These findings are also confirmed by Fink and Neumann (2007), who conceptually argue for and empirically confirm the causal interrelations between IT infrastructure and IT personnel capabilities.

Secondly, the quality of IT–business partnerships depends on many factors. One of these is the ability of IT personnel to understand the business environment they support. In turn, the better the IT–business partnerships, in the form of information sharing and mutual goal development, the more IT personnel can improve their knowledge of the working environment of the business side. Hence, the constructs IT personnel capability and IT management capability were covaried and strong effects between the two were measured (standardised effect of 0.45). This therefore indicates that different types of IT capabilities are not independent as one might gather from some previous studies (Wade & Hulland 2004), but are related (Byrd & Turner 2001a; Fink & Neumann 2007) and release their full potential by mutually reinforcing each other.

***Summary***

In sum, this PhD study has found similar results to the previous research on IT capabilities; that is, that the theorised IT capabilities can have a positive influence on IT business support. This research extends the previous research by examining the direct and indirect effects of IT infrastructure capability, the broad technical and business knowledge of IT personnel and the quality of IT–business partnerships on various IT support for core competences (market and operational) and IT's ability to enable firms' dynamic capabilities separately. Furthermore, several positive effects of IT capabilities on IT's ability to help firms adapt to environmental change were discovered. Fundamentally, , this study emphasized that most IT effects are not direct, but rather indirect through a complex chain of generating complementarities with other (IT) capabilities.

## 8.5. SUMMARY

The purpose of this chapter was to analyse and discuss the research findings. Descriptive analysis was conducted to provide an understanding of the research variables under investigation within the organisational context in which this research took place. As far as a comparison with overseas studies was possible, the research variables were found to perform similarly within Australian organisations to organisations in other countries. Multivariate statistics (SEM) were further utilised to assess the structural model and test the research hypotheses of this PhD study. The structural model was validated on four counts. Firstly, model fit indices of the assessed model revealed acceptable values above the recommended thresholds. Secondly, the measurement model did not show a significant improvement on the structural model. Thirdly, the variance extracted (28% for competitive advantage, around 50% for IT support for core competence (market and operational) and 72% for adaptive IT capability) indicated an acceptable level. Finally, the strengths, significance and direction of the theorised paths were in nearly all cases consistent with the theorised research model. The hypothesis test further revealed that nine out of the 13 hypotheses were statistically significant at a 95% confidence interval.

This PhD study has revealed that adaptive IT capability and its antecedent factors positively contribute to and significantly influence competitive advantage. Adaptive IT capability was found to have a significant positive influence on competitive advantage, confirming the theorised research model and extending prior theory on IT and DCP. In addition, the body of knowledge on IT and competitive advantage was enhanced by revealing that IT support for core competences (market and operational) do not have significant direct impacts on competitive advantage; rather they exhibit their influence on the market and financial performance of firms indirectly through the mediating role of adaptive IT capability. Furthermore, existing theory on IT capabilities (infrastructural, personnel and managerial) and their influence on IT's support for firms' competences, IT's ability to enable the adaptation of firms' competences and competitive advantage was placed in context with previous studies and extended. The next chapter revisits and summarises the key findings of this PhD study, discusses the theoretical and managerial implications of the results, and outlines the limitations and implications for further research.

# Chapter 9

# SUMMARY AND CONCLUSION

*The fact that I have entered into IT-related business is proof that businesses have to evolve and keep up with time. One has to re-invent continuously.*
*Kerry Packer (Australia's richest man and Media Magnate)*[14]

## 9.1. INTRODUCTION

The purpose of this chapter is to present the key findings of the dissertation. It offers a discussion of how this PhD study addressed the research questions and attempts to answer them. Furthermore, it outlines the contributions and limitations of this study, and suggests avenues for further research.

To address the vital question of whether and how IT contributes to competitive advantage the research rationale elucidated in Chapter 1, as well as Chapters 2, 3 and 4, argued for seeking answers through considering the DCP of IT and competitive advantage. Building on prior works and adding the notion of adaptive IT capability a research model was developed to investigate the IT– competitive advantage relationship. The developed research model was empirically tested and the findings indicate that the IT-based constructs of this study explained 28% of the variance in competitive advantage, hence supporting the strategic role of IT in enabling competitive advantage. Section 9.2 outlines how this PhD study addressed the research questions posed in Chapter 1, and presents the answers to these questions. Section 9.3 discusses the contributions of this PhD study both to theory and practitioners. The limitations of this PhD study and avenues for further research are outlined in section 9.4. Finally, section 9.5 finishes this PhD study with some concluding remarks.

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[14] (Biographies (accessed 30.03.2009))

## 9.2. RESEARCH QUESTIONS REVISITED

Drawing from the main research question and the research rationale a research gap was identified and subsequently three research questions evolved. Firstly: '*Is adaptive IT capability a source of competitive advantage*?' Secondly: *'Is adaptive IT capability mediating the relationship between IT support for core competence and competitive advantage?*' Finally, since adaptive IT capability is a higher order construct and builds on other factors, the question was asked: '*Which factors influence adaptive IT capability*?'

A research model was developed to investigate these three research questions. The research model developed in Chapter 4 firstly acknowledged prior research and hypothesised direct positive effects of IT support for core competences (market and operational) on competitive advantage (Ravichandran & Lertwongsatien 2005). Secondly, a new construct, adaptive IT capability, which represents IT's ability to enable the building, renewal and reconfiguration of organisational competences, was introduced and hypothesised to have a direct positive effect on competitive advantage. Thirdly, IT support for core competences (market and operational) were theorised to have, in addition to the direct impact on competitive advantage, an indirect impact through adaptive IT capability. Finally, extending the prior research several IT capabilities were identified which could have a positive effect on adaptive IT capability Figure 9-1 below displays an overview of the revisited research model.

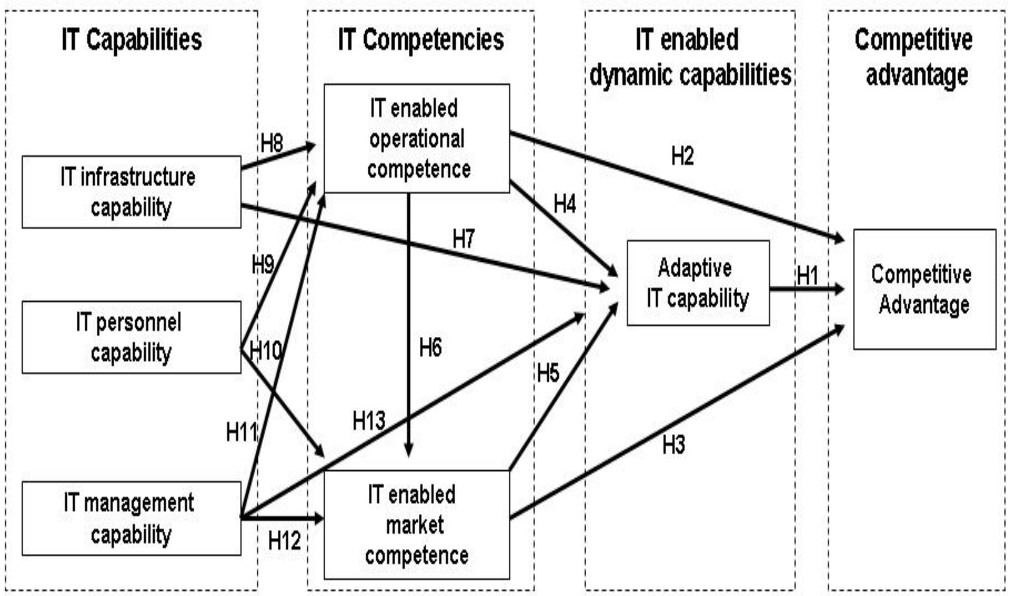


**Figure 9-1: Research Model Revisited**[15]

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[15] Insignificant paths are presented by dotted lines

Ten out of the 13 hypotheses were supported by a 95% confidence interval (Figure 9-1 above), hence providing rich arguments with which to discuss and answer the research questions.

The following sections will address and answer the research questions in sequence based on the previous research and insights from this research. Firstly, the effect of adaptive IT capability on competitive advantage is discussed in section 9.2.1. Secondly, the mediating role of adaptive IT capability on the relationship between IT support for core competence and competitive advantage is discussed by examining the effects of IT support for core competences, adaptive IT capability and competitive advantage in section 9.2.2. Finally, the questions concerning the factors that influence adaptive IT capability are addressed in section 9.2.3.

### 9.2.1. Is adaptive IT capability a source of competitive advantage?

An increasing number of studies are arguing for the DCP as a convincing framework to examine IT's potential for creating competitive advantage, the majority of which has been conceptual. Even though strong arguments link the higher order resource of adaptive IT capability to competitive advantage (as discussed in Chapter 4), no study has been found which empirically examines this relationship. Hence, the first research question of this study was: '*Is adaptive IT capability a source of competitive advantage?*'

To address this research question, a classification of dynamic capabilities was adopted from the previous literature and the construct of adaptive IT capability was defined as a higher order resource which refers to IT's ability to enable firms to constantly integrate, build and reconfigure internal and external competences to address changing environments. To operationalise this construct items were developed that measure IT's ability to enhance and adapt firms' competences quickly and effectively to new products, customers and markets. More specifically, existing research instruments that measure IT's static support for business and innovation processes, knowledge-sharing, cross-functional integration, and products and services, as well as for identifying customer needs and new market segments, were identified. The developed measures for adaptive IT capability are based on these static measures and adapted to measure how well IT can support the adaptation of this static support for firms' competences. A panel of experts survey and a pilot test with CIOs further improved the adaptive IT capability construct.

The structural model and hypothesis testing conducted in the previous chapter revealed that this higher order construct of adaptive IT capability has a significant positive effect on firms' market and financial performance. Especially strong are two interlinked capabilities' contributions to the financial and market performance of firms. These are the ability to adapt IT to new customer and market demands and the ability of IT to quickly change firms' products and services.

The findings of this research strengthen the argument for the strategic potential of IT as a source of competitive advantage. Thus, the argument that IT's ability to provide firms with an edge over competitors in the form of financial and market performance could derive from a hard-to-imitate, unique and heterogeneous ability which enables firms' dynamic capabilities can be supported through the findings of this PhD study. Hence, the research question, '*Is adaptive IT capability a source of competitive advantage*?' can be positively answered by the results of this PhD study.

These results are novel in so far as this PhD study is one of the first to empirically test the claim that a higher order resource of adaptive IT capability can provide companies with an edge over competitors in market and financial performance. This PhD study is the first to conceptually and empirically examine this construct of adaptive IT capability. This not only strengthens the argument for IT's potential to create competitive advantage through enabling firms' dynamic capabilities, it also provides practitioners and researchers with a validated framework to assess this potential.

### 9.2.2. Is adaptive IT capability mediating the effect of IT support for core competences (market and operational) on competitive advantage?

Apart from investigating the effect of adaptive IT capability on competitive advantage the research model of this study also incorporated insights from previous studies of IT support for core competences' impact on competitive advantage. Previous studies have found a positive relationship between IT support for core competences and competitive advantage (Ravichandran & Lertwongsatien 2005). In addition to these direct effects of IT support for core competences on competitive advantage, this study theorised indirect effects of IT support for core competences on competitive advantage mediated through the higher order resource of adaptive IT capability. The research rationale outlined in Chapter 1 and the research model presented in Chapter 4 delineated that firms not only need IT that provides optimal support for products, services, cross-functional integration and knowledge-sharing, but also need the ability to rebuild and reconfigure their IT support to gain an advantage in market and financial performance. Hence, the second research question of this study was: *'Is adaptive IT capability mediating the effect of IT support for core competences (market and operational) on competitive advantage*?'

To answer this research question previous research instruments on IT support for core competences were identified, adjusted and validated to be used as constructs in the research model. The direct and indirect effects (via the developed construct adaptive IT capability) were assessed in the structural model. The results indicated that IT support for core competences have a stronger effect on the market and financial performance relative to competitors if they are mediated by the ability to adapt to environmental changes. The direct effects of both IT support for market competences and IT support for operational competence were non-significant, whereas the indirect effects via adaptive IT capability were significant.

IT support for business competences are static IT support for core competences which can provide short-term advantage but might lack heterogeneity and are likely to be imitated in the long run. Thus, static IT support for business competences has limited potential to generate a consistent edge over competitors in market or financial performance. Nevertheless, IT support for business competences can be a base competence on which the higher order resource of adaptive IT capability is built. IT which enables a wide variety of business processes and information-sharing options can have an indirect impact on competitive advantage by enhancing IT's ability to adapt itself to necessary changes in firms' environments.

Hence, the answer to the research question, '*Is adaptive IT capability mediating the effect of IT support for core competences (market and operational) on competitive advantage*?' can be positively answered by this PhD study. Firms not only need IT that provides optimal support for cross-functional integration and business processes, they also need the ability to rebuild and reconfigure their IT support to improve market and financial performance.

### 9.2.3. Which factors influence adaptive IT capability?

As adaptive IT capability is a higher order resource which depends on several IT capabilities, this study was further interested to examine the factors that influence the building of adaptive IT capability. Hence, the third research question of this study was: '*Which factors influence adaptive IT capability?*'

To address this research question, three IT capabilities (IT infrastructure capability, IT personnel capability and IT management capability) were identified and theorised to influence adaptive IT capability directly and indirectly. IT management capability was initially operationalised to consist of three variables: IT management strategic foresight, IT–business partnerships and strategic IT management. During the process of instrument validation IT management strategic foresight and strategic IT management were dropped, as they did not fit into the nomological linkage between IT capabilities, IT support for core competences, adaptive IT capability and competitive advantage. All other constructs were validated and used in descriptive and analytical data analysis with the structural model.

The assessment of the structural model and hypothesis testing performed in Chapter 8 revealed several positive direct and indirect effects of IT capabilities (infrastructure, personnel, management) on adaptive IT capability. IT infrastructure capability and IT management capability both have a direct positive and statistically significant influence on adaptive IT capability. Furthermore, all three IT capabilities were found to indirectly positively influence adaptive IT capability via IT support for operational competence. In addition to these previously theorised effects, IT personnel capability was further found to influence IT management and IT infrastructure capability.

Hence, the question, '*Which factors influence adaptive IT capability?*' can be answered by this PhD study. The connectivity and compatibility of IT infrastructure as well as the quality of IT–business partnerships both have statistically significant, positive direct effects on adaptive IT capability. In addition, these factors and broad IT/business knowledge of IT personnel have indirect positive effects (via IT operational and market competence) on adaptive IT capability.

Furthermore, the manifold indirect influences of IT capabilities on adaptive IT capability and among IT capabilities give reason to argue that IT capabilities exhibit a greater potential for developing the higher order resource of adaptive IT capability if they mutually reinforce each other and form part of a complex chain with other IT capabilities and IT support for core competences.

Since positive influences of adaptive IT capability on competitive advantage were also discovered, one can argue that IT capabilities (infrastructural, personnel and managerial) indirectly influence the market and financial performance of firms in so far as they provide the base competence for a higher order resource of adaptive IT capability. In other words, this PhD study suggests that IT capabilities have the potential to contribute to competitive advantage by providing a base capability on which the higher order resource adaptive IT capability can be build. In this sense this study argues that if IT capabilities are used to dynamically support business strategy, they have the potential to contribute to a formidable barrier to imitation.

## 9.3. CONTRIBUTIONS OF THIS STUDY

Given the importance of dynamic capabilities for contemporary firms and the lack of research on IT and competitive advantage from the DCP, this PhD study has several theoretical and practical contributions.

### 9.3.1. Theoretical contributions

This PhD study contributes to the body of knowledge on IT, the DCP and competitive advantage in several ways.

Firstly, the developed model explicates the strategic role of IT in attaining competitive advantage through IT's potential to enhance firms' ability to deal with change. The results of this study indicate that IT can improve both market-based and financial performance in relation to competitors. The developed model explains 28% of the variance in competitive advantage of the sample firms. This adds to the body of knowledge on the relationship between IT and competitive advantage.

Secondly, it has synthesised previous fragmented work on various IT-based constructs and competitive advantage from the DCP of strategic management. Hence, the research model of this study has not only considered previous works on the resource-based view (e.g. Byrd & Turner 2000; Ravichandran & Lertwongsatien 2005) but also integrated research on IT-enabled dynamic capabilities (e.g. Pavlou & Sawy (2006); Sambamurthy 2003) into the theoretical framework.

Thirdly, by using structural equation modelling (SEM) as a data analysis tool, the existing theory on IT capabilities, IT support for core competences and competitive advantage was extended. Previous studies have used partial least squares (PLS) techniques to examine similar models (Ravichandran & Lertwongsatien 2005) but did not split IT support for core competences into IT support for market and operational competences. Hence, this PhD study extends previous works by examining the different impacts of IT support for market competence and IT support for operational competence on competitive advantage and by investigating the relationship between these two competences.

Fourthly, this PhD study has enhanced the understanding of how IT can contribute to firms' dynamic capabilities through introducing and examining the higher order resource of adaptive IT capability, its impact on competitive advantage (downstream factor) and its antecedent variables (upstream factors).

Fifthly, this PhD study extends existing work on IT capabilities, IT support for core competences and competitive advantage by arguing and positively testing for the mediating influence of adaptive IT capability on the relationship between IT support for core competences and competitive advantage. Hence, existing theory on IT's direct effect on competitive advantage is extended.

Sixthly, the construct that measures IT support for operational competence was derived from the works of Ravichandran and Lertwongsatien (2005). In their work, this construct could not be empirically confirmed, because it lacked validity in their measurement model. Nevertheless, calls have been made for further empirical evidence and theoretical support to explore whether IT support for business processes and cross-functional integration fits within the nomological network of relationships linking IT capabilities, IT support for core competences and competitive advantage (Ravichandran & Lertwongsatien 2005). This PhD study has addressed this call by developing and empirically examining the construct of IT support for operational competence and can positively conclude that such a construct does, indeed, fit into the nomological network of IT capabilities, IT support for core competences and competitive advantage.

Finally, this PhD study provides a validated framework to assess the ability of firms' IT to support organisational changes and the paths which can enhance such ability. The developed scales can be used in future research to explore the roles of these variables in other contexts.

In sum, this PhD study adds to the body of knowledge by integrating and extending various frameworks within the previous research on IT and competitive advantage. Furthermore, this research overcomes the limitations of path dependencies of previous research frameworks. Path dependencies arise from firms' previous investments and development of IT-related constructs and can limit a company's ability to adapt to environmental changes, hence negatively influencing its competitive advantage. The notion of adaptive IT capability overcomes this limitation and facilitates a broader perspective on the relationship between IT and competitive advantage.

### 9.3.2. Managerial contributions

From the perspective of practice, this study provides valuable insights for IT managers/CIOs and business managers alike.

Firstly, many IT managers/CIOs are often faced with the question: '*How can I justify the contribution of our IT department towards the market and financial performance of our* *company?*' This study enhances the knowledge of how IT can contribute to the market and financial performance of organisations. The results of this study confirm that IT can to some extent contribute positively to competitive advantage if IT supports firms' business processes, operational efficiency, and cross-functional integration, as well as identifying customer needs and new markets, and thus assists in redefining the scope of the business. In order to contribute significantly to competitive advantage firms need (in addition to these IT support for core competences) the ability to reconfigure and adapt their IT support to increase the speed of responding to new business opportunities and threats, such as addressing new customer needs and markets, and to adapt products and services, therewith quickly adapting business processes and organisational structures. Practitioners can use this study to argue for the strategic role of IT as an enabler of organisational agility.

Secondly, building on the notion of IT's potential to enable organisational agility, practitioners might ask: '*How can we measure whether our IT is able to support the firm's adaptations to new environments?*'. The research instrument developed in this study, especially the adaptive IT capability construct, gives practitioners the ability to measure the extent to which their IT supports their company's ability to adapt to new environments. Practitioners can complete the survey and compare it to the descriptive findings in chapter eight and through that benchmark their IT against the average Australian companies' IT. Hence, the validated research instrument can be utilised to assess the ability of companies' IT to deal with change in comparison to other Australian companies.

Thirdly, increasing environmental turbulence has altered managerial decision making from 'make and sell' towards 'sense and respond' (Bradley & Nolan 1998). Thus, an increasing demand for IT to enable organisations to deal with changes has evolved. IT managers/CIOs are often confronted with questions like, '*How can we increase the capability of our IT to strengthen our company's ability to deal with change*?' The framework developed for this study examined the IT-related factors that contribute to the ability of IT to enhance organisational change. As a result, the flexibility of IT infrastructure (such as the ability of any technological component to attach to any other component inside and outside the organisational environment or the ability to share any type of information across any technology component), the broad technical and business knowledge of IT personnel and the quality of IT–business partnerships were all found to both directly and indirectly positively influence IT's adaptive capability, which in turn strengthens firms' ability to deal with environmental change. Notably, the flexibility of IT infrastructure had the strongest effect on IT's adaptive capability and was sensitive to organisational size. Practitioners can use these results as a decision support for action plans and IT investment decisions. IT infrastructure concepts, such as service-oriented architectures (SOA) or grid computing, might help to increase the integration of IT infrastructure, thus providing an interesting discussion point for managerial decision making (Tallon 2008).

Finally, this study provides an indication of the extent to which organisations are poised to exploit the value generation potential of IT and, in particular, the adaptive capability or their IT. Practitioners can use the exploratory results of this study to benchmark the status of their own IT capabilities.

In sum, this PhD study informs business and IT executives about the strategic role IT can play in the contemporary business environment. Further, it provides executives with background information for developing the strategic potential of their IT investments and other managerial IT decisions.

## 9.4. LIMITATIONS AND FURTHER STUDY

Various limitations and implications for further research opportunities can be noted.

First, this PhD study was set out to explicate the impact of the higher order resource of adaptive IT on competitive advantage in both turbulent and less-turbulent environments across industries. As such, the primary interest was to investigate how IT can improve firms' ability to adapt to change and how to apply DCP theory to IT–competitive advantage research. For the sake of model parsimony, we did not control for environmental turbulence or information intensity of the industries. Our approach is in sync with most of the previous research on IT, firms' ability to react to change and competitive advantage (Fink & Neumann 2007; Overby, Bharadwaj & Sambamurthy 2006; Powell & Dent-Micallef 1997; Ravichandran & Lertwongsatien 2005; Sher & Lee 2004). Our findings demonstrate that adaptive IT capability has a positive influence on competitive advantage. However, it does not as such show whether that effect is stronger and more significant when one controls for environmental dynamism. This, therefore, represents an area for further research.

For example, emerging information systems research is arguing that information intensive firms that operate in volatile environments tend to develop and need dynamic capabilities more than other firms (Melville, Gurbaxani & Kraemer 2007; Pavlou & El Sawy 2006; Tallon 2008). As a result, these researchers include the extent of environmental dynamism, usually measured in terms of industry clock-speed reflecting the rate of change of new product innovation, customer turnover and product or service life cycles, as moderating the effect of dynamic capabilities on competitive advantage. The empirical evidence from such studies remains equivocal. While Pavlou and El Sawy (2006) and

Melville, Gurbaxani and Kraemer (2007) found environmental dynamism to moderate the impact of dynamic capabilities on competitive advantage, Tallon (2008) argues that environmental dynamism does not uniformly translate into greater agility. Environmental dynamism was found to have a different moderating effect on IT personnel and managerial capabilities' contribution to business process agility (Tallon 2008). The developed and validated research model of this PhD study can therefore serve as a foundation for future studies to examine the moderating effect of information intensity and environmental volatility on the relationship between adaptive IT capability and the competitiveness of firms.

Second, the cross-sectional design of the empirical study provided a snapshot of the variables under investigation and did not allow for examination of the longitudinal impact of IT capabilities, IT support for core competences and adaptive IT capability on competitive advantage. The higher order resource of adaptive IT capability builds on several other constructs which could take time to develop. Furthermore, developed adaptive IT capabilities might require some time before their existence has an effect on competitive advantage. Nevertheless, the items concerning competitive advantage are concerned with superior market and financial performance over the last three years ('*Over the past three years our financial performance has exceeded our competitors'*, '*Over the past three years, we have been more profitable than our competitors*', *'Over the past three years, our sales growth has exceeded our competitors*'). Data recollection within a couple of years could be interesting regarding possible time lag factors. Although a longitudinal analysis would entail some advantages, cross-sectional models must first be established before future research can investigate their viability over time (Pavlou & El Sawy 2006). Hence, this study provides a foundation for further studies which might use this PhD study as a foundation to retest the research model in a couple of years to compare the results.

Third, the data of this study were collected from medium to large-sized Australian organisations. Business environments might differ across the globe. Hence, the ability to generalise the findings of this study depends on the limitations of comparable environmental backgrounds of Australian and other international organisations. A replication of this study within different business environments will help to shed light on the question if the research environments of IT and competitive advantage differ across the globe.

Fourth, the data collection is based on the key informant method. One single respondent from each organisation was selected to answer the research questions. The most knowledgeable person to answer the questions of this research was identified as the CIO or CEO. This method has its advantages, as outlined in Chapter 5. The identified respondents are likely to have provided valid representations of their organisation.

Nevertheless, their views represent a single opinion, and future studies could adopt a research design which allows for multiple respondents within an organisation to cross-validate the results.

Fifth, even though a rigorous process of model development, data collection and instrument validation was followed, measurement errors cannot be completely ruled out. Measurement error can occur from sampling errors or a low sample size. Smaller sample sizes can reduce the ability to generalise the research findings. To ensure appropriate sample size two guidelines were considered. On the one hand, according to the literature a sample size of 200 is appropriate for the analytic method of structural equation modelling (SEM) (Hair et al. 2006). On the other hand, this decision was further norm referenced by comparable studies in Chapter 5. The sample size of this study (250 initially, 203 after data cleaning and instrument validation) is comparable to that of other studies in this field. Hence, while a higher sample size could lead to more accurate results, the sample size of this study can be considered appropriate. Further studies could retest the model utilising a higher sample size.

Sixth, following common practice and advice (Anderson & Gerbing 1988; Byrne 2001; Hair et al. 2006; Kline 2005) the measurement model was respecified and a few items dropped. This could lead to over-fitting of models and might generate results which are data-driven. To ensure that this potential source of measurement error is minimised, each respecification of the measurement model was not based solely on data. Rather, to address this concern, for each respecification of the model the constructs and items under question were scrutinised. Respecifications were then only conducted in line with theoretical underpinnings, which are documented in Chapter 7.

Seventh, the conceptualization of the concept IT support for core competences divides it into an internal side (IT support for operational competence) and an external side (IT support for market competence). Further research could include a broader conceptualization of the external side and include not only the market side but the whole supply chain. This would also encompass the supplier side and provide more insight into the IT and competitive advantage research.

Eighth, the sample selection of this study included CIOs and CEOs. The sampling rule was to only include one respondent per company. If available, the primary contact was the CIO and the CEO was contacted only in those cases where the CIO was not available. Hence, the sample after data cleaning contained 86% CIOs and only 14% CEOs. Since, it is within the tradition of IS research to include both respondents (CEO and CIO) for this kind of research and literature regards the next best informed respondent as an appropriate substitute (Huber & Power 1985) it is assumed in this study that the 14% of

CEOs in the sample do not significantly influence the results of this research. Further research with equal samples of CIOs and CEOs could investigate if their judgement significantly differs in regards to adaptive IT capabilities and competitive advantage.

Ninth, the construct of IT management capability was theorized to consist of two main variables (strategic IT management and business IT partnerships) which where theorised from previous literature to have an impact on adaptive IT capability. During the measurement validation process all items of the variable strategic IT management were dropped. Strategic IT management did not fit the nomological network of relationships as represented in the research model of this study and was excluded from the model. Further empirical evidence could re-examine if this variable do not fit the nomological relationship between IT capabilities, IT support for core competences, adaptive IT capability and competitive advantage.

Finally, avenues for further research can be identified in utilising the validated research model of this PhD study as a foundation to examine other potential moderating effects. Potential moderators, proposed in the IT literature but which were beyond the scope of this PhD study, include for example senior management commitment to IT (Wade & Hulland 2004). Senior management who perceive IT as a service provider might focus more on cost-efficient IT services and less on IT's strategic potential as an enabler of organisational change. In contrast, senior management who perceive and commit to IT as a strategic enabler might develop different IT capabilities.

## 9.5. FINAL CONCLUDING REMARKS

This PhD study bridged a research gap and integrated IT's ability to enable firms' dynamic capabilities, as well several IT capabilities (infrastructure, personnel and management) and IT support for core competences (operational and market) that enable IT to do so, into the ongoing research on IT and competitive advantage.

The results of this PhD study explicate the strategic role of IT as an enabler of firms' ability to deal with change. This study contributes to both theory and practice on IT, competitive advantage and dynamic capabilities by developing and validating an instrument to assess key indicators of IT-related constructs that have a positive effect on IT's ability to enable organisational change, and thus to be a source of competitive advantage. Furthermore, a concrete construct (adaptive IT capability) was introduced and validated that can measure the extent of IT's ability to support firms' dynamic capabilities. Adaptive IT capability was found to make a significant contribution to competitive advantage.

Developing dynamic capabilities is becoming increasingly important for companies operating in ever more unstable environmental conditions. Hence, the potential contribution of IT to the competitive advantage of companies by enhancing firms' ability to deal with change is likely to increase in future and provide fertile ground for ongoing research on IT and competitive advantage.

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# APPENDIX A: HISTORY OF STRATEGY AND STRATEGIC MANAGEMENT

The field of strategic management evolved from many different disciplines. Its roots can be traced back to early works on military strategy, and some early records date back to the Greeks and Romans. One of the earliest theorists in this field was the Chinese general and military strategist, Sun Tzu, with his seminal work *The Art of War*, which was written 2000 years ago. Sun Tzu's concept of strategic planning and implementation, and his focus on the strength of management, people and the environment show some timeless similarities with the requirements facing today's organisations (Viljoen & Dann 2003). Another seminal protagonist in the field of strategy was the 19$^{th}$-century Prussian military strategist Carl von Clausewitz (von Clausewitz 1973). Rather than applying his work to specific military strategies of the 19th century, or other specific systems or time, Clausewitz (1973) focused on systems which could be applied independent of time and specific situation. Therefore, his work remains a major influence in military strategy today (Viljoen & Dann 2003).

# APPENDIX B: INITIAL POOL OF SAMPLE ITEMS

| Construct | Variable | Item | Source |
|---|---|---|---|
| IT infrastructure capability | Connectivity | Our Company has a high degree of system interconnectivity | Tallon & Kraemer (2004) |
| | | Our system are sufficiently flexible to incorporate electronic links to external parties | |
| | | Data is available to everyone in the company in real time | |
| | Compatibility | Our user interfaces provide transparent access to all platforms and applications | Tallon & Kraemer (2004) |
| | | Our company makes intensive use of middleware to integrate key enterprise applications | |
| | Modularity | Legacy systems within our firm do NOT hamper the development of new IT applications | Tallon & Kraemer (2004) |
| | | Functionality can be quickly added to critical applications | |
| | | Our company can easily handle variations in data formats and standards | |
| IT personnel capability | Broad IT Knowledge | Our IT personnel are crosstrained to support other IT services outside their domain | Byrd &Turner (2001) |
| | | Our IT personnel are skilled in multiple programming languages | Byrd, Lewis & Turner (2004) |
| | | Our IT personnel are skilled in multiple operating systems | |
| | | Our IT personnel are knowledgeable about our IT products | Byrd &Turner (2001) |
| | Business Knowledge | Our IT personnel are knowledgeable about the key success factors in our organisation | Byrd &Turner (2001) |
| | | Our IT personnel understand the business environments they support | |
| IT management capability | Strategic IT Management | Our IT management knows about the latest development in business | OWN |
| | | Our IT management follows the latest developments in business | OWN |
| | | Our IT Management is evaluating chances and risks from emerging technologies | Duncan (1995a) |
| | | IT management contributes to our business strategy | |
| | | We manage IT strategically | Duncan (1995b) |
| | | IT initiatives are managed at the top levels of our organization | Duncan (1995a)<br>Ravichandran & Lertwongsatien (2005) |
| | Business- IT partnerships | There is a high degree of trust between our IT department and business units | Ravichandran & Lertwongsatien (2005) |
| | | Critical information and knowledge that affect IT projects are shared freely between business units and IS department | |
| | | Our IT department and business units understand the working environment of each other very well | |
| | | The goals and plans for IT projects are jointly developed by both the IT department and the business units | |
| | | Our IT management is able to interpret business problems and develop solutions | OWN |
| | | Conflicts between IT departments and business units are rare and few in our organization | Ravichandran & Lertwongsatien (2005) |
| | | We get timely, relevant and accurate information from our IT vendors and service providers to respond to our IT needs | |
| | | We have trusting partnerships with our key vendors and service providers | |

| | | |
|---|---|---|
| IT support for Market Competences | Our IT supports identifying market segments | Ravichandran & Lertwongsatien (2005) |
| | Our IT is utilized to redefine the scope of our business | |
| | Our IT supports analysing customer needs (i.e. products, preferences, pricing and quality) | |
| | Our IT is utilized to increase the speed of responding to business opportunities/ threats | |
| | Our IT is utilized to produce our products /services | OWN |
| IT support for Operational Competence | Our IT is supporting our strategic business processes | OWN |
| | Our IT is improving our operational efficiency | Gregor et al. (2004) |
| | Our IT supports our innovation processes | Rivard et al. (2006) |
| | Out IT supports our product development | Ravichandran & Lertwongsatien (2005) |
| | Our IT supports crossfunctional integration in our firm | |
| | Our IT supports knowledge sharing in the company | Rivard et al. (2006) |
| | Our IT supports our organizational learning | |
| Adaptive IT Capability | Our IT is able to adapt quickly to changes in knowledge sharing in the company | Adaptability measure of IT support for core competence item |
| | Our IT is able to adapt quickly to changes in organisational learning | |
| | Our IT is able to adapt quickly to changes which can become necessary when the firm changes it's Products or Services | |
| | Our IT is able to develop new products and services | |
| | Our IT is able to adapt quickly to changes in the product development | |
| | Our IT is able to adapt strategic business process reengineering | |
| | Our IT is able to adapt quickly to changes in the crossfunctional integration of our firm | |
| | Our IT is able to enhance business process flexibility | Ravichandran & Lertwongsatien (2005) |
| | Out IT is able to identify new market segments | |
| | Our IT is able to identify new customer needs | |
| | Our IT is able to adapt quickly to changes which can become necessary when the firm addresses changes in the market and customer demands | OWN |
| | Our IT is able to adapt quickly to changes which can become necessary because of competitors actions | OWN |
| | Our IT is able to adapt quickly to changes which can become necessary when the firm redesigns its business processes and organisational structures | OWN |
| COMPETITIVE ADVANTAGE | Over the past 3 years, our financial performance has exceeded our competitors | Powell and Dent Micalleff (1997) |
| | Over the past 3 years, we have been more profitable than our competitors | |
| | Over the past 3 years, our sales growth has exceeded our competitors | |

# APPENDIX C: PANEL OF EXPERTS SURVEY INVITATION EMAIL

Dear Professor <First Name> <Last Name>,

I am a doctoral candidate at the school of Business IT at RMIT University, Melbourne, Australia. I am writing to you, to ask you to help me with the instrument development by answering my panel of experts questionnaire. I have selected your name and email address from the relevant literature because I believe that your knowledge will help me with the development of my research instrument and have a contribution to my research. The aim of this research is to develop an understanding of adaptive Information Technology (IT) capabilities and their role in the competitiveness of firms from a dynamic capabilities perspective and its relations to IT infrastructure, IT personnel, IT management and IT support for core competences. After reviewing the relevant literature I believe your expertise to be of valuable input in developing and refining the research instrument. I got your contact details from your publications in academic journals, conferences or university homepages.

I hope that you will agree to complete this survey, which will take approximately 10 minutes to complete. To access the online questionnaire, please click here: http://www.rmit.edu.au/bus/bit/expertsurvey

Thank you very much for your attention.

Sincerely Yours,
Joerg Paschke
PhD student
School of Business Information Technology, RMIT Business

# APPENDIX D: PLAIN LANGUAGE STATEMENT FOR PANEL OF EXPERT SURVEY

INVITATION TO PARTICIPATE IN A RESEARCH PROJECT, PROJECT INFORMATION STATEMENT

Project Title:
Adaptive IT capabilities and its role in the competitiveness of firms: A dynamic capabilities perspective
Investigators:


- Joerg Paschke, Business Computing PhD student (Joerg.Paschke@rmit.edu.au)
- Dr Alemayehu Molla (Senior Lecturer, RMIT University, alemayehu.molla@rmit.edu.au.
- Prof. Bill Martin (Professor RMIT University, Bill.Martin@rmit.edu.au)


Dear Participant,
You are invited to participate in a research project conducted by the RMIT University. This information sheet describes the project in straightforward language, or ‘plain English’. Please read this sheet carefully and be confident that you understand its contents before deciding whether to participate. If you have any questions about the project please ask one of the investigators.
This research is being conducted by Joerg Paschke, a business computing PhD student enrolled in the School of Business Information Technology. The research is supervised by Dr Alemayehu Molla and Professor Bill Martin of the School of Business Information Technology, RMIT University. You have been approached to participate in this research project because the researcher believes your expertise to be of valuable input in developing and refining the research instrument. The researcher got your contact details from your publications in academic journals.
The aim of this research is to develop an understanding of adaptive Information Technology (IT) capabilities and their role in the competitiveness of firms from a dynamic capabilities perspective and its relations to IT infrastructure, IT personnel, IT management and IT support for core competences. This research project has been approved by the RMIT Human Research Ethics Subcommittee.
A draft survey instrument has been developed to operationalise the above constructs and the researcher is now testing the relevance of these questions using a panel of experts. A total of 20 academics will be invited to participate in this survey. The survey consists of 8 Variables and 40 Items and will take approximately 15–20 minutes to complete.

Your responses to the questions will be captured electronically. All information gathered during the course of this research including your responses will be securely stored for a period of five years in the School of Business Information Technology, RMIT University and can only be accessed by the researchers. After five years the data will be destroyed. The data will be analysed to improve the research instrument for a large-scale survey. Results published in academic journals and conferences will not include information that can potentially identify you.

There are no foreseeable risks associated with your participation in this research project. There are no direct benefits to you in participating in this research. However, your participation will assist the researcher and the wider information systems community in developing a sound understanding of the role of IT capabilities on the competitiveness of firms.

Due to the nature of this data collection process, we are not obtaining written informed consent from you. Instead, we assume that you have given consent by your completion and return of the questionnaire.

Your participation in this research is voluntary. As a participant, you have the right to withdraw your participation at any time; have any unprocessed data withdrawn and destroyed, provided it can be reliably identified, and provided that so doing does not increase your risk; and have any questions answered at any time. Any information that you provide can be disclosed only if (1) it is to protect you or others from harm, (2) a court order is produced, or (3) you provide the researchers with written permission.

If you agree to participate, please go to the online questionnaire at <Webadress>.

If you have any questions regarding this research, please contact the researcher, Joerg Paschke, +613, 992-51673, E-mail: Joerg.Paschke@rmit.edu.au or the supervisors listed above.

Yours Sincerely,

Joerg Paschke

# APPENDIX E: PANEL OF EXPERTS QUESTIONNAIRE

## Part 1: IT Management Capability

Please rate the relevance of these Variables by using the following scale: 1 - Not Relevant, 2 - Less Relevant, 3 - Relevant, 4 - More Relevant, 5 - Highly Relevant, NA - No Answer.

| | 1 | 2 | 3 | 4 | 5 | NA | Comments |
|---|---|---|---|---|---|---|---|
| Our IT Management knows about the latest development in Business | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our IT Management follows the latest developments in Business | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our IT Management is evaluating chances and risks from emerging technologies | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| In our firm top management perceives IT to be a source of strategic opportunity | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our Top Management consistently hires "Business Visionary CIO's" instead of "Service oriented CIO's" | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our Top Management sees IT as an enabler to alter our industry | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our CIO is involved into corporate strategic planning | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |

| | 1 | 2 | 3 | 4 | 5 | NA | Comments |
|---|---|---|---|---|---|---|---|
| There is a high degree of trust between our IT department and business units | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Critical information and knowledge that affect IT projects are shared freely between business units and IS department | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our IT department and business units understand the working environment of each other very well | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| The goals and plans for IT projects are jointly developed by both the IS department and the business units | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Conflicts between IT departments and business units are rare and few in our organization | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our IT management is able to interpret business problems and develop solutions | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| We get timely, relevant and accurate information from our IT Vendors and service providers to respond to our IT needs | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| We have trusting partnerships with our key vendors and service providers | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |

## Part 2 Adaptive IT Capability

Please rate the relevance of these Variables by using the following scale: 1 - Not Relevant, 2 - Less Relevant, 3 - Relevant, 4 - More Relevant, 5 - Highly Relevant, NA -No Answer.

| | 1 | 2 | 3 | 4 | 5 | NA | Comments |
|---|---|---|---|---|---|---|---|
| Our IT is able to adapt quickly to changes which can become necessary when the firm addresses changes in the market and customer demands | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our IT are able to adapt quickly to changes which can become necessary when the firm changes it's Products or Services | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our IT is able to identify new market segments | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our IT is able to identify new customer needs | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our IT is able to develop new products and services | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |

| | 1 | 2 | 3 | 4 | 5 | NA | Comments |
|---|---|---|---|---|---|---|---|
| Our IT is able to adapt quickly to changes which can become necessary when the firm redesigns its Business Processes and Organisational structures | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our IT is able to adapt strategic business process reengineering | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our IT is able to adapt quickly to changes in the product development | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our IT is able to adapt quickly to changes in knowledge sharing in the company | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our IT is able to adapt quickly to changes in organisational learning | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our IT is able to adapt quickly to changes in the cross-functional Integration of our Firm | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our IT is able to enhance strategic business process flexibility | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |

## Part 3: IT Support for Market Competences

Please rate the relevance of these Variables by using the following scale: 1 - Not Relevant, 2 - Less Relevant, 3 - Relevant, 4 - More Relevant, 5 - Highly Relevant, NA -No Answer.

| | 1 | 2 | 3 | 4 | 5 | NA | Comments |
|---|---|---|---|---|---|---|---|
| Our IT supports identifying market segments | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our IT supports analysing customer needs (i.e. products, preferences, pricing and quality) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our IT is utilized to produce our products /services | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our IT is utilized to increasing the speed of products and service delivery | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our IT is utilized to redefine the scope of our business | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our IT is utilized to increase the speed of responding to business opportunities/ threats | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |

## Part 4: IT Support for Operational Competences

Please rate the relevance of these Variables by using the following scale: 1 - Not Relevant, 2 - Less Relevant, 3 - Relevant, 4 - More Relevant, 5 - Highly Relevant, NA -No Answer.

| | 1 | 2 | 3 | 4 | 5 | NA | Comments |
|---|---|---|---|---|---|---|---|
| Our IT is supporting our strategic business processes | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our IT is improving our operational efficiency | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our IT supports our innovation processes | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our IT supports our product development | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our IT supports Knowledge sharing in the company | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our IT supports our organizational learning | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Our IT supports cross-functional integration in our Firm | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |

Thanks for your contribution. Please provide any additional comments in the space below before submitting your response.

# APPENDIX F: RESULTS FROM PANEL OF EXPERTS QUESTIONNAIRE

| Before POE | AVE | COMMENTS | ACTION TAKEN | AFTER POE |
|---|---|---|---|---|
| Our IT management knows about the latest development in business | 4.36 | - Perhaps this could be rephrased as "Our IT Management contributes to Our business strategy"<br>- the word latest is ambiguous maybe you could say: Our IT Management is up to date with the business development | Replaced with new Question | Our IT management is up to date with the business development |
| Our IT management follows the latest developments in business | 3.50 | what is the difference between knowing and following? Can one follow without knowing? Can one know without following?<br>not clear wording<br>- the word latest is ambiguous maybe you could say: Our IT Management is up to date with the business development | | |
| Our IT Management is evaluating chances and risks from emerging technologies | 4.43 | opportunities rather than risks<br>-evaluates rather than "is evaluating" | Wording changed | Our IT Management evaluates chances, opportunities and risks from emerging technologies |
| In our firm top management perceives IT to be a source of strategic opportunity | 4.71 | | | In our firm top management perceives IT to be a source of strategic opportunity |
| IT management contributes to our business strategy | 4.62 | | | IT Management contributes to our business strategy |
| We manage IT strategically | 4.33 | | | We manage IT strategically |
| IT initiatives are managed at the top levels of our organization | 4.14 | | Wording changed | IT initiatives are managed at the top levels of our organization |
| There is a high degree of trust between our IT department and business units | 3.50 | | | There is a high degree of trust between our IT department and business units |
| Critical information and knowledge that affect IT projects are shared freely between business units and IS department | 4.07 | | | Critical information and knowledge that affect IT projects are shared freely between business units and IS department |
| Our IT department and business units understand the working environment of each other very well | 3.86 | very well is ambiguous | Deleted ambiguous phrase "very well" | Our IT department and business units understand the working environment of each other |
| The goals and plans for IT projects are jointly developed by both the IT department and the business units | 4.57 | | | The goals and plans for IT projects are jointly developed by both the IT department and the business units |
| Conflicts between IT departments and business units are rare and few in our organization | 2.64 | Lack of conflict could mean lack of interaction/engagement? | Deleted due to: not relevant | |
| We get timely, relevant and accurate information from our IT vendors and service providers to respond to our IT needs | 2.86 | | Deleted due to: not relevant | |
| We have trusting partnerships with our key vendors and service providers | 2.93 | | | |
| Our IT management is able to interpret business problems and develop solutions | 4.57 | | | Our IT management is able to interpret business problems and develop solutions |

| Panel of experts survey results and changes done in research instrument (Part II- IT support for Core Competence construct) | | | | |
|---|---|---|---|---|
| **Before POE** | **AVE** | **COMMENTS** | **ACTION TAKEN** | **AFTER POE** |
| Our IT supports identifying market segments | 4.50 | | | Our IT supports identifying market segments |
| Our IT is utilized to redefine the scope of our business | 4.29 | | | Our IT is utilized to redefine the scope of our business |
| Our IT supports analysing customer needs (i.e. products, preferences, pricing and quality) | 4.71 | | | Our IT supports analysing customer needs (i.e. products, preferences, pricing and quality) |
| Our IT is utilized to produce our products /services | 3.86 | | | Our IT is utilized to produce our products /services |
| Our IT is utilized to increase the speed of responding to business opportunities/ threats | 4.29 | | Deleted | |
| Our IT is supporting our strategic business processes | 4.71 | | | Our IT is supporting our strategic business processes |
| Our IT is improving our operational efficiency | 4.64 | | | Our IT is improving our operational efficiency |
| Our IT supports our innovation processes | 4.86 | | | Our IT supports our innovation processes |
| Out IT supports our product development | 4.64 | How is this different from "Our IT is utilized to produce our products /services" | | Out IT supports our product development |
| Our IT supports knowledge sharing in the company | 4.43 | | | Our IT supports Knowledge sharing in the company |
| Our IT supports our organizational learning | 4.36 | | Deleted, because knowledge sharing is a sub question of org learning and more relevant to IT | |
| Our IT supports crossfunctional integration in our firm | 4.29 | | | Our IT supports crossfunctional integration in our Firm |

| Panel of experts survey results and changes done in research instrument (Part III- Adaptive IT Capability) | | | | |
|---|---|---|---|---|
| **Before POE** | **AVE** | **COMMENTS** | **ACTION TAKEN** | **AFTER POE** |
| Our IT is able to adapt quickly to changes which can become necessary when the firm addresses changes in the market and customer demands | 4.64 | too wordy confusing question complex question | shortened question | Our IT is able to adapt quickly to changes in the market and customer demands |
| Our IT is able to adapt quickly to changes which can become necessary when the firm changes it's Products or Services | 4.79 | | Grammar corrector and shortened question | Our IT is able to adapt quickly to changes in firm's products or services |
| Out IT is able to identify new market segments | 3.57 | is this their job? | Deleted - Questions are least relevant in measuring variable | |
| Our IT is able to identify new customer needs | 3.71 | is this their job? | | |
| Our IT is able to develop new products and services | 4.29 | | | Our IT is able to develop new products and services |
| Our IT is able to adapt quickly to changes which can become necessary because of competitors actions | 4.86 | need possessive case | | Our IT is able to adapt quickly to changes which can become necessary because of competitors actions |
| NEW ITEM | | | Moved from "IT Support for Market Competencies" (6SMCF) | Our IT is utilized to increase the speed of responding to business opportunities/ threats |
| Our IT is able to adapt quickly to changes which can become necessary when the firm redesigns its Business Processes and Organisational structures | 4.86 | Shorten | shortened Question | Our IT is able to adapt quickly to changes in business processes and organisational structures |
| Our IT is able to adapt quickly to changes in knowledge sharing in the company | 4.50 | IT should be an active enabler of knowledge sharing through relevant tools. | | |
| Our IT is able to adapt strategic business process reengineering | 3.64 | wording not clear | deleted | |
| Our IT is able to adapt quickly to changes in the product development | 4.57 | | Wording changed | Our IT is able to adapt quickly to changes in product development |
| Our IT is able to adapt quickly to changes in organisational learning | 3.43 | IT should be an active enabler of organisational learning through relevant tools.<br>-org learning should occur with IT<br>-not clear what your item means | | |
| Our IT is able to adapt quickly to changes in the crossfunctional Integration of our Firm | 4.43 | hard to understand exactly what is meant | | Our IT is able to adapt quickly to changes in the crossfunctional Integration of our Firm |
| Our IT is able to enhance strategic business process flexibility | 4.64 | | | Our IT is able to enhance strategic business process flexibility |

# APPENDIX G: EMAIL INVITATION FOR MAIN SURVEY

Dear <Title> <First Name> <Last Name>,

I am a doctoral candidate at the School of Business IT at RMIT University, Melbourne, Australia. I am writing to you because you are recognised as a leader in your field and invite you to participate in a research project that aims to identify the key attributes of IT, its ability to adapt to changes in the business and technical environment and its impact upon the competitiveness of firms.

The questions asked relate to your IT Infrastructure, personnel, management, and competences and your business performance. I believe that your knowledge will help us to understand the value Australian organisations are generating from their IT. If you provide a contact address in the space provided for this purpose inside the survey, we will send you a summary of the results of the study which will provide a benchmark of your IT.

The survey will take approximately 10 minutes and is available at http://www.rmit.edu.au/bus/bit/expertsurvey

Many thanks for your assistance,

Sincerely,
Joerg Paschke

Joerg Paschke
PhD student
School of Business Information Technology, RMIT Business
Joerg.Paschke@rmit.edu.au

# APPENDIX H: MAIN SURVEY PLAIN LANGUAGE STATEMENT

Invitation to Participate in a Research Project, Project Information Statement

Project Title:
Adaptive IT capability and its role in the competitiveness of firms: A dynamic capabilities perspective

Please read the following Project Information statement carefully
Investigators:
Joerg Paschke, Business Computing PhD degree student
Dr Alemayehu Molla (Senior Lecturer, RMIT University, alemayehu.molla@rmit.edu.au, 99255803)
Prof. Bill Martin (Professor RMIT University, Bill.Martin@Rmit.edu.au, 99255783)

Dear Participant,
You are invited to participate in a research project conducted by the RMIT University. This information sheet describes the project in straightforward language, or ‘plain English’. Please read this sheet carefully and be confident that you understand its contents before deciding to participate. If you have any questions about the project please ask one of the investigators.
This research is being conducted by Joerg Paschke, a Business Computing PhD student enrolled in the School of Business Information Technology. The research is supervised by Dr Alemayehu Molla and Professor Bill Martin of the School of Business Information Technology, RMIT University. This research project has been approved by the RMIT Human Research Ethics Subcommittee.
You have been approached to participate in this research project because you have been identified as a chief information officer, Senior IT Manager or chief executive officer. The survey will take approximately 8–13 minutes to complete.
The aim of this research is to develop an understanding of Information Technology (IT) capabilities and its contribution to the performance of firms. The questions to be asked cover issues related to IT Infrastructure, IT Personnel, IT Management and IT Competences.
Your responses to the questions will be captured electronically. All information gathered during the course of this research, including your responses will be securely stored for a period of five years in the School of Business Information Technology, RMIT University and can only be accessed by the researchers. After five years the data will be destroyed. Results published in academic journals and conferences will not include information that can potentially identify either you or your organisation.

There are no foreseeable risks associated with your participation in this research project. Your participation will assist the researcher and the wider information systems community in developing a sound understanding of how IT Capabilities could be developed and managed for better performance of firms. You might elect to receive a summary of the results of the study. In order to do so, you need to provide us with a contact address in the space provided on the questionnaire. Addresses collected in such a manner will only be used for disseminating the results and will be destroyed afterwards.

Due to the nature of this data collection process, we are not obtaining written informed consent from you. Instead, we assume that you have given consent by your completion and return of the questionnaire.

Your participation in this research is voluntary. As a participant, you have the right to withdraw your participation at any time; have any unprocessed data withdrawn and destroyed, provided it can be reliably identified, and provided that so doing does not increase your risk; and have any questions answered at any time. Any information that you provide can be disclosed only if (1) it is to protect you or others from harm, (2) a court order is produced, or (3) you provide the researchers with written permission.

**Please read the following Project Information statement carefully and if you agree to participate, please proceed to the Online Questionnaire.**

If you have any questions regarding this research16, please contact the researcher, Joerg Paschke, +613, 992-51673, E-mail: Joerg.Paschke@rmit.edu.au or the supervisors listed above.

Yours Sincerely,
Joerg Paschke

[16] Any complaints about your participation in this project may be directed to the Secretary, Portfolio Human Research Ethics Sub Committee, Business Portfolio, RMIT, GPO Box 2476V, Melbourne, 3001. The telephone number is (03) 9925 5594 or email address rdu@rmit.edu.au. Details of the complaints procedure are available from the above address or via the internet at http://ww.rmit.edu.au/council/hrec

# APPENDIX I: MAIN SURVEY QUESTIONNAIRE

| Main Survey Questionnaire I | | |
|---|---|---|
| IT infrastructure capability | 1IIFB | Our Company has a high degree of system interconnectivity |
| | 1IIFC | Our system is sufficiently flexible to incorporate electronic links to external parties |
| | 1IIFD | Data is available to everyone in the company in real time |
| | 1IIFE | Our user interfaces provide transparent access to all platforms and applications |
| | 1IIFF | Our company makes intensive use of middleware to integrate key enterprise applications |
| | 1IIFG | Legacy systems within our firm do NOT hamper the development of new IT applications |
| | 1IIFH | Functionality can be quickly added to critical applications |
| | 1IIFI | Our company can easily handle variations in data formats and standards |
| IT personnel capability | 2HRFA | Our IT personnel are cross-trained to support other IT services outside their domain |
| | 2HRFB | Our IT personnel are skilled in multiple programming languages |
| | 2HRFC | Our IT personnel are skilled in multiple operating systems |
| | 2HRFD | Our IT personnel are knowledgeable about our IT products |
| | 2HRFE | Our IT personnel are knowledgeable about the key success factors in our organisation |
| | 2HRFF | Our IT personnel understand the business environments they support |
| IT management capability | 3SMCA | Our IT management is up to date with the business development |
| | 3SMCB | Our IT management evaluates chances, opportunities and risks from emerging technologies |
| | 3SMCG | IT management contributes to our business strategy |
| | 3SMCI | We manage IT strategically |
| | 4OMCA | There is a high degree of trust between our IT department and business units |
| | 4OMCB | Critical information and knowledge that affect IT projects are shared freely between business units and IS department |
| | 4OMCC | Our IT department and business units understand the working environments of each other |
| | 4OMCD | The goals and plans for IT projects are jointly developed by both the IT department and the business units |
| | 4OMCE | Our IT management is able to interpret business problems and develop solutions |
| IT support for market competence | 5SMCA | Our IT supports identifying market segments |
| | 5SMCB | Our IT is utilised to redefine the scope of our business |
| | 5SMCC | Our IT supports analysing customer needs (i.e. products, preferences, pricing and quality) |
| | 5SMCD | Our IT is utilised to produce our products /services |
| IT support for operational competence | 6SOCA | Our IT is supporting our strategic business processes |
| | 6SOCB | Our IT is improving our operational efficiency |
| | 6SOCC | Our IT supports our innovation processes |
| | 6SOCD | Our IT supports our product development |
| | 6SOCE | Our IT supports knowledge-sharing in the company |
| | 6SOCF | Our IT supports cross-functional integration in our firm |

| Main Survey Questionnaire II | | |
|---|---|---|
| Adaptive IT capability | 8AMAA | Our IT is able to adapt quickly to changes in the market and customer demands |
| | 8AMAB | Our IT is able to adapt quickly to changes in the firm's products or services |
| | 8AMAC | Our IT is able to develop new products and services |
| | 8AMAD | Our IT is able to adapt quickly to changes which can become necessary because of competitors' actions |
| | 8AMAE | Our IT is utilised to increase the speed of responding to business opportunities/ threats |
| | 9AOAA | Our IT is able to adapt quickly to changes in business processes and organisational structures |
| | 9AOAB | Our IT is able to adapt quickly to changes in knowledge-sharing in the company |
| | 9AOAC | Our IT is able to adapt quickly to changes in product development |
| | 9AOAD | Our IT is able to adapt quickly to changes in the cross-functional Integration of our firm |
| | 9AOAE | Our IT is able to enhance strategic business process flexibility |
| CA | 11CAA | Over the past 3 years, our financial performance has exceeded our competitors |
| | 11CAB | Over the past 3 years, we have been more profitable than our competitors |
| | 11CAC | Over the past 3 years, our sales growth has exceeded our competitors |

# APPENDIX J: VIEWS ON MISSING DATA ANALYSIS

| | Profile | Suggestion |
|---|---|---|
| 1 | A Professor and Director of Research at a Business School | I guess it depends on a number of factors:<br>1. The frequency (proportion) of N/A responses... high (f) might indicate inappropriate question... therefore exclude the item or make another appropriate decision.<br>2. N/A is not missing data, as there is a response.<br>3. Substitution with another value is biasing the data, as you are changing their response<br>4. Why not consider using another value e.g., "0" as part of the original analysis... this will not lead to a reduction in (n) and plus u r using the data. |
| 2 | Professor | I have not had experience with this particular issue, but I would be inclined to say that you don't want to treat it as missing data. The<br>reason that I say that is that you would impute a value to that response when the responder is saying that it is not applicable and therefore<br>Does not have a value. For example, I am now retired. If the question was "If employed, what is your salary?" my response would be NA. But if you looked at other variables to which I responded it might be relatively easy to compute what my salary would be if I were not<br>retired, but you would not want to substitute that for my NA. |
| 3 | A distinguished professor and world known senior IT scholar, editor of one of the top five IS journals | If you recode as a mean, you lower the variance and this affects the T-test against the researcher, so it is perfectly legitimate, but it may not produce significance. It will probably work better for factor analysis. The stability of the factor structures is highly susceptible to sample size so it would help there. |
| 4 | A retired statistics professor and an author of a book on missing data | You need to first evaluate the meaning of "Not Applicable" answers in the questionnaire. Based on that analysis of what the answers imply, he can then treat such responses as a 'negative' category, impute a replacement response based on those given to the other related items in the survey under the same construct, or equate those NA responses with missing data.<br><br>If the missing data case is applicable in his situation, then he can use any of four well-known strategies: cold deck imputation; hot deck imputation; treating the missing responses as if they were not offered in the survey; and using a model which considers respondents' tendency in responding to items. |
| 5 | A marketing professor and quantitative researcher | Generally I just let the software treat the data as missing, which effectively reduces the sample size. If there was quite a bit missing I'd exclude the questionnaire as a whole. It would be pair wise if just correlation, but effectively list wise if multiple regression or multivariate stuff. But often this is because (for whatever reason) people have left a question blank versus ticking a "not applicable". I think that situation depends on the context. If it really is not applicable to them, surely they should not be included, and "implying" a value of some sort does not seem appropriate. If it is a Likert type question, people generally seem to complete those even if they don't have a strong opinion, because the neutral box is there. There seem to be different points of view about whether to add a "not applicable" box as well. I guess that depends on the context of the study and questions.<br>The advantage of replacing a missing value with something is that you are increasing the sample size and therefore in theory the power of the test. This may well make a difference in being able to accept/reject a null hypothesis if the sample is relatively small, with a fair number of missing errors.<br>If you are in this situation, what you could do is try out a few of the techniques and see whether the conclusions you draw are sensitive to this - do you get the same result, or different ones according to the method used.<br>NB: One key thing - I am talking in general, and I now notice the subject of the email refers to SEM, which needs a lot of data. I would do a search for any specific recommendations on how to treat missing data using SEM, as there may be specific implications relevant to this approach. It may depend on the software "variation” you are using (I am not well acquainted with these). Is it LISREL, the offering in Statistical, etc.?<br>That's about all I can suggest. |

# APPENDIX K: MULTICOLLINEARITY TEST

Multicollinearity Inter-Item Correlations I

| | 1B | 1C | 1D | 1E | 1G | 1H | 1I | 2A | 2C | 2D | 2E | 2F | 3A | 3B | 3G | 3I | 4A | 4B | 4C | 4D | 4E |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1B | 1.00 | 0.56 | 0.34 | 0.28 | 0.22 | 0.37 | 0.27 | 0.24 | 0.07 | 0.17 | 0.16 | 0.19 | 0.20 | 0.10 | 0.20 | 0.29 | 0.29 | 0.33 | 0.19 | 0.27 | 0.23 |
| 1C | 0.56 | 1.00 | 0.37 | 0.32 | 0.16 | 0.26 | 0.30 | 0.22 | 0.10 | 0.24 | 0.16 | 0.21 | 0.16 | 0.15 | 0.18 | 0.19 | 0.31 | 0.23 | 0.15 | 0.19 | 0.05 |
| 1D | 0.34 | 0.37 | 1.00 | 0.50 | 0.28 | 0.34 | 0.22 | 0.18 | 0.01 | 0.11 | 0.12 | 0.03 | 0.01 | 0.12 | 0.10 | 0.11 | 0.22 | 0.15 | 0.13 | 0.11 | 0.09 |
| 1E | 0.28 | 0.32 | 0.50 | 1.00 | 0.29 | 0.31 | 0.26 | 0.21 | 0.08 | 0.11 | 0.15 | 0.11 | 0.15 | 0.26 | 0.07 | 0.13 | 0.33 | 0.14 | 0.09 | 0.09 | 0.12 |
| 1G | 0.22 | 0.16 | 0.28 | 0.29 | 1.00 | 0.49 | 0.42 | 0.20 | -0.09 | 0.02 | 0.15 | 0.14 | 0.19 | 0.14 | 0.11 | 0.16 | 0.18 | 0.34 | 0.23 | 0.19 | 0.19 |
| 1H | 0.37 | 0.26 | 0.34 | 0.31 | 0.49 | 1.00 | 0.56 | 0.22 | 0.03 | 0.18 | 0.27 | 0.22 | 0.32 | 0.20 | 0.23 | 0.31 | 0.28 | 0.32 | 0.21 | 0.19 | 0.34 |
| 1I | 0.27 | 0.30 | 0.22 | 0.26 | 0.42 | 0.56 | 1.00 | 0.21 | 0.13 | 0.22 | 0.27 | 0.24 | 0.32 | 0.18 | 0.12 | 0.21 | 0.28 | 0.30 | 0.23 | 0.17 | 0.25 |
| 2A | 0.24 | 0.22 | 0.18 | 0.21 | 0.20 | 0.22 | 0.21 | 1.00 | 0.29 | 0.50 | 0.41 | 0.36 | 0.22 | 0.28 | 0.18 | 0.25 | 0.36 | 0.25 | 0.28 | 0.14 | 0.34 |
| 2C | 0.07 | 0.10 | 0.01 | 0.08 | -0.09 | 0.03 | 0.13 | 0.29 | 1.00 | 0.42 | 0.19 | 0.21 | 0.01 | 0.05 | 0.14 | 0.14 | 0.18 | 0.04 | 0.03 | 0.01 | 0.10 |
| 2D | 0.17 | 0.24 | 0.11 | 0.11 | 0.02 | 0.18 | 0.22 | 0.50 | 0.42 | 1.00 | 0.46 | 0.44 | 0.28 | 0.32 | 0.31 | 0.37 | 0.38 | 0.20 | 0.16 | 0.17 | 0.31 |
| 2E | 0.16 | 0.16 | 0.12 | 0.15 | 0.15 | 0.27 | 0.27 | 0.41 | 0.19 | 0.46 | 1.00 | 0.67 | 0.35 | 0.28 | 0.30 | 0.37 | 0.36 | 0.27 | 0.30 | 0.19 | 0.46 |
| 2F | 0.19 | 0.21 | 0.03 | 0.11 | 0.14 | 0.22 | 0.24 | 0.36 | 0.21 | 0.44 | 0.67 | 1.00 | 0.33 | 0.20 | 0.25 | 0.25 | 0.18 | 0.18 | 0.20 | 0.23 | 0.32 |
| 3A | 0.20 | 0.16 | 0.01 | 0.15 | 0.19 | 0.32 | 0.32 | 0.22 | 0.01 | 0.28 | 0.35 | 0.33 | 1.00 | 0.42 | 0.37 | 0.48 | 0.19 | 0.37 | 0.21 | 0.28 | 0.43 |
| 3B | 0.10 | 0.15 | 0.12 | 0.26 | 0.14 | 0.20 | 0.18 | 0.28 | 0.05 | 0.32 | 0.28 | 0.20 | 0.42 | 1.00 | 0.24 | 0.39 | 0.20 | 0.22 | 0.13 | 0.16 | 0.35 |
| 3G | 0.20 | 0.18 | 0.10 | 0.07 | 0.11 | 0.23 | 0.12 | 0.18 | 0.14 | 0.31 | 0.30 | 0.25 | 0.37 | 0.24 | 1.00 | 0.67 | 0.13 | 0.31 | 0.15 | 0.34 | 0.28 |
| 3I | 0.29 | 0.19 | 0.11 | 0.13 | 0.16 | 0.31 | 0.21 | 0.25 | 0.14 | 0.37 | 0.37 | 0.25 | 0.48 | 0.39 | 0.67 | 1.00 | 0.23 | 0.36 | 0.23 | 0.32 | 0.36 |
| 4A | 0.29 | 0.31 | 0.22 | 0.33 | 0.18 | 0.28 | 0.28 | 0.36 | 0.18 | 0.38 | 0.36 | 0.18 | 0.19 | 0.20 | 0.13 | 0.23 | 1.00 | 0.42 | 0.38 | 0.27 | 0.35 |
| 4B | 0.33 | 0.23 | 0.15 | 0.14 | 0.34 | 0.32 | 0.30 | 0.25 | 0.04 | 0.20 | 0.27 | 0.18 | 0.37 | 0.22 | 0.31 | 0.36 | 0.42 | 1.00 | 0.49 | 0.48 | 0.40 |
| 4C | 0.19 | 0.15 | 0.13 | 0.09 | 0.23 | 0.21 | 0.23 | 0.28 | 0.03 | 0.16 | 0.30 | 0.20 | 0.21 | 0.13 | 0.15 | 0.23 | 0.38 | 0.49 | 1.00 | 0.48 | 0.36 |
| 4D | 0.27 | 0.19 | 0.11 | 0.09 | 0.19 | 0.19 | 0.17 | 0.14 | 0.01 | 0.17 | 0.19 | 0.23 | 0.28 | 0.16 | 0.34 | 0.32 | 0.27 | 0.48 | 0.48 | 1.00 | 0.42 |
| 4E | 0.23 | 0.05 | 0.09 | 0.12 | 0.19 | 0.34 | 0.25 | 0.34 | 0.10 | 0.31 | 0.46 | 0.32 | 0.43 | 0.35 | 0.28 | 0.36 | 0.35 | 0.40 | 0.36 | 0.42 | 1.00 |

Multicollinearity Inter-Item Correlation II

| | 5A | 5B | 5C | 5D | 6A | 6B | 6C | 6E | 6F | 8A | 8B | 8D | 8E | 9A | 9B | 9D | 9E | 11A | 11B | 11C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5A | 1.00 | 0.57 | 0.45 | 0.33 | 0.26 | 0.34 | 0.36 | 0.35 | 0.33 | 0.31 | 0.34 | 0.38 | 0.43 | 0.32 | 0.26 | 0.25 | 0.29 | 0.22 | 0.23 | 0.21 |
| 5B | 0.57 | 1.00 | 0.50 | 0.38 | 0.30 | 0.44 | 0.47 | 0.38 | 0.34 | 0.29 | 0.30 | 0.42 | 0.42 | 0.28 | 0.30 | 0.23 | 0.28 | 0.16 | 0.24 | 0.24 |
| 5C | 0.45 | 0.50 | 1.00 | 0.38 | 0.36 | 0.54 | 0.42 | 0.42 | 0.38 | 0.47 | 0.57 | 0.51 | 0.46 | 0.44 | 0.41 | 0.44 | 0.48 | 0.29 | 0.35 | 0.34 |
| 5D | 0.33 | 0.38 | 0.38 | 1.00 | 0.32 | 0.35 | 0.31 | 0.31 | 0.23 | 0.31 | 0.31 | 0.34 | 0.41 | 0.29 | 0.25 | 0.23 | 0.35 | 0.19 | 0.19 | 0.20 |
| 6A | 0.26 | 0.30 | 0.36 | 0.32 | 1.00 | 0.63 | 0.54 | 0.46 | 0.54 | 0.40 | 0.37 | 0.37 | 0.41 | 0.41 | 0.40 | 0.40 | 0.52 | 0.25 | 0.24 | 0.27 |
| 6B | 0.34 | 0.44 | 0.54 | 0.35 | 0.63 | 1.00 | 0.66 | 0.58 | 0.52 | 0.47 | 0.48 | 0.49 | 0.47 | 0.51 | 0.47 | 0.42 | 0.52 | 0.32 | 0.34 | 0.36 |
| 6C | 0.36 | 0.47 | 0.42 | 0.31 | 0.54 | 0.66 | 1.00 | 0.54 | 0.41 | 0.41 | 0.42 | 0.53 | 0.53 | 0.45 | 0.50 | 0.36 | 0.41 | 0.30 | 0.33 | 0.40 |
| 6E | 0.35 | 0.38 | 0.42 | 0.31 | 0.46 | 0.58 | 0.54 | 1.00 | 0.67 | 0.42 | 0.45 | 0.46 | 0.52 | 0.56 | 0.61 | 0.49 | 0.45 | 0.27 | 0.31 | 0.35 |
| 6F | 0.33 | 0.34 | 0.38 | 0.23 | 0.54 | 0.52 | 0.41 | 0.67 | 1.00 | 0.40 | 0.43 | 0.39 | 0.44 | 0.48 | 0.48 | 0.51 | 0.48 | 0.22 | 0.27 | 0.30 |
| 8A | 0.31 | 0.29 | 0.47 | 0.31 | 0.40 | 0.47 | 0.41 | 0.42 | 0.40 | 1.00 | 0.80 | 0.69 | 0.66 | 0.68 | 0.56 | 0.54 | 0.64 | 0.34 | 0.36 | 0.44 |
| 8B | 0.34 | 0.30 | 0.57 | 0.31 | 0.37 | 0.48 | 0.42 | 0.45 | 0.43 | 0.80 | 1.00 | 0.71 | 0.64 | 0.69 | 0.57 | 0.54 | 0.59 | 0.36 | 0.41 | 0.41 |
| 8D | 0.38 | 0.42 | 0.51 | 0.34 | 0.37 | 0.49 | 0.53 | 0.46 | 0.39 | 0.69 | 0.71 | 1.00 | 0.69 | 0.59 | 0.56 | 0.55 | 0.63 | 0.29 | 0.31 | 0.36 |
| 8E | 0.43 | 0.42 | 0.46 | 0.41 | 0.41 | 0.47 | 0.53 | 0.52 | 0.44 | 0.66 | 0.64 | 0.69 | 1.00 | 0.64 | 0.56 | 0.48 | 0.62 | 0.38 | 0.38 | 0.41 |
| 9A | 0.32 | 0.28 | 0.44 | 0.29 | 0.41 | 0.51 | 0.45 | 0.56 | 0.48 | 0.68 | 0.69 | 0.59 | 0.64 | 1.00 | 0.67 | 0.59 | 0.68 | 0.37 | 0.35 | 0.41 |
| 9B | 0.26 | 0.30 | 0.41 | 0.25 | 0.40 | 0.47 | 0.50 | 0.61 | 0.48 | 0.56 | 0.57 | 0.56 | 0.56 | 0.67 | 1.00 | 0.63 | 0.61 | 0.33 | 0.36 | 0.38 |
| 9D | 0.25 | 0.23 | 0.44 | 0.23 | 0.40 | 0.42 | 0.36 | 0.49 | 0.51 | 0.54 | 0.54 | 0.55 | 0.48 | 0.59 | 0.63 | 1.00 | 0.72 | 0.27 | 0.25 | 0.30 |
| 9E | 0.29 | 0.28 | 0.48 | 0.35 | 0.52 | 0.52 | 0.41 | 0.45 | 0.48 | 0.64 | 0.59 | 0.63 | 0.62 | 0.68 | 0.61 | 0.72 | 1.00 | 0.34 | 0.34 | 0.35 |
| 11A | 0.22 | 0.16 | 0.29 | 0.19 | 0.25 | 0.32 | 0.30 | 0.27 | 0.22 | 0.34 | 0.36 | 0.29 | 0.38 | 0.37 | 0.33 | 0.27 | 0.34 | 1.00 | 0.84 | 0.73 |
| 11B | 0.23 | 0.24 | 0.35 | 0.19 | 0.24 | 0.34 | 0.33 | 0.31 | 0.27 | 0.36 | 0.41 | 0.31 | 0.38 | 0.35 | 0.36 | 0.25 | 0.34 | 0.84 | 1.00 | 0.74 |
| 11C | 0.21 | 0.24 | 0.34 | 0.20 | 0.27 | 0.36 | 0.40 | 0.35 | 0.30 | 0.44 | 0.41 | 0.36 | 0.41 | 0.41 | 0.38 | 0.30 | 0.35 | 0.73 | 0.74 | **1.00** |

# APPENDIX L: ALTERNATE RELIABILITY ASSESSMENT

Six different techniques can be used to assess reliability, each with its own area of application within positivistic research (Straub, Boudreau & Gefan 2004). Firstly, *split half approaches* is a traditional technique to measure reliability. The sample is split into two parts and scores correlated between the parts are estimated. The main problem with this technique is that the results vary according to how the sample is split (Kumar 2005). Split half approaches are not suitable for the reliability assessment of this research. Secondly, the *test-retest approach* checks whether the instrument produces the same scores again if data capture is repeated with the same sample. Even though it can be used effectively in some situations, it is very costly as data has to be collected on different occasions. The data collection process with CEOs/CIOs in this research could not be repeated, due to the restrictions that email addresses could only be used once and that a second purchase of the same email addresses was not possible due to budget constraints. The test-retest approach is, therefore, not relevant for this research. Thirdly, the a*lternative or equivalent forms approach* assesses reliability by utilising different instruments to measure the same constructs. Reliabilities from the different instruments can vary significantly, and it is hard to assess which instrument is the better one (Sarantakos 2005). Also, as with the test-retest approach, it is costly and data has to be collected at different time periods, introducing possible bias in the data. Therefore, this approach has not been used recently in IT research (Straub, Boudreau & Gefan 2004), nor is it applicable for this research. Fourthly*, the inter-rater or inter-coder approach* tests whether different coders or raters' agree in their judgements (Kumar 2005). This approach is especially important if the data collection process does not automatically produce data in quantitative form e.g. interviews. Inter-rater reliability can also be useful in cases where it is of interest wether different raters' agree on their judgement of an item[17] (Neuman 2006). The data collection for the main survey involved directly quantifiable data and inter-rater agreements were not of interest. Hence, the inter-rater and inter-coder reliability approach was not deemed appropriate for purifying measures in this research. Fifthly, *unidimensional reliability* is a highly sophisticated approach that is, according to Straub et al. (Straub, Boudreau & Gefan 2004), the least applied, newest and least understood construct in IT research. Unidimensional reliability, which can be assessed in covariance-based SEM, examines whether a measurement item only reflects one latent construct by examining parallel correlation patterns between constructs. Unidimensional reliability exists if no parallel correlation patterns can be found. Unidimensionality can also be seen as a form of construct validity and can be used in either or both the reliability or the construct validity

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[17] During the panel of experts survey in Chapter 5, section 3 the inter-rater reliability was calculated to estimate to reliability of the experts in their judgement.

context.[18] Unidimensional validation of the research instrument for this study will be discussed in the following sections. Finally, *internal consistency reliability* analysis was adopted in this research. This is because internal consistency reliability assesses whether the instrument itself is consistent, that is, if respondents answer consistently on all items of a construct (Neuman 2006). The recommended and most commonly used statistic to assess internal consistency reliability are inter-item correlations and the estimation of Cronbach's alpha (Churchill 1979).

[18] According to Straub et al. (2004), it is still not clear whether unidimensionality is a form of reliability, construct validity or both.

# APPENDIX M: DEVELOPING MEASUREMENT MODEL IN SEM

Defining the individual constructs includes sound operationalisations of constructs, pre-testing and an overall rigorous process. Hair's (2006) proposed process encompassed the development of the overall measurement model in stage two. These steps were performed and are documented in the antecedent chapters. Chapter 5 explained the process of instrument development. This process was based on recommendations drawn from the research literature (Churchill 1979; Straub, Boudreau & Gefan 2004).

After specifying the measurement model, a study was designed to test the measurement model. Issues concerning the design can be categorised into those relating to the research design and those concerning model estimation (Hair et al. 2006). Research designs using SEM modelling need to address three issues (Hair et al. 2006). Firstly, the type of data analysed has to be determined. The type of data refers to the data input into the SEM software. Older versions required an input either, and decisions regarding the type of data input had to be made at this point of the research design (Hair et al. 2006). Modern SEM software, however, can input raw data and compute a model solution from this raw data. Nevertheless, decisions on the type of data input are important for interpretive and statistical issues. As modern SEM software can produce a standardised solution from both correlations and covariances, interpretive issues are not of much concern. The statistical impact, however, favours the use of covariation input matrices. They contain greater information and, hence, provide far more capability (Hair et al. 2006). Hair et al.'s (2006) recommendations were followed and covariation matrices used as input.

The next important issue in SEM modelling research design is the treatment of missing data (Hair et al. 2006). In Chapter 6, the treatment of the missing data was explained in detail. The different remedies were discussed and as a result the model-based (EM) approach was identified as the most suitable remedy for missing data. The sample size is another important issue in the research design for SEM modelling. This issue was discussed in detail in Chapter 5. In summary, a sample size of 200 is appropriate for modest communalities (0.45–0.55) and models containing constructs with fewer than three items. After discussion of the design issues inherent in SEM modelling, the more unique issues for SEM modelling, model estimation issues are discussed below.

The choice of the relevant estimation technique is straightforward. While previous attempts at SEM started with different estimation techniques, maximum likelihood estimation, hereafter referred to as MLE, is the most commonly used technique in SEM software. MLE is less biased and more efficient, assuming that the assumption of multivariate normality is met. However, MLE seems to be fairly robust with violations of the normality assumption (Hair et al. 2006). The normality of the data was tested and the results were discussed in Chapter 5, section 1. Overall, the data were univariate normal and well within the recommended threshold of skewness and kurtosis (see Chapter 6).

As the multivariate SEM techniques are complex, specialised software is required to apply them. New specialised software packages for conducting SEM analysis include (Weston & Paul A. Gore 2006): AMOS (Analysis of Moment Structures), EQS (Equations), Mplus and LISREL (Hair et al. 2006). As these programs become increasingly similar as they evolve, the choice of software package should be based on preferences and availability (Hair et al. 2006). The software employed for SEM in this research was AMOS, because it was easily available as an addition to SPSS.

# APPENDIX N: MODEL IDENTIFICATION

Before the measurement model could be analysed, it was important to estimate its identification. Model identification refers to the existence of a unique set of parameters consistent with the data. A model is ‘identified’ if a unique solution to the parameters can be found (Byrne 2001; Tabachnick & Fidell 2007). Models can be identified into one of the three categories: just-identified, under-identified and over-identified. The measure degrees of freedom, is linked to model identification and, hence, is mentioned here. Degrees of freedom, hereafter referred to as df, is an indicator of how much information is available to estimate the model parameters (Kline 2005) that is the number of independent units of information in a sample relevant to the estimation of a parameter or calculation of a statistic (Everitt 2006). The formula to calculate the df is: $df = 0.5 * ((p) (p+1))-k$, with p representing the number of observed variables and k the number of estimated (free) parameters.

Under-identified models have more parameters to be estimated as variances models cannot be solved, and covariances exist. Hence, insufficient information exists to obtain a determinate solution for the parameter estimation. Under-identified models have an infinite number of solutions and are not solvable (Byrne 2001). Just-identified models have exactly the amount of data required to solve the parameters, that is, there are the same amounts of parameters to be estimated and variances/covariances. Even though just-identified models are able to produce a unique solution, scientifically they are not useful, as there is no degree of freedom and the model cannot be rejected (Byrne 2001). Over-identified models have fewer parameters to be estimated than data available. These models are solvable, have positive degrees of freedom and can be rejected. Therefore, they are of interest for scientific use (Byrne 2001). Several approaches to estimating model identification exist in the literature. For example, Holmes-Smith (2007) proposed a two-step approach to model identification. The first step consists of applying a so-called ‘t-rule’. Referring to Bollen (1989), Holmes-Smith (2007) presents the t-rule as follows: $t \leq 0.5 * k(k+1)$ , with t representing the number of free parameters to be estimated and k the number of observed variables. This t-rule is a necessary condition, but not a sufficient one (Holmes-Smith 2007). If the conditions of the t-rule are met, the second step of the Holmes-Smith (2007) model identification approach is to utilise AMOS outputs to check for model identification.

# APPENDIX O: GOODNESS OF FIT INDICES

Goodness of Fit Indices can be categorised into three groups: absolute fit indices, incremental fit indices and parsimonious fit indices. Absolute fit indices indicate the degree to which the proposed model fits/predicts the observed covariance matrix (Ho 2006). In the following section three commonly used absolute fit indices are introduced, the Chi-Square statistic, the goodness-of-fit index (GFI) and the root mean square error of approximation (RMSEA).

### *Chi-Square statistic*

The Chi-Square statistic is the only statistically based measure in SEM and also the most fundamental one (Jöreskog & Sörbom 1993). The Chi-Square statistic tests the hypothesis that there is no difference between the matrix of implied variances and covariances and the matrix variances and covariances of the empirical sample (Holmes-Smith 2007). In other words, the Chi-Square statistic tests the hypothesis that the proposed model fits the collected empirical data. Hence, it is a test of exact fit between the proposed model and empirical data (Holmes-Smith 2007). Research practice in SEM encompassed the use of the Chi-Square statistic test to not reject the null hypothesis; moreover research practice is to aim for low Chi-Square values to support an exact fit hypothesis (Ho 2006). Issues to consider while using the Chi-Square statistic are its sensitivity to the complexity of the model, with more complex models producing higher Chi-Square values. Further, the Chi-Square statistic is sensitive to multivariate normality, larger sample sizes and the fact that empirical data are based on samples that approximately fit the population, not the population itself. Hence, exact fit is hard to obtain, especially in non-multivariate normal and larger sample sizes (Ho 2006; Holmes-Smith 2007). Another absolute fit GOF indicator, the root mean square error of approximation, addresses these issues and is discussed below.

### *Normed Chi-Square*

To address the inherent problem of the Chi-Square test’s sensitivity to complex models (see above), a modified indicator can be used with more complex models. The normed Chi-Square takes the complexity of the model into account, and divides the Chi-Square by the degrees of freedom.

Apart from estimating the model fit, the normed Chi-Square can also be used to estimate the parsimony of the model. This is due to the fact that a low value can be achieved by adding extra parameters to the model, thus over-specifying the model. Over-specified models are not parsimonious. Hence, normed Chi-Square values lower than 1.0 indicates overfit; values between 1.0 and 2.0 are acceptable.

### *Root Mean-Square Error of Approximation (RMSEA)*

The Root Mean-Square Error of Approximation, hereafter referred to as RMSEA, addresses the issue of error in the approximation of the population via a sample survey, from the above discussed Chi-Square test (Holmes-Smith 2007). The obtained value for the RMSEA is a representation of the GOF of the model in the whole population, rather than in the sample (Ho 2006). It relaxes the stringent requirement of the Chi-Square test for the model to fit exactly (Holmes-Smith 2007). In contrast to the exact fit test of the Chi-Square, the RMSEA is a measure of discrepancy per degree of freedom (Ho 2006). Holmes-Smith (2007) argues for acceptable levels of RMSEA of <0.05 (close fit), whereas other authors also consider higher values. Ho (2006) argues for slightly different acceptance levels for RMSEA GOF. According to these sources, RMSEA of 0.05–0.08 are acceptable, values from 0.08–0.10 indicate a mediocre fit and values > 0.1 indicate poor fit (Ho 2006).

The statistical software employed, AMOS, has the ability to calculate two other interesting values: a hypothesis test if RMSEA is a close fit, called PCCLOSE, and a confidence interval on the population value of RMSEA. PCCLOSE is a p-value, testing the close fit of RMSEA. PCCLOSE ≥ 0.05 indicates that the close fit hypothesis can be accepted (Holmes-Smith 2007). The lower and upper limits of the confidence interval are represented by the values of LO90 (lower limit) and HI90 (upper limit), with LO90=0 supporting the hypothesis that the model is an exact fit (Holmes-Smith 2007).

The next category of GOF indicators is called incremental fit indices. In comparison to the absolute fit indices discussed above, which measure the fit between the proposed model and the observed data, the incremental fit indices compare the proposed model to some baseline model. Hence, they are also often called comparative fit indices. This baseline model is often also referred to as a null or independence model (Ho 2006). The observed variables in this highly constrained independence model are assumed to be uncorrelated with each other, thus providing poor fit indices for the model. In the following we will discuss two indices, the Goodness-of-Fit and the Comparative Fit index.

### *Goodness-of-Fit Index (GFI and AGFI)*

The goodness-of-fit index, hereafter referred to as GFI, is a non-statistical measure. It ranges from 0 (poor fit) to 1 (perfect fit) and is a measurement of how much better the model fits compared to no model at all (Ho 2006). Although no threshold has been established in the research literature (Ho 2006), overall higher values can be regarded as an indication of better fit (Byrne 2001). Kline (2005) proposes a GFI of greater than 0.90 to be acceptable. GFI is indirectly sensitive to sample size (Hair et al. 2006). AGFI adjusts the GFI for the number of parameters estimated (Tabachnick & Fidell 2007). GFI and AGI are not as consistently reported as the normed chi square (Weston & Gore 2006). Hu and Bentler (1998) recommended against the usage of GFI and AGFI because they are not only insufficiently and inconsistently sensitive to model misspecification, they are also strongly influenced by sample size (MacCallum & Austin 2000). Hence, GFI and AGFI were not used in this study.

***Comparative Fit index (CFI)***

The comparative fit index (CFI) is one of the most widely used GOF indices (Hair et al. 2006). It is based on the normed fit index (NFI). The NFI is a ratio of the difference between the Chi-Square value for the fitted model and an independence model divided by the Chi-Square value of the independence model (Hair et al. 2006). CFI is the improved and normed version of the NFI to include model complexity. This makes the CFI insensitive to complex models, which accounts for its popularity (Hair et al. 2006). Values range from 0 (poor fit) to 1 (perfect fit). Hair (2006) and Kline (2005) argue for values of above 0.9 as acceptable.

Models that are parsimonious, meaning models that have fewer unknown parameters have a better chance of being scientifically explainable and replicable (Ho 2006). As the absolute fit and the comparative fit measures have been outlined above the chapter now turns to a discussion of measures that enables to measure how parsimonious a model is. The last category of GOF indicators, parsimonious fit indices, relates the GOF of the proposed model to the number of estimated parameters required to achieve the fit (Ho 2006). This is done via a parsimony ratio. The parsimony ratio PRATIO is calculated simply by dividing the degrees of freedom for the proposed model through the independence model. The parsimony adjusted comparative fit index (PCFI) is based on the CFI, adjusted by multiplying it with a (PRATIO). The same can be done for the GFI, resulting in PGFI (Holmes-Smith 2007). Values range from 0 to 1.0, with the higher value as the preferred one. The use of parsimonious fit indices is controversial, but it is useful to compare alternative models (Hair et al. 2006).