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EFFECTS OF KNOWLEDGE CAPABILITIES ON THE POST-IMPLEMENTATION BENEFITS OF ENTERPRISE RESOURCE SYSTEMS WITHIN SOUTH AFRICAN FIRMS

RESEARCH REPORT

Submitted in fulfilment of the requirements for the degree of

Master of Commerce by Research in the field of Information Systems

School of Economic and Business Sciences

Faculty of Commerce, Law and Management

University of the Witwatersrand, Johannesburg

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Date:	30 March 2015

DECLARATION

I declare that this dissertation is my own, unaided work. It is being submitted for the degree of Master of Commerce in Information Systems to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any other degree or examination at this or any other University.

_____

Ncamiso Mathebula

30th Day of March 2015.

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ABSTRACT

This study recognized as a research problem that the size and complexity of enterprise resource planning (ERP) systems makes their implementation a specialized discipline with a number of reported failures. Valuable insights have emerged from studies into factors critical for a successful ERP implementation, however it has been noted that the successful implementation of an ERP system does not necessarily translate to sustained business performance. Literature has explored some of the ERP factors which are necessary for sustaining benefits post-implementation. This literature points to the importance of ERP knowledge as well as the role of other organizational, contextual, and contingency factors in the realization of post-implementation benefits. However, empirical studies of the role of ERP knowledge capabilities in sustaining the post-implementation effects of ERP systems still remains under-explored.

Therefore, the aim of this research study was to contribute to this gap. Specifically, it developed and tested a research model underpinned by the Resource and Knowledge-Based View of the Firm, Contingency Theory, and Transaction Cost Theory. A systematic literature review was conducted to gauge the state of the field, and thereafter the research model was developed. This model investigated the role of internal ERP knowledge capabilities, namely business process knowledge and ERP module knowledge, in sustaining the Operational Benefits of an ERP system. The model also investigated the conditions under which it is necessary for organisations to develop an internal ERP knowledge capability. Lastly, the model investigated the role of two contingency factors (structural complexity and environmental turbulence) in moderating the relationship between an internal ERP capability and the operational benefits obtained from ERP systems. The research model was tested using a survey methodology. This involved operationalizing the variables hypothesized in the research model and collecting data through a questionnaire instrument.

The self-administered online questionnaire was administered to 900 key informants representing large organisations that have implemented ERP systems in South Africa of which 198 returned responses. Following initial screening, 130 usable responses were retained for analysis. The usable data passed through reliability and validity tests which confirmed that the construct measures provided consistent and reproducible results (reliability) and accurately represented the constructs they were intended to measure (validity). After reliability and validity was demonstrated, correlation and regression was used to test the hypothesized research model.

The results of the study indicate ERP module knowledge is an important internal ERP capability for sustaining the post-implementation benefits of ERP systems. The results also found business process knowledge to be more important to realization of post-implementation benefits for firms with higher levels of structural complexity. ERP firm specificity was found to have no influence on the building of internal ERP knowledge capabilities, and the question as to why some firms seek to develop stronger internal ERP capabilities remains a question for future research.

The study of post-implementation benefits from ERP systems still remains a topic of interest for both academics and practitioners. Through the application of the Resource and Knowledge- Based View of the Firm, Contingency Theory, and the Transaction Cost Theory this study has advanced our understanding of the importance of ERP knowledge capabilities and contributed results that offer practical implications for vendors and for organisations that have implemented or are considering implementing ERP systems.

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LIST OF ABBREVIATIONS

AFSUG	Africa SAP User Group
CFA	Component Factor Analysis
CIO	Chief Information Officer
CRM	Customer Relationship Management Systems
CT	Contingency Theory
DV	Dependent Variable
ERP	Enterprise Resource Planning Systems
KBV	Knowledge-Based View of the Firm
IS	Information Systems
IT	Information Technology
IV	Independent Variable
PCA	Principal Component Analysis
PLS	Partial Least Squares
RBV	Resource –Based View of the Firm
SEM	Structured Equation Modelling
SLR	Systematic Literature Review
TCT	Transaction Cost Theory

1. INTRODUCTION

1.1 Introduction to the problem of ERP Knowledge Capability

Business organisations today are facing a more complex and competitive environment than ever before (Yang and Su, 2009). As a result, to remain successful and to be competitive, organisations turn to technology to improve firm performance (Yang and Su, 2009). Organisations are faced with a number of challenges that include inefficient business processes, unsupported legacy systems, poor integration between existing systems and costly maintenance of existing systems. Enterprise resource planning (ERP) systems promise to address these challenges by enabling organisations to integrate information about their entire enterprises seamlessly. These systems are designed to integrate business processes and functions, and present a holistic view of a business by permitting the sharing of common data and practices in real-time (Ifinedo, 2007).This includes customer orders, production, purchasing, inventory, distribution, human resources, and receipt of payments (Kang, Park, and Yang, 2008).

With expectations of such potential benefits, a number of organisations throughout the world have made huge investments in ERP systems (Kang *et al*., 2008). Business organisations are continuing to adopt ERP systems in an effort to improve operations and enhance strategic advantages (Ifinedo, 2011). The demand for ERP systems by South African firms continues to rise; a move boosted by the low cost systems available to the mid and low-end enterprise markets (Frost and Sullivan, 2008). The top participants that include the likes of SAP, Oracle, and Microsoft dominate the high-end market among the corporate clients. These providers command 60-70 per cent of the total ERP market in South Africa (Frost and Sullivan, 2008).

Enterprise Resource Planning (ERP) systems are however complex business information technology (IT) packages (Ifinedo, 2007). The implementation of these systems is therefore often problematic and numerous failed implementations have been reported (Karimi, Somers and Bhattacherjee, 2007; Scott and Vessey, 2002; Umble, Haft and Umble, 2003; Scheer and Habermann, 2000). Within academic and practitioner literatures, studies of factors critical to the success of ERP implementations have received much attention (Nah, Zuckweiler and Lau, 2009; Hong and Kim; 2001; Somers and Nelson, 2001). Such factors include a firm's size, culture and structure, top management support, external expertise, relevant internal support, software integration, implementation costs, employee training, user participation, effective project team and management style (Tsai *et al.*, 2009; Ifinedo, 2011). However, successful implementation of an ERP system does not necessarily guarantee long-lasting benefits (Tsai *et al*., 2011). Subsequent to a successful implementation, an organisation still needs to sustain benefits by constantly maintaining the ERP system throughout its lifecycle.

While some firms have achieved impressive benefits from their ERP systems, others have experienced difficulty in gaining the benefits they expected (Gattiker and Goodhue, 2005). A survey of 117 executives conducted by the Conference Board in 2001 revealed that 40% of ERP projects failed to achieve their business case after one year of going live (Tsai, Li, Lee and Tung, 2011). Factors influencing the realization of benefits once the ERP system has been implemented and is in use are not however as thoroughly researched as issues of ERP system selection and implementation (Gattiker and Goodhue, 2005). Previous studies that were focused on system implementation often overlook the organisational capabilities required to successfully maintain the system post-implementation and to realize post-implementation benefits (Tsai *et al*., 2011). Thus, focus has recently shifted to the problem of assessing the post-implementation benefits of ERP systems (Chand,

Hachey, Hunton, Owhoso and Vasudevan, 2005). The lack of empirical studies on the post-implementation impacts of ERP reflects the difficulties experienced in measuring the impacts of ERP systems. This has led to a gap in our understanding of why the expected benefits of ERP systems contrast with actual post-implementation benefits and impacts (Karimi, Somers and Bhattacherjee, 2007). Certain factors may however help or hinder an enterprise to sustain the benefits of an ERP system. For example, the capability of a firm to adapt and manage its ERP system post-implementation may be an important factor required for delivering positive business process outcomes (Karimi *et al*., 2007). If an ERP system is unable to be adapted to cope with changes in business operations, its effectiveness is likely to disappear and this in turn diminishes its impacts on business performance (Tsai *et al*., 2011). Thus, long-term benefits of an ERP system may depend on the presence of a team that has the knowledge capabilities needed to maintain the ERP system (Tsai *et al*., 2011). Vandaie (2008) suggests that ERP implementation is so knowledge-intensive that the fate of the whole project is in hands of a group of knowledgeable employees from across the firm and the success of the ERP project thus relies heavily upon effective management of knowledge into, within, and out of this team over the entire system lifecycle.

1.2 Statement of the Problem

The ERP software lifecycle consists of four distinct phases: 1) acquisition, (2) implementation, (3) stabilization, and (4) operation and improvement (Dibbern, Brehm, and Heinzl 2001). This study focuses on the fourth stage i.e. the operation and improvement phase - also known as the post-implementation phase. Typical tasks in the post-implementation phase include implementing updates or new releases, supporting users and providing training, operating the ERP system, continuous business process improvement, and respective systems tailoring (Dibbern *et al*., 2001). To successfully execute these tasks, organisations require a high level of knowledge and experience to be available to them (Dibbern *et al*., 2001). Knowledge resources have been found to be among the most critical IS resources for building the IS functional capabilities required to realize the benefits from IT (Karimi *et al*., 2007).

Research classifies the benefits of ERP systems into three categories, namely operational, tactical and strategic benefits (Yang and Su, 2009). Amongst these benefits, operational benefits have been found to be more representative of ERP systems evaluations (Yang and Su, 2009) and are thus the focus of this study. **The thesis of this study is that the post-implementation phase of an ERP system requires an ERP knowledge capability in order to carry out the tasks of the post-implementation phase so that the benefits of the ERP system can be sustained.**
The link between ERP Knowledge capability and ERP success has been recognized in relation to the other phases of the lifecycle (Vandaie, 2008). The complexity of an ERP system calls for intensive interactions among ERP team members and system users (Tsai *et al*., 2011). All these interactions involve constant knowledge creating, sharing, extraction, preservation, and learning. The knowledge intensity of the ERP post-implementation phase has led to the suggestion that a well-structured knowledge management mechanism be implemented to support the ERP team (Tsai *et al*., 2011).

ERP knowledge capability is conceptualized as consisting of two dimensions, namely business process knowledge and ERP module knowledge. The importance of these knowledge areas to the ERP capability is strongly advocated in literature (Tsai *et al*., 2011 and Karimi *et al*., 2007).
Business process knowledge is the ability to understand the business environment, learn about business functions, and interpret business problems (Boyle and Strong, 2004). ERP module knowledge refers to the ability to configure and maintain information systems in support of the

business operations (Stratman and Roth, 2004). This knowledge includes deep understanding of the ERP module integration points, database tables, interface requirements with third parties, updates, data requirements and other critical ERP functions.

However, the problem is that the development of such capabilities within the firm is not without cost, and the question arises as to whether firms should develop such capabilities internally or whether they are better off procuring them in the market. Evidence of the contribution of an internal ERP knowledge capability to the realization of post-implementation ERP benefits is important to answering this question.

This leads to the study's first two Research Questions.

- 1. To what extent is an internal ERP knowledge capability (i.e. Business Knowledge & ERP Module Knowledge available within the firm) associated with Operational Benefits of an ERP system?

- 2. Under what conditions do firms develop an internal ERP knowledge capability?

Furthermore, an additional problem arises in that the benefits firms derive from investment in the development of an internal ERP knowledge capability may also be contingent on certain factors. For example, the structure of a firm is considered to be very important when firms adopt ERP (Ifinedo, 2007). The more complex the firm the more difficult aligning the ERP system and business becomes, thereby increasing the need for ERP knowledge capabilities. Thus, an internal ERP capability may be more important to structurally complex firms.

Moreover, as time goes by, changes in the environment, turnover of members, and variations of customer demands may significantly impact the existing processes and operations of a business. These environmental changes will cause changes to the business processes (Tsai *et al.*, 2011). The ERP system is expected to adapt to the turbulent business environment by supporting the changing business processes. If a firm is unable to adapt the ERP system to these changes, its effectiveness is likely to disappear and this in turn diminishes business performance (Tsai *et al*., 2011). Thus, an internal ERP capability may be more important to firms operating in more turbulent business environments.

This leads to the third Research Question:

- 3. To what extent do structural complexity and environmental turbulence increase the need for an internal ERP knowledge capability i.e. moderate the relationship between ERP knowledge capability and ERP operational benefits?

1.3 Research Purpose and Objectives

To address Research Question 1, this study aims to contribute additional empirical evidence of the effects of a firm's internal ERP capability on the post-implementation benefits of ERP systems. Drawing on the resource-based view of the firm, this study hypothesizes that knowledge is a critical component on an internal organisational ERP capability, which is required to sustain the long-term benefits of an ERP system. The long-term benefits of ERP systems are associated with the ERP system's capability to deliver positive business process outcomes during the entire ERP system lifecycle.

To address Research Question 2, this research draws on Transaction Cost Theory to hypothesize the role of the ERP's asset specificity on the decision to develop an internal ERP knowledge capability rather than outsource to the market.

To address Research Question 3, this study draws on Contingency Theory to hypothesize the moderating effects of organisational complexity and environmental turbulence on the relationship between knowledge capability and ERP benefits.

The context of this study will be South Africa. The population under study are all South African organisations that have implemented ERP systems. The sampling frame constitutes large South African organisations that have implemented ERP systems. A survey design will be used to collect data from key informants from the sampled organisations. Following tests of data reliability and validity, correlation and multiple regression techniques will be used to test the study's hypotheses.

1.4 Theoretical and Practical Implications

Gattiker and Goodhue (2005) point to a lack of theoretical frameworks in the area of post implementation impacts of ERP systems. A theoretical contribution of this study is its use of three theoretical perspectives (Resource and Knowledge-Based View of the Firm, Transaction Cost Theory and Contingency Theory) to study the post-implementation impacts of ERP systems on business performance. The Resource and Knowledge-Based View of the Firm perspective will help explain the role of ERP module knowledge and business process knowledge in the building of ERP capabilities and their role in sustaining the post-implementation benefits of ERP systems. The Contingency Theory perspective will explain the moderating effect of two contingency factors (structural complexity and environmental turbulence) on the relationship between the ERP knowledge capabilities and the operational benefits of ERP systems post-implementation. By adopting the Transaction Cost Theory perspective this study will explain whether the asset specificity of an ERP system influences firms to build internal ERP knowledge capabilities rather than to source such skills from external markets.

By integrating these perspectives, this study aims to answer the call by IS researchers to address post-implementation impacts of ERP systems with strong theoretical foundations (Ifinedo, 2007).

This study is also one of the few studies of ERP impacts to be conducted in the South African context and thus it makes a contextual contribution to an environment in which investments in ERP systems are still growing.

The study will provide managerial guidance by identifying the importance of building an effective internal ERP knowledge capability and the conditions under which doing so is most necessary. This study will also benefit firms that are contemplating adoption of ERP systems as they will understand the need to build an ERP knowledge capability to sustain the benefits of ERP systems.

1.5 Delimitation and Assumptions

The first assumption is that there will be a continued implementation of ERP systems within the South African over the coming years, validating the reasons for this study.

The second assumption is that a sample frame of large organisations is suitable, since these firms are more likely to have the necessary IT and organisational resources required to engage in the ERP implementation process. These firms are likely to have complex business processes and hence they are more likely to consider ERP systems adoption.

The third assumption is that IT managers and business process managers within the sampled organisations will be suitably positioned to understand their organisation's ERP capability and as a result be appropriate respondents for this study.

The research is conducted within the following framework:

1. The scope of the study is limited to South African firms that have adopted ERP systems; however the literature review is global and not only limited to South Africa. Therefore, it is assumed that the reviewed literature is applicable to the South African organisational context.
2. This study will include all ERP vendors and not be limited to a particular ERP application.
3. A web-based structured questionnaire will be used for collecting cross-sectional, quantitative data from the sample frame; this is a researcher-independent technique. The data will be subjected to statistical analysis with the purpose of testing the hypotheses and drawing inferences from the findings. The results will be used to answer the Research Questions and contribute to resolving the research problem.
4. This study will not include firms outside of South Africa.

1.6 Structure of Report

This chapter has introduced the problem of ERP knowledge capability by highlighting factors that may aid or hinder an organisation to sustain the benefits of its ERP system. It conceptualized ERP knowledge capability as consisting of business process knowledge and ERP module knowledge. It then formulated the study's Research Questions. It then discussed the aims and objectives of the study, which are; to contribute additional empirical evidence of the effects of a firm's internal ERP capability on the post-implementation benefits of ERP systems, to examine the role of the ERP's asset specificity on the decision to develop an internal ERP knowledge capability rather than outsource to the market, to examine the moderating effects of organisational complexity and environmental turbulence on the relationship between knowledge capability and ERP benefits.

The remaining chapters of this dissertation will be structured as follows:

Chapter 2 presents the literature review. First, it will discuss the overview of ERP systems, highlighting the evolution of ERP systems. It will then outline the definition of ERP systems and briefly describe the ERP vendors and their market share. The benefits and problems of ERP systems will then be discussed. The discussion will then focus on the post-implementation phase of the ERP process. The chapter concludes with the contributions and shortcoming of past literature highlighting the gap in past work that has led to the case for this study.

Chapter 3 presents the theoretical background to the development of the research model. The Resource and Knowledge-Based View of the Firm, Transaction Cost Theory and Contingency Theory are presented as underpinnings for the development of the research model. The research model is presented and its associated hypotheses are derived.

Chapter 4 presents the research methodology used to test the research model and hypotheses. Data collection including sampling and questionnaire development are discussed as well as ethical considerations in data collection. This is followed by discussion of reliability and validity testing, strategies for hypothesis testing, and the limitations of the selected methods.

Chapter 5 presents the study's empirical results. The sample profile is described before empirical data is tested for validity and reliability. The hypotheses are tested using correlation and multiple regression techniques.

Chapter 6 discusses the findings with implications for both literature and practice.

Chapter 7 concludes the study with a summary of the chapters in the study. The implications and contributions of the study for theory and practice are discussed together with study limitations and recommendations for future research.

2. LITERATURE REVIEW

2.1 Introduction

This chapter presents past work that has been conducted on ERP systems implementations and post-implementation. It first discusses the overview of ERP systems, highlighting the history and evolution of ERP systems. It then outlines the definition of ERP systems and explores vendors of ERP systems and their market share. The benefits and problems of ERP systems are then discussed. The focus on the post-implementation phase of the ERP process is explored in detail. A review of prior studies on the post-implementation benefits of ERP systems is then presented. The chapter concludes with the contributions and shortcoming of past literature highlighting the gap in past work that has led to the case for this study.

2.2 History and Overview of ERP Systems

In the late 1970's and earlier 1980's functional business units operated in silos and therefore the need to integrate these isolated business units. This prompted organisations to move beyond the traditional Material Requirements Planning (MRP) systems (Jacobs and Weston, 2007). MRP which was the antecedent of MRPII and lately of ERP was first developed towards the end of the 1960s (Jacobs and Weston, 2007). Critical enterprise functions that operated in isolation such as master data scheduling, shop floor control and forecasting posed a need for organisations to find an integrated solution. MRP's therefore were developed to close the gaps between these important enterprise functions that operated in silos. Due to the MRP's integration potential, they rapidly became a recognized and trusted solution in control and production management (Jacobs and Weston, 2007). However, MRP II, motivated by the need to close the gap of enterprises operating in silos, extended the scope of MRP from the production environment to other business functions such as distribution, manufacturing, and order processing (Rashid, Hossain and Patrick, 2002).

MRP II was extended to ERP systems in the latter years of the 1980s and the earlier years of the 1990s (Rashid *et al*., 2002). The Gartner Group came up with term ERP in the beginning of the 1990s. Their explanation of the term incorporated the level to which the software was integrated both at a business function level and externally across independent business functions (Jacobs and Weston, 2007). ERP systems extend the scope of MRP II to other business functions that include, but are not limited to purchasing, warehouse management, controlling, managerial finance, environmental management and sales and order management (Kumar and Hillersgersburg, 2000). ERP systems promise to integrate loosely coupled business functions such as financials, supply chain management, manufacturing, production planning, maintenance, logistics, distributions, sales, marketing, health and safety, and customer services (Rashid *et al*., 2002). Moreover, they promise to enable consistency, accessibility and the much needed visibility across firms. This was to be possible as ERP systems were building on the technological advances gained from MRP and MRP II (Rashid *et al*., 2002). ERP systems extended the MRP II scope by addressing concepts such as relational databases, graphical user interface, computer aided software engineering tools, open systems portability and client server architecture. These are some of the technical advances that facilitated ERP systems to extend beyond MRP II systems (Sammon and Adam, 2005).

2.3 Definition of ERP Systems

ERP systems are made of packaged software modules that have the potential to integrate business processes and extend beyond internal integration to also include external integration for supplier management (Tang and Su, 2009). ERP systems are off-the-shelf packaged software applications that are developed by software vendors. Their complexity requires trained and experienced consultants to implement, and on occasion to customize, the software package in order to fulfil the business requirements of the organisation. Their design is based on pre-packaged business processes and thus in most cases implementing organisations are constrained to align their business processes to those of the ERP system (Rashid *et al*., 2002). Organisations are at liberty to procure the ERP modules separately based on their needs at that point in time. Each ERP module is designed to support a specific business functions and the more common modules include those for material management, financials (e.g. accounts payable, cash accounting, accounts receivable, bank management .), sales and distribution and human capital management (see Table 1 for an example of SAP ERP modules). Module integration is enabled by the supporting architecture of the ERP software and thus movement of information across all business functions is consistent and visible within the organisation (Rashid *et al*., 2002). The dynamic nature of business has meant that business processes change over time therefore requiring a need for ERP systems to respond to changing business practises. ERP vendors have responded with add-ons to core modules and thus allowing more extended ERP's to emerge. With the introduction of the internet ERP vendors have also had to make amendments to ERP systems to enable ERP software integration with the internet (Rashid *et al*., 2002). In response to addressing external business challenges, ERP vendors developed mostly internet based business modules such as Customer Relationship Management (CRM), Sales Force Automation, Business Intelligence, Supplier Relationship Management (SRM), and e- business capabilities (Rashid, *et al*., 2002). This was enabled by the environment that allowed for the access of resources anywhere and anytime.

Table 1: List of ERP modules from SAP AG

Abbreviation of SAP ERP Module	**Module Name**
SD	Sales and Distribution
PS	Project Systems
PP	Production Planning
MM	Materials Management
QM	Quality Management
FI	Financial Accounting
TR	Treasury
CO	Controlling
AM	Asset Management
PM	Plant Maintenance
HR	Human Resources
CRM	Customer Relationship Management
SRM	Supplier Relationship Management
EHS	Environmental Health & Safety

2.4 ERP Market and Vendors

The ERP market has been over the past two decades the largest and fastest growing industry in the software space. A significant amount of financial resources to the tune of about $300 billion have been spent on ERP implementations globally in the 21st century (Mabert, Soni and Venkataramanan, 2000). Among large organisations (Fortune 1000 and 500) an estimated 80% of these organisations have ERP systems implemented (Mabert, *et al*., 2000). Recent global estimates of 30,000 organisations have ERP systems implemented (Gattiker and Goodhue, 2005). The global adoption of ERP systems has been observed in large and medium organisations with an approximate estimation of 60 percent in services and 75 percent for manufacturing (Gattiker and Goodhue 2005). An estimated annual investment of $80 billion globally on ERP implementations has been observed from organisations (Gefen and Ragowsky, 2005). The ERP market has an estimated compound annual growth rate of almost 11% (Gefen and Ragowsky, 2005). Globally there has been a significant growth in ERP adoption across all industry sectors.

South Africa has not lagged behind in the adoption of ERP systems. The demand for ERP systems by South African firms continues to rise; a move boosted by the low cost systems available to the mid and low-end enterprise markets (Frost and Sullivan, 2008). The continuous adoption of ERP systems by South African firms has been observed, this can be explained by the availability of reduced systems costs on the lower and medium end markets (Frost and Sullivan, 2008). The influence of global organisations that have operations in South Africa has accelerated the adoption of ERP systems in South Africa. The adoption of ERP systems in South Africa has also been boosted by the global shift by organisations to look for growth in emerging markets of which South Africa is a major player. Government departments, municipalities, state-owned enterprises, and institutions of higher learning have adopted ERP systems in South Africa. The adoption of ERP systems has also been noted among small and medium enterprises, a move motivated by the availability of industry-specific ERP solutions tailor-made for the small and medium enterprise market segment. South Africa's well developed technology infrastructure and as a mature market has opened up opportunities for investments by ERP vendors. This will in turn increase the adoption of ERP systems by South African organisations.

The ERP software market is wide and complex. There a number of vendors that offers ERP applications, some focusing on industry-specific solutions such as human resources, manufacturing, distribution, retail, and others. According to recent ERP market penetration data, SAP, Oracle, Sage, Infor, and Microsoft are the major players in the ERP software market (Columbus, 2013). Figure 1 below shows the worldwide ERP market share by vendor for 2012.

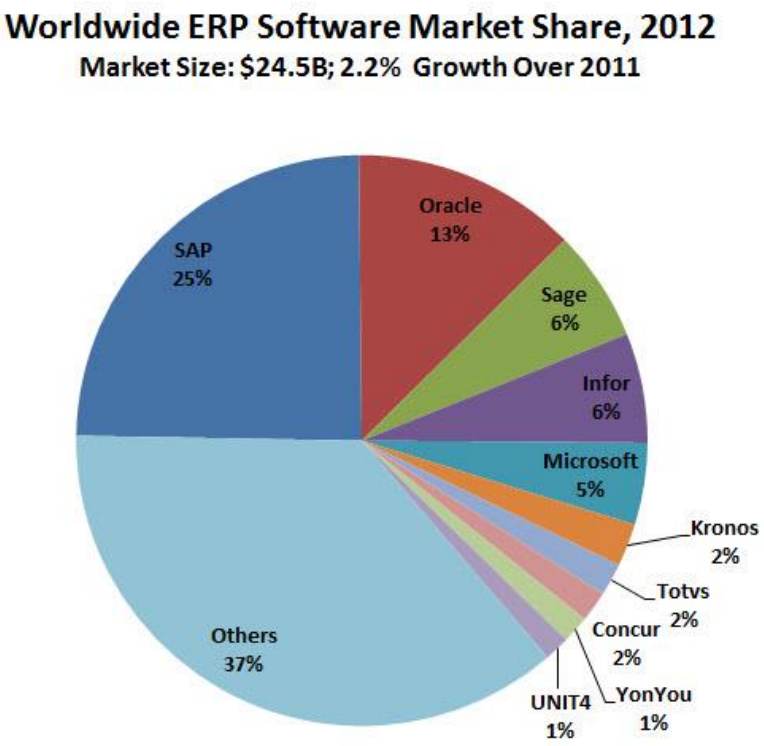


Figure 1: 2012 Worldwide ERP Market Share

SAP as a leading ERP software vendor has the largest global ERP market share in 26.4% of the market and revenue estimates in excess of $6 billion by 2012 (Columbus, 2013). SAP is closely followed by Oracle with almost half of its revenue at $3.12 billion while Sage sat at estimated $1.5 billion software revenue by 2012. Oracle and Sage had a market share of 12.8% and 6.8% respectively in 2012 (Columbus, 2013). The continued market dominance by SAP globally is evident from Figure 1 above. Africa is one of SAP's fastest growing markets with expected growth of $1 billion revenue by 2016 (Cohen, 2013). Market dominance by SAP has been widely noticeable in Africa with an extensive coverage of about 46 countries. SAP's extensive presence in Africa has seen it occupy 50% of the ERP market share with an excess of an estimated 1300 customers on the continent and it has accredited more than 250 partners across the continent (Van Zyl, 2013). The market presence in South Africa mirrors the global and African picture. The ERP market in South Africa is dominated by the likes of SAP, Oracle and Microsoft with an estimated combined market share of about 70% of the total ERP market in South Africa (Frost and Sullivan, 2008)

2.5 Benefits of ERP Systems

Developing complex and powerful information systems in-house tends to be a resource intensive exercise for organisations. Organisations then turn their investments to ERP systems with the hope of accessing these powerful information systems at a lower cost and thus gaining the much needed competitive advantage (Shang and Seddon, 2002; Jeng and Dunk 2013). Evidence from literature suggests that organisations that have properly implemented ERP systems have achieved substantial benefits (Watson and Schneider, 1999). Globally there has been an increase in ERP system sales and evidence points to the ability of ERP systems to solve business problems caused by customized legacy systems. ERP systems deliver business value through rapid implementations, high quality systems, and reduced cost (Chou *et al.*, 2013). Literature has identified a number of business benefits derived

from ERP systems. Improvements in operations, support for organisational strategy and enhanced decision-making are some of the benefits of ERP systems suggested in literature (Shang and Seddon, 2002). The review of literature on ERP system benefits found the comprehensive view provided by Shang and Seddon (2002) as the most representative of ERP system benefits anticipated by organisations when they adopt ERP systems. In their framework of ERP system benefits they classify ERP system benefits as consisting of multiple dimensions namely: managerial, operational, IT Infrastructure, organisational and strategic benefits. Figure 2 shows the classification of ERP benefits by Shang and Seddon (2002).

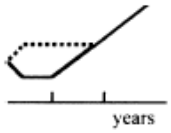
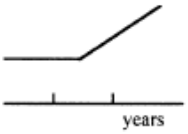
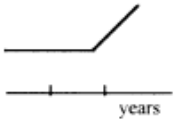
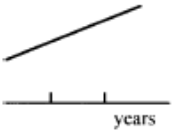
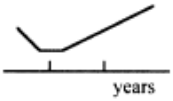
Dimensions of ES benefits	Operational benefits	Managerial benefits	Strategic benefits	IT infrastructure benefits	Organizational benefits
Path of ES benefit development					
Early benefits	Automation benefits from savings in labour and time	Quicker decision making using real-time information	No immediate strategic benefits	Replacement of legacy systems	Immediate drop in employee morale
Problems	Extra time and labour in data entry	Rigidity in resource allocation because of tightly linked system integration	Loss of competitive advantages when competitors use similar processes	Inflexible system changes Frequent system upgrades	Low employee morale due to extra work, mismatched processes, data errors and change pressures
Explanations for benefits and problems	Business process change ES modifications Organizational learning	Enhanced reporting functions Accumulated data Organizational learning	ES technology upgrading	Attain, expand and extend ES	Business and system changes Organizational learning
Pace of benefit development	1–2 year plateau for busines changes and organizational learning	1–2 year plateau for system enhancement and organizational learning	Depends on business strategies of ES use	Gradually increased with system expansion. Significantly increased when system use achieved economies of scale	2–3 years for users to forget initial problems and to build system knowledge

Figure 2: Classification of ERP benefits 1 (source: Shang and Seddon, 2002 page 375)

2.6 Problems facing ERP Sytems

Although a number of studies have documented the successes of ERP systems, contrary evidence of ERP system implementation failures has also been presented in literature. Notable ERP system implementation failures discussed in the literature include Dell Computers, Mobil Europe, Fox Meyer Drug, and Dow Chemical (Ditkaew and Ussahawanitchakit, 2010). As ERP system implementations are costly undertakings substantial financial losses are suffered from failed implementations. This has resulted in a number of cases of litigation between ERP vendors and companies, some of these losses have even led to bankruptcy (Ditkaew and Ussahawanitchakit, 2010; Bearda and Sumner, 2004). A

number of abandoned ERP projects have been noted in literature costing organisations millions of dollars wasted in ERP investments (Bearda and Sumner, 2004). The high failure rate of such expensive investments called for an extensive understanding of the factors critical to ERP implementation success. Through extensive research ERP scholars have identified and explored the issues critical to ERP Implementation success popularly known as "key success factors of ERP Implementaton" (Nah *et al*., 2009). The studies into the issues critical to ERP implementation success presented valuable insights such as approach to re-engineering business processes, change management strategy, knowledgeable implementation team, end-user training approach, support from top management, involvement of end users, ERP vendor choice, ERP implementation methodology and a well articulated business case (Karimi, Somers and Bhattacherjee, 2007; Scott and Vessey, 2002; Umble, Haft and Umble, 2003; Scheer and Habermann, 2000; Gattiker and Goodhue, 2005). Nah *et al* (2009) through an extensive literature review of factors critical to ERP implementations identified 11 factors summarized in Figure 3 below.

Table 1: Review of Critical Success Factors for Enterprise Resource Planning (ERP) Implementation

	ERP Teamwork and Composition	*Change Management Culture and Program*	*Top Management Support*	*BPR with Minimum Customization*	*Business Plan and Vision*	*Project Management*	*Project Champion*	*Communication*	*Monitoring and Evaluation of Performance*	*Software Development, Testing and Troubleshooting*	*Appropriate Business and IT Legacy Systems*
Bingi, Sharma, and Godla (1999)	x	x	x	x						x	
Buckhout, Frey, and Nemec (1999)	x		x		x						
Falkowski, Pedigo, Smith, and Swanson (1998)	x	x			x	x	x	x	x		
Holland, Light, and Gibson (1999)	x	x	x	x	x	x		x	x	x	x
Murray and Coffin (2001)		x	x	x		x	x		x	x	
Roberts and Barrar (1992)		x	x	x	x				x		x
Rosario (2000)	x	x		x	x	x	x	x	x	x	
Scheer and Habermann (2000)										x	
Shanks et al. (2000)	x	x	x	x	x	x	x	x			
Stefanou (1999)	x						x				
Sumner (1999)	x	x	x	x		x	x	x	x		
Wee (2000)	x	x	x	x	x	x		x		x	
Number of citations	9	9	8	8	7	7	6	6	6	6	2

Note. BPR = Business Process Reengineering; IT = Information Technology.

Figure 3: Review of ERP Critical Success Factors of ERP Implementations (source: Nah *et al*., 2009 page 10)

2.7 A Review of ERP Post-Implementation Literature

2.7.1 Background

After the implementation of the ERP system, a full test of the ERP system is executed before it is handed over to end users for normal transactional processing. Then the post-implementation stage begins, typically from the first day of transacting on the new system up until the system is retired and replaced with a new system (Zhu *et al*., 2010). The entire ERP effort can only be deemed a success if success in the post-implementation stage of the ERP system is achieved (Zhu *et al*., 2010).

A successfully implemented ERP system does not automatically translate to sustained business performance. For ERP systems to enable profitability certain avenues have to be explored by organisations. These avenues enable some organizations to derive value from their ERP systems to a

greater degree than their peers (Gattiker and Goodhue, 2005). For an organisation to sustain the performance of its ERP system it is imperative that post-implementation factors are fully explored (Tsai *et al*., 2011). Unfortunately, much of the existing ERP literature focuses on the issues related to the selection and implementation of ERP packages and there is a dearth of information on the post-implementation factors required to sustain the benefits of ERP (Gattiker and Goodhue, 2005). A review of ERP literature was carried out, which identified recent efforts to identify factors critical to sustaining long term benefits of ERP systems. These factors include proper maintenance after an ERP implementation, knowledge sharing and communication among stakeholders, IS/ERP capabilities, organisational and contextual factors (Tsai *et al*., 2011; Zhu *et al*., 2010; Jeng and Dunk 2013; Ifinedo, 2007; Karimi *et al*., 2007; Morton and Hu, 2008; Gattiker and Goodhue, 2002). These past studies are summarized in Table 3 and discussed further below.

2.7.2 Post – Implementation factors critical to ensuring ERP system benefits

2.7.2.1 Knowledge as an ERP Capability

The complexity of ERP systems calls for huge amounts of IT resources to be allocated in order to sustain their benefits. Karimi *et al* (2007) posits that the effective roll-out of information systems (IS) resources vital for the implementation of ERP systems will lead to greater benefits derived from ERP packages. ERP capability may be closely linked to the resource base entrenched in the business processes of the organisation which might be different across organisations depending on the resource's unique configuration (Karimi *et al*., 2007). In their study they identified three IS resources that are critical in building an effective ERP capability. Knowledge resources, IT resources, and infrastructure resources were identified as the critical IS resources in building ERP capabilities which will have the greatest impact on the business processes which should in turn lead to greater business performance.

In their study they looked at the impact of these IS resources in the building of ERP capabilities and the conditions under which these ERP capabilities will have the greatest impact on business performance. IT departments and business departments interact constantly in the business lifecycle and thus trust will develop as a result of these constant interactions. Trust then becomes a significant element of relationship resources which can positively impact the knowledge sharing of these departments (Karimi *et al*., 2007). Hardware, networks, software, data centers and other IT assets shared by departments is defined as infrastructure resources (Karimi *et al*., 2007). The shared responsibility and risk by the business and IT departments in the development and support of IT applications is defined as relationship resources (Karimi *et al*., 2007).

The leveraging of intellectual capital, unique skills, insights, expertise and experience to build IT capabilities is defined as knowledge resources by Karimi *et al* (2007). Their results revealed that knowledge resources (project management knowledge, business process knowledge) are vital resources in the quest to build ERP capabilities. Relationship resources (user involvement and top management support) follows closely and infrastructure resources (hardware, networks, software, data centers) are less important that knowledge and relationship resources (Karimi *et al*., 2007). These IS resources were also found to have synergistic relationships. Their advice to ERP system adopters is that because building and sustaining ERP capabilities are complex managerial activities they therefore require concentrated investments in the development of the organisation's knowledge resources. It is evident from this literature that firms that effectively deploy IS resources (knowledge) to build ERP capabilities are expected to benefit greater from their ERP system investments.

Xu *et al* (2006) identified knowledge as key capability in the ERP lifecycle both for consultants and ERP adopting organisations. Knowledge is an important capability that can be used to support the ERP implementation, gather user requirements, analyze user requirements, and carry out system design, development, maintenance and testing (Xu *et al*., 2006). They found that an ERP capability consisting of a strong knowledge base can improve the business processes supported by the ERP system to increase the organisation's competitive advantage. They also found that the interaction between ERP and knowledge management systems are synergistic and of significant importance in enhancing the business performance (Xu *et al*., 2006).

2.7.2.2 Knowledge Creation, Sharing and Communication among ERP stakeholders

According to the knowledge based perspective, it is an imperative for organisations contemplating the deployment of complex information systems such as ERP systems to invest in acquiring the required expertise and knowledge (Chou *et al.,* 2013). The integrated nature of ERP systems requires frequent communications among all stakeholders. These communications require sufficient knowledge exchange among these stakeholders (Chou *et al.,* 2013). These stakeholders may include business end users, ERP support teams, technology infrastructure teams, vendor support teams, and third party support teams.

The management of knowledge in maximizing the potential of ERP systems has been advocated in literature (Jeng and Dunk, 2013). In order for organisations to enable a sustainable business performance it's important to leverage on a knowledge management process that is highly effective and efficient (Tsai *et al*., 2011). Proper knowledge management process will enable ERP end users to systematically accumulate the relevant knowledge, refresh and rectify their available knowledge, and improve the impact of the ERP systems on business performance (Tsai *et al*., 2011). In their study of the top manufacturing and services organisations in China, the knowledge management impact was investigated on the organisation's successful implementation of an ERP system. A considerable moderating effect of knowledge management on the relationship between business performance and post-implementation performance was confirmed in their study (Tsai *et al*., 2011). This implied that the impact of post-implementation maintenance on business performance is stronger when knowledge that is effectively stored is further shared within the organization. Additionally this implied that when knowledge is efficiently stored but not shared among team members its impact on business performance is reduced (Tsai *et al*., 2011). Therefore, the effect of post-implementation maintenance on business performance will be stronger in the presence of an effective knowledge management mechanism (knowledge storage and sharing). Profitability was also found to be positively influenced by an effective knowledge management process.

Jeng and Dunk (2013) demonstrated in their study that organisations implementing ERP systems need to leverage on their knowledge found internally to guarantee an implementation that is sustainable and successful. In their study of apparel and footwear manufactures in North and South America they found that where enablers of knowledge (organizational culture, structure and IT support) were present there was improvement in the overall knowledge creation that further improves the success with the ERP system. Knowledge creation was defined as skills and expertise possessed by ERP stakeholders that are critical in order to implement certain knowledge that creates value for the organisation. In the ERP process significant amount of knowledge is required by ERP stakeholders in order to track problems, record solutions, manage system changes, use previous solutions to solve current problems, track the person that solved the problem and to overcome implementation difficulties thus improving the sustainability of the ERP system. This type of knowledge has to be created by organisations to enable effective ERP systems that will ensure business competitiveness

(Jeng and Dunk, 2013). In their study they found that such knowledge is likely to be created in an organisation where the emphasized learning culture is trustful and collaborative. This will turn increase the chances of success with the ERP system. Their results also revealed that where knowledge creation was emphasized a successful ERP system was observed. Jeng and Dunk (2013) concluded that because of the complexity of ERP systems and thus a greater difficulty in sustaining their performance, internal knowledge creation between ERP stakeholders to ensure implementation challenges are resolved is an imperative. This knowledge is also critical in ensuring the ERP system is sustainable post its implementation. A sustainable ERP system will increase the likelihood that an organisation will have greater success with the system (Jeng and Dunk, 2013)

Ifinedo (2011) posited that relevant skills possessed internally are important to an effective ERP system. These skills consist of computer literacy among end-users (non-IT), knowledge among end users, and specialized ERP skills among in-house ERP professionals (Ifinedo, 2011). In their study they were investigating the role of these skills as predictors of ERP effectiveness. They posited that when such skills, expertise and knowledge are available within the organisation, a solid foundation for the building of ERP specific knowledge is formed. In their study of Finnish and Swedish organisations, they found that organisational stakeholders with the appropriate ERP skills, knowledge and expertise available to them, such organisations are well positioned to realize the benefits of complex information systems such as ERP. This study tends to confirm the widely held belief that for off-the-shelf complex packages like ERP systems it is imperative that business employees (non-IT) are well equipped with general computer skills and in-house ERP support personnel have sufficient ERP expertise in order for organisations to achieve a high level of success from their ERP system (Ifinedo, 2011). The importance of the complementary role of ERP skills (from ERP/IT professionals) and general IT skills (from business end users) on the success of the ERP system is therefore advocated.

2.7.2.3 Proper Maintenance after ERP implementation

The successful implementation of an ERP system alone is not sufficient to sustain competitiveness unless it is properly maintained and allowed to evolve to satisfy new business requirements (Law, Chen and Wu, 2010). The maintenance of the ERP is a critical process that has to be carried into the post-implementation phase of the ERP lifecycle. If the ERP system is not properly maintained, the system will not be useful and thus business performance will be heavily impacted (Lopez and Salmeron, 2014). The nature of the ERP system calls for an effective and efficient maintenance strategy in order to enable the continuous performance of the ERP system post-implementation. Maintenance of an ERP system post-implementation is defined by Tsai *et al* (2011) as the combination of maintaining system quality and data. System maintenance enhances the capability of the system to generate information in real-time while data maintenance generates reliable and valid information for the organisation. The combination of system maintenance and data maintenance ensures an improved performance of the ERP system (Tsai *et al*.,2011).

Tsai *et al* (2011) found in their study of Taiwanese firms that business performance greatly improved in firms where post-implementation maintenance of their ERP systems was successfully executed. They found system maintenance to have a direct impact on the profitability of a business. Data maintenance was found to positively impact the quality of decision making which in turn improved organisational performance (Tsa *et al*., 2011). Zhu *et al* (2010) adds that, a properly maintained ERP system will enable an easy assimilation of the system in the organisation and thus laying a solid foundation for reaping the rewards promised by ERP vendors. Law *et al* (2010) found that maintenance and support are critical activities in the ERP lifecycle and they must be handled

appropriately in order for the investment in ERP to yield the desired benefits. Lopez and Salmeron (2014) continue to say that the successful maintenance of ERP systems has been observed to be a difficult and complicated activity. The complexity of this exercise calls for knowledgeable practitioners to manage, plan, and execute the ERP maintenance process.

2.7.2.4 Organisational and Contextual Factors

Realizing benefits of an ERP system depends not only on technology success but also on the business environment and the organisation itself (Zhu *et al*., 2010). This is caused by the nature of the ERP system becoming a critical business infrastructure once at an operational phase (Zhu *et al*., 2010). Their argument was underpinned by the Technology Organisation Environment (TOE) theory. They used this theoretical lens to identify related technology, organisational and environmental factors that will have an impact on the success of the ERP system post-implementation.

The TOE posits that a proper integration of an IS which includes the implementation, adoption, and post-implementation is impacted by certain key factors linked to technology, organisation, and environment (Zhu *et al*., 2010). ERP implementation quality is identified as a technological factor, organisational readiness is identified as an organisational factor and external support is identified as an environmental factor. They argue based on the TOE that these technological, organisational and environmental factors will impact the success of the ERP systems post-implementation. In their results tested on Chinese retail companies, technological and organisational factors were found to positively influence the benefits obtained from ERP systems. They also found that top leader's attitude and commitment towards ERP has a significant influence on the attitudes of other business employees. Therefore, they recommended that decisive powers of top leadership should be used to show commitment to the ERP endeavour. They also emphasize that the consistency between the organisation and the ERP system is an imperative.

2.7.2.5 The Role of Contingency Factors

Others identify organisational factors such as organisation's culture, size, and structure as positively influencing the success of ERP systems (Ifinedo, 2007). The influence of these factors on the success of the ERP system was investigated in Ifinedo's (2007) study of Finnish and Estonian organisations. In their study they also tested the impacts of the interactions among these three contingencies and IT assets (IT department value and IT expertise of IT employees) and IT resources (size of the IT budget and the IT department size).Their results revealed a positive relationship between the three contingent variables (organisational culture, structure and size) and ERP systems success. This study revealed the significant antecedent role played by these three contingent factors in influencing the success of the ERP system. They found that larger size organisations are better positioned to benefit from ERP systems as opposed to smaller organisations. They attribute this to the pre-packaged nature of ERP systems which is pre-configured using business processes of larger organisations and thus inherited functionality will tend to favour larger organisations. With regards to culture they found certain attitudes promote an easy assimilation of ERP in the organisation. Therefore, they recommend that the promotion of cooperative, supportive and collaborative attitudes is imperative for organisations that have adopted or are contemplating adopting ERP systems. With regards to structure, they found a positive effect of organisational structures that create an environment conducive for ERP adoption and ERP system success. These attitudes have been found in literature to promote the diffusion of ERP systems in organisations. Their study thus illustrates how the realization of benefits in ERP post-implementation may be contingent on organisational factors (e.g. size, culture and structure).

2.7.2.6 Fit between ERP and Organisational Processes

ERP systems are designed on "best-practice" business processes which are inherited by ERP adopting organisations. A key contributing factor to the failure of ERP systems is the failure by organisations to re-engineer their business process to align to those of the ERP systems (Morton and Hu, 2008). Business processes inherent in ERP systems which are meant to enable standardization and integration may not be a proper "fit" between the existing business processes of the ERP adopting organisations and those imposed by the ERP system design (Morton and Hu, 2008). This misalignment between these business processes will influence the possibility of success or failure with the ERP system (Morton and Hu, 2008).

They found in their results that where organisations achieved a fit between their structures and those offered by the ERP systems, those organisatons had greater success chances with their ERP implementations. They found that where a poor fit was achieved between organisational structures and the ERP system, organisational resistance to the ERP system was observed and thus decreasing the chances of success with the ERP system. Their recommendation to organisations implementing ERP systems is that consideration must be paid to: the implications of re-engineering their business processes, the willingness from within and the fit between the ERP system and organisational structures.

2.7.2.7 Top Management and External Support

Top management support and external consultant support has been identified as critical for the achievement of a successful ERP process (Wang and Chen, 2006). The adoption an ERP system is a change process posing an organisational wide challenge and thus a concentrated effort is required from users and top management (Wang and Chen, 2006). The complexity of the ERP system, mainly caused by its integrative make-up, complicates the implementation process as opposed to other generic packages (Wang and Chen, 2006). Organisations are then faced with a challenge of having capable resources internally to support the ERP system without which benefits from the ERP system tend to diminish. Firms tend to utilize ERP consultants to address this knowledge gap. External consultants are expected to provide the necessary business and technical expertise and thus reduce the learning burden on the client resources (Wang and Chang, 2006). They tested their propositions from a randomly selected list of 600 Taiwanese manufacturing companies. They found a significant role played by external consultants in the delivering of a quality implemented ERP system and ensuring a coherent ERP consulting process is revealed in their study. Top management was found to indirectly influence the ERP system quality through a more effective resolution of conflicts. Consistent with Wang and Chang (2006)'s findings, Ifinedo (2008) found that the quality of external consulting expertise is imperative to the success of an ERP system. The engagement of quality vendors and consultants has been found in literature to be catalysts for an effective ERP system (Ifinedo, 2008). Quality expertise from external consultants and vendors can balance the organisation's capability to understand how the ERP system will support its business processes (Ifinedo, 2008). These studies are consistent with Dezdar and Ainin's (2011) study, which found that support from top management positively influenced organisational impact of ERP. Top management support and commitment is imperative for companies looking at getting maximum benefits from their ERP systems (Dezdar and Ainin's, 2011). They also found training and education to have a direct significant impact on user satisfaction which was found to positively influence organisational impact.

2.7.2.8 Integration across business units

From literature we can deduce that the primary role of the ERP system is to improve business efficacy and operational efficiency (Gattiker and Goodhue, 2005). Operational improvement and business

efficacy is enhanced by enabling integration and standardization across different units of the business which then leads to overall benefits from ERP systems. Chou and Chang (2008) posit that there are prominent predecessor factors that influence the integration and standardisation which are the business cases of ERP. It is imperative to carefully explore these underlying interventions in ERP research. Standardization and integration is impacted by two salient antecedents which are organisational mechanisms (OM) and customizations (Gattiker and Goodhue, 2005). They explain Organisational Mechanisms (OM) as activities which are focused at improving the acceptance of the ERP system by the organisation; this is ensured by closely aligning the business processes of the organisation with the ERP best practice processes. The inherited business processes offered by the ERP system may not be a perfect fit to the business processes required by the organisation. This then requires the ERP system to be modified to fit the organisational requirements. This process is known as customization (Chou and Chang, 2008). Organisational capability for customization can resolve the misalignment between ERP software and business processes and therefore enable better integration which in turn leads to benefits from the ERP system (Chou and Chang, 2008). On OM, organisations which have invested in OM will have ERP users which are well equipped to understand the functionality of the system and thus can effectively utilize the system to achieve organisational goals as a result of the alignment (Chou and Chang, 2008). This is caused by a positive impact of OM on resolving the misalignment that is stemming from the organisational acceptance of the ERP system. In their results they found that both OM and customization impact positively on the intermediate benefits from ERP systems which then significantly influences the overall benefits in the post implementation stage of the ERP system.

Table 2 summarizes the past literature on post-implementation ERP benefits.

Table 2: Empirical studies that examine factors required to sustain the business value of ERP systems

Reference	Theory/ Model/ Framework	ERP Data	Dependent Variable	Independent Variable	Control Variable	Moderating Variable	Key Findings
Jeng and Dunk (2013)	Socialization, Externalization, Combination, and Internalization (SECI) model	North and South America manufactures of apparel and footwear	ERP Success	Knowledge Creation (Socialization, Externalization, Combination, and Internalization) Collaboration Trust Learning Decentralization Low Formalization IT Support	NA	NA	Positive relationship between enablers of knowledge management (organisational structure, organisational culture, and IT support) and overall knowledge creation Internal knowledge creation will likely ensure organisations have greater success with their ERP systems.
Ifinedo (2011)	Contingency Theory DeLone and McLean	ERP User Lists and Vendor Lists from Finnish and Swedish firms	ERP system effectiveness.	ERP Quality ERP Impact Computer skills of business employees Skills of In-house IT professionals	NA	NA	Employees with the appropriate skills, knowledge and expertise of technology/ IT available to them, such organisational stakeholders are well positioned to realize the benefits of complex information systems such as ERP

Reference	Theory/ Model/ Framework	ERP Data	Dependent Variable	Independent Variable	Control Variable	Moderating Variable	Key Findings
Tsai *et al* (2011)	Knowledge Management	600 Large manufacturing and service Taiwanese firms	Business Performance (financial performance, internal process performance)	Post-implementation maintenance (Data maintenance and System maintenance)	Industry type Corporate capital Duration of implementation	Knowledge management (Sharing and Storage)	Business performance greatly improved in firms where post-implementation of their ERP systems was successfully executed. System maintenance was found to have a direct impact on the profitability of a business and data maintenance was found to positively impact the quality of decision making, and thus the ERP systems increased its effectiveness
Zhu *et al* (2010)	Technology Organisation Environment (TOE) theory.	139 Chinese Retail Firms	ERP Post-implementation success	Technological aspect Environmental aspect Organisational readiness Project Management System Configuration Leadership Involvement Organisational Fit	NA	NA	Technological and organisational factors were found to positively influence the benefits obtained from ERP systems. Top leader's attitude and commitment towards ERP has a significant influence on the attitudes of other business employees towards ERP acceptable
Rhodes *et al* (2009)	Resource-based	380 Chinese Firms	Organisational Performance (Non-financial based and financial based)	Effectiveness of ERP Implementation High performance HR practices	NA	NA	Strategic alignment and leadership engagement was found to be an important intangible factor for ERP system implementation and organisational performance

Reference	Theory/ Model/ Framework	ERP Data	Dependent Variable	Independent Variable	Control Variable	Moderating Variable	Key Findings
	View of the Organisation(RBV)			Strategic alignment/leadership Organisational/ Corporate culture			
Ifinedo and Nahar (2009)	Contingency Theory	Estonia and Finnish firms	ERP System Success	IT assets IT resources Employees' general IT skills Satisfaction with IT Legacy systems		Size Structure	Firms with larger IT departments (IT resources) and larger IT budgets (IT resources) are well positioned to benefit greater from their ERP systems. Their results revealed that firms possessing a pool of IT professionals (IT assets) with specialised expertise who are well respected by business end-users will likely enjoy success from their ERP systems than firms where such IT professionals lack such expertise
Morton and Hu (2008)	Structural Contingency Theory (CT)	Cases of ERP Implementations in the United States	ERP Implementation Success	Organisation Structure Structure – ERP Fit ERP System	NA	NA	Organisations achieved a fit between their structures and those offered by the ERP systems, those organisatons had greater success chances with their ERP implementations. Where a poor fit was achieved between organisational structures and the ERP system, organisational resistance to the ERP system was observed and thus decreasing the chances of success with the ERP system
Chou and Chang (2008)	Organisational Information Processing Theory	1100 Chinese and Taiwanese organisations	Overall ERP Benefits	Customization, Organisational Mechanisms	NA	NA	Both OM and customization impact positively on the intermediate benefits from ERP systems which then significantly influences the overall benefits in the post implementation

Reference	Theory/ Model/ Framework	ERP Data	Dependent Variable	Independent Variable	Control Variable	Moderating Variable	Key Findings
	(OIPT)			(OM) Coordination Improvement Task Efficiency			stage of the ERP system.
Kang *et al* (2008)	Strategic Alignment Theory	341 Korean firms sourced from both business and academic databases.	Business Performance	ERP alignment (with integration modes) Clarity of ERP objective	ERP size Degree of ERP customization Experience with ERP ERP operating period ERP maintenance effort IT conversion effectiveness Organisational size Industry environment	NA	Better alignment between integration nodes and the ERP system is better achieved where the ERP Objective is well formulated
Ifinedo (2008)		Finland and Estonia Firms	ERP System Success	Top management support Business vision External	NA	NA	Top management support, business vision and quality external expertise influence ERP system success.

Reference	Theory/ Model/ Framework	ERP Data	Dependent Variable	Independent Variable	Control Variable	Moderating Variable	Key Findings
	Contingency Theory			Expertise			
Karimi *et al* (2007)	Resource-based View of the Organisation (RBV)	Fortune 1000 Firms	Business Process Outcomes	IS Resources (Knowledge, Relationship and Infrastructure) ERP Capabilities (ERP functional scope, ERP geographical scope, organisational scope)	Organisational Size	IS Resources	Knowledge resources (project management knowledge, business process knowledge), are critical resources for establishing ERP capabilities, closely followed by relationship resources top management support, user involvement), and both are more important than infrastructure resources (hardware, software, network)
Ifinedo (2007)	Contingency Theory	Finland and Estonia Firms	ERP System Success	Size Culture Structure	NA	IT Assets IT Resources	Positive relationship between the three contingent variables (organisational culture, structure and size) and ERP systems success.
Wang and Chen (2006)	Contingency Theory	1000 Taiwanese firms	ERP System Quality	Communication effectiveness Conflict Resolution Top Management Support User Support Consultant Quality	Local ERP Package	NA	Consultant quality and Conflict resolution can positively influence ERP system quality Insignificant support for communication effectiveness
Gattiker and Goodhue (2005)		American Production and Inventory Control Society (APISC)	Overall ERP impacts	Task efficiency Coordination Improvements Interdependence	ERP Customization Time	NA	ERP-enabled interplant coordination improvements lead to local level overall ERP benefits which varied across organisations.

Reference	Theory/ Model/ Framework	ERP Data	Dependent Variable	Independent Variable	Control Variable	Moderating Variable	Key Findings
	Organisational Information processing Theory (OIPT)	members		Differentiation Customization Time elapsed since Implementation	Elapsed Since ERP implementation Data Quality		
Hsu and Chen (2004)	Contingency Theory	MIS Directors from United States Firms	Integrated -Interaction performance	Gap in Interaction Process (Gap in interface congruence, Gap in resource sharing) Internal factors (Organisational Structure, Organisational Climate) External factors (market turbulence, technology dynamic)	NA	ERP Benefits (Tangible and Intangible benefits)	The ERP system moderates the relationship between the gap in interaction process between marketing and manufacturing departments which further improves organisational performance.

2.7.3 Contributions and Shortcomings of Prior Literature

Table 3 summarizes studies that have examined the impacts of ERP suinvestments on business value at different levels of analysis. They examine the factors that are critical to organisations in order to realize the promised benefits of ERP systems. These factors have been summarized into the categories detailed above namely proper maintenance after an ERP implementation, knowledge management, IS/ERP Capabilities, the role of contingency variables, other organisational and technological factors (internal IT support, top management support, external expertise, ERP alignment).

From the above literature review valuable insights have emerged with regards to understanding the post-implementation benefits of ERP systems. The literature tries to explain why some organisations benefit from their ERP implementation while others do not. Across many studies, the role of knowledge was found to greatly influence the post-implementation benefits associated with ERP systems. Jeng and Dunk (2013) found knowledge sharing and creation to greatly predict success with an ERP system. A considerable moderating effect of knowledge management on the relationship between business performance and post-implementation performance was confirmed by Tsai *et al* (2011) in their study of Taiwanese organisations. Ifinedo (2011) found that where internal knowledge, expertise, and skills of computers/IT are available to key organisational stakeholders: such employees will be better poised to realize the opportunities and benefits of adopted complex IT systems, such as ERP (Ifinedo, 2011). Karimi *et al* (2007) also found knowledge resources (project management knowledge and business process knowledge) to be critical IS resources in the quest to build ERP capabilities.

Literature has established the importance of knowledge to facilitate the continuous performance of the ERP system once it has been implemented. The important role of knowledge has been found in the entire ERP lifecycle from its initial implementation up until the post-implementation phase before the system is retired. The knowledge-based perspective has often been drawn upon in past studies to support the role of knowledge as an ERP capability needed to achieve the post-implementation benefits of ERP systems. Within these previous studies, however, knowledge has been conceptualized at a higher level. Jeng and Duck (2013) operationalized ERP knowledge as knowledge creation, trust and learning. Ifinedo (2011) operationized ERP knowledge as computer skills of business employees and skills of in-house IT professionals. Tsai *et al* (2011) operationalized ERP knowledge as knowledge sharing and storage. Karimi *et al* (2007) operationalized ERP knowledge at a sufficient level focusing at business process knowledge and project management, however, this is narrow as project management knowledge is more valuable at the implementation stage but not necessarily at the post-implementation stage.

The role of knowledge has been explored in ERP literature however because of the broadness of the knowledge phenomena it is still unclear which knowledge areas are well suited to explain the post-implementation effects of ERP system. There is a need to consider the multi-dimensional nature of knowledge and its impact on the post-implementation stage of the ERP lifecycle. This will shed light into the specific knowledge areas that are required in order to sustain the post-implementation benefits of ERP systems. In the post-implementation stage of the ERP lifecycle, organisations rely on certain interventions that bring business process into alignment with the ERP system processes. Such interventions require specialized knowledge by ERP system personnel in order to successfully close the misalignment gap between the ERP processes and the organisational processes. Customization is one such example of knowledge content that is required to successfully execute these interventions. Customization was found to be a significant influence on the overall benefits associated with ERP systems (Chou and Chang, 2008). As much as this is a valuable insight there is a need to understand

in detail the skills that are required in order for one to be able to fully customize an ERP system. An ERP system consists of multiple modules which are meant to support a specific business process. ERP system customization is carried out at a module level and this requires module specific ERP knowledge in order to fully customize the system. Looking at the ERP skills at a module level will provide a valuable insight which has not been fully explored by existing ERP studies. The role of business process know-how has been found to be a key requirement for firms looking at benefitting from their ERP system implementations.

Business process knowledge was found to be an imperative resource for organisations that want to build ERP capabilities which will in turn lead to sustained benefits from their ERP systems (Karimi *et al*., 2007). The importance of business process knowledge in relation to ERP has been highlighted in literature, however, these studies have looked at the role of business process knowledge in isolation. There is a need to understand the complimentary role of business process knowledge and ERP module knowledge and their combined influence on ERP performance.

Past studies also identified the importance of technology and organisational factors in relation to the post-implementation benefits of ERP systems (e.g. Zhu *et al*., 2010). Using the Contingency Theory valuable insights emerged from these studies in relation to the relevance of factors such as size, structure, culture, and other IT assets and resources (Ifinedo, 2007; Wang and Chang, 2006; Dezdar and Ainin, 2011). However, these past studies did not consider these contingency factors in relation to ERP knowledge. Consequently, there is a need to understand the role of these contingency variables on the relationship between ERP knowledge and ERP system success. This will close the gap in understanding the interacting effect of these contingency variables on the relationship between ERP knowledge and the post-implementation benefits of ERP systems.

2.8 Conclusion

This chapter introduced ERP systems as a solution to business integration problems within organisations. The size and complexity of ERP systems makes its implementation a specialized discipline with a number of reported failures calling for IS scholars to pay attention to this area of enquiry. Valuable insights have emerged from studies into factors critical for a successful ERP system implementation. However, it has been noted that the successful implementation of an ERP system does not necessarily translate to sustained business performance. There are other factors that help organisations sustain positive outcomes from ERP systems post-implementation. Past research has explored some of these factors which point to the importance of ERP knowledge as well as the role of other organizational, contextual and contingency factors. Contribution and shortcomings of past literature was summarized. A gap in the literature was identified in relation to the multi-dimensional nature of the knowledge areas that are well suited to explain the post-implementation effects of ERP system. Another gap that was identified was the extent to which other organizational and contextual factors influence the relationship between an ERP knowledge capability and the sustained operational benefits from the ERP system. The next chapter will discuss the theoretical assertions of the study's research model through which the above gaps will be addressed. The model's hypotheses are also developed.

3. THEORETICAL BACKGROUND AND RESEARCH MODEL

3.1 Introduction

The prior chapter identified the gaps that are intended to be addressed in this study. The first gap this study intends to address relates to role of an internal ERP knowledge capability (i.e. business process knowledge & ERP module knowledge available within the organisation) in sustaining the Operational Benefits of an ERP system. This study also intends to investigate the conditions under which it is necessary for organisations to develop an internal ERP knowledge capability. Lastly, this study intends to investigate the role of contingency factors (structural complexity and environmental turbulence) in moderating the relationship between an internal ERP capability and the Operational Benefits obtained from ERP systems. The purpose of this chapter is to develop the research model that addresses these objectives. The theoretical underpinnings are discussed followed by the development of the model's underlying hypotheses

3.2 Theoretical Underpinnings

Three theoretical perspectives explain this research. These are the Resource and Knowledge-Based View of the Firm, Contingency Theory and Transaction Cost Theory.

3.2.1 Resource and Knowledge-Based Views of the Firm

The link between internal ERP knowledge capability and Operational Benefits of ERP systems (Research Question 1) is supported by the Resource and Knowledge-based Views of the Firm. The Resource-Based View of the Firm explains organisational performance in terms of internal resources and capabilities (Karimi *et al.,* 2007). The Knowledge-Based perspective defines resources as inimitable, nonsubtitutable, and rare assets that are specific to an organisation. These assets are critical to an organisation's operations as they support organisational strategies by improving effectiveness and efficiency (Karimi *et al.,* 2007). Resources can be tangible or intangible (Das and Teng, 2000). The use of intangible internal resources in performing a set of co-ordinated activities in order to achieve certain organisational outcomes is defined as capabilities (Karimi *et al.,* 2007).

Capabilities are essential in sustaining a firm's competitive advantage. The selection and deployment of resources towards the building of capabilities better positions organisations to achieve economic advantages than their competitors (Duhan, Levy and Powell, 2010). For the context of this study, the interest is on knowledge-based resources. The organisation's intangible skills and know-how is termed as its knowledge-based resources (Das and Teng, 2000). Because of the uniqueness of knowledge resources they are an essential capability in sustaining a firm's competitive advantage. Effectively managing knowledge has been found in literature to be an imperative in an organisation's quest for success thus making knowledge a vital organisational capability (Nevo and Chan, 2007). The Resource-Based view was extended to the Knowledge-Based View of the Firm.

The knowledge- based view of the firm posits that a firm's competitiveness could be generated on the basis of the knowledge possessed by an organisation and the ability to develop it (Cabrera-Suárez *et al.,* 2001). Organisations that effectively leverage their knowledge assets to build an ERP capability are likely to be successful with their ERP systems. Karimi *et al* (2007) found in their study that knowledge is a critical IS resource for building an ERP capability. Ifinedo (2007) found that where knowledge, expertise, and skills of computers/IT are available to key organisational stakeholders, such employees will be better poised to realize the opportunities and benefits of off-the shelf complex IT systems, such as ERP. This theory thus explains the hypothesized link between a firm's possession of an internal ERP knowledge capability and the Operational Benefits derived from the ERP system.

3.2.2 Transaction Cost Theory

The question (Research Question 2) as to when a firm chooses to develop an internal ERP knowledge capability will be considered through the Transaction Cost Theory (TCT). TCT has been widely used in IS to explain why some firms in-source their IT functions whilst others outsource. The development of an internal ERP knowledge capability is a form of in-sourcing. According to TCT, after organisations do an evaluation of their internal capabilities and resources as compared to the offering of the external market they are better equipped to make a decision of whether to develop the capabilities internally or outsource to the market (Dibbern *et al*., 2001). The TCT describes transactions as three dimensional constructs consisting of: 1) the transaction frequency 2) the state of asset specificity that is required in supporting the transaction 3) the extent and type of uncertainty that surrounds the transaction (Dibbern *et al*., 2001). In the IS context, asset specificity has been defined as the unique skills, business processes and business know-how that is required to successfully execute an outsourcing deliverable or project (Wang, 2002). During an ERP system implementation process significant amount of specific irreversible business process and ERP module knowledge is made by firms (Wang, 2002). This form of knowledge is specific to the ERP implementing organisation and thus increases the asset specificity of the ERP system. Investment in specific assets, knowledge in this instance, will increase the transaction costs (Aubert *et al*., 2003) associated with the ERP system. As asset specificity increases, obtaining these assets from external sources becomes difficult as vendors may not be willing to invest in organisation specific transactions (Aubert *et al*., 2003). The complexity and inefficiency of obtaining this specific knowledge from the market increases the transaction costs associated with outsourcing the ERP system. When these costs are too high, it would be more appropriate to conduct the transaction in-house (Aubert *et al*., 2003), which in this study's context translates to developing internal ERP knowledge capabilities rather than procuring them in the market.

3.2.3 Contingency Theory

The third Research Question asks whether the impacts of an ERP knowledge capability on outcomes might be contingent on certain internal and/or external organisational factors. If so, then developing internal capabilities may not have the same significance for all organisations. The Contingency Theory is a well suited theoretical framework from which to address this question. The Contingency Theory posits that when external and /or internal contingency factors match with key characteristics of the organisation this can result in a more effective organisation (realization of ERP operational benefits in this instance) (Ifinedo, 2012). A variable that has the capability to moderate the influence of an organisational characteristic on the performance of an organisation is termed a contingency (Ifinedo, 2007). Under the Contingency Theory perspective an internal ERP knowledge capability may be more important for some firms than for others. Organisational structure and environmental turbulence may be particularly important contingency variables influencing the relative impacts of an internal knowledge capability on business performance. These two factors have been important contingency variables in other studies. For example organisational structure was found to moderate the effects of IT capabilities (assets and resources) on ERP systems success (Ifinedo, 2007). Environmental turbulence was found to moderate the effect of internally focused IT capabilities and externally focused IT capabilities on organisational performance (Stoel and Muhanna, 2009).Therefore, environmental turbulence is expected to moderate the relationship between an internal ERP knowledge capability and Operational Benefits of ERP systems such that firms in a more turbulent environment will benefit more from an internal ERP capability. Structural complexity is also expected to moderate the relationship between an internal ERP capability and Operational Benefits from ERP systems such that more complex firms will benefit more from an internal ERP capability.

3.3 Research Model and Hypothesis

Drawing on the above theoretical perspectives, the study's research model has been developed and is illustrated in Figure 4 below

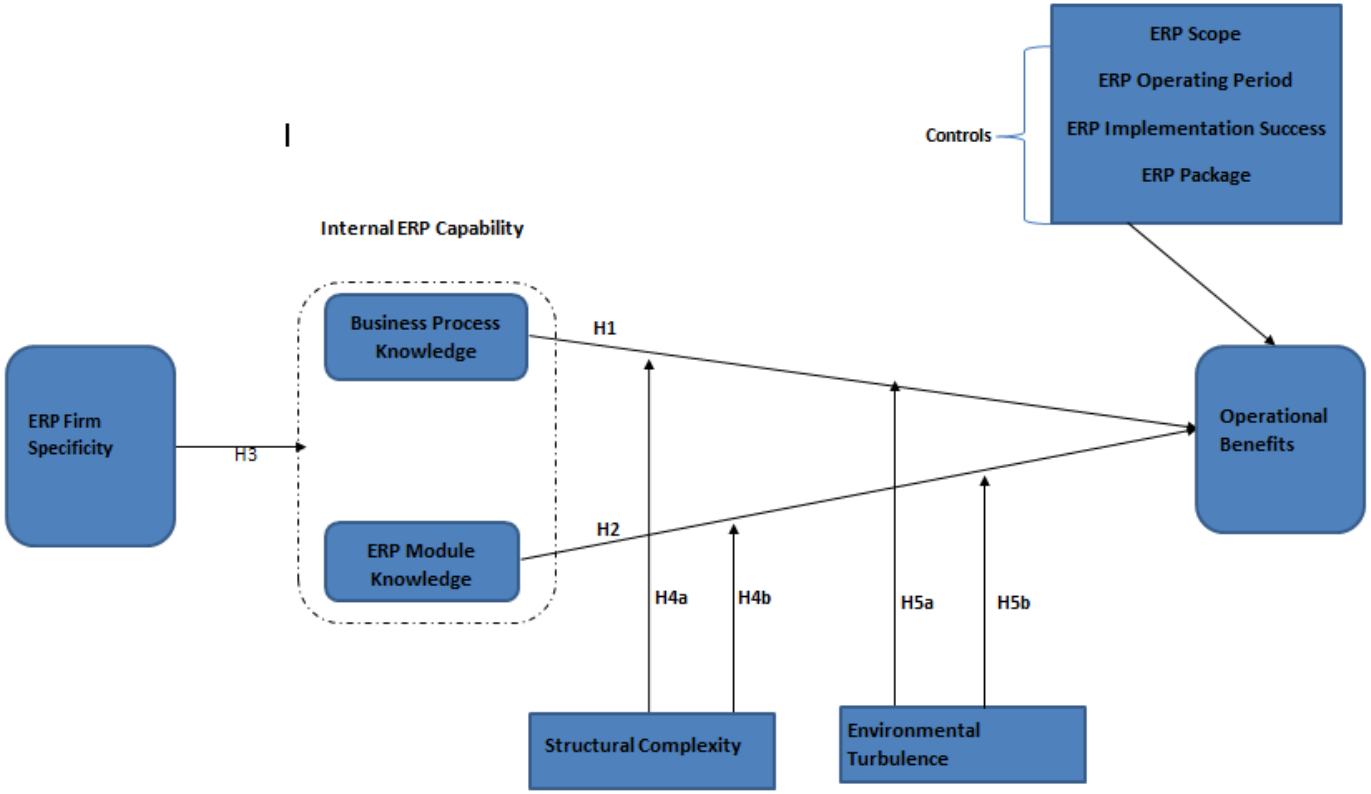


Figure 4: The Research Model (Source: Own)

The dependent variable in the model is Operational Benefits of an ERP system. It represents the post-implementation benefit of interest because an ERP implementation that is successful will compel organisations to re-engineer, standardize and align their internal business processes (Yang and Su, 2009). Operational benefits reflect the cross-functional business process integration and automation brought about by an ERP system (Shang and Seddon, 2002). The operational benefits of an ERP are daily operational improvements leading to a reduction in operational costs, quality improvements, productivity improvements, improved control of inventory, improved internal processes, improved employee morale and an increase in customer satisfaction (Yang and Su, 2009). Higher order business performance measures (e.g. profitability and competitiveness) can be driven by operational benefits derived from the ERP systems and thus operational benefits are considered an appropriate first order outcome of an ERP system.

Drawing on the knowledge-based perspective, the model illustrates that the internal ERP knowledge capability (as a critical organisational capability) is necessary for sustaining the benefits of ERP systems (H1 and H2). Transaction Cost Theory explains through the idea of asset specificity the decision of firms to choose to build an internal ERP knowledge capability as opposed to sourcing the knowledge from the outside market (H3). Furthermore, Contingency Theory supports the argument that organisational complexity and environmental turbulence will moderate the relationship between the internal ERP knowledge capability and business performance (H4a, H4b, H5a and H5b).

The arrows in the model illustrate the hypothesized relationships that are developed below.

3.3.1 The link between internal ERP Knowledge Capability and Post-implementation Operational Benefits

The internal ERP knowledge capability is expected to play a fundamental role in sustaining the performance benefits offered by the ERP system. Business process knowledge and ERP module knowledge have been identified as the two dimensions of knowledge that are critical in sustaining the benefits of an ERP system post implementation. Business process knowledge is important for the accurate gathering of business requirements, integrating process and data across value-chain processes and enabling the means for system performance tracking (Karimi *et al*., 2007). Because of the daily operational demands of IS activities, IT support staff often lack the capacity to gain the necessary business process knowledge to build ERP capabilities (Karimi *et al*., 2007). Since an ERP system is meant to support business functions, it is imperative for IT personnel to have an understanding of business processes, to ensure they understand the needs of the business and advise on how the ERP system can assist. Because of the complex nature of ERP systems, concentrated interactions between ERP support team members and end users are required. These intensive interactions involve constant sharing, creation, preservation, learning, and extraction of knowledge among ERP stakeholders (ERP team members and end users) (Tsa *et al*., 2011). The understanding of business needs and processes would ensure an efficient knowledge exchange between ERP end users and internal ERP support personnel (Dibbern *et al*., 2001). This effective exchange will lead to an easy assimilation of the ERP system in the organisation and more effective usage of the ERP system by end users. Once end users feel that they understand the role of the ERP systems in their daily operations enhanced by the understanding of business operations by ERP support personnel better utilization of the ERP system by end users may be realized. When the business requirements from end users are not implemented by the ERP support team likely caused by the lack of business process understanding of the ERP support team, end users may feel unsupported and thus their utilization of the system will drop. If the correct

utilization of the ERP system drops the operational benefits associated will the ERP system will diminish. The correct usage of ERP applications is imperative in achieving the anticipated benefits of the system by adopting organisations (Dibbern *et al*., 2002). Karimi *et al* (2007) described how lack of user support (business process knowledge) at a global organisation led to an underutilization of a technologically sound financial accounting system. This led to a reduction in the performance of the ERP system and thus the system was dis-continued. Karimi *et al* (2007) found that business process knowledge resources are the most critical resources for building ERP capabilities. Organisations that invest in empowering their IT/ERP support personnel with business process knowledge should thus increase their chances of building an effective ERP knowledge capability. This is because ERP personnel that are knowledgeable in business processes are well equipped to understand business requirements and how the ERP will solve unique business requirements. This will in turn lead to well supported end users of the ERP system and possibly more effective usage of the ERP system that can lead to increased Post-Implementation Operational Benefits. The ERP capability is important in ensuring the end user requirements are met which in turn increases system utilization and further improves the operational benefits associated with the ERP system (Tsai *et al*., 2011). This leads to the first hypothesis:

H1: The greater the organisation's internal business process knowledge, the greater will be the operational benefits from the ERP system.

The complex nature of ERP systems calls for effective post-implementation maintenance (Tsai *et al*., 2011). After the completion of the ERP system implementation process the following tasks are required to sustain the performance of an ERP system; implementation of updates and upgrades, support of end users, configuration of change requests, integration with third parties and other business process improvement activities. Given the complexity of the ERP system, the aforementioned tasks are done at an ERP module level. ERP module knowledge is thus a critical skill for internal IT support personnel in order to sustain the continued positive performance of the ERP system at its latter years of its lifecycle (Ifinedo, 2011). ERP module skills are not only required during the implementation process, they are also required during post-implementation phase to configure and adapt system specific attributes on an ongoing basis (Stratman and Roth, 2004). This knowledge is required to configure an ERP module to adjust to changing operational and strategic goals of the organisation (Stratman and Roth, 2004). ERP module knowledge ensures the ERP adapts to changing business requirements by configuring the ERP system according to business requirements. Without such knowledge, the ERP system will not be configured correctly and Operational Benefits associated with the ERP system are likely to diminish.
These arguments lead to the next hypothesis:

H2: The greater the organisation's internal ERP module knowledge, the greater will be the operational benefits from the ERP system.

3.3.2 The link between internal Firm Specificity of the ERP System and internal ERP Capability

To maintain their ERP system post-implementation, firms are faced with a decision to either develop an ERP knowledge capability internally or get the knowledge from the market by outsourcing to external consultants. Transaction Cost Theory (TCT) posits that asset specificity is the most important consideration when firms decide to outsource or insource (Wang, 2002). High asset specificity occurs when investments, services and products are customized to fit a specific transaction making this asset not deployable to another transaction or task (Wang, 2002). During an ERP implementation process

firms may adapt their organisational processes to fit the ERP system. Because ERP systems are developed by the software vendor based on vendor process definitions, vanilla or "off-the-shelf" adoption of these systems requires that organisations adapt their business processes to those of the software package (Gattiker and Goodhue, 2002). In other cases however, the organisation may tailor or customize the ERP software to meet specific organisational needs. This will occur during the configuration process (Gattiker and Goodhue, 2002). During the configuration process, the ERP system is customized to meet the specific business needs which are not catered for as part of the standard ERP system offering. A highly customized ERP system thus has the characteristics of asset specificity i.e. they become an organisational asset that is unique to the organisation and thus not easily deployable to another organisation. Maintaining customized systems will require specific business process and ERP module knowledge because this specific knowledge is required when tailoring the ERP system to meet the organisational needs. As the specificity of the knowledge required in operating and maintaining the ERP system increases as result of a highly customized solution, it becomes too costly and complicated to obtain that knowledge from the market. This is because there is insufficient incentive for vendors to invest in developing such organisation-specific knowledge (Wang, 2002). Vendors are unlikely to be willing to invest in developing the knowledge required to support an organisation-specific ERP system because they are unlikely to benefit from leveraging this form of knowledge to other outsourcing opportunities in the market. As a result the more specific the ERP system, the less likely the knowledge to support it can be procured more cheaply in the market, and the more necessary it would become to build that knowledge in-house. Based on the above arguments, this study posits in line with the TCT that the high transaction costs associated with sourcing the capability from the market to support an ERP system with high asset specificity would lead the organisation to develop this knowledge capability in house. It is therefore hypothesized that:

H3: The greater the organisation-specificity of the ERP system, the greater will be the firm's internal ERP knowledge capability.

3.3.3 The moderating effect of Organisational Complexity

Structural complexity of an organisation is defined as the organisational condition of being composed of many parts (Miller, 1987). Structural complexity has been found to be a key consideration when organisations adopt ERP systems (Ifinedo, 2007). This is because the more subunits the organisation has, the more ERP integration effort may be required to align the software to the needs of the business (Gattiker and Goodhue, 2005). Complex firms have different lines of business (Miller, 1987), which may lead to increases in post implementation tasks such as system changes, end-user training, module updates, customizations, and third-party integration. An ERP system is more suited for organisations having multiple and specialized business functions (Ifinedo, 2007). In order to exploit the potential of the ERP system to support these multiple business functions, there is a need for knowledgeable IT/ERP personnel who understand the offering of the ERP system as well as the demands of the multiple business functions. A complex organisation will require more integration effort from the ERP system to support the alignment of the different organisational sub-units (Morton and Hu, 2008). This integration effort requires specialized ERP knowledge from within the organisation and thus improving the effect of an internal ERP capability on the Operational Benefits obtained from the ERP system. This argument is consistent with the Contingency Theory which posits that organisational performance (Post-Implementation Operational Benefits) can be the consequence of the interaction between organisational characteristics (internal ERP knowledge capability) and contingency factors (organisational structural complexity) (Ifinedo, 2007). It is therefore believed that structural

complexity is a contingency factor that moderates the relationship between an internal ERP knowledge capability and the operational benefits of an ERP system, such that more complex firms will have a greater need for an ERP knowledge capability. This leads to the following hypotheses:

H4a: The greater the structural complexity of the firm, the stronger the relationship will be between business process knowledge and the operational benefits of an ERP system.
H4b: The greater the structural complexity of the firm, the stronger the relationship will be between ERP module knowledge and the operational benefits of an ERP system

3.3.4 The moderating effect of Environmental Turbulence

Environmental turbulence exists when changes in technology and consumer preferences result in unpredictability and uncertainty (Pavlou and El Sawy, 2006). These environments are also characterized by higher levels of competition and pressure from the industry (Rajagopal, 2002). When met with such turbulence, firms may invariably turn to their information systems department to help them use and adapt their IT systems to save resources and improve responsiveness (Rajagopal, 2002). Rajagopal (2002) found that performance levels of organisations have significantly improved through the recent turbulent environments because they invested heavily on IT technology that improved the automation of core organisational processes. This was evident in organisations that invested in the usage and effective application of such IT tools as ERP systems. Turbulent business environments will require frequent changes of internal business practices (Stoel and Muhanna, 2009) which in turn require system changes. Without an internal ERP capability firms are not likely to be able to respond appropriately to these required changes. The greater the degree of environmental change, the greater the need for internal ERP capabilities to adapt the ERP to ensure sustained operational benefits are derived from the system. With these arguments this study posits that the link between ERP knowledge capability and operational benefits will be strongest amongst firms operating in turbulent business environments. For firms operating in more stable environments with fewer systems implications, development of a strong internal ERP capability may not result in greater operational benefits and may unnecessarily consume organisational resources in developing a capacity that would not add much value. This leads to the fourth hypothesis:

H5a: The greater the environmental turbulence, the stronger the relationship will be between business process knowledge and the operational benefits of an ERP system
H5b: The greater the environmental turbulence, the stronger the relationship will be between ERP module knowledge and the operational benefits of an ERP system

3.4 Controls

Controls are required to assure internal validity (causality) of research designs (Bhattacherjee, 2012). In this study, it was considered important to control for (a) initial/base-line ERP implementation success, (b) ERP package scope, (c) ERP operating period, and (d) ERP vendor.

ERP implementation success is defined as the extent to which the pre-defined project goals such as expected completion time, project cost and expected performance of the system were achieved (Hong and Kim, 2002). Literature suggests the post-implementation benefits of ERP systems will be influenced by a successful ERP implementation exercise (Zhu, et. al., 2010), and it is thus important to control for any possible confounding effect of ERP implementation success on subsequent post-implementation realization of operational benefits. ERP operating period is defined as the time in months that had elapsed since the first transaction run of the ERP system in the organisation (Kang *et al*., 2008). Literature suggests that a number of organisations have not been able to achieve the

expected benefits of ERP systems after the first 12 months; however, most organisations do get the anticipated benefits after a considerable time-lag (Gattiker and Goodhue, 2005). The ERP operating period may thus have a confounding effect on the operational benefits of ERP systems and thus the control for this variable in this study. ERP scope is the number of ERP modules implemented (Kang, *et al*., 2008). The ERP scope influences the anticipated value of the system for an organisation due to the business and technical integration potential of a larger scoped investment (Ranganathan and Brown, 2006). The ERP scope will influence operational benefits derived from an ERP system and thus the importance of controlling for this variable.

The important role of ERP system vendors in providing technical support, enhancements, and upgrades with improved business and technical functionality has been found to influence the vendor choice made by ERP adopting organisations and thus some vendors have been found to offer better value to adopting organisations (SAP and Oracle) (Ranganathan and Brown, 2006). Controlling for ERP system vendor is important in this study to control for any operational benefits that are likely influenced by the underlying ERP package

3.5 Conclusion

This chapter developed the study' research model. First, it explored the three theoretical perspectives that underpin the research. These are the Resource and Knowledge-Based View of the Firm, Transaction Cost Theory (TCT) and Contingency Theory. Drawing on the theoretical perspectives, the study's research model was developed. Drawing on the resource and knowledge-based perspective, the model argues that the internal ERP knowledge capability (as a critical organisational capability) is necessary for sustaining the benefits of ERP systems. Transaction Cost Theory explains through the concept of asset specificity why some firms are more likely to build an internal ERP knowledge capability as opposed to sourcing ERP knowledge from the outside market. Furthermore, Contingency Theory explains the argument that organisational complexity and environmental turbulence will moderate the relationship between the internal ERP knowledge capability and business performance. Based on these assertions, a hypothesized research model was presented. The hypotheses are summarized as follows:

Table 3: Hypothesis Summary

Hypothesis	**Definition**
Hypothesis 1	*The greater the organisation's internal business process knowledge, the greater will be the operational benefits from the ERP system.*
Hypothesis 2	*The greater the organisation's internal ERP module knowledge, the greater will be the operational benefits from the ERP system.*
Hypothesis 3	*The greater the firm specificity of the ERP system, the greater will be the firm's internal ERP knowledge capability.*
Hypothesis 4a*:*	*The greater the structural complexity of the firm, the stronger the relationship will be between business process knowledge and the operational benefits of an ERP system.*
Hypothesis 4b*:*	*The greater the structural complexity of the firm, the stronger the relationship will be between ERP module knowledge and the operational benefits of an ERP system*
Hypothesis 5a*:*	*The greater the environmental turbulence, the stronger the relationship will be between business process knowledge and the operational benefits of an ERP system*

Hypothesis 5b:	*The greater the environmental turbulence, the stronger the relationship will be between ERP module knowledge and the operational benefits of an ERP system*

The next chapter presents the research methodology used to test the research model and hypotheses and in so doing to address the study's objectives.

4 RESEARCH METHODOLOGY

4.1 Introduction

This research study aims to determine whether an internal ERP knowledge capability is important in sustaining the benefits of an ERP system post-implementation. This research also aims to examine the role of the ERP's asset specificity on the decision to develop an internal ERP knowledge capability and the moderating effects of organisational complexity and environmental turbulence on the relationship between an internal ERP knowledge capability and the benefits of the ERP system post-implementation. The previous section outlined these hypothesized relationships by drawing on past literature and the three theoretical perspectives supporting these studies. This section provides detail on the methodology that will be used to conduct this research.

The selected research paradigm used in this study is explained and justified. The data collection tool used in this study is explored. The procedure for data collection including pre and pilot testing is discussed in detail. The empirical context for testing the research model is the South African context. The details on the population, sampling frame of South African firms and sampling method are discussed. The operationalization of constructs is discussed in detail. The research instrument, data collection and analysis are also explored in detail. The limitations of the methods are discussed.

4.2 Research Methodology

Bryman and Bell (2007) propose that a research design provides a framework for the collection and analysis of data, that is, it outlines the specific procedures necessary to obtain data required to solve the problem being investigated. For any piece of work to be considered a research item in academia, it has to contribute to the body of knowledge and it has to follow a scientific method (Bhattacherjee, 2012). Science is defined as referring to a systematic and organized body of knowledge in any area of inquiry that is acquired using the scientific method (Bhattacherjee, 2012). Science can be grouped into two separate but broad categories natural science and social science. This study falls into the social science category which is defined as the science of people or collections of people, such as groups, firms, societies, or economies, and their individual or collective behaviours (Bhattacherjee, 2012).

Positivism and Interpretivism are the two main research paradigms in social science research. The Positivist paradigm is defined by Lee (1991) as the development of theoretical propositions using hypothetico-deductive logic, so that the theoretical propositions satisfy the four requirements of empirical falsifiability, logical consistency, relative explanatory power, and survival. Similarly, Bryman and Bell (2007) explains positivism as an epistemological position that advocates the application of the methods of the natural sciences to the study of social reality. The interpretivist paradigm is concerned with the understanding of human behaviour from the participants own frame of reference (Hussey and Hussey, 1997) and according to Bryman *et al* (2007) it shares the view that people and their institutions are profoundly different from that of the natural sciences.

Since this study is supported by existing theoretical propositions and proceeded in a hypothetico-deductive manner, the study has been informed by a positivist approach. The theoretically derived research model is tested through observation and consistent with the positivist approach is also characterized by the use of quantitative data, large samples and hypothesis testing through inferential statistics. There is a strong focus on ensuring high reliability in measurement and high generalizability from sample to population although it is acknowledged that there may be low internal validity due to difficulty controlling for extraneous factors (Hussey and Hussey, 1997). The positivist approach aims

to reduce the threat of subjectivity by gathering data objectively and in manner that minimizes the influence of bias from the researcher's values and attitudes.

4.3 Research Design

The positivist paradigm is often associated with the relational research design. Relational research is designed to investigate the relationships between two or more variables. The relational research is ideal for this study because of the aim to test associations between hypothesized relationships (Bhattacherjee, 2012). Even though the relational design is criticised for providing weak evidence of causation it nonetheless allows for quantified measurement, and for direction and strength of association between variables through the use of correlational and regression testing to be established (Bhattacherjee, 2012). The relational design is often associated with the survey method of data collection.

Surveys are non-experimental designs that do not control for or manipulate independent variables or treatments, but measure these variables and test their effects using statistical methods (Bhattacherjee, 2012). Survey research involves acquiring information about one or more groups of people by asking questions and tabulating the answers. Survey questionnaire methods have been used to collect data in this study in line with the relational design. The strength of the survey data collection method is the ease with which it can be administered to large samples, which allows findings to be generalized from sample to population. Another notable strength of surveys is their external validity (since data is collected in field settings), their ability to capture and control for a large number of variables, and their ability to study a problem from multiple perspectives or using multiple theories (Bhattacherjee, 2012). The aim of the survey is to learn about a bigger population by surveying a sample that is representative of the population, summarising the results with statistical tools or graphical representations and then using this information to draw inferences about the particular population studied. The survey itself can take many forms e.g. face to face interviews, telephonic interviews, written questionnaires and online questionnaires (Leedy and Ormrod, 2005). This study employed a survey questionnaire as the main data collection method.

A cross-sectional survey method was used which implied that data on all variables was collected at a single point in time. The limitation with using such cross sectional data is that temporal precedence cannot be established and therefore causality cannot be inferred. The specific data collection and analysis methods used are discussed in the next section.

4.3.1 Research Instrument

A questionnaire is a formalised framework consisting of a set of questions and scales designed to generate primary data from research participants (Shiu *et al*., 2009). Also, a questionnaire can be explained as a research instrument consisting of a set of questions (items) intended to capture responses from respondents in a standardized manner (Bhattacherjee, 2012). Questionnaires can be used to elicit information directly from a group of people that is presumed to be representative of the larger study population (Leedy and Ormrod, 2005). Questions may be unstructured or structured. Unstructured questions ask respondents to provide a response in their own words, while structured questions ask respondents to select an answer from a given set of choices (Bhattacherjee, 2012). Questions should be designed such that respondents are able to read, understand, and respond to them in a meaningful way, and hence the survey method may not be appropriate or practical for certain demographic groups such as children or the illiterate (Bhattacherjee, 2012). In this study, structured questions were used in the questionnaire. The structured questions were used to capture responses along the study's variables which would allow for subsequent statistical testing hypothesized

relationships. Structured questions help respondents make quick decisions because they reduce the amount thinking and effort required by respondents, reduce bias and help the researcher to code the information easily for subsequent analysis (Sekaran *et al*., 2013).

Most online survey questionnaires tend to be self-administered over the internet, where the same questionnaire is emailed to a large number of subjects, and willing respondents can complete the survey at their own convenience (Bhattacherjee, 2012).. They are also inexpensive to administer to a large sample compared with traditional mail or hand delivery. Another advantage is that confidentiality and guarantee of anonymity are easy to maintain and this allows the subjects to respond freely without fear of penalty or loss. The type of information obtained from a questionnaire is varied and includes factual, attitudinal, and interpretational or opinion based data (Leedy and Ormrod, 2005). The use of an online survey approach was thus considered appropriate for this study. However, it is recognized that response rates from mail surveys tend to be quite low since most people tend to ignore survey requests. There may also be long delays (several months) in respondents' completing and returning the survey (or they may simply lose it) (Bhattacherjee, 2012). Responses must therefore be constantly monitored, tracked and reminders sent out in the data collection period. Questionnaire surveys are also not well suited for issues that require clarification on the part of the respondent or those that require detailed written responses. To guard against potential problems, questions (measurement items) must be constructed by drawing on literature and a pilot test conducted to ensure ambiguity is removed from questionnaire items. The operationalization of constructs and measurement items are discussed next.

4.4 Operationalization

In chapter 3, a theoretical construct was conceptualized and defined. Once a theoretical construct has been defined the next step is to define the measurement for that construct. Operationalization refers to the process of developing indicators or items for measuring these constructs (Bhattacherjee, 2012). This process enables the researcher to examine the closeness amongst these indicators as an assessment of their accuracy (reliability) (Bhattacherjee, 2012). ERP knowledge capability is a multi-dimensional construct consisting of two dimensions ERP module knowledge and business process knowledge. The other variables are Structural Complexity, Environmental Turbulence and Asset Specificity. The dependent variable is Operational Benefits of ERP system. The conceptual and operational definitions of the constructs are detailed in the table below as well the literature source from where there construct measures were derived.

Table 4: Constructs Definitions

Variable	Conceptual Definition	Operational Measures	Scale	Literature Source
Business Process Knowledge	The ability of internal ERP support staff to understand the business environment, learn about business functions, and interpret	1. The internal ERP support staff has sufficient knowledge of business functions. 2. The internal ERP support staff is willing to learn in detail a specific business functional area 3. The internal ERP support staff has the ability to quickly understand the needs of customers	7 point Likert – strongly disagree to strongly agree	Boyle and Strong (2004)

Variable	Conceptual Definition	Operational Measures	Scale	Literature Source
	business problems.	4. The internal ERP support staff has the ability to understand the business environment 5. The internal ERP support staff has the ability to interpret business problems 6. The internal ERP support staff has the ability to develop appropriate technical solutions to business problems		
ERP Module Knowledge	ERP skills refer to the ability of an internal ERP staff to configure and maintain an ERP system in support of the business.	1.The internal ERP staff have the ability to conduct routine ERP systems maintenance 2.There is a high degree of technical ERP expertise in our ERP firm 3.The database administrator is an expert in the ERP database management system 4.Internal ERP team members understand custom ERP software programs 5.The internal ERP staff are able to efficiently implement ERP system upgrades 6.The ERP staff have the technical ability to conduct a formal validation of all system changes 7.ERP staff are able to analyse the technical impact of proposed system changes 8.The ERP staff actively builds relationships with business managers 9.ERP staff offer ideas on how IT can be used to achieve business goals 10.ERP staff communicate with functional use groups in the ERP Entity 11.The ERP firm provides a service to the business	7 point Likert – strongly disagree to strongly agree	Stratman and Roth (2002)

Variable	Conceptual Definition	Operational Measures	Scale	Literature Source
Structural Complexity	The extent to which a firm is divided into structural components of unit	1. Functional differentiation, typically measured by the total number of units below the chief executive level		Damanpour (1996)
	Condition of being composed of many parts.	1. Number of operating sites (plants/branches) 2. Levels in the organisational hierarchy 3. Variety of different functional specialists working in the firm 4. Number of different lines of business.		Miller (1987), Damanpour (1996)
Environmental Turbulence	Describes the general conditions of uncertainty or unpredictability because of changes in consumer preferences and technology developments	1. The environment in our product area is continuously changing. 2. Environmental changes in our industry are very difficult to forecast. 3. The technology in this product area is changing rapidly. 4. Technological breakthroughs provide big opportunities in this product area. 5. Our kind of business, customers' product preferences change a lot over time. 6. Marketing practices in our product area are constantly changing. 7. New product introductions are very frequent in this market. 8. There are many competitors in this market.	7 point Likert – strongly disagree to strongly agree	Pavlou and El Sawvy (2006)
ERP Specificity	ERP specificity is defined by the uniqueness of the implemented ERP system to the firm.	Please indicate the uniqueness of the following aspects of your ERP system? 1. Functional/information requirements 2. Operating procedures 3. Training for the developers 4. Technical skills required	7 point Likert scale: 1 = Not at all unique; 7 = very unique	Wang (2002)

Variable	Conceptual Definition	Operational Measures	Scale	Literature Source
		5. The ERP system was altered to improve its fit with this firm 6. A standard version of the ERP software was implemented without changes being made to fit the particular requirements of this firm (reversed) 7. When the ERP system was being implemented, the package was changed to better meet the needs of this plant	7 point Likert – strongly disagree to strongly agree	Gattiker and Goodhue (2005)
Operational Benefits of ERP	The operational benefits of an ERP are expected to improve day-to-day operations (short-term impact), which include improved inventory control, improved cash management, and reduction in operating costs	1. My firm has better control of business operating expenses and decreased operations cost after adopting ERP system. 2. My firm has reduced production cycle times and increased inventory turns. 3. My firm has increased power user involvement by user training for operational tasks 4. My firm has improved quality management and control. 5. My firm meets customer needs proactively and more efficiently.	7 point Likert – strongly disagree to strongly agree	Yang and Su (2009)

The control variables are ERP implementation success, ERP operating period, ERP scope and ERP package. ERP implementation success was measured as the ERP project being implemented within budget and delivered in the scheduled timeframe. The operating period of less than 12 months is used to represent companies that are in the stabilization phase in this study. However, an operating period greater than 12 months is used to represent firms that are now in the post-implementation phase of the ERP lifecycle. Therefore, the operating period has been used to separate between firms which are in the stabilizing phase of the ERP lifecycle and those which are on the post-implementation phase. ERP scope was measured as the number of ERP modules implemented by the organisation ERP package was measured as the different vendors that offer ERP systems in South Africa

Content validity is an assessment of how well a set of scale items matches with the relevant content domain of the construct that it is trying to measure (Bhattacherjee, 2012). The content validity of the instrument was ensured predominantly by using scales from the existing literature. However, prior to administration the questionnaire items were also subjected to a pre-test by three academics in the

department of Information Systems who are familiar with ERP research and the constructs under study. This exercise further improved content validity of scale items.

In order to further test the adequacy of the research instrument, a pilot test was then conducted with a small convenient sample of ten firms drawn from the sampling frame list and with key informants with similar characteristics to the intended study participants. The pilot-test is important to detecting potential problems in the research design and to ensure that the measurement instruments used in the study are reliable and that the instrument has face validity (Bhattacherjee, 2012). This process resulted to a change in one questionnaire item related to business process knowledge of ERP support team. The item showed poor variance as it was too agreeable. The initial item adapted from literature (Boyle and Strong, 2004) read as "Our internal ERP support staff have the ability to interpret business problems". Following additional consultation with experts in the field, it was therefore decided to reword the item as "Our internal ERP support staff are meeting our expectations in terms of their ability to interpret business problems".

4.5 Population and Sample

4.5.1 Target Population

A population can be defined as all people or items (unit of analysis) with the characteristics that one wishes to study. The unit of analysis may be a person, group, organisation, country, object, or any other entity that you wish to draw scientific inferences about (Bhattacherjee, 2012). Likewise, Bryman *et al*. (2007) describes the target population as the universe from which the sample is to be selected.. Since this is an organisational level study the unit of analysis will be the organisation. The population under study is all South African organisations across all industry sectors that have implemented ERP systems. This constituted a large enough population for this relational study.

4.5.2 Sample and sampling method

Sampling is the statistical process of selecting a subset (called a “sample”) of a population of interest for purposes of making observations and statistical inferences about that population (Bhattacherjee, 2012). There are two broadly used sampling designs: probability and non-probability. Probability sampling is a process where a sample is selected randomly so that each unit in the population has a known chance of being selected and non-probability is selecting each sampling unit is not known and the selection of sampling units is based on some type of intuitive judgement or knowledge of the researcher (Shiu, Hair, Bush & Ortinau, 2009). This study followed the non-probability sampling approach.

Shiu *et al*., (2009) describes a sampling frame as a list of all eligible sampling units. The sampling frame for this study consists of large companies across all industry sectors that have implemented ERP system. A sampling frame is an accessible section of the target population (usually a list with contact information) from where a sample can be drawn (Bhattacherjee, 2012). The implementation and support of ERP systems can be very costly mainly caused by high business process re-engineering costs, extended implementation times, implementation costs, vendor license costs and overall costs of ownership. Smaller companies by definition are less likely to have the resources for the implementation and maintenance of an ERP system. ERP system vendors have responded with lower risk alternatives for small and medium organisations, however. its adoption is still at its infancy in South Africa and thus search for smaller organisation that have adopted ERP systems in South Africa produces a relatively small list.

Therefore, within the context of this study, only large organisations that have implemented ERP systems have been surveyed which constituted the sampling frame. Literature estimates ERP systems to have been implemented by more than a 1000 large customers across both the public and private sector in South Africa (Strachan, 2005). SAP is the leading vendor with about 350 companies in South Africa that have implemented SAP ERP.

A methodological control for impacts on operational benefits that might accrue due to differences in underlying software systems of different vendors will be mitigated by controlling for ERP vendor. A list of 900 large private and public South African organisations which have implemented ERP systems was obtained. The list was obtained from a third party company that maintains a list of South African organisations with an extensive IT end-user base. The third-party company is a marketing research consultancy that specialises in quantitative research and offers marketing of ERP products, conferences for ERP user groups i.e. AFSUG (Africa SAP user group) and knowledge exchange conferences for ERP stakeholders i.e. organisations, vendors and academic institutions.

The list contained key contact information for potential key informants at each organisation. The list contained the person name and surname, the organisation, the job title, email address, contact number and physical address. Survey questionnaires were administered to the identified key informant within each of the sampled organisations. The key informants were senior IT or business managers with close association to the ERP support team. These individuals were considered appropriate because their high-level knowledge of the firm's internal ERP capability (business processes and ERP modules) will equip them to respond to the survey questions.

4.6 Data Collection

As described earlier, a self-administered questionnaire that can be accessed online was used for data collection. Since this was an online based survey, respondents on the sampling frame were sent an electronic mail inviting them to participate with a link to an online website where the survey may be completed. An email was sent to each of the 900 contacts identified from the lost. A cover letter (see Appendix B) explained the purpose of the study, promised confidentiality and anonymity, and explained that participation was voluntary.

The self-administered questionnaire allowed key informants to complete the survey at their own convenience. Data collection took place over a two month period; in line with self-administered surveys a low response rate was observed. Responses were constantly monitored, tracked and three reminders were sent out in the data collection period to encourage participation.At the end of two months, responses from 198 organisations was received which was an acceptable response rate for business studies.

4.7 Data Analysis

All fieldwork culminates in the analysis and interpretation of some set of data, be it quantitative survey data, experimental recordings, historical and literary texts, qualitative transcripts or discursive data (Mouton, 2004). Since this study collected quantitative data, statistical tools are used to analyse data in two ways descriptive and inferential analysis. Descriptive analysis refers to statistically describing, aggregating, and presenting the constructs of interest or associations between these constructs while inferential analysis refers to the statistical testing of hypotheses (theory testing) (Bhattacherjee, 2012). In order to perform statistical analysis, the raw data gathered from the questionnaire was processed by making use of Statistical Package for the Social Sciences (SPSS).

Data was analyzed making use of SPSS. SPSS was selected for this purpose as it is an effective and efficient means of managing qualitative data.

4.7.1 Measurement validity and reliability

It is important for a researcher to make sure that the instrument that is used or selected to measure a particular concept are accurately measuring the variable, that is, is it really measuring the concept it is set out to measure (Sekran *et al*., 2013). Therefore, it is important to calculate the reliability and validity of the scales to be used in the study because good instruments will ensure more accuracy in results henceforth enhancing the scientific quality of the research.

Validity is the extent to which a measure adequately represents the underlying construct that it is supposed to measure (Bhattacherjee, 2012). In addition to content and face validity being established through the use of literature to derive questionnaire items and through pre-testing and pilot testing of the questionnaire, it is also necessary to establish the convergent and discriminant validity of constructs. A Principal Components Factor (PCA) analysis was used to assess convergent and discriminant validity. Preferably an item is expected to be related with other items that measure the same variables (convergent validity), but differ from items which measure different variables (discriminant validity). Convergent validity requires that measures that are theoretically related should be related in the observation while discriminant validity requires that measures that are theoretically not related should not be related in observation. Convergent validity has been confirmed in the PCA when measurement items load onto their expected constructs with high loadings, generally above 0.60. Furthermore, the Average Variance Extracted (AVE) of each construct should be above 0.50. To ensure discriminant validity, low loadings of less than 0.4 are expected for items in relation to constructs they do not intend to measure.

Reliability is the degree to which the measure of a construct is consistent or dependable (Bhattacherjee, 2012). The reliability of a measure indicates the extent to which it is without bias and hence ensures consistent measurement across time and across the various items in the instrument (Sekaran *et al*., 2013). Cronbach's alpha was used to ensure reliability as it was found to be an established technique to ensure reliability using the internal consistency approach. Coefficients should be above 0.7 to ensure reliable scales. Reliability was further ensured in this study by;

- Adapting existing scale from literature that are free from ambiguity
- Simple English wording was used on questionnaire items
- Carefully selecting our respondents so they are equipped to respond to questionnaire items
- A pilot study was conducted to ensure reproducibility of the questionnaire
- Clear instructions provided to assist respondents with the completion of survey

Once reliability and validity have been confirmed, aggregate scores are then calculated for use in subsequent hypothesis testing.

4.8 Hypothesis Testing

Correlation and regression analysis was used to test the hypothesized relationships in this study. This technique involves identifying the relationship between a dependent variable and one or more independent variables. A model of the relationship is hypothesized, and estimates of the parameter values are used to develop an estimated regression equation (Bhattacherjee, 2012).

H1 and H2 hypothesized the effects of business process knowledge and ERP module knowledge on obtaining operational benefits from ERP systems. To test these hypotheses, regression analysis was used to test the effect of the independent variables (business process and ERP module) on the independent variable (ERP operational benefits)

H3 hypothesized that the greater the firm specificity of the ERP system, the greater will be the firm's internal ERP knowledge capability. To test this hypothesis regression analysis was used to test the effect of ERP specificity on both ERP module knowledge and business process knowledge.

For H4a, H4b, H5a, H5b moderation was tested by including interaction terms within moderated regression analysis. The interacting terms are:

- Business process knowledge and environmental turbulence
- ERP module knowledge and environmental turbulence
- Business process knowledge and structural complexity
- ERP module knowledge and structural complexity

4.9 Ethical Considerations of the Study

Given the intention to survey individuals as key informants, it is necessary to consider ethical implications. In particular, three ethical considerations are identified, namely voluntary participation, informed consent, anonymity and confidentiality (no sharing data with third parties).

Firstly, potential respondents were invited to participate by completing a web-based survey. A cover letter (participant information sheet) provided details regarding the researcher and reasons for the research, the potential respondents were informed that participation is entirely voluntary and a consent section was included notifying the potential participant that completion of the survey assumes consent. The cover letter is contained in APPENDIX B.

Secondly, respondents were informed that there will be no risks or penalties or loss of benefits whether or not they participate. Respondents were able to withdraw at any stage in the research by exiting the survey.

Thirdly, responses were anonymous. Participants were not asked to provide any identifying information about themselves or their company. The respondent's name was not recorded anywhere and it is not possible to connect the respondent to the answers given.

Results are only reported in the aggregate. Raw data will not be provided to any other parties, and the data is being used for research purposes only. Responses are stored electronically in a secure, password protected database that is accessible only to the researcher and supervisor.

Ethics clearance was applied for and obtained from the university's human subjects (non-medical) ethics committee (see APPENDIX A).

4.10 Limitations of Study

This study was conducted at only large organisations that have implemented ERP systems in the South African context across all industry sectors. A total of 900 organisations were identified and requested to participate in the study. Key informants representing the 900 organisations were sent questionnaires and requested to participate in the study by completing survey questionnaires. Exclusion criteria for this study included small and medium enterprises that have implemented ERP systems. It also excluded all organisations that are outside of South Africa. All other organisations large organisations that have implemented other legacy technologies apart from ERP systems were also excluded in this study.

Field surveys are known for their enhancement of external validity since data is collected in natural settings and their ability to capture and control for a large number of variables, and their ability to study a problem from multiple perspectives or using multiple theories (Bhattacherjee, 2012). However, any non-response or selection biases may affect external validity and limit the generalisability of the results. Non- response bias is a limitation of survey research where low response rates raise the possibility of systematic bias which impacts the generalisability of results beyond South African firms (Bhattacherjee, 2012). The use of a single informant also causes a common method bias where phenomenon under investigation may not be adequately separated from measurement artifacts (Bhattacherjee, 2012).

Another limitation synonymous with field's survey is its weak causation where claims of causality cannot readily be made. This is because data on dependent and independent variables is collected at the same time, causality is difficult to infer from any observed correlations (Bhattacherjee, 2012). Causal inferences can therefore only be made on the basis of theory. Another limitation of this study is that it does not consider the dynamic nature of knowledge; it does not consider the changing nature of ERP module and business process knowledge in the data collection process. Furthermore survey may be associated with social desirability bias where the respondent offers socially acceptable response instead of their true response. Even though this study controlled for some confounding factors, it is almost impossible in survey research to control for all extraneous factors and thus compromising the internal validity of the study.

4.11 Conclusion

In this chapter the research design which was applied during this research project was discussed. The study was informed by a positivist perspective and makes use of a quantitative research method. A survey research design was used to collect data. The questionnaire was compiled making use of items that had been published previously in literature and validated during a pilot study. Nine hundred (900) South African firms were invited to participate. The key informants were senior IT or business managers with close association to the ERP support team at sampled organisations. Reliability and validity are confirmed through the use of techniques such as PCA and Cronbach's alpha prior to hypothesis testing with multiple regression. Results from the data analysis are discussed and presented in the next chapter.

5 EMPIRICAL FINDINGS

5.1 Introduction

Chapter 3 drew on three theoretical perspectives to develop the study's research model. The research design and methods employed to gather and analyse data were then discussed in detail in the previous chapter. This chapter presents the empirical findings.

The chapter is structured as follows. First, missing values, outliers and data cleansing are described. Next, the profile of respondents is presented. Results of tests of reliability and validity of the measures are then presented. Finally, results of tests of the study's hypotheses are presented in detail.

5.2 Data cleaning, Missing Data and Outliers

Key informants from 900 organisations that have implemented ERP systems in South Africa were invited to complete the online survey questionnaires. After a 10 week period 198 responses were received representing a 22% response rate. A detailed data cleaning exercise was conducted from the 198 returned responses. Responses with large amounts of missing data and responses that were considered to be outliers were removed leaving 130 usable responses. The data cleaning approach that was implored is explained in detail in the next section.

5.2.1 Data Cleaning and Missing Values

Previous studies have shown that in any empirical work missing values are inevitable. This was also the case in this study as a number of respondents had missing responses on some questionnaire items. To deal with missing values in this study, a common method called listwise deletion was applied. This technique deletes responses with missing values from any questionnaire items. This approach reduces the sample size while making sure only quality responses are maintained for data analysis. The listwise deletion technique was used to handle missing values in this study as well as to remove responses where reliability of responses was questionable and discrepancies could not be resolved:

28 responses (14%) were deleted because respondents were missing more than 10% of questionnaire items.
7 responses were deleted because the organisation was not running an ERP system.
8 responses were deleted because the job profiles of respondents did not equip them enough to provide quality responses.
7 responses were deleted because the numbers of years the ERP was running in the organisation was reported to be greater than the number years the organisation had started operations.
8 responses were deleted because the number of ERP users was greater than the number of employees in the organisation.
3 responses were deleted because the number of years the respondent was involved in the organisation's ERP system were greater than the number of years in the organisation.

5.2.2 Outlier Analysis

The data was also screened so as to identify any responses with unusually high or unusually low responses to questionnaire items as such responses may be outliers. The standardized score technique was used to determine outliers from the data set. A standardised score greater than +- 3 represents observations that are 3 or more standard deviations away from the mean. Within a normal distribution 99.7% of all observations should fall within 3 standard deviations of the mean. Respondents with a standardized score of greater than +-3 on more than one questionnaire item represented outliers In this study 7 responses were deleted because their responses were either unusually high or unusually low on more than one questionnaire item and were therefore considered as outliers. This suggested that

these respondents may not be from the same population as the other respondents and therefore should not be included in the analysis.

5.2.3 Reverse Coding

Only one item in the dataset needed to be reverse coded before analysis could proceed. The item "A standard version of the ERP software was implemented without changes being made to fit the particular requirements of our business", which was measured using 7 point likert scale was reverse coded so as to reflect ERP specificity.

5.3 Response Profile

The final sample consisted of 130 usable responses from 130 unique organisations. In this section the 130 unique responses will be profiled according to the respective demographic criteria used within the survey instrument: job title, years employed at the organisation, number of ERP users, ERP scope, years ERP system running in the organisation, industry type, ERP package type and size of organisation.

5.3.1 Respondents by Type of ERP Package

Of the 130 usable responses, most organisations were running SAP at 60% followed by Oracle with 20%, Microsoft was next with only 6.9 %, Sage was next at 3.1%, Baan and JD Edward followed at 1.5% each. Other minority ERP packages that were not included in the selection constituted a shared 6.9% of the surveyed organisations. The types of ERP packages implemented at the different organisations are depicted in Table 5 below. Figure 5 shows the graphical view of the ERP packages implemented at different organisations.

Table 5: Types of ERP package

	Frequency	Percent	Valid Percent	Cumulative Percent
SAP	78	60.0	60.0	60.0
Oracle	26	20.0	20.0	80.0
Sage	4	3.1	3.1	83.1
Microsoft	9	6.9	6.9	90.0
Baan	2	1.5	1.5	91.5
JD Edward	2	1.5	1.5	93.1
Other (specify please)	9	6.9	6.9	100.0
Total	130	100.0	100.0	

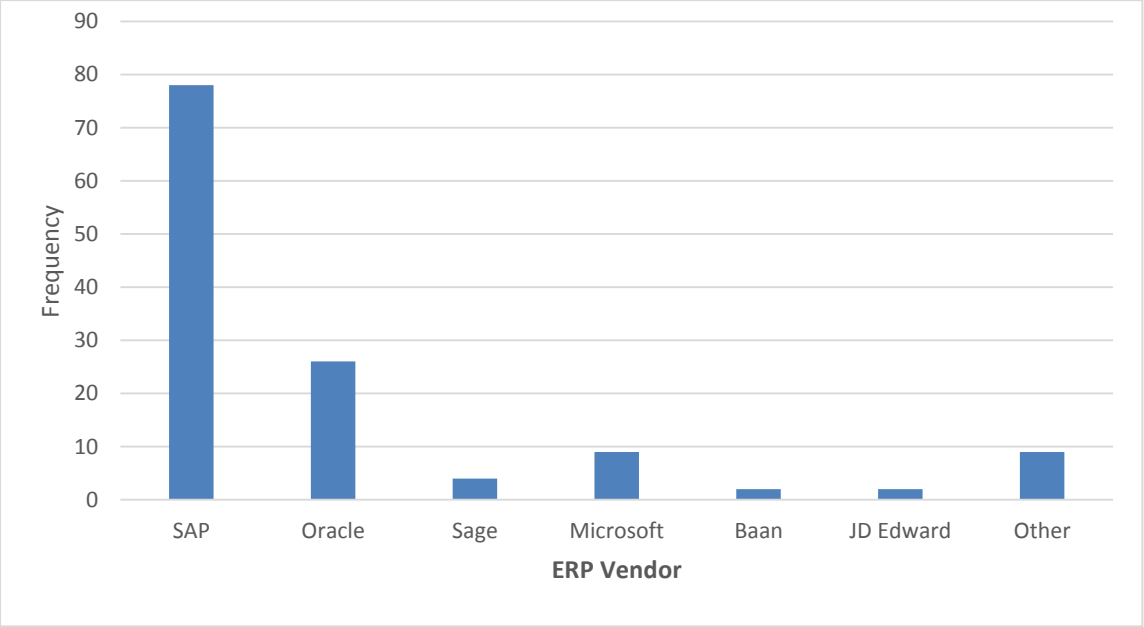


Figure 5: Types of ERP packages

5.3.2 Respondents by Job titles of Key Informant

Of the 130 respondents 33.8% were Information Technology (IT) managers, 28.5% were business process managers, 18.5% were IT project managers, 11.5% were Chief Information Officers and 7.7% were other relevant positions in the organisation. Table 6 below depicts the respondent's job titles in the organisation. Figure 6 depicts the graphical view of the job titles of key informants.

Table 6: Job titles of Key Informants

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Chief Information Systems (CIO)	15	11.5	11.5	11.5
	Information Technology Manager	44	33.8	33.8	45.4
	Business Process Manager	37	28.5	28.5	73.8
	Project Manager	24	18.5	18.5	92.3
	Other (Please Specify)	10	7.7	7.7	100.0
	Total	130	100.0	100.0	

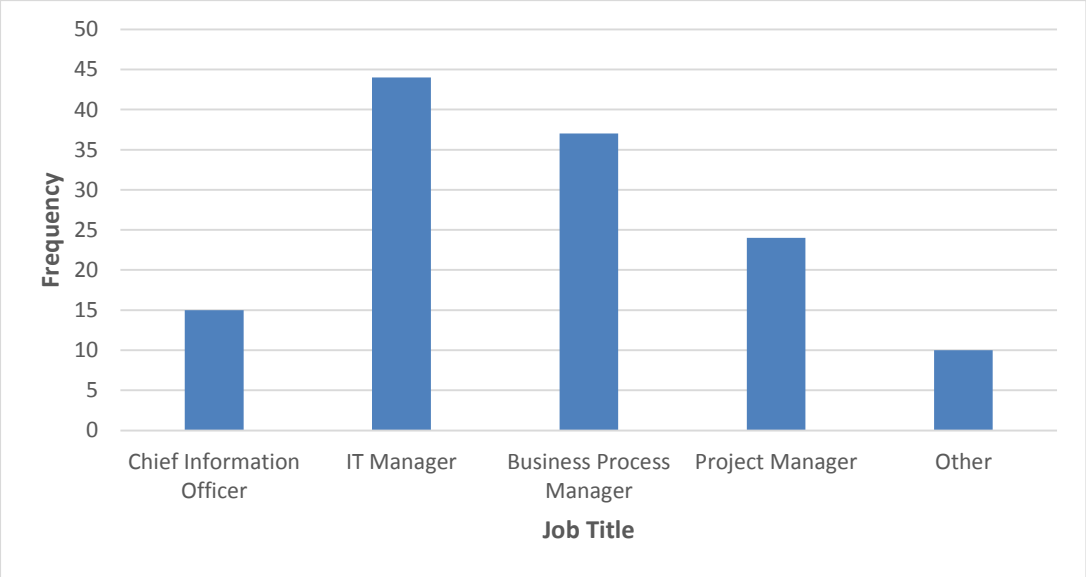


Figure 6: Job titles of Key Informants

5.3.3 Respondents by Organisational Size

Most of the respondents were from large organisations with 36.9% of the respondents from organisations with greater than 5000 employees, 31.5% of the respondents were from organisations consisting of between 1001 to 5000 employees, 18.5% of the respondents were from organisations consisting of employees between 501 to 1000 employees, 10% of the respondents were from organisations consisting of employees between 301 to 500 employees, 8% of the respondents were from organisations consisting of employees between 50 to 100 and 2.3% of the respondents were from organisations consisting of 101 to 300 employees. Table 7 below depicts the employee sizes of surveyed organisations. Figure 7 depicting a graphical view of organisational size.

Table 7: Respondents by Organisational size

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	50 to 100	1	0.8	0.8	0.8
	101 to 300	3	2.3	2.3	3.1
	301 to 500	13	10.0	10.0	13.1
	501 to 1000	24	18.5	18.5	31.5
	1001 to 5000	41	31.5	31.5	63.1
	Greater than 5000	48	36.9	36.9	100.0
	Total	130	100.0	100.0	

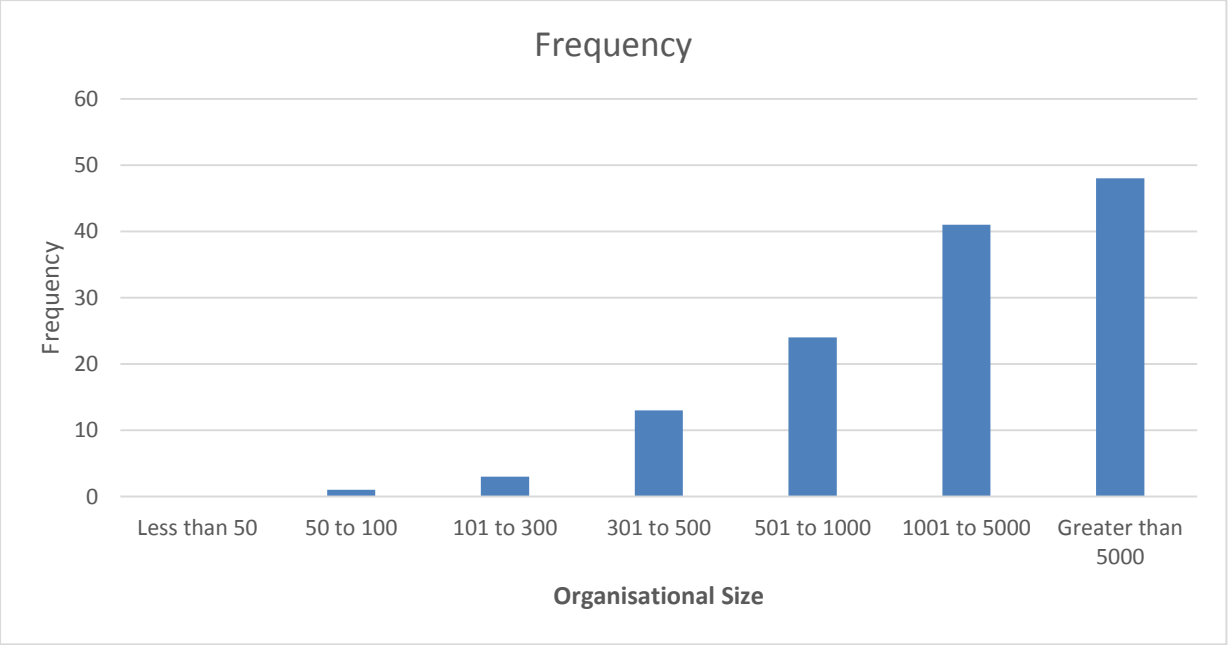


Figure 7: Respondent by Organisational size

5.3.4 Respondents by Number of ERP users

On the ERP user base, 25.4% of the organisations had an ERP user base of between 501 to 1000 employees, 23.8% of the organisations had an ERP user base of between 1001 to 5001 employees, 16.2% of the organisations had an ERP user base of between 101 to 300 employees, 13.8% of the organisations had an ERP user base of greater than 5000 employees, 10.8% of the organisations had an ERP user base of between 301 to 500 employees, 6.2% of the organisations had an ERP user base of between 50 to 100 employees and 3.8% of the organisations had an ERP user base of less than 50 employees. Table 8 below depicts the ERP user base of surveyed organisations. Figure 8 depicting a graphical view of the ERP user base at surveyed organisations.

Table 8: ERP user base at surveyed organisations

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 50	5	3.8	3.8	3.8
	50 to 100	8	6.2	6.2	10.0
	101 to 300	21	16.2	16.2	26.2
	301 to 500	14	10.8	10.8	36.9
	501 to 1000	33	25.4	25.4	62.3
	1001 to 5000	31	23.8	23.8	86.2
	Greater than 5000	18	13.8	13.8	100.0
	Total	130	100.0	100.0	

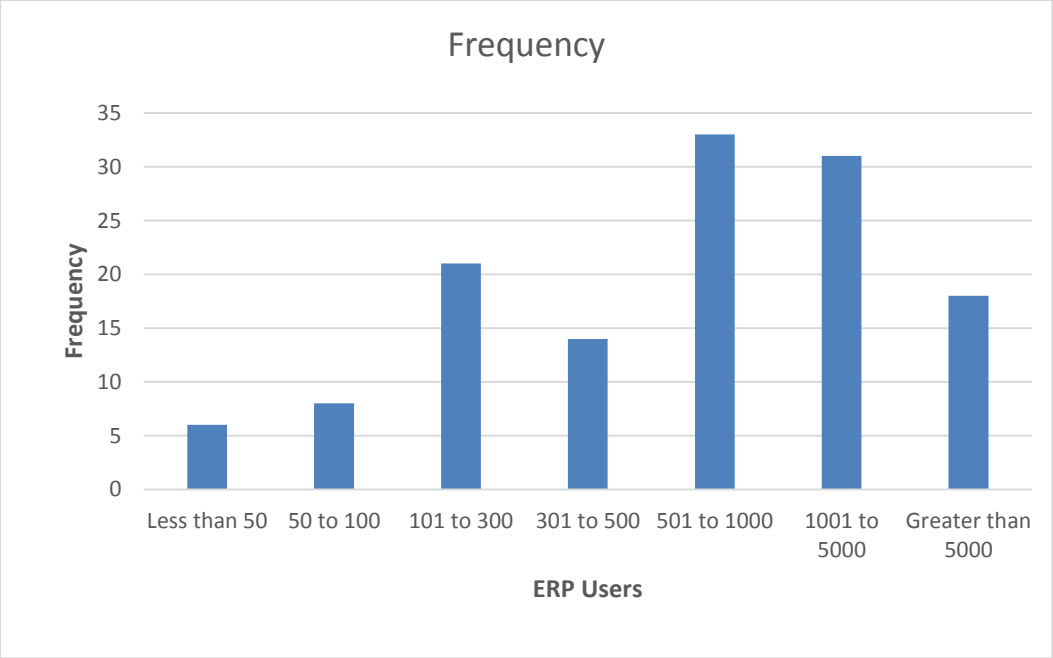


Figure 8: ERP user base at surveyed

5.3.5 Respondents by ERP Scope

On the ERP scope all surveyed respondents implemented the financial accounting module, 84% implemented the supply chain management module, 75% implemented the controlling module, 80% implemented materials management, 73% implemented sales and distribution, 68% implemented the logistics module, 50% implemented production planning module, 41% implemented quality management, 23% implemented plant maintenance, 24% implemented projects systems and 34% implemented human resource module. Figure 9 below depicts the graphical view of the modules implemented by all 130 organisations.

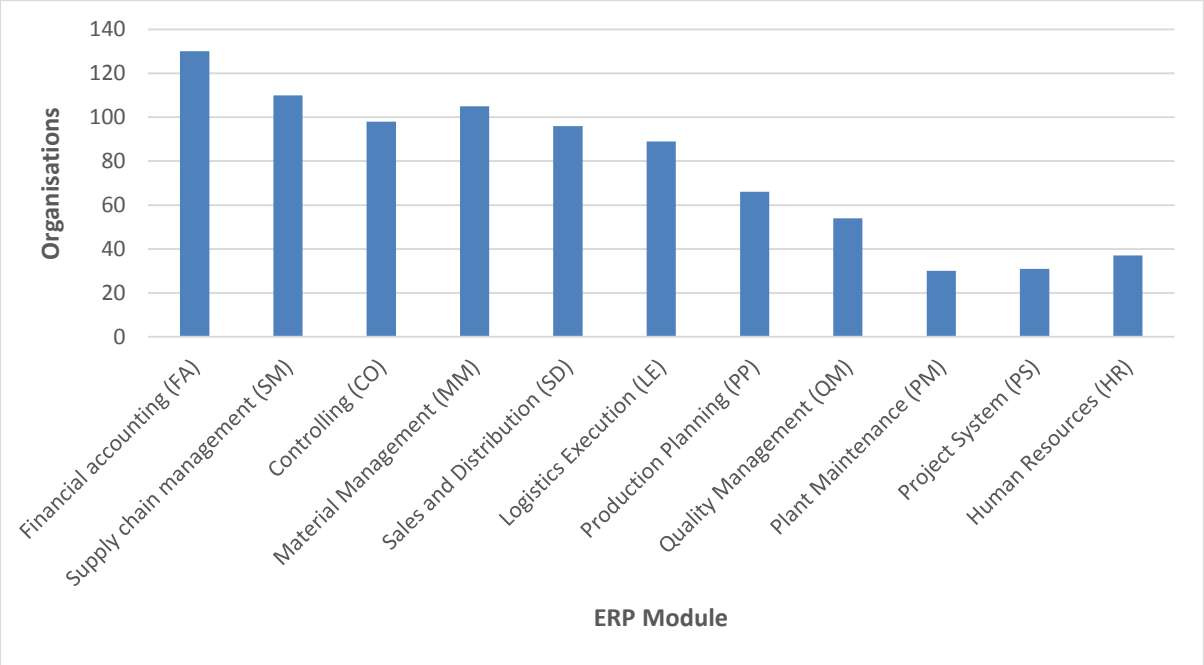


Figure 9: ERP modules implemented by organisations

5.3.6 Respondents by ERP Package and Industry adoption

A comparison of the usage of the different ERP packages by the different industries revealed SAP to be the most popular among the different industries. In Manufacturing, 58% of the surveyed organisations run SAP, followed by Oracle with 28%, Microsoft followed with a 6% and lastly Sage with 3%. In Resources SAP dominated with 88% of the surveyed organisations and the remaining 13% shared by the combination of other smaller ERP organisations. The financial services was not different with SAP adopted in 61% of the organisations, Oracle followed with 22% adoption and Microsoft closely followed with 17% adoption by surveyed organisations. The public sector was fairly distributed, however, with SAP dominating with 56% of government organisations, Oracle followed with 17% adoption, Sage followed at 11% adoption and Microsoft had 6% of public sector organisations. The smaller ERP vendors had a combined 11% share of government organisations. In Health Care, SAP led with 59% adoption followed by Oracle with 27% and lastly Microsoft, Baan and JD Edward shared a 5% share respectively. The Retail space had SAP leading at 50% of the organisations, followed by Oracle and JD Edward at 17% respectively. Smaller ERP players had a combined 17% adoption by retail organisations. The services industry's was slightly different as Microsoft led with 43% of the market with SAP taking second place at 29% followed by Oracle at 14% of services organisations. Smaller ERP vendors shared a 14% adoption by service organisations. In the transportation sector SAP led with an adoption percentage of 83% of the logistics organisations and the other 17% shared between smaller ERP vendors. The communication industry was dominated with SAP having been adopted by all surveyed organisations with a 100% adoption. SAP's dominance is evidenced in this study as it is the only ERP that was implemented across every industry sector. Table 9 below shows the comparison of ERP vendors and their adoption by different industries. Figure 10: shows a graphical distribution of the ERP vendors and their adoption at different industries.

Table 9: ERP vendors and industry adoption comparison

	Manufacturing	Resources	Financial Services	Government	Health Care	Retail	Services	Transport	Communication
SAP	58%	88%	61%	56%	59%	50%	29%	83%	100%
Oracle	28%	0%	22%	17%	27%	17%	14%	0%	0%
Sage	3%	0%	0%	11%	5%	0%	0%	0%	0%
Microsoft	6%	0%	17%	6%	0%	0%	43%	0%	0%
Baan	0%	0%	0%	0%	5%	0%	0%	0%	0%
JD Edward	0%	0%	0%	0%	5%	17%	0%	0%	0%
Other	6%	13%	0%	11%	0%	17%	14%	17%	0%

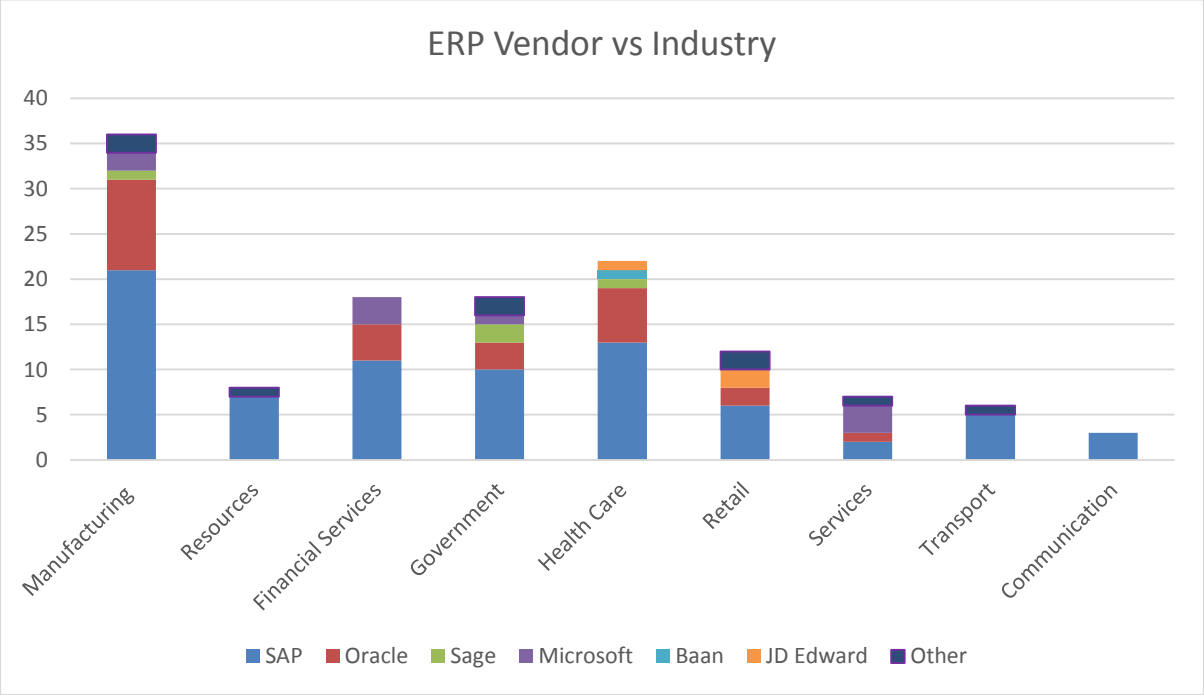


Figure 10: ERP vendors and industry adoption analysis

5.4 Reliability and Validity of the measurement model

The study's research model hypothesized relationships amongst six variables (ERP specificity, business process knowledge, ERP module knowledge, operational benefits, structural complexity and environmental turbulence). Each of these variables was measured using multi-item scales as described in Chapter 4. One control variables, implementation success, was also measured using multiple scale items. These multi-item scales were tested for validity and reliability before hypothesis testing could proceed.

5.4.1 Validity Measurement

In this study, Bartlett's test of sphericity (p=0.00) indicates that the statistical probability that the correlation matrix has correlations that are significant among some of the variables, and therefore that a factor analysis could be appropriately carried out. The Kaiser –Meyer-Olkin (KMO) measure of sampling adequacy showed an acceptable sampling adequacy at 0.746 which is above 0.500.

A principal components factor analysis was conducted to investigate the convergent validity of the items measuring business process knowledge, ERP module knowledge, ERP specificity, implementation success, environmental turbulence, structural complexity and operational benefits of ERP systems. Table 9 represents the results of the factor analysis. After seven rotations, seven factors were extracted. The results of the principal component analysis (PCA) indicate that these seven factors are distinct and uni-dimensional scales.

Convergent validity requires that measures that are theoretically related should be related in the observation while discriminant validity requires that measures that are theoretically not related should not be related in observation. Convergent validity is confirmed through the PCA when the Average Variance Extracted (AVE) of each construct is above 0.5 and the loadings of items onto their intended constructs is above 0.60. Discriminant validity is also evidenced in the PCA when items do not load highly onto constructs they are no intended to measure.

Initial runs of the PCA identified items that did not load as expected and these were therefore dropped. The items dropped were ET1 (Our business environment is continuously changing); this item was dropped because of the interpretation of the word 'continuously', which may not reflect the idea of unpredictable and uncertain business environments in terms of the definition. This caused ambiguity in the interpretation of the question which led to inconsistent responses. ET8 (There are many competitors in this market); this was also dropped because the word 'competitors' does not deal with turbulence in the nature of this question in line with its definition. EFS2 (A standard version of the ERP software was implemented without changes being made to fit the particular requirements of our business); this item couldn't load as expected even after it was reverse coded, this may be caused by the word 'standard' which may not be the exact opposite of specific i.e. degree of agreement on standard may not be equated to degree of disagreement on specific. The poor interpretation of the word standard led to inconsistent responses thus leading to this item to be dropped. EFS6 (We invested a lot of time and effort designing the operating procedures for the ERP system); this item was dropped as it doesn't speak to specificity in the same way as the other items. This speaks to operating the ERP system not the specificity of the software. EFS8 (A high degree of company-specific knowledge was required in order to implement our ERP system); this item did not load because even if the system lacks specificity, implementation of even a general system may still require knowledge of company. The other items seem to speak more directly to the specificity of the ERP software system. This question did not speak specifically to the ERP software but was more generic to company knowledge in its application. BPK5 (The internal ERP support staff has the ability to interpret business problems); this item was dropped because the word 'interpret' does not adequately address the amount of business process knowledge of the ERP support staff in line with the definition. This caused ambiguity in the interpretation of the question which led to inconsistent responses. BPK6 (The internal ERP support staff has the ability to develop appropriate technical solutions to business problems); this was dropped because this question reflected interpretations of technical ability rather than business knowledge.

After these initial PCA runs, a stable solution emerged. This is illustrated in Table 10 which provides the factor matrix with loadings of each of the seven factors on business process knowledge, ERP module knowledge, ERP specificity, implementation success, environmental turbulence, structural complexity and operational benefits of ERP systems. All item loadings are acceptably high, above 0.60 or close enough to be considered acceptable.

Table 10: Rotated Component Matrix

	Component						
	1	2	3	4	5	6	7
BPK1					.712		
BPK2					.689		
BPK3					.689		
BPK4					.685		
EMK1	.571						
EMK2	.726						
EMK3	.696						
EMK4	.738						
EMK5	.767						
EMK6	.838						
EMK7	.681						
OB1				.572			
OB2				.747			
OB3				.609			
OB4				.602			
OB5				.745			
IS1							.864
IS2							.842
ET2			.658				
ET3			.770				
ET4			.746				
ET5			.721				
ET6			.688				
ET7			.552				
SC1						.517	
SC2						.607	
SC3						.762	
SC4						.676	
EFS1		.480					
EFS3		.784					
EFS4		.813					
EFS5		.663					
EFS7		.711					
EFS9		.696					

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

5.4.2 Internal Consistency Reliability

To test for reliability of the constructs, Cronbach's alpha reliability coefficient was used. The reliability coefficients for the multi-item scales ranged from 0.62 to 0.87. The Cronbach's alphas co-efficient are represented in Table 11 below. Most alpha's are above 0.7 and all were above 0.6, which is considered acceptable cut-off in more exploratory studies.

Table 11: Reliability tests of all constructs

Construct	Initial Items	Final Items	Cronbach Alpha	Mean	Standard Deviation	AVE	Skewness	Kurtosis
Business Process Knowledge	6	4	0.692	5.587	0.782	0.527	-1.892	5.605
ERP Module Knowledge	7	7	0.871	5.660	0.725	0.567	-0.651	0.896
Operational Benefits of ERP	5	5	0.793	5.366	0.790	0.554	-1.322	3.907
ERP Implementation Success	2	2	0.812	5.169	1.249	0.84	-0.945	0.795
Environmental Turbulence	6	4	0.814	5.360	0.819	0.521	-1.140	1.471
Structural Complexity	4	4	0.625	5.675	0.759	0.477	-0.888	2.679
ERP Specificity	9	6	0.815	5.221	0.879	0.522	-1.384	1.871

In examining the reliability of the variables an acceptable value of above 0.6 was used. The 7 items dropped after the PCA which are ET1, ET8, BPK5, BPK6, EFS2, EFS6 and EFS8 were not included in the calculation of the Cronbach's alpha. Good reliability was revealed with all Cronbach's alpha values above an acceptable level of above 0.60 for all variables. Kurtosis refers to the flatness of the distribution; the variables reveal an acceptable distribution as the rule of thumb for kurtosis is between ±3 with an exception of business process knowledge at 5.06, which was also slightly negatively skewed suggesting respondents mostly considered their ERP support staff to have high process knowledge. The remaining variables exhibited acceptable levels of skewness lying close to the generally accepted range of between ± 1.

Satisfied as to the reliability and validity of the measures, composite scores for each of the study's constructs was calculated as the arithmetic average of the scale items (only items retained after PCA and reliability testing were used). Multiple scale items cannot be used in correlation analysis, they have to be reduced to single composite scores. Composite scores were computed for the multi-scale items which are ERP module knowledge, business process knowledge, ERP specificity, structural complexity, implementation success, environmental turbulence and operational benefits of ERP system.

5.4.3 Correlation Analysis

In order to measure the strength and direction (positive or negative) of a relationship between two variables a correlation analysis is used.

Table 12 below shows the correlation matrix of all the independent, control and dependent variables in this study. The six independent variables namely ERP module knowledge, business process knowledge, ERP specificity, environmental turbulence and structural complexity are included in the correlation matrix. The control variables of ERP implementation success and ERP operating period are also included in the correlation matrix. The dependent variable operational benefits from ERP systems are also included in the correlation matrix.

The control variables ERP package and ERP scope are not included in correlation matrix, their significance is analysed using a one-way ANOVA in the next section.

Table 12: Correlation Matrix.

	Operational Benefits	ERP Module Knowledge	Business Process Knowledge	ERP Specificity	Implementation Success	Environmental Turbulence	Structural Complexity	ERP Operating Period
Operational Benefits	1							
ERP Module Knowledge	.488***	1						
Business Process Knowledge	.093	.242**	1					
ERP Specificity	.174*	.085	-.201*	1				
Implementation Success	-.144	-.228**	-.278**	.221*	1			
Environmental Turbulence	.276**	.224*	-.113	.288**	.158	1		
Structural Complexity	-.091	.086	.135	.066	-.042	.199*	1	
ERP Operating Period	.110	.271**	.047	-.085	-.023	.103	.188*	1

***. Correlation is significant at the 0.001 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The correlation matrix reflects that ERP module knowledge correlates significantly ($r = 0.488$, $p<0001$) with ERP operational benefits. However, business process knowledge has no relationship ($r = 0.093$) with ERP operational benefits while both variables were drawn from the Resource and Knowledge-Based View of the Firm. A relationship between ERP specificity and operational benefits is visible even though the strength is not that strong ($r = 0.174$, $p<0.05$). A negative correlation is reflected between ERP implementation success and ERP module knowledge ($r =-0.228$, $p<0.01$) and between ERP implementation success and business process knowledge ($r =-0.278$, $p<0.01$). A

negative relationship even though non-significant (r = -0.144) exists between implementation success and ERP operational benefits.

The negative sign with ERP implementation success is expected as the items measuring the constructs were measuring whether implementation was delivered behind the scheduled delivery date and the project had budget over-runs. Thus, the data shows that when ERP module knowledge and process knowledge is higher there is less likely to be cost and schedule over-runs.

Environmental turbulence is the variable with the most positive correlations in this study; operational benefits (r = 0.276, p<0.01), ERP module knowledge (r = 0.224, p<0.05), ERP specificity (r = 0.288, p<0.01) and structural complexity (r = 0.199, p<0.05). The ERP operating period was found to be not significant for operational benefits (r = 0.110). The significance of the other control variables will be analysed using the one-way ANOVA approach in the next section.

The significant relationships found in the correlation analysis between the independent variables and ERP operational benefits requires a further analysis of their combined effects using a regression analysis. In later sections of the chapter, regression analyses is used to further explore the effect of the independent variables (ERP module knowledge, business process knowledge, ERP specificity, structural complexity and environmental turbulence) on the dependent variable (ERP operational benefits) as well as for considering the hypothesized moderating effects of structural complexity and environmental turbulence.

5.4.4 One- Way ANOVA

For the purpose of testing whether the control variable of ERP scope has an effect on the ERP operational benefits, a one-way ANOVA was conducted. First, using the data on the ERP modules implemented, each organisation was classified into one of four groups namely; any one or two unrelated modules (Level 1), manufacturing and finance (core) (Level 2), manufacturing, finance and project systems and/or human resources (core plus) (Level 3), and all modules (core plus plus) (Level 4) Table 13 below shows the results of the one-way ANOVA.

Table 13: ERP scope one-way ANOVA.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.109	3	.370	.587	.625
Within Groups	79.302	126	.629		
Total	80.411	129			

The results reflect that there is no statistically significant difference (F =0.587, p = 0.625) on the means of the dependent variable (ERP operational benefits) between organisations with different levels of ERP scope. Given that the control variable ERP scope has no significant effect on the dependent variable ERP operational benefits as indicated by the one-way ANOVA, ERP scope will dropped from further consideration.

For the purposes of testing the impact of ERP package (vendor) on the ERP operational benefits, a one-way ANOVA also conducted. The ERP packages or vendors were allocated numerical numbers to represent each ERP package namely; 1 = SAP, 2 = Oracle, 3 = Sage, 4 = Microsoft, 5 = Baan, 6 = JD Edward and 7 = Other. Table 14 below shows the results of the one-way ANOVA.

Table 14: ERP Package one-way ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4.279	6	.713	1.152	.336
Within Groups	76.132	123	.619		
Total	80.411	129			

The results reflect that there is no statistically significant difference (F =1.152, p = 0.336) between the means of the dependent variable (ERP operational benefits) and the independent control variable (ERP package). The control variable ERP package has no significant effect on the dependent variable ERP operational benefits as indicated by the one-way ANOVA, and ERP package is thus also dropped from further consideration.

5.4.5 Regression Analysis

5.4.5.1 ERP Module Knowledge, Business Process Knowledge and ERP Specificity

A regression analysis was conducted to examine the effects of the independent variables namely, business process knowledge, ERP module knowledge and ERP specificity on the dependent variable ERP operational benefits. Table 15 below shows the regression analysis model summary below.

Table 15: ERP module, business process knowledge and ERP specificity model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.506[a]	.256	.238	.68921

a. Predictors: (Constant), ERP Specificity, ERP Module Knowledge, Business Process Knowledge

Table 16 above shows that the three predictors (ERP Specificity, ERP Module Knowledge, Business Process Knowledge) are important in predicting the dependent variable ERP operational benefits (R = 0.256) thus explaining 26% of the variance.

Table 16: ERP module, business process knowledge and ERP specificity ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	20.559	3	6.853	14.427	.000[b]
	Residual	59.852	126	.475		
	Total	80.411	129			

a. Dependent Variable: Operational Benefits

b. Predictors: (Constant), ERP Specificity, ERP Module Knowledge, Business Process Knowledge

The ANOVA Table 16 above shows the significance of R Squared on the independent variable (ERP Specificity, ERP Module Knowledge, Business Process Knowledge) on the dependent variable (Operational Benefits) (F = 14.23 and p = 0.000). The R squared is significant at p<0.001.

Table 17: ERP module, business process knowledge and ERP specificity Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.024	.718		2.820	.006
	ERP Module Knowledge	.480	.081	.475	5.938	.000
	Business Process Knowledge	.005	.089	.005	.059	.953
	ERP Specificity	.121	.071	.135	1.703	.091

a. Dependent Variable: Operational Benefits

The independent variable that has the largest significant effect on operational benefits is ERP module knowledge. Its standardized beta coefficient of .475 is significant at the p<0.001 level. Business process knowledge and ERP specificity have non-significant effects on operational benefits (b = 0.005, p =0.953 and b = 0.125, p = 0.091) respectively.

These results thus confirm H2 and reject H1.

5.4.5.2 Business Process Knowledge and ERP Specificity

A regression analysis was conducted to examine the effects of the independent variable ERP specificity on the dependent variable business process knowledge. Table 18 below shows the regression analysis model summary below.

Table 18: Business process knowledge and ERP specificity model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.201[a]	.040	.033	.71340

a. Predictors: (Constant), ERP Specificity

Table 18 above shows that the ERP Specificity is not a significant predictor of the dependent variable business process knowledge. The R = 0.040 which explains 4% of the variance is not significant.

Table 19: Business process knowledge and ERP specificity ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.732	1	2.732	5.368	.022[b]
	Residual	65.144	128	.509		
	Total	67.875	129			

a. Dependent Variable: Business Process Knowledge

b. Predictors: (Constant), ERP Specificity

The ANOVA Table 19 above shows the significance of R Squared on the independent variable (ERP Specificity) on the dependent variable (Business Process Knowledge) (F = 5.368 and p = 0.022). The R squared is not significant.

Table 20: Business process knowledge and ERP specificity Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	6.524	.378		17.240	.000
	ERP Specificity	-.166	.071	-.201	-2.317	.022

a. Dependent Variable: Business Process Knowledge

The independent variable (ERP specificity) has no significant effect on the dependent variable (business process knowledge). The p (0.022) is < 0.05 and therefore significant. The results imply that more ERP specificity is associated with lower levels of business process knowledge. This is not in the expected direction of the relationship in line with this study's hypothesis.

Thus, H3 is rejected

5.4.5.3 ERP Module Knowledge and ERP Specificity

A regression analysis was conducted to examine the effects of the independent variable ERP specificity on the dependent variable ERP module knowledge. Table 21 below shows the regression analysis model summary below.

Table 21: ERP module knowledge and ERP specificity model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.085[a]	.007	-.001	.78211

a. Predictors: (Constant), ERP Specificity

The table above shows that the ERP Specificity is not a significant predictor of the dependent variable ERP module knowledge. The R = 0.007 which explains less than 1% of the variance is not significant.

Table 22: ERP module knowledge and ERP specificity ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.570	1	.570	.932	.336[b]
	Residual	78.297	128	.612		
	Total	78.867	129			

a. Dependent Variable: ERP Module Knowledge

b. Predictors: (Constant), ERP Specificity

The ANOVA Table 22 above shows the significance of R Squared on the independent variable (ERP Specificity) on the dependent variable (ERP Module Knowledge) (F = 0.932 and p = 0.336).

The R squared is not significant

Table 23: ERP module knowledge and ERP specificity Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	5.192	.415		12.513	.000
	ERP Specificity	.076	.078	.085	.966	.336

a. Dependent Variable: ERP Module Knowledge

The independent variable (ERP specificity) has no significant effect on the dependent variable (ERP module knowledge). Its standardized beta coefficient of .085 is not significant.

Thus, H3 is rejected

5.4.5.4 Moderated Hierarchical Regression

To test the moderating effects of structural complexity and environmental turbulence on the relationships between ERP module and process knowledge and operational benefits, the product indicator (interaction) approach was used. This approach has been found in literature to provide a more accurate estimation of interaction effects between an independent variable and a moderator variable by accounting for the measurement error that attenuates the estimated relationships (Chin *et al.*, 2003). An important step in undertaking the product indicator approach is to first standardize all variables, this allows for easier interpretation of the effect sizes and to avoid multicollinearity. Standardized (z scores) were computed in SPSS for all involved variables namely business process knowledge, ERP module knowledge, environmental turbulence, structural complexity and ERP operational benefits. The interaction terms are then calculated by multiplying the standardized independent variable with the standardized moderator variable.

Hierarchical regression analysis was then used to analyse the effect of the independent variable (business process knowledge) and interacting term (structural complexity) on the dependent ERP operational benefits variable. The first block (model 1) of the hierarchal regression entered the independent variables business process knowledge and structural complexity and the second block entered the computed variable representing the interaction between business process knowledge and structural complexity (bpksc). Table 24 below shows hierarchical regression analysis of the interaction effect of structural complexity on business process knowledge and ERP operational benefits.

Table 24: Business Process Knowledge and Structural Complexity model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.140[a]	,020	,004	,78791	,020	1,264	2	127	,286
2	.223[b]	,050	,027	,77878	,030	3,996	1	126	,048

a. Predictors: (Constant), Business Process Knowledge, Structural Complexity

b. Predictors: (Constant), Business Process Knowledge, Structural Complexity, bpkxsc

The results above show that, model 2 with the addition of the interaction term (structural complexity x business process knowledge) accounted for a significant increase in R-squared (Δ in R^2 = 0.03, p = 0.048) over model 1. Figure 11 shows a graphical representation of the moderating effect of structural complexity on the relationship between business process knowledge and operational benefits.

Table 25: Business Process Knowledge and Structural Complexity coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	5.329	.707		7.538	.000
	Business Process Knowledge	.116	.097	.107	1.207	.230
	Structural Complexity	-.110	.092	-.105	-1.189	.237
2	(Constant)	5.543	.707		7.841	.000
	Business Process Knowledge	.121	.095	.111	1.270	.207
	Structural Complexity	-.155	.094	-.149	-1.647	.102
	bpkxsc	.113	.056	.179	1.999	.048

a. Dependent Variable: Operational Benefits

The interaction term has a significant effect on the dependent variable (Operational Benefits). Its standardized beta coefficient of .179 is significant at $p < 0.05$.
The graph shows that when structural complexity is high, higher levels of business process knowledge are required to achieve comparable levels of performance to organisations with lower levels of structural complexity. Under-performance results when organisations with high structural complexity have low levels of business process knowledge within their ERP teams.

Thus, H4a is supported

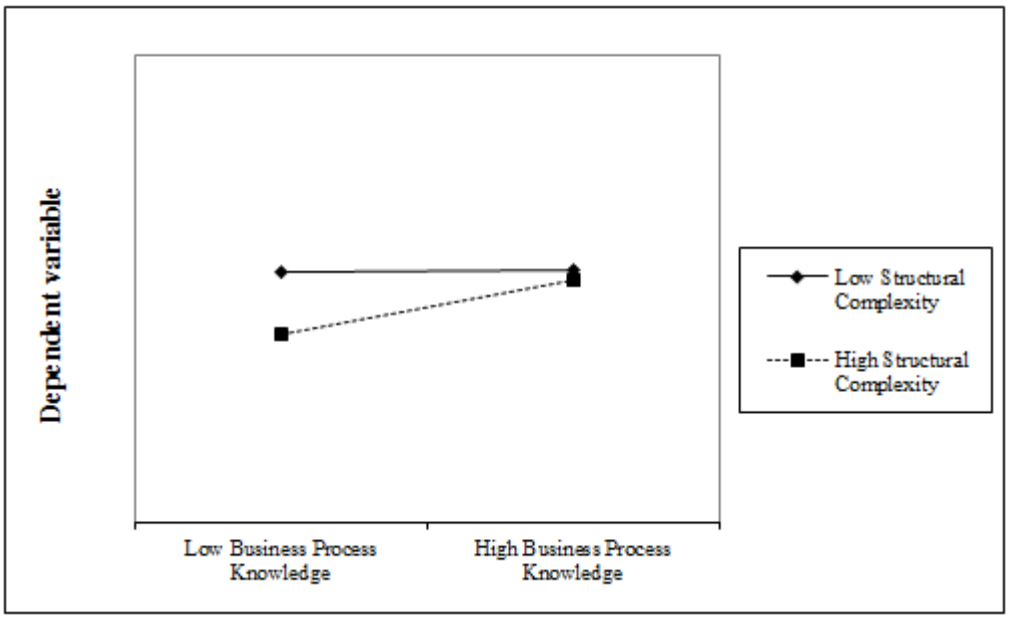


Figure 11: Business Process Knowledge and Structural Complexity

The moderating effect of structural complexity on the relationship between ERP module knowledge and ERP operational benefits was similarly analysed. The first block (model 1) of the hierarchal regression entered the independent variables ERP module knowledge and structural complexity, and the second block entered the computed variable representing the interaction between ERP module knowledge and structural complexity (mksc). Table 26 below shows hierarchical regression analysis of the interaction effect of structural complexity on ERP module knowledge and ERP operational benefits.

Table 26: ERP Module Knowledge and Structural Complexity model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.506[a]	,256	,244	,68648	,256	21,815	2	127	,000
2	.552[b]	,305	,289	,66595	,049	8,951	1	126	,003

a. Predictors: (Constant), ERP Module Knowledge, Structural Complexity

b. Predictors: (Constant), ERP Module Knowledge, Structural Complexity, mkxsc

The results above show that, model 2 with the addition of the interaction term (structural complexity x ERP module knowledge) accounted for a significant increase in R-squared (Δ in R^2 = 0.049, $p < 0.001$) over model 1. Figure 12 shows a graphical representation of the moderating effect of structural complexity on the relationship between ERP module knowledge and operational benefits.

Table 27: ERP Module Knowledge and Structural Complexity coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.341	.603		5.543	.000
	Structural Complexity	-.139	.080	-.134	-1.745	.083
	ERP Module Knowledge	.504	.078	.499	6.498	.000
2	(Constant)	3.760	.601		6.254	.000
	Structural Complexity	-.193	.080	-.186	-2.428	.017
	ERP Module Knowledge	.486	.076	.481	6.433	.000
	mkxsc	-.132	.044	-.229	-2.992	.003

a. Dependent Variable: Operational Benefits

The interaction term (structural complexity x ERP module knowledge) has a significant effect on the dependent variable of operational benefits (b=-.229, p<0.01) in addition to the significant direct effect of ERP module knowledge (b=0.481, p < .001).

The interaction effect is depicted in the following graph. The results show that organisations with higher ERP module knowledge always perform higher than organisations with lower ERP module knowledge. However, it is much more difficult for organisations with higher structural complexity to achieve comparable levels of operational benefits even when ERP module knowledge is high.

Thus, H4b is rejected.

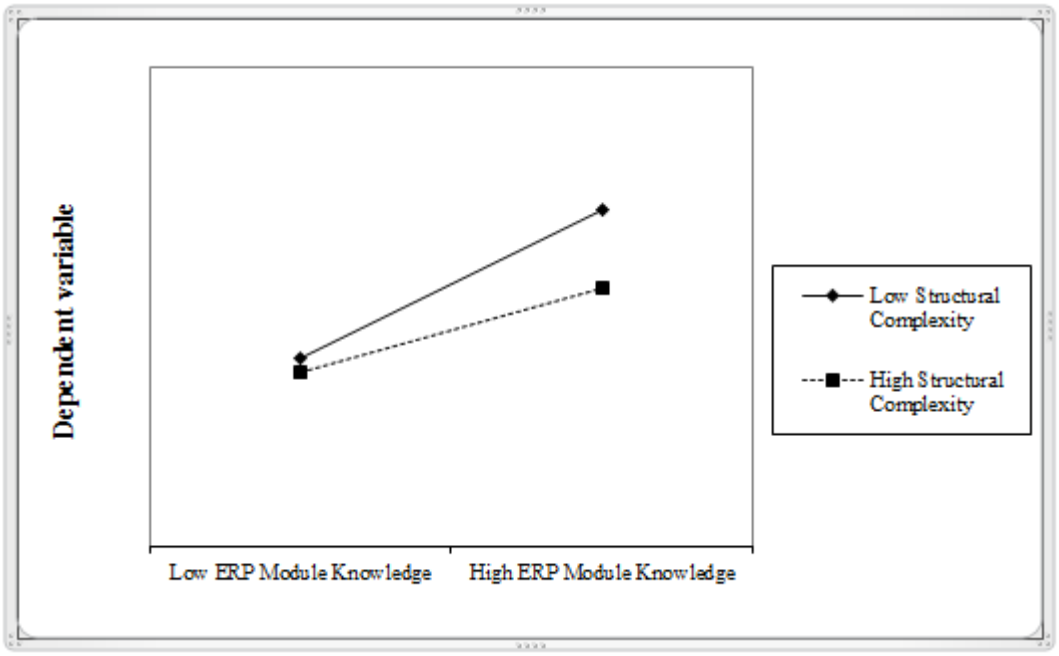


Figure 12: ERP module knowledge and Structural complexity relationship

The interacting effect of environmental turbulence on the relationship between business process knowledge and ERP operational benefits was similarly analysed using hierarchical regression. The first block (model 1) of the hierarchal regression entered the independent variables business process knowledge and environmental turbulence and the second block the computed variable representing the interaction between business process knowledge and environmental turbulence (bpkxet). Table 28 below shows hierarchical regression analysis of the interaction effect of environmental turbulence on business process knowledge and ERP operational benefits.

Table 28: Business Process Knowledge and Environmental Turbulence model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.303[a]	.092	.078	.75825	.092	6.430	2	127	.002
2	.320[b]	.103	.081	.75677	.011	1.495	1	126	.224

a. Predictors: (Constant), Environmental Turbulence, Business Process Knowledge

b. Predictors: (Constant), Environmental Turbulence, Business Process Knowledge, bpkxet

The results above show that, model 2 with the addition of the interaction term (environmental turbulence x business process knowledge) accounted for a non-significant increase in R-squared (Δ in R^2 = 0.01, p = 0.224) over model 1. Figure 13 shows a graphical representation of the moderating effect of environmental turbulence on the relationship between business process knowledge and operational benefits.

Table 29: Business Process Knowledge and Environmental Turbulence coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.091	.724		4.266	.000
	Business Process Knowledge	.137	.093	.126	1.477	.142
	Environmental Turbulence	.280	.082	.291	3.414	.001
2	(Constant)	3.293	.742		4.439	.000
	Business Process Knowledge	.125	.093	.114	1.339	.183
	Environmental Turbulence	.257	.084	.266	3.054	.003
	bpkxet	.071	.058	.106	1.223	.224

a. Dependent Variable: Operational Benefits

The independent variable (business process knowledge x environmental turbulence) has a non-significant effect on the dependent variable (operational benefits). Environmental turbulence, however, does have an independent effect on operational benefits. Its standardized beta coefficient of .266 is significant at $p < 0.05$. Firms are more likely to report higher levels of operational benefits resulting from their ERP system if they operate in more turbulent environments.

Thus H5a is not supported, because the interaction term (environmental turbulence x business process knowledge) does not have a significant effect on operational benefits ($b = 0.106$, $p = 0.226$). Figure 13 graphically illustrates the non-significant moderating effect. Although the effect is not significant, firms with higher levels of business process knowledge outperform firms with lower levels of business process knowledge under conditions of high environmental turbulence.

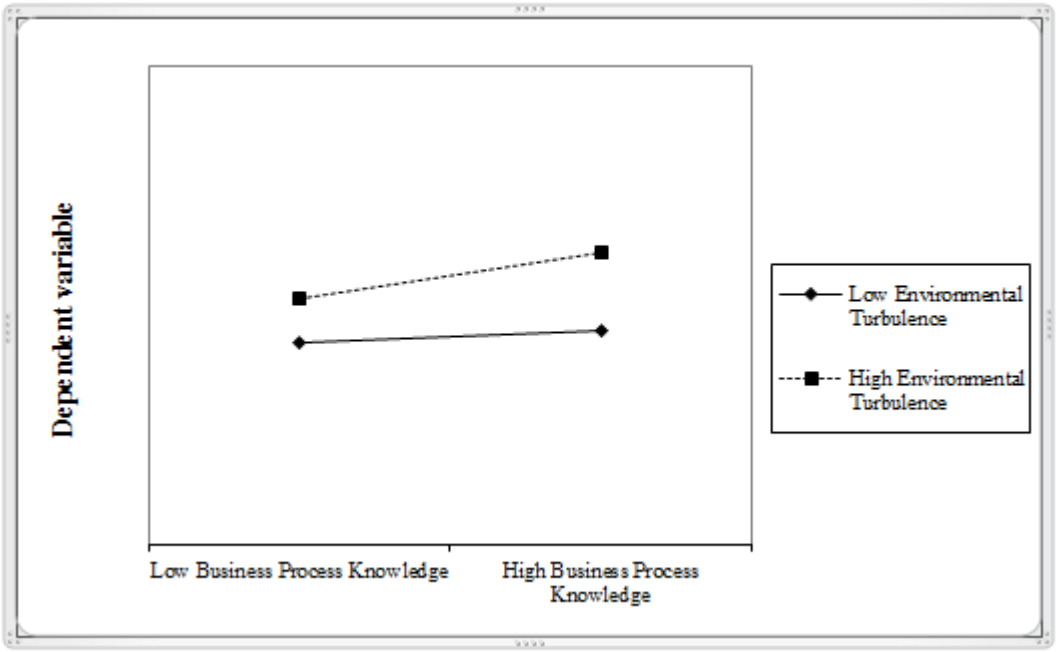


Figure 13: Business Process Knowledge and Environmental Turbulence relationship

The interacting effect of environmental turbulence on the relationship between ERP module knowledge and ERP operational benefits was similarly analysed using hierarchical regression. The first block (model 1) of the hierarchal regression entered the independent variables ERP module knowledge and environmental turbulence, while the second block entered the computed variable representing the interaction between ERP module knowledge and environmental turbulence (mkxet). Table below shows hierarchical regression analysis of the interaction effect of environmental on turbulence ERP module knowledge and ERP operational benefits.

Table 30: ERP module knowledge and Environmental Turbulence Model Summary and Coeffients

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.517[a]	,267	,256	,68117	,267	23,152	2	127	,000
2	.528[b]	,279	,262	,67830	,012	2,076	1	126	,152

a. Predictors: (Constant), Environmental Turbulence, ERP Module Knowledge

The results above show that, model 2 with the addition of the interaction term (environmental turbulence x ERP module knowledge) accounted for a non-significant increase in R-squared (Δ in $R^2 = 0.006$, $p = 0.152$) over model 1. Figure 14 below shows a graphical representation of the moderating effect of environmental turbulence on the relationship between ERP module knowledge and operational benefits

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.929	.529		3.648	.000
	ERP Module Knowledge	.453	.079	.448	5.751	.000
	Environmental Turbulence	.169	.075	.176	2.254	.026
2	(Constant)	2.349	.602		3.904	.000
	ERP Module Knowledge	.402	.086	.398	4.673	.000
	Environmental Turbulence	.147	.076	.152	1.920	.057
	mkxet	-.063	.044	-.125	-1.441	.152

a. Dependent Variable: Operational Benefits

The interaction term (environmental turbulence x ERP module knowledge) has a non-significant effect (b = -0.125, p = 0.152) on the dependent variable (Operational Benefits) while ERP module knowledge has a direct effect (b=0.398, p = .000).
The graph below illustrates the interaction effect.

The graph shows that higher ERP module knowledge always results in higher operational benefits, and that organisations operating under both high and lower levels of environmental turbulence require ERP module knowledge.

Thus, H5b is rejected.

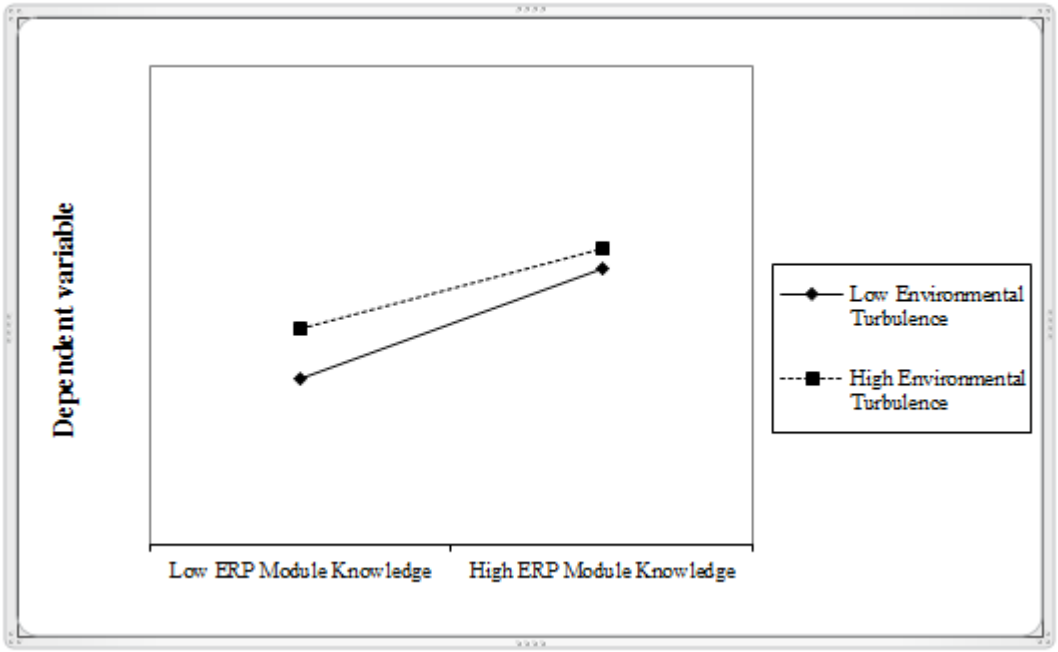


Figure 14: ERP Module Knowledge and Environmental Turbulence

5.5 Conclusion

In this chapter the empirical findings of this study were presented. Through this chapter the approaches for data cleaning, missing values and outliers was detailed and discussed. Items that were reverse coded were revealed and approached explained. The profile of the respondents was discussed

in detail; the demographic data was discussed and represented in graphical formats. The tests for tests for reliability and validity followed. Correlations and regression analyses were carried out to test the study's hypotheses. A summary of the results of hypothesis testing is represented in Table 5.2 below. The results confirm that ERP module knowledge is a significant factor in the building of an internal ERP capability which is critical for realizing ERP operational benefits. The results found that business process knowledge did not have a direct effect on operational benefits but was moderated by both structural complexity such that higher levels of business process knowledge are required when structural complexity is high. The results are summarized on Table 31 below.

Table 31: Hypothesis results

Hypothesis	Description	Results
Hypothesis 1	*The greater the organisation's internal business process knowledge, the greater will be the operational benefits from the ERP system.*	*Direct effect not supported. The relationship is moderated.*
Hypothesis 2	*The greater the organisation's internal ERP module knowledge, the greater will be the operational benefits from the ERP system.*	*Supported*
Hypothesis 3	*The greater the firm specificity of the ERP system, the greater will be the firm's internal ERP knowledge capability.*	*Rejected*
Hypothesis *4a:*	*The greater the structural complexity of the firm, the stronger the relationship will be between business process knowledge and the operational benefits of an ERP system.*	*Supported*
Hypothesis *4b*	*The greater the structural complexity of the firm, the stronger the relationship will be between ERP module knowledge and the operational benefits of an ERP system*	*Not Supported*
Hypothesis *5a*	*The greater the environmental turbulence, the stronger the relationship will be between business process knowledge and the operational benefits of an ERP system*	*Not Supported, but results in the expected direction.*
Hypothesis *5b*	*The greater the environmental turbulence, the stronger the relationship will be between ERP module knowledge and the operational benefits of an ERP system*	*Not Supported*

6 DISCUSSION OF RESULTS

6.1 Introduction

The aim of this research study was to investigate the role of an internal ERP knowledge capability (i.e. business process knowledge & ERP module knowledge available within the organisation) in sustaining the Operational Benefits of an ERP system. The research study also aimed to investigate the conditions under which it is necessary for organisations to develop an internal ERP knowledge capability. Lastly, the study intended to investigate the role of contingency factors (structural complexity and environmental turbulence) in moderating the relationship between an internal ERP capability and the operational benefits obtained from ERP systems. Hypothesized relationships were drawn from three theoretical perspectives namely; resource and knowledge-based view of firm, Contingency Theory and the Transaction Cost Theory. Data from 130 South African organisations was used to test the hypotheses. Empirical results were presented in the previous chapter.

A discussion of the empirical results is presented in this chapter. The results are interpreted and related back to literature and theory. The empirical results are used to explain whether the resource and knowledge- based view of the firm is supported as an explanation for why internal ERP capabilities should be important to performance outcomes, whether Contingency Theory is useful for suggesting the factors that might moderate the relationship between an internal ERP capability and the operational benefits of ERP systems, and whether Transaction Cost Theory helps explain why firms choose to build internal ERP capabilities rather than source capabilities from the market.

6.2 Discussion on the role of the Resource and Knowledge-Based View of the Firm

The Resource and Knowledge-Based View of the Firm argues that a firm's performance depends on the internal resources and capabilities possessed by an organisation, including the firm's knowledge base (Cabrera-Suárez *et al.*, 2001).

This study asked the question, to what extent is an internal ERP knowledge capability (i.e. business process knowledge & ERP module knowledge available within the firm) associated with increased operational benefits of an ERP system to the firm? The resource and knowledge based views of the firm were considered a useful perspective from which to consider this question. This is because organisations that effectively leverage their knowledge assets to build ERP capabilities have previously been found to be more successful with their ERP systems (Karimi *et al.*, 2007). Drawing on the Resource and Knowledge-Based View of the Firm, two knowledge capabilities were theorized in this study to be critical ERP capabilities. These were business process knowledge and ERP module knowledge. The effects of these two knowledge capabilities on the realization of Operational Benefits from an ERP system were tested.

6.3 Business Process Knowledge and ERP Operational Benefits

Business process knowledge is important for the accurate gathering of business requirements, integrating process and data across value-chain processes and enabling the means for system performance tracking (Karimi *et al*., 2007). Since an ERP system is meant to support business functions, it is imperative for IT personnel to have an understanding of business processes, to ensure they understand the needs of the business and advise on how the ERP system can assist. Because of the complex nature of ERP systems, concentrated interactions between ERP support team members and end users are required. These intensive interactions involve constant sharing, creation,

preservation, learning and extraction of knowledge among ERP team members and end users (Tsa *et al*., 2011).

If internal ERP support personnel understand business needs and processes then a more efficient knowledge exchange with ERP end users may result (Dibbern *et al*., 2001). This can facilitate better usage of the ERP system and better user support both of which are important to realization of system benefits (Karimi *et al*., 2007). Karimi *et al* (2007) concluded that business process knowledge resources are the most critical resources for building ERP capabilities. Organisations that invest in empowering their IT/ERP support personnel with business process knowledge should thus increase their chances of building an effective ERP knowledge capability.

Empirical results, however, found that business process knowledge has no direct effect on the operational benefits of ERP systems for all firms. Hypothesis H1 was thus rejected. Thus business process knowledge may only be important to realization of ERP operational benefits for some but not all firms. Specifically, results found that the effect was moderated by structural complexity such that process knowledge was important to operational benefits for firms with higher levels of structural complexity. This is discussed further in Section 6.3.

6.4 ERP Module Knowledge and ERP Operational Benefits

ERP module knowledge is defined as the ability to configure and maintain information systems in support of the business operations (Stratman and Roth, 2004). This knowledge includes deep understanding of the ERP module integration points, database tables, interface requirements with third parties, updates, data requirements and other critical ERP functions. ERP module knowledge was theorized to be an important knowledge resource in the building of ERP capabilities which are critical in order to sustain the post-implementation benefits of ERP systems (Stratman and Roth, 2004). This is because, after the completion of the ERP implementation process the following tasks are required to sustain the performance of an ERP system; implementation of updates and upgrades, support of end users, configuration of change requests, and integration with third party systems. Given the complexity of the ERP system the aforementioned tasks are done at an ERP module level. Ifinedo (2011) found that ERP module knowledge is a critical skill for internal IT support personnel in order to sustain the continued positive performance of the ERP system in the later years of its lifecycle. Tsai *et al* (2011) found that ERP module knowledge is a critical factor in the post-implementation maintenance of the ERP system. They also found that business performance greatly improved in firms where post-implementation maintenance of their ERP systems was successfully executed.

Empirical results of this study supported this hypothesis (H2). It was found that ERP module knowledge has a significant effect on the operational benefits obtained from ERP systems. This finding is consistent with Stratman and Roth (2004) who found that ERP module skills are not only required during the implementation process, they are also required during the post-implementation phase to configure and adapt system specific attributes on an ongoing basis. Thus, ERP module knowledge is supported as a necessary knowledge capability important for custom. Firms that do not develop this internal ERP knowledge capability are less likely to configure their ERP systems appropriately in response to changing operational and strategic goals of the organisation and operational benefits are likely to diminish.

6.5 The moderating effect of Structural Complexity

The research model theorized that impacts of an ERP capability on outcomes might be contingent on certain internal and/or external organisational factors i.e. that developing internal capabilities may not have the same significance for all organisations. Therefore, this study asked the question of, to what extent do structural complexity and envi ronmental turbulence increase the need for an internal ERP knowledge capability i.e. moderate the relationship between ERP knowledge capability and ERP operational benefits. Under the Contingency Theory perspective, an internal ERP knowledge capability may be more important for some organisations than for others.

Organisational structure may be a particularly important contingency variable influencing the relative impacts of the two internal ERP knowledge capabilities (business process knowledge and ERP module knowledge) on post-implementation operational benefits. Structural complexity is defined as the condition of being composed of many parts (Miller, 1987). Ifinedo (2007) found structural complexity to be a key consideration when organisations adopt ERP systems. This is because the more subunits the organisation has, the more ERP integration effort may be required to align the software to the needs of the business (Gattiker and Goodhue, 2005; Morton and Hu, 2008). Complex firms have different lines of business (Miller, 1987), which may lead to increases in post implementation tasks such as system changes, end-user training, module updates, customizations, and third-party integration. In order to exploit the potential of the ERP system to support the multiple business functions of a structurally complex organisation, it was hypothesized that there would be a greater need for knowledgeable IT/ERP personnel who understand the offering of the ERP system as well as the demands of the multiple business functions. Empirical results confirmed that structural complexity has a significant moderating effect on the relationship between business process knowledge and the operational benefits from ERP systems. Thus H4a was supported.
This means in organisations where structural complexity is high, higher levels of business process knowledge are required to achieve comparable levels of performance to organisations with lower levels of structural complexity. Under-performance results when organisations with high structural complexity have low levels of business process knowledge within their ERP teams. This study is consistent with theory which posits that that organisational performance (operational benefits) can be the consequence of the interaction between organisational characteristics (internal ERP knowledge capability) and contingency factors (organisational structural complexity) (Ifinedo, 2007).

However, the empirical results in this study found structural complexity to have no significant effect on the relationship between ERP module knowledge and operational benefits from ERP systems. Hypothesis H4b was thus rejected. The results show that organisations with higher ERP module knowledge always perform higher than organisations with lower ERP module knowledge. However, it was also found that it was much more difficult for organisations with higher structural complexity to achieve comparable levels of operational benefits to firms with lower levels of structural complexity, even when their ERP module knowledge is high (refer Figure 5.8). Achieving benefits from ERP systems is thus on average more difficult for structurally complex firms.

6.6 The moderating effect of Environmental Turbulence

Similar to structural complexity, environmental turbulence may be a particularly important contingency variable influencing the relative impacts of an internal knowledge capability on business performance. Environmental turbulence is described as developments in technology and consumer preferences changes that results in unpredictable and uncertain environments (Pavlou and El Sawy, 2006). These environments are as result of high levels of competition and pressure from the industry (Rajagopal, 2002). When met with such turbulence, firms may invariably turn to their information

systems department to help them use and adapt their IT systems to save resources and improve responsiveness (Rajagopal, 2002). Rajagopal (2002) found that performance levels of organisations have significantly improved through the recent turbulent environments because they invested heavily in IT technology that improved the automation of core organisational processes. Turbulent business environments should thus require more frequent changes of internal business practices (Stoel and Muhanna, 2009) which in turn require system changes. Consequently, it was hypothesized that without an internal ERP capability, firms are not likely to be able to respond appropriately to these required changes. The greater the degree of environmental change, the greater the need for internal ERP capabilities to adapt the ERP to ensure sustained operational benefits are derived from the system. However, for organisations operating in more stable environments with fewer systems implications, it was hypothesized that the development of a strong internal ERP capability may not result in greater operational benefits, and may unnecessarily consume organisational resources in developing a capacity that would not add much value.

Empirical results showed that environmental turbulence did not have a significant moderating effect on the relationship between ERP module knowledge and operational benefits from ERP systems. H5b was rejected. The results suggests that ERP module knowledge always results in higher operational benefits, and that organisations operating under both high and lower levels of environmental turbulence require ERP module knowledge. This means environmental turbulence does not moderate the relationship between ERP module knowledge and operational benefits from ERP systems according to the empirical evidence in this study. Environmental turbulence was also found to have a non -significant effect on the relationship between business process knowledge and operational benefits from ERP systems. Thus H5a was not supported. However, the results did show that the firms operating in more turbulent environments could achieve higher levels of operating benefits with higher levels of process knowledge.

The results also reveal that environmental turbulence also has a significant direct effect on the operational benefits of ERP systems. This has implications for what organisations in such environments should expect as returns from their investments in ERP systems. This positive effect implies that ERP systems in turbulent organisations will be responsive in these environments as opposed to stable organisations and therefore ERP systems may be especially beneficial to organisations operating in turbulent environments.

6.7 Firm Specificity of the ERP system and Internal ERP Knowledge Capabilities

In addition to examining the influence of ERP knowledge capabilities on post-implementation operational benefits, this study sought an answer to the question of the conditions under which firms develop an internal ERP knowledge capability. To address this, this study drew on Transaction Cost Theory, and more specifically its concept of asset specificity. Assets by nature can vary, they can be machinery required to manufacture a product, needed knowledge to execute a service or even a convenient location appropriate for dealing other parties (Aubert *et al.*, 2003).

In the context of IS, Transaction Cost Theory (TCT) posits that asset specificity is the most important consideration when firms decide to outsource or insource (Wang, 2002). High asset specificity occurs when investments, services and products are customized to fit a specific transaction, making this asset not deployable to another transaction or task (Wang, 2002). During an ERP implementation, significant amount of specific irreversible business process and ERP module knowledge is made by firms (Wang, 2002). This form of knowledge is specific to the ERP implementing organisation and

thus increases the asset specificity of the ERP system. A highly customized ERP system thus has the characteristics of asset specificity i.e. they become an organisational asset that is unique to the organisation and thus not easily deployable to another organisation. Maintaining customized systems will require specific business process and ERP module knowledge because this specific knowledge is required when tailoring the ERP system to meet the organisational needs. As the specificity of the knowledge required in operating and maintaining the ERP system increases as result of a highly customized solution, it becomes too costly and complicated to obtain that knowledge from the market. As a result it was hypothesizes that the more specific the organisation's ERP system, the less likely the knowledge to support it can be procured more cheaply in the market, and the more likely it would be for an organisation to build that knowledge and retain that knowledge in-house.

However, empirical results did not find a significant correlation between the asset specificity of the firm's ERP system and the extent to which the firm had developed business process knowledge or ERP module knowledge. Given these empirical results, the need to develop internal ERP capabilities may not necessarily be driven by the high firm specificity of the ERP system. This is inconsistent with Aubert *et al* (2003) who found that as asset specificity of the ERP system increases, obtaining these assets from external sources becomes difficult as vendors may not be willing to invest in organisation specific transactions, therefore a greater need to build capabilities internally. The empirical result in this study found high asset specificity of the ERP system does not influence organisations to build ERP capabilities internally. Transaction Cost Theory through its concept of asset specificity has thus not provided an explanation for the observed differences in the internal ERP capabilities of firms in the South African context. However, because this study established that internal ERP capabilities are important to realization of benefits. The question as to under what conditions do firms develop an internal ERP knowledge capability deserves continued attention by future research. Correlation analyses showed that ERP specificity was slightly correlated with operational benefits i.e. more customized ERP systems were associated with better performance benefits. Future research may consider whether knowledge moderates the effects of ERP specificity on operational benefits i.e. only firms with higher levels of knowledge may be able to translate a more customized system into operational benefits.

6.8 Discussion on the effects of the Control Variables

Controls are required to assure internal validity (causality) of research designs (Bhattacherjee, 2012). This study identified four control variables derived from ERP literature namely ERP implementation success, ERP Scope, ERP Operating type and ERP vendor. ERP Implementation success is defined as the extent of variation between the pre-defined project goals such as expected completion time, project cost and expected performance of the system. Literature suggests the post-implementation benefits of ERP systems will be influenced by a successful ERP implementation exercise (Zhu, *et. al.*, 2010). However, implementation success was not found to have an effect on realization of post-implementation operational benefits. This suggests that implementation problems do not constrain an organisations ability to reap future benefits. This has useful implications for organisations considering abandoning implementation as a result of cost or schedule over-runs.

Correlation analysis showed that firms with higher levels of process knowledge and ERP module knowledge were less likely to experience implementation problems. Thus knowledge is important to both implementation success and later realization of operational benefits. Firms with higher levels of ERP specificity were less likely to experience implementation success i.e. more likely to report cost and schedule overruns. This finding is consistent with the view that 'vanilla' implementations of ERP

are more likely to be successful and that higher levels of customization result in greater implementation problems.

ERP operating period is defined as the time in months that had elapsed since the first transaction run of the ERP system in the organisation (Kang *et al.*, 2008). Literature suggests that a number of organisations have not been able to achieve the expected benefits of ERP systems after the first 12 months; however, most organisations do get the anticipated benefits after a considerable time-lag (Gattiker and Goodhue, 2005). Results did not suggest this factor influenced the degree of operational benefits reported by responding firms.

ERP scope is the number of ERP modules implemented (Kang, *et al*., 2008). The ERP scope influences the anticipated value of an organisation due to the business and technical integration potential of a larger scope investment (Ranganathan and Brown, 2006). The scope of the ERP system was, however, not found to have a confounding effect on the realization of operational benefits by organisations.

The important role of ERP vendors in providing technical support, enhancements, and upgrades with improved business and technical functionality has been found to influence the vendor choice made by ERP adopting organisations and thus some vendors have been found to offer better market valuations to adopting organisations (SAP and Oracle) (Ranganathan and Brown, 2006). Results however did not confirm a link between the ERP vendor and the realization of post-implementation benefits.

6.9 Conclusion

This chapter discussed the study's empirical results with reference to literature and theory. It focused on the finding that ERP module knowledge is an important internal ERP capability for sustaining the post-implementation benefits of ERP systems. It was discussed how business process knowledge is found more important to realization of post-implementation benefits for firms with higher levels of structural complexity and also results in some added benefit for organisations in turbulent environments . ERP firm specificity was found to have no influence in the building of ERP capabilities, and the question as to why some firms develop stronger internal ERP capabilities remains a question for future research.

The next chapter concludes the study by discussing the limitations, implications for theory and practice, and recommendations for future studies.

7 CONCLUSION

7.1 Introduction

This chapter first presents a summary of the study's aims, methods and findings. It then concludes the study by discussing the limitations, implications for theory, practice and vendors, and recommendations for future studies.

7.2 Summary of the Study

This study recognized as a research problem that the size and complexity of ERP systems makes its implementation a specialized discipline with a number of reported failures. Valuable insights have emerged from studies into factors critical for a successful ERP implementation, however it has been noted that the successful implementation of an ERP system does not necessarily translate to sustained business performance. Past research has explored some of the ERP factors which are necessary for sustained business performance. These empirical studies point to the importance of ERP knowledge as well as the role of other organizational, contextual and contingency factors. A gap in the literature was identified in relation to the multi-dimensional nature of the knowledge areas that are well suited to explain the post-implementation effects of ERP systems. Another gap that was identified was the extent to which other organizational and contextual factors influence the relationship between an ERP knowledge capability and the sustained operational benefits from the ERP system.

This study thus investigated the role of an internal ERP knowledge capability (i.e. business process knowledge & ERP module knowledge available within the organisation) in sustaining the Operational Benefits of an ERP system. The research study also investigated the conditions under which it is necessary for organisations to develop an internal ERP knowledge capability. Lastly, the study investigated the role of contingency factors (structural complexity and environmental turbulence) in moderating the relationship between an internal ERP capability and the operational benefits obtained from ERP systems.

To achieve this aim, the research had the following objectives:
First, to conduct a literature review to understand the current state of the field while identifying shortcomings of past work, then to develop a research model hypothesizing the relationships derived from the Resource and Knowledge-Based View of the Firm, the Contingency Theory and the Transaction Cost Theory. In addition, to the variables drawn from the Resource and Knowledge-Based View of the Firm, the Contingency Theory and the Transaction Cost Theory, the research model considered the possible need for controls such as ERP scope, ERP package, ERP implementation success and ERP operating period.

The research model was tested using a survey methodology. This required that the hypothesized independent and dependent variables were operationalized from the literature and the questionnaire instrument was developed. The self-administered online questionnaire was administered to 900 key informants representing organisations that have implemented ERP systems in South Africa of which 198 returned responses. Following initial screening, 130 usable responses were retained for analysis. For the purposes of this study internal consistency reliability was measured using Cronbach's alpha; principal component analysis (PCA) was used to assess convergent validity and discriminant validity. The stated hypotheses were tested with correlation and regression techniques.

Through the descriptive analysis of ERP systems adoption it was discovered that ERP systems in the form of SAP, Oracle, and other packages have been implemented across industries and organisations

of varying sizes in South Africa. Hence, from this study it is observed that the ERP systems have been widely implemented among large organisations in South Africa however there is still a huge portion of large organisations that haven't implemented ERP systems.

Results supported the relationship between ERP module knowledge and ERP operational benefits. This study concludes that ERP module knowledge is an important internal ERP capability for sustaining the post-implementation benefits of ERP systems. The empirical results also supported the moderating effect of structural complexity on the relationship between business process knowledge and ERP operational benefits. Business process knowledge is found to be more important to realization of post-implementation benefits for firms with higher levels of structural complexity, and somewhat important for organisations operating under environmental turbulence. ERP firm specificity was found to have no influence in the building of internal ERP knowledge capabilities.
These findings have useful implications for practice, ERP vendors as well as implications for future research, which are discussed further below together with limitations of the work.

A revised model arising from the empirical findings is presented below:

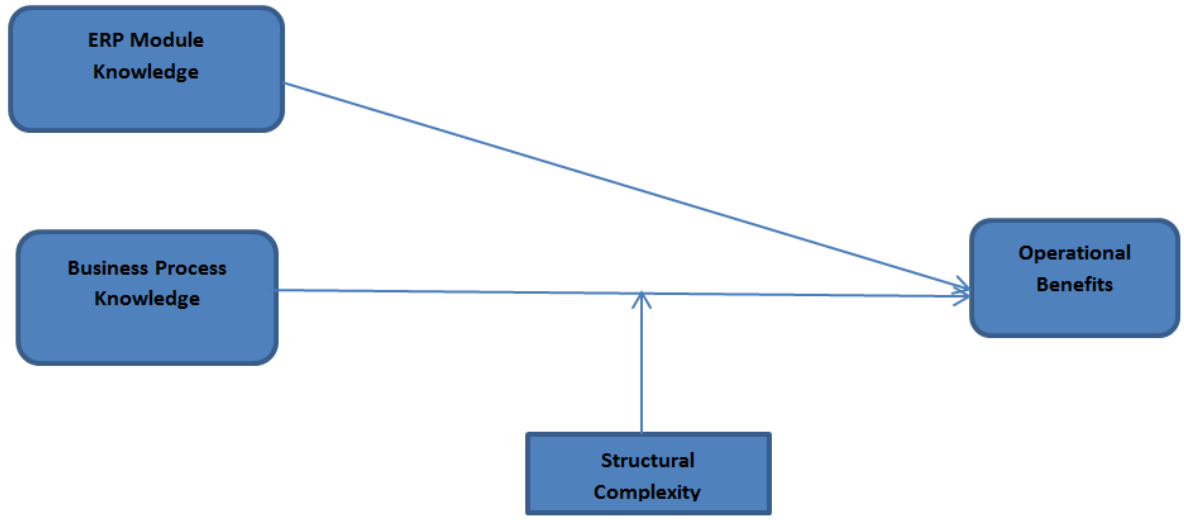


Figure 15: A revised model based on empirical findings

7.3 Limitations and Future Research Direction

In considering the implications of this study, it is important to consider some of the study's limitations.

Firstly, this research study was conducted in South Africa and was further focused on large organisations, with the consequence that the findings may not be fully generalisable to other organisations in other geographies, and may not be generalisable to small and medium organisations.

Secondly, even though large organisations in South Africa were targeted, a sizable target sample, there were a limited number of usable responses (130). The sample size was a function of the response rate therefore there is a possible non-response bias. This could be because organisations that did not respond could be significantly different from those that responded. Since it not possible to know the characteristics of non-respondent organisations there might be a problem with external validity of the findings, therefore the findings in relation to the relationships may not be generalizable to the organisations that did not participate in the study due to a possible non-response bias.

Thirdly, data collected was cross-sectional and therefore claims of causality cannot readily be made. Future research may wish to consider longitudinal case-study designs to better understand the role of an internal ERP knowledge capability (business process knowledge and ERP module knowledge) in sustaining the Operational Benefits of an ERP system.

Fourthly, future research should work on improving the measurement scales for the variables such as ERP specificity so as to further advance the application of Transaction Cost Theory in future ERP studies.

Another limitation of this study is the reliance on a single key informant from each organisation. This may have caused a common method bias. Future work may wish to collect data on ERP knowledge and performance benefits from multiple key informants.

This study did not consider the dynamic nature of knowledge i.e. that knowledge may change over time among South Africans organisations. Hence future research might consider examining the dynamic nature of ERP module knowledge and business process knowledge through longitudinal case-study designs. Longitudinal case study designs may also help to better understand how the changing nature of business process knowledge and ERP module knowledge available within the organisation impacts and sustains the Operational Benefits of an ERP system

Across the sample responses it was observed with regards to ERP package adoption, SAP (60%) is the most adopted vendor, followed by Oracle (20%) while Baan and Sage were the least adopted at 1.5% respectively. Future research could thus be towards understanding the factors that promote the adoption of each of these respective ERP packages among South African organisations. For example, to what extent are ERP adoption decisions rational, i.e. based on an assessment of the costs and benefits and organisational fit of alternative vendor solutions, versus based on mimetic and normative pressures or reputation of the vendor?

7.4 Implications of the Study for Research

Past literature discovered that there is a dearth of empirical research work undertaken to understand ERP post-implementation within the South African context, and more importantly no research that utilized all three theoretical perspectives namely Resource and Knowledge-Based View of the Firm, Contingency Theory and Transaction Cost Theory to explain ERP post-implementation benefits in the South African context. The contributions of each theoretical perspective are discussed below.

Results from the literature review conducted in this study found that minimum empirical academic research has been undertaken to understand the role of an internal knowledge capability on sustaining the post-implementations effects of ERP systems. There is still vast amount of knowledge to be learnt about the knowledge factors that affect Operational Benefits of ERP systems. ERP post-implementation is a relatively understudied area within IS therefore the need for IS scholars to respond to this new area of enquiry, more importantly to understand the role of knowledge artefacts in the building of ERP capabilities which are necessary to sustain operational benefits of ERP systems post-implementation.

Furthermore, this study found that business process knowledge and ERP module knowledge were critical knowledge areas in the quest to build internal ERP capabilities which in turn led to sustained operational benefits from ERP systems. This study was thus successful in applying principles of the resource and knowledge based view of the firm to our understanding of ERP outcomes. Having done so, more opportunities for future advances are opened up. For example, limited research has been undertaken to understand the complimentary role of business process knowledge and ERP module

knowledge on sustaining the post-implementation effects of ERP systems. The resource based view of the firm suggests that complementary organizational capabilities can act synergistically to influence the performance of organisations (Tanriverdi and Venkatraman, 2005). In their study, they found that cross business knowledge synergies improves the corporate performance of a business i.e. their joint value is greater than the sum of their standalone values (Value (a,b) > value (a) + value (b)). This study didn't look into the synergistic potential value of business process knowledge and ERP module knowledge, and therefore there is a room for future research to consider this question. From the resource-based of the firm perspective this study did however found that ERP module knowledge has a significant direct effect on the operational benefits obtained from ERP systems, this finding was consistent with past literature e.g. Stratman and Roth (2004). This study has therefore contributed by finding ERP module knowledge as highly important in the South African context to sustaining the benefits of ERP systems post-implementation. However the results in this study differed from studies carried in other contexts with regards to business process knowledge. Specifically, business process knowledge was not found to have an independent effect in sustaining the post-implementation benefits of ERP systems.

Past studies also identified the importance of technology and organisational factors in relation to the post-implementation benefits of ERP systems (e.g. Zhu *et al*., 2010). Past studies have questioned whether factors such as size, structure, culture, environmental turbulence and other IT assets and resources are important to ERP benefits (Ifinedo, 2007; Wang and Chang, 2006; Dezdar and Ainin, 2011). However these past studies did not consider these contingency factors in relation to ERP knowledge (business process knowledge and ERP module knowledge). By drawing on Contingency Theory to test whether structural complexity and environmental turbulence moderate the effects of ERP module knowledge and business process knowledge on performance benefits, this study was able to provide valuable insights. Specifically, results showed that structural complexity positively moderated the effect of business process knowledge on ERP operational benefits. As a result, it is now known that business process knowledge is more important for structurally complex firms. Business process knowledge was found to be somewhat more important for deriving operational benefits for firms operating under environmental turbulence. ERP module knowledge was found important for all firms regardless of structural complexity or environment. . This study has thus shown Contingency Theory a useful perspective and facilitated the discovery that the role of business process knowledge in sustaining the benefits of ERP systems post-implementation is not direct but instead moderated. Specifically, by adopting a Contingency Theory perspective, this study has contributed by finding that the effect of business process knowledge on operational benefits is moderated by structural complexity. The effect of environmental turbulence as moderating factor could not be explained by the contingency, however a direct effect of environmental turbulence was observed in this study which can be a focus for future research.

Transaction Cost Theory (TCT) has been widely used in Information Systems to explain why some firms in-source their IT functions whilst others outsource (Dibbern *et al*., 2000). Limited research has however applied Transaction Cost Theory in an effort to understand the role of the organisational specificity of the ERP system in influencing the decision to whether build ERP capabilities internally or to source the required knowledge from external markets. This study contributed by studying the conditions under which it's necessary for organisations to build ERP capabilities internally or to outsource to external markets. Results however did not confirm that asset specificity of the ERP system influences organisations to build internal ERP capabilities as posited by the TCT. Therefore, theories other than TCT may usefully be considered to explain why some firms build stronger internal ERP capabilities. TCT has thus not provided an explanation for the observed differences in the

internal ERP capabilities of firms. The question as to under what conditions do firms develop an internal ERP knowledge capability deserves continued attention by future research.

7.5 Implications of the Study for Practice

This study provides several implications for ERP system vendors and organisations that have implemented or contemplating implementing ERP systems.

An important implication arising from this study's results is that an internal ERP capability is critical in sustaining the post-implementation benefits of ERP systems. More importantly ERP module knowledge was found to be the most significant factor in the building of ERP capabilities which are necessary for an organisation to realize benefits from its implemented ERP system. This implication is important to organisations that have implemented ERP systems to invest in empowering its ERP support staff with relevant module knowledge; this will enable the ERP support staff to customize the ERP system to adjust to changing operational and strategic goals of the organisation.

This implication is also important for organisations contemplating adopting ERP systems as they will have to make sure the internal ERP support personnel is heavily involved in the ERP implementation process. Organisations desiring an internal ERP module knowledge capability must develop the ability of internal ERP staff to analyse the technical impact of proposed system changes, the technical ability to conduct a formal validation of all system changes, the ability to efficiently implement ERP system upgrades, expertise in ERP database management, the ability to understand custom ERP software programs, a high degree of technical ERP expertise and the ability to conduct routine ERP system maintenance.

Results found that in organisations where structural complexity is high, higher levels of business process knowledge are required to achieve comparable levels of performance to organisations with lower levels of structural complexity. This has an implication for organisations that are contemplating adoption ERP systems, managers in structurally complex organisations need to invest in empowering its ERP support personnel with the relevant business process knowledge. To empower ERP support personnel with process knowledge, firms should make sure their ERP support personnel have sufficient knowledge of business functions, are willing to learn about business functions, have the ability to quickly understand the needs of business users, have the ability to understand the business environment, have the ability to interpret business problems and have the ability to develop appropriate technical solutions to business problems.

With regards to implementation, results showed that ERP implementation success is not necessarily a predictor of realization of post-implementation benefits of ERP systems. Early cost and schedule overruns during implementation may not compromise later performance benefits. However, higher levels of ERP specificity are associated with more implementation problems.

Results of this study show that most sampled organisation have implemented either SAP or Oracle. However, the choice of ERP vendor does not influence the self-reported underlying performance of the ERP system post-implementation. This has positive implications for organisations contemplating the adoption of ERP systems, because there is no specific link between choice of vendor and ERP benefits, organisations may wish to make their ERP selection decisions based on other factors such as the availability ERP module skills (consultants), vendor hardware requirements and user-friendliness of the ERP package. Organisations should also consider the potential to build ERP module knowledge internally and that the feasibility of bringing ERP module knowledge skills in-house may be an important consideration to make. Also, the level and type of training ERP vendors may provide to

facilitate the development of ERP module knowledge is another important consideration for organisations.

Since this study found that ERP module knowledge to be an important factor in the building of internal ERP capabilities, ERP vendors may wish to consider how they can assist organisations with the relevant training and support to enable organisations to build ERP module skills internally.

7.6 Conclusion

This research developed and tested a research model to understand the impact of two internal ERP knowledge capabilities, namely business process knowledge and ERP module knowledge, on the Operational Benefits of an ERP system. Data collected from a sample of South African firms confirmed the importance of ERP module knowledge and showed that process knowledge is important for more structurally complex firms. The study has confirmed the knowledge-based view of the firm and Contingency Theory as useful for explaining observed variations in ERP post-implementation benefits. Results have practical implications for vendors and for organisations that have implemented or are considering implementing ERP systems.

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APPENDIX A: ETHICS CLEARANCE

Research Office

HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)
R14/49 Mathebula

CLEARANCE CERTIFICATE	PROTOCOL NUMBER H13/06/04
PROJECT TITLE	Effects of internal ERP knowledge capabilities on the post-implementation performance of ERP systems in SA
INVESTIGATOR(S)	Mr N Mathebula
SCHOOL/DEPARTMENT	Economic and Business Sciences
DATE CONSIDERED	21/06/2013
DECISION OF THE COMMITTEE	Approved Unconditionally
EXPIRY DATE	13/06/2015
DATE 14/06/2013	CHAIRPERSON (Professor T Milani)

cc: Supervisor : Prof J Cohen

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and ONE COPY returned to the Secretary at Room 10003, 10th Floor, Senate House, University.

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. I agree to completion of a yearly progress report.

Signature

14/06/2013
Date

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

APPENDIX B: SURVEY COVER LETTER

My name is Ncamiso Mathebula; I am a Masters Information Systems student at Wits University.

I am writing this note to invite you to take part in my research study titled "Effects of internal ERP knowledge capabilities on the post-implementation performance of ERP systems within South African firms." This is a prerequisite for the completion of my master's programme at Wits University. The master's research project aims to investigate the effects of an internal ERP capability on the post-implementation benefits of ERP systems, more specifically; the study focuses on the role of internal ERP module knowledge and internal ERP business process knowledge in sustaining the post-implementation benefits of your ERP system.

You have been invited to participate in this study because of your rich understanding of your firm's business processes and the role of the ERP system in supporting your business functions. Your high-level knowledge of the firm's internal ERP knowledge and capabilities makes you best positioned to participate in the study. Participation is entirely voluntary and estimated time to complete the study is thirty minutes at most. Should you choose to participate, please click on the link below to complete the survey.

Survey Link

Data collected from this study will only be used for purposes of the research study, which will aid me in gaining a greater understanding on the research topic stated above. This data will be securely stored and your responses will not be shared with any third party. Furthermore, data will not be reported at the individual level, but will only be reported at an aggregate level to ensure your confidentiality. Your responses are completely anonymous and as thus, you will not be required to provide your name nor that of your organisation at any point on the survey.

Please note that it is entirely up to you to decide whether or not to take part in the study. If you decide to take part, your response to survey questions will be taken as informed consent. On the other hand, if you decide to take part but later decide to withdraw, you may do so at any time without giving a reason and without disadvantaging yourself.

The results of this study will be reported in a dissertation. It may be also published on conference papers and academic journals. This study is conducted under the supervision of Jason Cohen, who can be contacted via at: Jason.Cohen@wits.ac.za or 0117178164. There are no known benefits or risks for you in this study. A summary of the research findings will be made available to participants on request.

Please take time to read through all the information carefully before you participate and revert if there is any clarification required or if you just need more information around the study, all queries can be directed to my email address: ncamiso@hotmail.com or to my mobile number: 079 536 0924. Thank you in advance for your participation in this important project.

Contact for further information

Ncamiso Mathebula
Role: Student
Mobile: 0795360924
Email: ncamiso@hotmail.com

Thank you in advance for your participation.

APPENDIX C: SURVEY QUESTIONNAIRE

SECTION ONE

This survey aims to understand the effects of an internal ERP capability on the post-implementation benefits of ERP systems. The survey consists of 53 questions, divided into two sections, and should take 10-15 minutes to complete.

1 Does your organisation run an ERP system?

- [ ] Yes
- [ ] No

2 Which ERP system does your organisation run? Please select from the list

- [ ] SAP
- [ ] Oracle
- [ ] Sage
- [ ] Microsoft
- [ ] Baan
- [ ] JD Edward

Other (Please Specify)

3 What is your Job title? Please select from the list below and indicate if other

- ( ) Chief Information Systems (CIO)
- ( ) Information Technology Manager
- ( ) Business Process Manager
- ( ) Project Manager
- ( ) Other (Please Specify):

4 Number of years you have been with your organisation:

5 Number of years that you have been involved with your organization's ERP system

6* Approximate number of employees in your organization (please select one of the options below):

- <50
- 50-100
- 100-300
- 300-500
- 500-1000
- 1000-5000
- >5000

7 Number of users of the ERP system (please select one of the options below):

- <50
- 50-100
- 100-300
- 300-500
- 500-1000
- 1000-5000
- >5000

8 **ERP Operating Period**

Please indicate the time (months) since the ERP first started to run in production mode (went live) in the organization?

9 **ERP Scope**

Please indicate the core SAP modules that your organisation has implemented by selecting from the list below:

- [ ] Financial accounting (FA)
- [ ] Supply chain management (SM)
- [ ] Controlling (CO)
- [ ] Material Management (MM)
- [ ] Sales and Distribution (SD)
- [ ] Logistics Execution (LE)
- [ ] Production Planning (PP)
- [ ] Quality Management (QM)
- [ ] Plant Maintenance (PM)
- [ ] Project System (PS)
- [ ] Human Resources (HR)

10 What industry does your organization operate in? Please select one of the options below;

- ○ Agriculture, Mining
- ○ Construction
- ○ Finance, Insurance, Real Estate
- ○ Government
- ○ Health Care
- ○ Manufacturing
- ○ Retail, Wholesale
- ○ Services
- ○ Transportation
- ○ Communications, Utilities

SECTION TWO

Please indicate the extent to which you agree with each of the following statements by marking the relevant column, using the key below:

KEY:
1- Strongly disagree
2- Disagree
3- Some-what disagree
4- Neutral
5- Some-what agree
6- Agree
7- Strongly agree.

11 **Business Process Knowledge**

The following statements relate to the business process knowledge of your internal ERP support staff.

	Strongly Disagree	Disagree	Some-what Disagree	Neutral	Some-what Agree	Agree	Strongly Agree
Our internal ERP support staff have sufficient knowledge of business functions	○	○	○	○	○	○	○
Our internal ERP support staff are willing to learn about business functions	○	○	○	○	○	○	○
Our internal ERP support staff have the ability to quickly understand the needs of business users	○	○	○	○	○	○	○
Our internal ERP support staff understand the business environment	○	○	○	○	○	○	○
Our internal ERP support staff have the ability to interpret business problems	○	○	○	○	○	○	○
Our internal ERP support staff have the ability to develop appropriate technical solutions to business problems	○	○	○	○	○	○	○

12 **ERP Module Knowledge**

The following statements relate to the ERP module knowledge of your internal ERP support staff.

	Strongly Disagree	Disagree	Some-what Disagree	Neutral	Some-what Agree	Agree	Strongly Agree
Our internal ERP support staff have the ability to conduct routine ERP systems maintenance	○	○	○	○	○	○	○
There is a high degree of technical ERP expertise amongst our internal ERP support staff	○	○	○	○	○	○	○
Our internal ERP support staff understand customized ERP programs	○	○	○	○	○	○	○
Our internal ERP support staff are able to efficiently implement ERP software programs	○	○	○	○	○	○	○
Our internal ERP support staff have the technical ability to conduct a formal validation of system changes	○	○	○	○	○	○	○
Our internal ERP support staff are able to analyze the technical impact of proposed system changes	○	○	○	○	○	○	○
Our internal ERP support staff offer ideas on how the ERP Module can be used to achieve business goals	○	○	○	○	○	○	○

13 **Operational Benefits of ERP**

The following statements relate to the operational benefits associated with your ERP system

	Strongly Disagree	Disagree	Some-what Disagree	Neutral	Some-what Agree	Agree	Strongly Agree
Operational costs were reduced since adopting our ERP System	○	○	○	○	○	○	○
Productivity levels increased since adopting our ERP system	○	○	○	○	○	○	○
Improvements in quality were realized since adopting our ERP system	○	○	○	○	○	○	○
Customer satisfaction increased since adopting our ERP system	○	○	○	○	○	○	○
Internal procedures improved since adopting our ERP system	○	○	○	○	○	○	○
Employee morale improved since adopting our ERP system	○	○	○	○	○	○	○

14 **ERP Implementation Success**

Please indicate the level of success of the ERP implementation

	Strongly Disagree	Disagree	Some-what Disagree	Neutral	Some-what Agree	Agree	Strongly Agree
The cost of the ERP project was significantly higher than initially expected	○	○	○	○	○	○	○
The ERP project took significantly longer to implement than initially expected	○	○	○	○	○	○	○

15 **Environmental Turbulence**

The following statements relate to the characteristics of your external business environment.

	Strongly Disagree	Disagree	Some-what Disagree	Neutral	Some-what Agree	Agree	Strongly Agree
Our business environment is continuously changing	○	○	○	○	○	○	○
Environmental changes in our industry are very difficult to forecast	○	○	○	○	○	○	○
The technology in our business environment is changing rapidly	○	○	○	○	○	○	○
Technological breakthroughs provide big opportunities in our business environment	○	○	○	○	○	○	○
In our kind of business, customers' product/services preferences change often	○	○	○	○	○	○	○
Marketing practices in our business environment are constantly changings	○	○	○	○	○	○	○
New product introductions are very frequent in this market	○	○	○	○	○	○	○
There are many competitors in this market	○	○	○	○	○	○	○

16 **Structural Complexity**

Indicate the level of structural complexity in your organization.

	Strongly Disagree	Disagree	Some-what Disagree	Neutral	Some-what Agree	Agree	Strongly Agree
Our organisation operates across a number of different sites or branches	○	○	○	○	○	○	○
There are a number of different functional specialists working in our organisation	○	○	○	○	○	○	○
Our organisation has a large number of business units	○	○	○	○	○	○	○
Our organisation has a deep hierarchical structure	○	○	○	○	○	○	○

17 **ERP Specificity**

Please indicate the level of customization of your ERP system

	Strongly Disagree	Disagree	Some-what Disagree	Neutral	Some-what Agree	Agree	Strongly Agree
The ERP system required a great deal of customization to improve its fit with our business	○	○	○	○	○	○	○
A standard version of the ERP software was implemented without changes being made to fit the particular requirements of our business	○	○	○	○	○	○	○
The functional requirements for our ERP system were very unique	○	○	○	○	○	○	○
The business domain knowledge required for our ERP system is very unique	○	○	○	○	○	○	○
We invested a lot of time and effort training the developers involved in our ERP project	○	○	○	○	○	○	○
We invested a lot of time and effort designing the operating procedures for the ERP system	○	○	○	○	○	○	○
The technical skills required to implement our ERP system are very unique	○	○	○	○	○	○	○
A high degree of company-specific knowledge was required in order to implement our ERP system	○	○	○	○	○	○	○
The operating procedures for the ERP system needed to be custom-tailored to our company	○	○	○	○	○	○	○

Thank you for taking your time to participate in this survey.

For a copy of results, please note my email address: ncamiso@hotmail.com

Table 32: Rotated Component Matrix

	Component						
	1	2	3	4	5	6	7
BPK1					.712		
BPK2					.689		
BPK3					.689		
BPK4					.685		
EMK1	.571						
EMK2	.726						
EMK3	.696						
EMK4	.738						
EMK5	.767						
EMK6	.838						
EMK7	.681						
OB1				.572			
OB2				.747			
OB3				.609			
OB4				.602			
OB5				.745			
IS1							.864
IS2							.842
ET2			.658				
ET3			.770				
ET4			.746				
ET5			.721				
ET6			.688				
ET7			.552				
SC1						.517	
SC2						.607	
SC3						.762	
SC4						.676	
EFS1		.480					
EFS3		.784					
EFS4		.813					
EFS5		.663					
EFS7		.711					
EFS9		.696					

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

APPENDIX C: TEST OF ASSUMPTIONS

Table 33: Test of linearity between Business Process Knowledge, ERP Module Knowledge, ERP specificity and ERP Operational Benefits

Tests of Between-Subjects Effects

Dependent Variable: Operational Benefits

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	20.559[a]	3	6.853	14.427	.000
Intercept	3.778	1	3.778	7.954	.006
CompEFS	1.378	1	1.378	2.900	.091
CompBPK	.002	1	.002	.003	.953
CompEMK	16.747	1	16.747	35.256	.000
Error	59.852	126	.475		
Total	3823.840	130			
Corrected Total	80.411	129			

a. R Squared = .256 (Adjusted R Squared = .238)

Table 34: Lack of Fit test for linearity

Lack of Fit Tests

Dependent Variable: Operational Benefits

Source	Sum of Squares	df	Mean Square	F	Sig.
Lack of Fit	58.232	118	.493	2.437	.087
Pure Error	1.620	8	.202		

F = 2.437 and P = 0.087 greater than 0.05 therefore the linear regression model is appropriate.

Table 35: Dublin-Watson test of independence of errors

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.506[a]	.256	.238	.68921	1.894

a. Predictors: (Constant), Business Process Knowledge, ERP Specificity, ERP Module Knowledge

b. Dependent Variable: Operational Benefits

Durbin-Watson statistic = 1.90 which falls within the acceptable range from 1.50 to 2.50. The assumption of independence of errors is satisfied

Table 36: Descriptives test for Normality

			Statistic	Std. Error
Studentized Residual	Mean		-.0017748	.08863318
	95% Confidence Interval for Mean	Lower Bound	-.1771377	
		Upper Bound	.1735881	
	5% Trimmed Mean		.0446831	
	Median		.0577497	
	Variance		1.021	
	Std. Deviation		1.01057377	
	Minimum		-3.73249	
	Maximum		2.12900	
	Range		5.86149	
	Interquartile Range		1.18768	
	Skewness		-.868	.212
	Kurtosis		1.833	.422

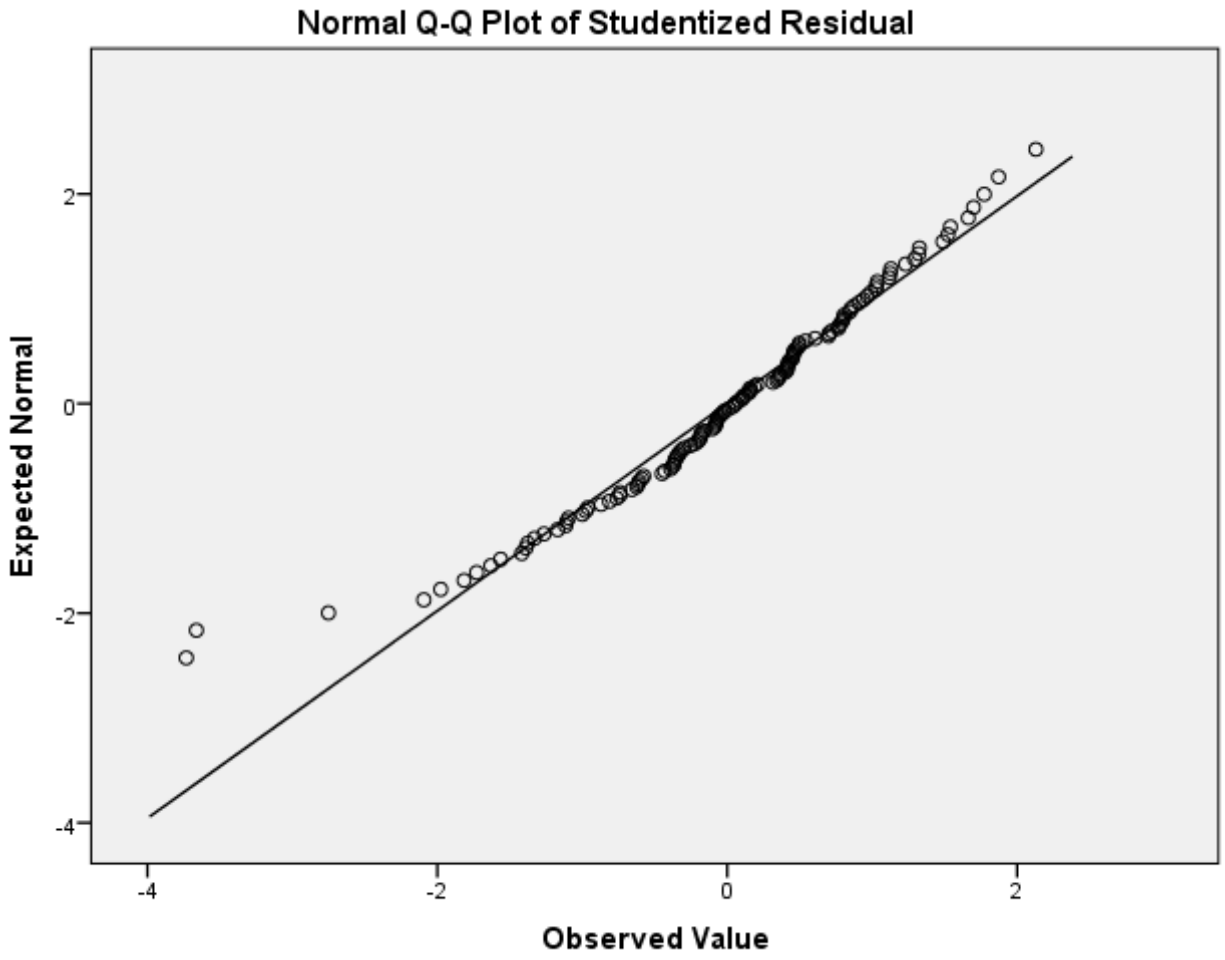


Figure 16: Q-Q plot test for normality (ERM Module Knowledge, Business Process Knowledge, ERP Specificity and ERP Operational Benefits)