Leveraging Information Systems Capabilities for Operational Performance in Services: The Role of Supply Chain Integration

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To my parents
For their unending support
And ongoing encouragement

ABSTRACT

The purpose of this thesis is to explore the link between IS capabilities and operational performance in services. More specifically, it aims to investigate how the processes for supplier and customer integration affect IS capabilities and consequently, firms' operational performance. Accordingly, this study examines the effects of three dimensions of IS capabilities (IT for supply chain activities, flexible IT infrastructure, and IT operations shared knowledge) on cost and quality performance via the mediation of the processes developed for supplier and customer integration in service firms. This is achieved by measuring SCI in terms of supply side integration processes (supplier integration) as well as customer side integration processes (customer transactions, customer connection, and customer collaboration).

A survey-based research design intended to measure the estimated relationships was adopted. Data were collected from 156 service establishments in the UK. Mediated multiple regression analysis revealed that integrating specific processes with supply chain members (supplier integration, customer transactions, customer connection, and customer collaboration) can fully or partially mediate the effects of IT for supply chain activities and IT operations shared knowledge on cost and quality performance; no support was found for the relationships between flexible IT infrastructure and cost and quality performance. These results provide a valuable explanation to academics as well as to practitioners regarding the importance of various processes developed for integration with supply chain members in leveraging IS for operational performance in services.

This thesis takes a step towards quelling concerns about the business value of IS, contributing to the development and validation of the measurement of IS capabilities in the service operations context. Additionally, it adds to the emerging body of literature linking supply chain integration to the operational performance of service firms.

DECLARATION

No part of this thesis has been submitted elsewhere for any other degree or qualification in this or any other university. It is all my own work unless referenced to the contrary in the text.

STATEMENT OF COPYRIGHT

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LIST OF ABBREVIATIONS

C	Cost
CClb	Customer Collaboration
CCnt	Customer Connection
CT	Customer Transactions
EDI	Electronic Data Interchange
ERP	Enterprise Resource Planning
GDP	Gross Domestic Product
IS	Information Systems
IT	Information Technology
ITINT	Flexible Information Technology Infrastructure
ITOSK	Information Technology Operations Shared Knowledge
ITSCA	Information Technology for Supply Chain Activities
MRP II	Material Requirements Planning II
OM	Operations Management
Q	Quality
RBV	Resource-Based View
SCI	Supply Chain Integration
SCM	Supply Chain Management
SI	Supplier Integration
URL	Uniform Resource Locator
VRIN	Valuable, Rare, Inimitable, and Non-substitutable

CHAPTER ONE:

INTRODUCTION

1.1 Overview

This thesis presents an analysis of the impact of information systems capabilities on supply chain integration and operational performance in services. This chapter describes the research background in which the research questions are raised. The motivation for the research, and the key contribution made by this study are then discussed, and an outline of the thesis follows.

1.2 Background to the Study

Since the technological revolution of the 1970s, the emergence of new technologies such as microelectronic technology and computerised systems, has allowed a platform to be erected on which other technology and related innovation depend. In establishing an information age, the technological shift into information systems (IS) has generated a new techno-socio-economic environment, and the consequent new challenges to corporate competitiveness (Santangelo, 2002).

IS as an entity, has been treated as the most shining technology in the information era. Not surprisingly, uncountable studies have been undertaken to investigate the relationship between IS and organisational performance. The resource-based view of the firm (RBV) has been developed as a theory of competitive advantage based on the resources a firm controls, and has often been used in the information systems (IS) and supply chain management (SCM) literature to explain how the deployment of IT can lead to improved performance. According to the RBV, the resources that a firm develops, or acquires, can be viewed as a strength or weakness of the firm, and the portfolio of product market positions that the firm holds is determined by the portfolio of resources that it controls. Therefore, the competition among product market positions that firms hold can be reflected in the competition among resource positions held by those firms (Wernerfelt, 1984). When firms have access to resources that are valuable, rare, inimitable, and non-substitutable, they can achieve sustainable competitive advantage by implementing fresh value-creating strategies that cannot be easily duplicated by their competing firms (Barney, 1991).

Since the conceptual work published in the 1980s, a growing number of researchers have made efforts to empirically test the key assertions of the RBV, mostly focusing on the influence of firm-specific resources on a firm's overall performance (Farjoun, 1998). For example, at the business strategy level, Barnett *et al*. (1994) examined the relationship between historical experiences in terms of competition, and current firm performance. Similarly, Huselid *et al*. (1997) tested the relationship between human resource management capabilities and firm-level performance, while Markides and Williamson (1994) analysed the relationship between different types of corporate asset and return on the sales of a firm.

Examining the aggregated firm-level performance may be intrinsically interesting to both researchers and managers, but it may not always be the best way to examine the resource-based theory (e.g., Ray *et al*., 2004, 2005; Wade and Hulland, 2004). As Ray *et al*. (2004) explain, firms can obtain competitive advantages in some business processes and competitive disadvantages in others. Furthermore, firms may control some resources that have the potential for generating competitive advantages, but this potential cannot be fully realised by firms' business processes and thus cannot be revealed in the aggregated performance. Therefore, examining the relationship between firm-specific resources associated with different processes and the overall firm performance can lead to misleading conclusions. Hence, the need emerges to examine the impact of IS on a firm's performance in the business process, e.g., operational performance.

1.2.1 Information Systems, Firm Performance, and the Underlying Mechanisms

To evaluate the business value of IS, researchers have adopted myriad approaches to assessing the mechanisms by which the organisational performance impacts of IS can be generated and their magnitude estimated. Despite the widespread adoption of IS, the relationship between those systems and firm performance is less straightforward. To better understand this relationship and the underlying mechanisms influencing it, the emerging consensus in the IS research stream has emphasised the importance of investigating the role of IS capabilities in enabling critical organisational processes to improve performance (e.g., Wade and Hulland, 2004). The basic logic for adopting this approach is that IS capabilities affect other business resources or processes which, in turn, lead to improved firm performance.

It is indisputable that IS have an enormous effect on contemporary business. The reason for investing in IS is to create a seamless integration of parties in a supply chain, which calls for the sharing of accurate and timely information, and the co-ordination of activities between business parties (e.g., Devaraj *et al*., 2007). Distorted information from one end of a supply chain to the other can lead to exaggerated order swings causing tremendous inefficiencies (Lee *et al*., 1997a). Certainly, firms invest in IS with the presumption that they will facilitate supply chain integration and that their performance will improve. However, a direct linkage between IS and operational performance still remains an elusive entity. Furthermore, if IS do not have a direct effect on operational performance, they may have an indirect effect on performance via their impact on the processes developed for supplier and customer integration. This perspective has not been well addressed in the literature.

1.2.2 The Service Context

Both information systems (IS) and operations management (OM) literature which examines the effect of IS on supply chain management and firm performance, has largely focused on traditional manufacturers (e.g., Zhang *et al*., 2011), and hence, the findings and implications are greatly related to manufacturing settings. The recent academic debate in the field of service research recognises the need to advance our understanding of the role of IS in services (e.g., Bitner *et al*., 2010; Chesbrough and Spohrer, 2006; Rust and Miu, 2006).

The service economy has always been the driving force of the economic growth of developed nations. In the UK, the service economy accounts for 75% of the GDP, and around 55% of the total employment (World Bank, 2009). Nonetheless, despite the importance of services, services have been reported to lag behind in process excellence and performance when compared to manufacturing (Van Ark *et al*., 2008; Office of National Statistics, 2009). One of the reasons behind this situation is that successful manufacturing organisations tend to integrate the supply, production, and delivery processes of their core products with the use of effective IS (Zhang *et al*., 2011; Bosworth and Triplett, 2004).

The rapid growth of the service industry over the last 50 years has generated the need for innovations and improved service productivity to fuel economic growth (Giannakis, 2011a). However, while services operations management has become established as a field of research, very few studies have investigated how service providers can create value through the IS-enabled integration of the processes that extend their organisational boundaries (Ellram *et al*., 2007; Voss and Hsuan, 2009). Given the background discussed, this study addresses the following two research questions:

- How do IS capabilities affect operational performance in services?
- How do the processes of supply chain integration influence IS capabilities and operational performance in services?

1.3 Motivation and Objectives of the Study

Within the context of IS and SCM, which is the focus of this study, researchers have utilised RBV to theoretically analyse how IT resources and supply chain integration processes can lead to competitive advantage (e.g., Mata *et al*., 1995), and subsequently improve firm performance (e.g., Powell and Dent-Micallef, 1997). Such research has often tried to focus on what these resources are and how they can be deployed within the organisation. Although typically such studies have focused on the business process level, e.g., implementation of a new computer system, dependent variables have focused on higher level organisational performance often bypassing the impact that such resources may have on other external and internal business processes.

IS scholars have argued that IT resources by themselves may not be the 'unique' resources held by a firm, and thus it is more useful to focus on how the firm's IS capabilities impact upon its performance (e.g., Bharadwaj, 2000; Santhanam and Hartono, 2003). IS capabilities, which encompass outside-in, inside-out and spanning dimensions, allow firms to achieve improved performance (Wade and Hulland, 2004). Accordingly, to evaluate how the link between IS and firm performance is created (Devaraj and Kohli, 2003; Dehning and Richardson, 2002; Tippins and Sohi, 2003), the emerging consensus in operations management (OM) research has emphasised the importance of investigating the role of IS capabilities in enabling supply chain processes to improve performance at the process level (e.g., Sender, 2008; Devaraj *et al*., 2007).

Research has revealed the value of IS in fostering information flows between a focal firm and its chain partners in order to make their supply chain management more effective. Indeed, valuable insights have been yielded in the existing studies in this domain, but their focus on IS as a highly aggregated concept (e.g., Subramani, 2004; Sanders and Premus, 2005; Zhang and Dhaliwal, 2009), or one specific type of technology (e.g., Sanders, 2007; Tan *et al*., 2010; Olson and Boyer, 2003), has resulted in a limited understanding of the impacts of IS capabilities. In particular, a conceptualisation of how the different dimensions of IS capabilities enable supply chain integration, and the resulting influence on the firm's operational performance is lacking (Ray *et al*., 2005; Zhang *et al*., 2011).

Much of the extensive body of research on the effect of IS on supply chain management and firm performance in both the IS and SCM fields has been conducted in the manufacturing context. As a result, little such research has been conducted in respect of services. Particularly, few studies have linked supply chain management to operational performance in services. The management of services is often quite different from manufacturing, since the obvious common link of managing the flow of goods is lacking among service supply chains. However, the underlying issues of SCM are similar. For instance, the processes used to design, manage, and control the assets of a supply chain to best meet the customer needs in a cost-effective manner are similar (Ellram *et al*., 2004). Further, similar to manufacturing firms, service firms compete on the basis of operational performance, such as cost, quality, delivery, and flexibility (Roth and Van Der Velde, 1991; Safizadeh *et al*., 2003). It is, therefore, believed that such a study on the relationship between SCM and the operational performance of service firms is important.

To sum up, this study addresses the following gaps in the existing literature:

- Understanding the relationship between a firm’s IS capabilities and operational performance and the underlying mechanisms.
- Evidence of how different dimensions of IS capabilities can impact upon the processes developed for supply chain integration, which in turn leads to improved operational performance.
- The limited empirical work on the relationship between supply chain integration and operational performance in service contexts.

1.4 Contribution of the Study

Based on the above observations, this study takes a step towards understanding the relationships between IS capabilities, supply chain integration, and operational performance of firms in service contexts. In line with the most recent research on operational performance in services (Prajogo *et al*., 2014), the study focuses on cost and quality as the performance outcomes in this study. Theoretical arguments have been provided to underscore the individual role of three dimensions of IS capabilities (IT for supply chain activities, flexible IT infrastructure, and IT operations shared knowledge), in improving supply chain integration, and in turn leading to improved cost and quality performance.

The study makes the following contributions. Firstly, it responds to calls by the RBV literature to explore IS capabilities at the business process level (e.g., Ray *et al*., 2004, 2005; Wade and Hulland, 2004), which is in line with the emerging consensus in the OM research stream that the role of IS capabilities in enabling supply chain processes to improve performance at process level should be examined (e.g., Sender, 2008; Devaraj *et al*., 2007). Secondly, it develops and validates the measurement scale of IS capabilities in managing service supply chains, which is consistent with the recent call within the supply chain management literature to explore a comprehensive range of IT in SCM (e.g., Zhang *et al*., 2011). In this study, the IS capabilities constructs are reflected in three dimensions, which allow better investigation of their individual effect upon cost and quality in services. Finally, it adds to the literature on the relationship between supply chain integration and operational performance in service contexts. The findings indicate that the effect of the relationships between IT for supply chain activities and IT operations shared knowledge, upon cost and quality performance are fully or partially mediated through processes developed for supply chain integration (supplier integration, customer transactions, customer connection, and customer collaboration), whereas there are no relationships between flexible IT infrastructure, and cost and quality performance. Specifically, one of the key findings of this study recognises the significance of IT knowledge shared by operations managers (IT operations shared knowledge) and its positive impacts on supply chain integration processes and relevant performance. These findings contribute to the literature by exploring how the different processes of supply chain integration can mediate the relationships between IS capabilities and operational performance in service firms.

In addition to the theoretical contributions, this thesis provides important insights for manages in service firms. The analysis indicates that for service firms, various types of process for supply chain integration should be taken into consideration for their mediation effects in linking IS capabilities and operational performance. Service firms that embark on the development of IS capabilities should at the same time implement processes that encourage supplier and customer integration. Furthermore, the analysis provides evidence that IS capabilities do help service firms reduce their cost and improve quality. As such, these results further underscore the fact that IS capabilities give firms competitive advantages and should motivate increased managerial attention toward IS development within service organisations.

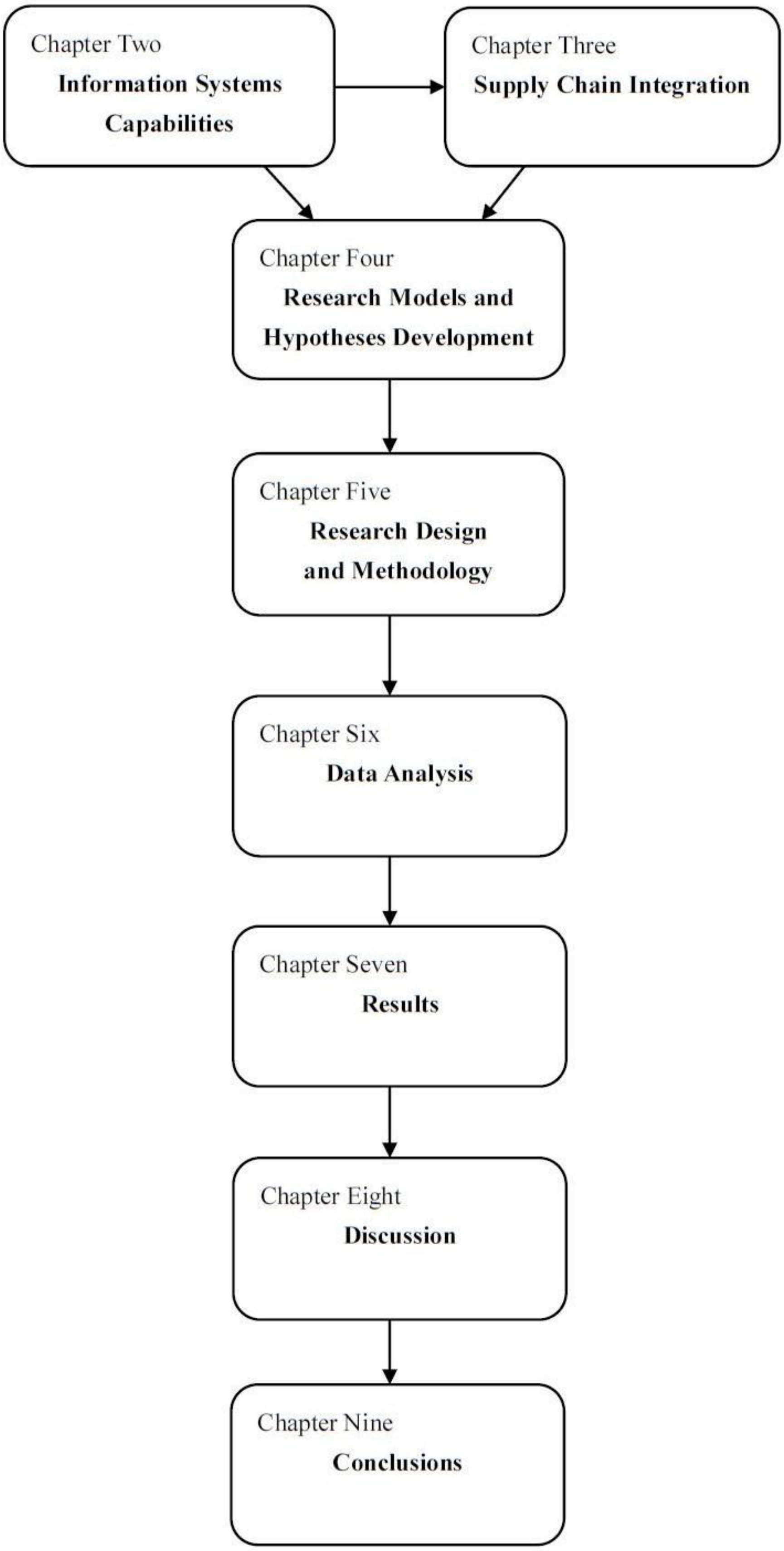
1.5 Thesis Structure

This thesis is structured as shown in Figure 1.1. The literature on IS capabilities, and supply chain integration, is reviewed in order to develop hypotheses which predict a mediating relationship between the IS capabilities and a firm's operational performance. Information concerning the data and methods used to test these hypotheses follows. The final chapters of this thesis concentrate on the results and conclusions of the study.

Chapter Two explores the business value of information systems (IS) resources. It presents the theory underpinning arguments for the value of IS resources. The resource-based view of the firm (RBV) is used as the primary theoretical basis to discuss the relationship between IS resources and operational performance, and for instilling the need to focus on the performance impacts of IS capabilities. The chapter then proposes a typology of IS capabilities – IT for supply chain activities, flexible IT infrastructure, and IT operations shared knowledge; additionally, it reviews existing literature concerned with the effect of these three dimensions of IS capabilities on supply chain integration and operational performance.

Chapter Three reviews IS capabilities in the context of supply chains, beginning with a recounting of the academic basis of supply chain integration. The chapter then focuses on the theoretical understanding of the dimensions and the importance of supply chain integration on operational performance. The final section of Chapter Three explores the concept of supply chain integration in the service business and considers the distinguishing characteristics of services. It ends with the proposition that traditional manufacturing-oriented supply chain integration strategies will be appropriate to the service industry in this study.

Figure 1.1: Thesis structure



Chapter Four discusses the arguments in favour of examining the relationships between each dimension of IS capabilities (IT for supply chain activities, flexible IT infrastructure and IT operations shared knowledge) and operational performance (cost and quality), and the underlying mechanisms (the processes developed for supplier and customer integration) in services. Furthermore, the chapter describes the development of research models and hypotheses about the impact of these dimensions of IS capabilities on supply chain integration and operational performance (Models 1–8) in detail.

Chapter Five explains the research methodology which has been adopted for this study on the basis of the research questions, research models, and the hypotheses described in Chapter Four. The chapter details the selection of a web survey as the research method, and describes the methods of survey design and administration, including the use of pilot study, sample selection, and data collection. The testing and validation of the research instrument used to collect data from the selected sample is also described in detail.

Chapter Six describes the statistical analysis of the data, indicating that the data collected from the web questionnaire is statistically analysed using the statistical package for social science (SPSS 19) software. The chapter reports the screening for missing data and outliers, the descriptive analysis of the derived independent, mediator, and dependent variables, as well as the assumptions of important statistical tests. The chapter then describes the use of exploratory factor analysis in detail, as well as the testing undertaken to ensure the validity and reliability of the data.

Chapter Seven details the results and findings of this study. The chapter demonstrates the procedures to perform mediated multiple regression analysis and explains the results of the hypothesis testing in detail. The chapter is organised such as to focus on each research model (Models 1–8).

Chapter Eight contains a discussion of the results presented in Chapter Seven. The chapter focuses on the findings of the hypothesis testing, and provides a discussion of the results, comparing these to previous findings reported in the literature. The chapter is organised such as to focus on each mediator variable (supplier integration, customer transactions, customer connection, and customer collaboration).

Chapter Nine provides a conclusion to the thesis, drawing together the results presented throughout. The chapter discusses the contributions that this thesis has been able to make to the existing field of study. It then addresses the limitations of the study, and from these it identifies potential areas for future research.

1.6 Conclusions

This chapter has provided an overview of the work which is reported in this thesis. In doing this, it has introduced the issue of IS in supply chain management and its role in firm performance in service contexts. The motivation for the research and the expected contributions have also been presented, and an outline of the thesis has been provided. The subsequent chapters of this thesis provide a more detailed account of the research.

CHAPTER TWO:

INFORMATION SYSTEMS CAPABILITIES

2.1 Introduction

The examination of the business value of information systems (IS) has gained great momentum over the past decades. Researchers have employed various approaches to assessing the mechanisms through which IT business value is generated and to what extent its magnitude is estimated. It has been suggested in previous research that IS may indeed contribute to improved organisational performance (e.g., Brynjolfsson and Hitt, 1996; Kohli and Devaraj, 2003).

This chapter presents the theoretical underpinning for the argument that IS are valuable. The resource-based view (RBV) of the firm is used as the primary theory to discuss the operational performance impacts of IS capabilities. A typology of IS capabilities is proposed – IT for supply chain activities, flexible IT infrastructure, and IT operations shared knowledge. The effects of each type of IS capability on operational performance will be discussed in further detail in Chapter Four.

2.2 The Value of Information Systems

By and large, most research on the value of IS is motivated by the desire to understand how and to what extent, a firm's IS leads to the improvement of organisational performance. Such research has focused on the ability of IS to add economic value to a firm, either by reducing the firm's costs or by differentiating its products or services

(Brynjolfsson, 1993; Brynjolfsson and Yang, 1996; Dedrick *et al*., 2003; Mata *et al*., 1995). According to IS scholars, IS has to be diversely conceptualised as hardware, software, and a range of contextual factors associated with its application within firms (Kling,1980; Markus and Robey, 1988), for example, IT as an engineering tool, the usefulness of IT perceived by people, and the interaction between individual and technology (Orlikowski and Iacono, 2001).

The value of IS (or IS business value) is commonly viewed as the impact of IS on firm performance seen in, for instance, cost reduction, inventory reduction, productivity enhancement, profitability improvement, and other improved measures of performance (Mukhopadhyay *et al*., 1995; Devaraj and Kohli, 2003; Hitt and Brynjolfsson, 1996). Synthesising the observations from both the process-level as well as the firm-level, Melville *et al*. (2004:287) refer to IS business value as "the organizational performance impacts of information technology at both the intermediate process-level and the organization-wide level, and comprising both efficiency impacts and competitive impacts". In this understanding, a firm's performance comprises business process performance as well as organisational performance. At firm level, the influence of IS is denoted in the aggregate performance of the organisation, being seen in revenue enhancement, market value, competitive advantage, etc. (Devaraj and Kohli, 2000; Dehning and Richardson, 2002). At process level, in contrast, the impacts of IS are seen in a range of measures associated with operational efficiency enhancement within specific business processes, such as quality improvement of product delivery processes or cycle time enhancement within inventory management processes. In previous IS business value studies, business process performance metrics have included inventory turnover (Barua *et al*., 1995), on-time shipping (McAfee, 2002), and customer satisfaction (Devaraj and Kohli, 2000). IS researchers have operationalised these measures via operations measures such as cost reduction, productivity enhancement, flexibility, information sharing, and inventory management, etc. (Melville *et al*., 2004).

2.2.1 The Value of IS and the Resource-Based View

The resource-based view of the firm (RBV) has been applied in examining the ability of specific resources and capabilities to be sources of sustained competitive advantage for firms, as well as in analysing the efficiency and competitive advantage implications of firm-specific resources, such as culture (Barney, 1986b), trust (Barney and Hansen, 1994), and human resources (Barney and Wright, 1998). It has also been used in the context of information systems (IS), conferring a robust framework for assessing whether and how, IS may be associated with firms' competitive advantages.

The RBV has been suggested as the paramount theory used in IS research to understand the relationships between IS and firm performance (Jarvenpaa and Leidner, 1998; Barney, 1991; Bharadwaj, 2000; Sambamurthy *et al*., 2003; Pavlou and El Sawy, 2006). Strategy researchers have utilised the RBV to theoretically analyse the competitive advantage implications of IS (e.g., Mata *et al*., 1995), as well as to empirically examine the links between IS resources and firm performance (e.g., Powell and Dent-Micallef, 1997). Increasingly, IS researchers have employed the resource-based logic to expand and deepen the understanding of the impact of IS on firm performance (e.g., Clemons, 1991; Bharadwaj, 2000).

The RBV provides a useful platform for IS researchers to consider how IS relates to firm performance. Wade and Hulland (2004) suggest at least three attributes of the RBV that are valuable and rare and that benefit IS research. Firstly, the RBV offers a convincing framework through which to analyse the strategic value of IS resources. It sets out a cogent link between firm-specific resources and sustained competitive advantages, providing a useful approach to measure the impact of IS resources on firm performance. Secondly, the RBV provides guidance on how to differentiate various types of IS resources, and how to investigate their separate impacts on firm performance (Santhanam and Hartono, 2003). It enables the specification of IS resources, laying the foundation for a set of mutually exclusive and exhaustive IS resources through a defined set of resource attributes. Finally, the RBV can promote cross-functional research since the theory develops a basis to facilitate comparisons between IS resources, and between IS and non-IS resources.

2.2.2 The RBV: Theoretical Foundations and Theory Development

This section describes the fundamental theoretical tenets of the RBV, and briefly discusses the key theoretical work upon which the RBV draws in the development of its predictions and prescriptions. It then describes the development of the RBV.

2.2.2.1 Theoretical Foundations

Focusing on understanding persistent performance differences among firms, the RBV theory explains the existence of sustained superior firm performance. The important influences on the evolution of the RBV mainly come from four sources:

Firstly, the theory is grounded in the traditional work of distinctive competencies which refer to a firm's attributes that enable the firm to pursue a strategy in a more effective and efficient manner than other firms (Hrebiniak and Snow, 1982; Hitt and Ireland, 1985a, 1985b, 1986). Concerned with general management capability, which features among the first distinctive competencies, such work emphasises top management as an important source of competitive advantage for a firm, and examines the influence of top management on a firm's performance.

Secondly, and different from the first source that exclusively focuses on managers as possible explanations of superior firm performance, Barney and Clark (2007) document Ricardo's analysis of land rents (1817) as another theoretical foundation of the RBV. This stream places an interest on the economic consequences of the "original, unaugmentable and indestructible gifts of nature" and focuses on the economic consequences of owning land (Ricardo, 1817). More fundamentally, as land is inelastic in supply (the total supply of land is relatively fixed and cannot be significantly increased in response to higher demand and prices), the firm with more fertile land and lower production costs has a higher level of performance than firms with less fertile land, and this difference in performance will persist since the fertile land is inelastic in supply.

Thirdly, in her theory of the growth of the firm, Penrose (1959) conceptualises the firm as a bundle of productive resources within an administrative framework that links and co-ordinates the activities of individuals and groups. According to Penrose, the productive opportunities arising from the bundle of productive resources, coupled with the speed of assimilation and accumulation of these resources, are key to the growth of a firm. Indeed, she observes that the fundamental heterogeneity of firms is caused by significant variation in the bundles of productive resources possessed by them. Additionally, the very broad definition of productive resources enables Penrose to study the competitive implications of a range of possible productive resources of the firm (tangible and intangible), whereas traditional economic work (e.g., Ricardo) emphasises only a few resources that may be inelastic in supply (e.g., land).

The fourth main source is from the perspective of the anti-trust implications of economics. In 1973, Demsetz argued that some firms may possess superior performance either because of luck or because these firms are more competent than their competitors in dealing with customer needs. Indeed, he argues that "since information is costly to obtain and techniques are difficult to duplicate, the firm may enjoy growth and superior rate of return for some time" (Demsetz, 1973:3).

Serving as the main foundations, the above theoretical streams have been modified to develop the RBV. Hence, it can be appreciated that the RBV is deeply rooted in both economic and sociological traditions, and embracing both of these, it has been developed to become an important explanation of the firm's persistent advantages and superior performance.

2.2.2.2 Theory Development

In 1984, Wernerfelt provided a seminal contribution to the RBV, developing the theory as one of competitive advantage based on the resources a firm controls, and the notion that resources developed or acquired by a firm can be viewed as strengths or weaknesses. These strengths and weaknesses determine the value and attractiveness of the overall portfolio of resources under a firm's control, and hence, the range of product market positions that the firm is able to assume. In this conception, the competition among firms for product market positions is a reflection of the competition among those firms in respect of the specific resource positions that they hold. In this respect, Wernerfelt (1984) proposes the notion of resource position barriers as a means of analysing the level of competition occurring as a result of the resources held by different firms. Such barriers are seen in obstacles to imitation, and links between resource attributes and profitability. Similarly, Rumelt (1984) suggests that firms can possess difficult-to-imitate resources through the protection of 'isolating mechanisms'.

Subsequent research studies examine links between resource attributes and competitive advantage. Barney (1986a) argued that firms' resource factors are different in the extent to which they are identified, and that the monetary value of these resources can be evaluated through strategic factor markets where firms control or develop their resources to implement their product market strategies. Dierickx and Cool (1989) further extended this argument by documenting that the resources that a firm has already controlled may lead to generate economic rents. Following the 'isolating mechanisms' suggested by Rumelt (1984), they suggest that economic rents are derived from the imitability and limited substitutability of asset accumulation processes, e.g., time-compression diseconomies in trying to imitate resources held by other firms.

Barney (1991) moves beyond the arguments of resource heterogeneity and above-normal firm performance by proposing a set of conditions for resources to confer a sustained competitive advantage. He specifies that when firms have access to resources that are valuable, rare, inimitable, and non-substitutable (VRIN attributes), they can achieve sustainable competitive advantage by implementing fresh value-creating strategies that cannot be easily duplicated by their competing firms. For example, if a firm possesses a valuable and rare resource, to which very few others have access, then that resource confers a temporary competitive advantage upon the firm; and that advantage can be sustained if this resource is also imperfectly imitable – that is, competing firms do not know what leads to success and thus do not know what to imitate, and have no readily available substitutes.

Thoroughly grounding resource-based logic in microeconomics, Peteraf (1993) argues that to create and sustain competitive advantage, resources held by firms are required to meet the conditions of *(a)* heterogeneity of efficiency in industry (e.g., Ricardian or monopoly rents), *(b)* ex-post limits to completion (e.g., rents from being competed away), *(c)* ex-ante limits to competition (e.g., rents not offset by costs), and *(d)* imperfect mobility (e.g., rents sustained within the firm). In a similar manner, Amit and Schoemaker (1993) suggest that firms differ in their positions in respect of controlling resources and capabilities due to resource-market imperfections and discretionary managerial decisions concerned with developing and deploying resources. Such differences among firms can be a source of sustainable economic rent in turn.

2.2.2.3 The RBV as the Chosen Theory Base

The RBV considers firms as bundles of resources, which are heterogeneously distributed across those firms, and which cause differences to persist over time. The competitive advantage derives from firm-specific resources that are scarce (rare) and superior in use. Applying this notion, information systems (IS) can be seen as resources that a firm controls and the VRIN IS resources can differentiate the firm's performance from its competitors. The focus of the RBV on resource attributes is extremely useful in evaluating the IS resources. Adopting Barney's formulation (1991), this study applies the RBV as the prime theory to analyse IT business value (the IS resources impacts).

Supporting theories are selected in order to cope with the limitation of the conventional RBV, which is noted by Melville *et al*. (2004), is the assumption that resources are always used to their potential, but its lack of attention to the issue of how this situation is achieved. Traditionally, the RBV specifies a set of necessary conditions for a firm's resource to obtain sustained competitive advantage, but does not identify the underlying mechanisms that enable success. Consequently, this study applies concepts from supporting theoretical bases, such as transaction cost, and absorptive capacity theory, in order to inform the understanding of how IS resources are applied within business processes to improve performance.

2.2.3 Defining Resources and Business Processes

The literature is mixed and replete with definitions of ‘resources’, ‘capabilities’ and ‘business processes’, so to simplify the interpretation of the theory, the relevant terms in this study have adopted the following definitions. In line with Wade and Hulland (2004), ‘resources’ are defined in this study as the tangible and intangible assets that firms apply and use in developing and implementing their strategies, whereas ‘capabilities’ transform inputs into outputs of greater worth (Amit and Schoemaker, 1993; Capron and Hulland, 1999; Christensen and Overdorf, 2000).

‘Business processes’ are defined as the routines or activities that firms engage in to succeed in achieving some business objectives or purposes (Nelson and Winter, 1982; Porter, 1991), including the process of sourcing supplies and acquiring materials, the process of producing goods or services, the process of delivering goods or services to customers, and the process of providing after sales service (Porter, 1985).

2.2.4 The Business Process as the Unit of Analysis

Since the conceptual work published in the 1980s, a growing number of researchers have made efforts to empirically test key assertions of the RBV. Mostly, these efforts focus on the influence of firm-specific resources on a firm’s overall performance. For example, at the business strategy level, Barnett *et al*. (1994) examine the relationship between historical experiences with competition, and current firm performance. Huselid *et al*. (1997) test the relationship between human resource management capabilities and firm-level performance. And at the corporate strategy level, Markides and Williamson (1994) analyse the relationship between different types of corporate asset and return on the sales of a firm. Farjoun (1998) assesses the relationship between physical and skill assets, and measures of corporate performance.

While the empirical work at the corporate level has its merits, there is an important limitation of this approach, since with few exceptions, the focus has been on the firm-level performance, which is a highly aggregated dependent variable. Ray *et al*. (2004, 2005), for example, argue that, whilst examining the aggregated firm-level performance may be intrinsically interesting to both academic researchers and business managers, it may not always be the best way to examine the resource-based theory. Further, they point out that firms can obtain competitive advantages in some business processes and competitive disadvantages in other business processes, and hence, an approach which examines the relationship between firm-specific resources associated with different processes and the overall firm performance can lead to misleading conclusions. Firms may obtain competitive advantages in some business processes, but various stakeholders may have appropriated the profits that these competitive advantages might have generated before they have any impact on overall firm-level performance. Alternatively, firms may control some resources that have the potential for generating competitive advantages, but this potential cannot be fully realised by those firms' business processes (thus cannot show in the aggregated performance).

In case of each of the above settings, simply examining the relationship between firm-specific resources and the overall firm-level performance can produce inaccurate conclusions with regard to the resource-based theory. Reflecting this limitation, four studies have adopted 'the effectiveness of business processes' as an alternative class of dependent variables to examine the empirical implications of the RBV. Henderson and Cockburn (1994) were the first to do this, choosing to examine the relationship between the 'architectural competence' of a firm and new product development performance by assessing the new drug development process in pharmaceutical firms. Subsequently, Schroeder *et al*. (2002) tested the relationship between manufacturing capabilities and manufacturing effectiveness by examining a sample of manufacturing firms; and more recently, Ray *et al*. (2004 and 2005) investigate the relationship between firms' resources and customer service process performance, using a sample of insurance firms.

Further, the business process approach is consistent with the business perspective of examining IT business value, suggesting that the focus of the impact of IT on lower levels of the organisation, is more appropriate. Indeed, numerous studies have pointed out that the impacts of IS at firm level can be measured only via their process level contributions (Barua *et al*., 1995; Mukhopadhyay *et al*., 1997; Sambamurthy, 2001;

Tallon *et al*., 2000; Ray *et al*., 2005). These researchers argue that IS are deployed in support of specific activities and processes, and therefore, the impacts of these systems should be examined at the point where their first-order effects are expected to materialise. In this sense, the review of benefits that are produced by IS should be closer to the actual operations – at lower levels of the organisation, rather than at a higher and integrated level. Following in this tradition, this study focuses on examining how IS capabilities affect operational-level performance in a sample of UK service establishments.

2.3 The RBV and IS Capabilities

2.3.1 Defining IS Capabilities

In much of the RBV work in the IS field, IS have been identified and defined either as a single resource or as sets of resources within a firm. For example, Ross *et al*. (1996) divide IS into three IT assets (see Table 2.1) and argue that IT assets together with IT processes (IT planning, support, and delivery processes) enhance firm competitiveness. Bharadwaj (2000) later modifies this categorisation, classifying IT resources into (1) the tangible resource, such as IT infrastructure components; (2) the human IT resources, such as technical and managerial IT skills; and (3) the intangible IT-enabled resources, such as knowledge assets and customer orientation.

Table 2.1: IS classification by Ross *et al*. (1996)

Three IT assets	Examples
(1) IT human resources	technical skills, business understanding, problem-solving orientation
(2) technology resources	physical IT assets, technical platforms, databases, architectures, standards
(3) relationship resources	partnerships between IT and other business divisions, client relationships, top management sponsorship, shared risk and responsibility

Adopted and developed from Day’s (1994) work, Wade and Hulland (2004) offer an alternative way of categorising IS resources. They suggest that the IS capabilities (use of IS resources) possessed by a firm can be classified into three types: outside-in, inside-out, and spanning (see Table 2.2). They explore information systems as a mixture of assets and capabilities formed around the productive use of information technology. Their approach provides a robust conceptual framework of multi-dimensional measures of IS capabilities on a theoretical basis, as well as a way to understand the role of IS resources as elements of a firm that in turn affect the firm at large.

Table 2.2: Typology of IS capabilities by Wade and Hulland (2004)

Type of IS capabilities	Definition	Examples
Outside-in	Externally oriented, focusing on leveraging external resources, creating and managing external relationships	contract facilitation, informed buying, vendor development, contract monitoring (Feeny and Willcocks 1998), coordination of buyers and suppliers, and customer service (Bharadwaj 2000)
Inside-out	Internally focused, deploying from inside a firm, these capabilities are focused on enhancing the capabilities of internal firm operations in response to market requirements and opportunities	flexible infrastructure resources – such as, IT infrastructure (Armstrong and Sambamurthy 1999; Bharadwaj 2000)
Spanning	Involving both internal and external analysis, integrate outside-in and inside-out capabilities of the firm	IS-business partnerships – such as, capacity to understand the effect of IT on other business areas (Benjamin and Levinson 1993)

2.3.2 Specification of IS Capabilities

IS capabilities in this study refer to firm-specific IT assets and abilities that influence how post-implementation IT applications and IT-related resources are used in the supply chain environment. The notion of IS capabilities in this study is derived from the work of Wade and Hulland (2004) on the typology of IS resources. As a general and conceptual framework, this typology must be situated within appropriate research contexts and with variables tailored to the specificity of the IS domain to empirically reflect each dimension of the capabilities. The RBV stresses the ‘uniqueness’ of corporate resources, that is, it is the valuable, rare, inimitable, and non-substitutable resources that a firm controls can differentiate the firm’s performance from its competitors (e.g., Barney, 1991; Bharadwaj, 2000). While it is often challenging to find resources that precisely fit these requirements (Dong *et al*., 2009), these requirements have been used as guidelines to find three resources that are particularly relevant in this research setting – IT for supply chain activities, flexible IT infrastructure, and IT operations shared knowledge. These three dimensions of IS capabilities are identified for the following reasons:

(1) IT for supply chain activities (ITSCA) is defined as a firm's use of IT for processing transactions, co-ordinating activities, and facilitating collaboration with suppliers and customers through information sharing. The use of IT for supply chain activities represents *outside-in IS capabilities* that facilitate a firm's efforts to manage the linkages with its suppliers and customers. Through information collection and exchange from the external sources, ITSCA provides firms with the ability to work with their suppliers to develop appropriate systems and infrastructure requirements for them (Feeny and Willcocks, 1998), and to manage customer relationships by providing support, solutions, and/or customer service (Bharadwaj, 2000). Capabilities in respect of working with and managing these relationships among external partners are valuable organisational assets, leading to competitive advantage and superior firm performance.

(2) Flexible IT infrastructure (ITINF) refers to a firm's ability to deploy a shareable platform that supports a foundation for data management, a communications network, and an application portfolio. A flexible IT infrastructure represents *inside-out IS capabilities* for a firm and these capabilities influence the strategic use of IT. The digitally-enabled supply chain processes require connecting functions at the back end that enable the effective information flow among various units of the firm and across the supply chain (Dong *et al*., 2009). A flexible and superior IT infrastructure provides an integrated platform that enforces standardisation and integration of data and processes (Lu and Ramamurthy, 2011). This level of integration links Web applications with back-office databases and facilitates timely and accurate information gathering and sharing along the value chain (Zhu and Kraemer, 2005).

(3) IT operations shared knowledge (ITOSK), is used to reflect the overlapping know-how between IT and line managers. It is defined from the perspective of the line manager and refers to the knowledge that the operations manager possesses about how IT can be effectively used to achieve the supply chain processes and operational

activities. IT operations shared knowledge represents *spanning IS capabilities* for a firm, reflecting the extent to which the firm enables management's ability to understand the value of IT investments and the processes of integration and alignment between the IS function and other functional areas of the firm (Lu and Ramamurthy, 2011; Wade and Hulland, 2004). Table 2.3 provides an overview of the typology of IS capabilities in this study, followed by detailed discussion.

Table 2.3: Typology of IS capabilities in this study

Type of IS capabilities	Dimension	Definition
Outside-in	IT for supply chain activities (ITSCA)	a firm's use of IT for processing transactions, co-ordinating activities, and facilitating collaboration with suppliers and customers through information sharing
Inside-out	Flexible IT infrastructure (ITINF)	a firm's ability to deploy a shareable platform that supports a foundation for data management, a communications network, and an application portfolio
Spanning	IT operations shared knowledge (ITOSK)	the knowledge that the operations manager possesses about how IT can be effectively used to achieve the supply chain processes and operational activities

2.3.2.1 IT for Supply Chain Activities

In the context of supply chains, the value of IT has been studied in terms of e-Business transactions and their impact on sales, procurement, and internal operations (Zhu and Kraemer, 2005). In contrast to traditional stand-alone IT innovations, IT-enabled supply chain integration is characterised by inter-organisation linkages (Dong *et al.*, 2009). To manage such external linkages, IT has been used for transactions and collaborations in the supply chain. The use of IT for processing transactions, including online purchase orders and sales, targets the automation of structured and routine processes (Saldanha *et al.*, 2013). Such applications utilise IT as a substitute for repetitive human effort, improving the efficiency of transactions (Aral and Weill, 2007).

The use of IT to facilitate collaboration through information sharing with external supply chain members represents a higher level of strategic partnership in the supply chain (Sabath and Fontanella, 2002). Indeed, research from both the IS and OM literatures has recognised the great managerial importance of the role of information sharing in this particular context (e.g., Cachon and Fisher, 2000; Devaraj *et al*., 2007; Mukhopadhyay *et al*., 1995). In itself, information sharing refers to the exchange of critical, often proprietary information between supply chain members through media such as face-to-face meetings, telephone, fax, mail, and the Internet (Mohr and Spekman, 1994). Sharing information with supply chain members is considered important because of its ability to enhance co-ordination (Sengupta *et al*., 2006), since in order for supply chain members to co-ordinate their activities effectively, various types of information must be shared among them (Kulp *et al*., 2004; Monczka *et al*., 1998). Typically, this involves information related to inventory, forecasting, sales, and production schedules (Lee and Whang, 2000; Li *et al*., 2005; Zhao *et al*., 2002b). The benefits of information sharing in the supply chain has been examined by various researchers (e.g., Cachon and Fisher, 2000; Zhou and Benton, 2007). Specifically, Malhotra *et al*. (2007) explain that information exchange in partnerships can mediate the use of standard electronic business interchanges and enhance adaptability in the supply chain. Such IT-enabled supply chain integration has positive impacts upon firm performance (Rai *et al*., 2006).

In this study, IT for supply chain activities (ITSCA) is defined as a firm's use of IT for processing transactions, co-ordinating activities, and facilitating collaboration with suppliers and customers through information sharing. The use of IT for supply chain activities represents *outside-in IS capabilities* that facilitate a firm's efforts to manage the linkages with its suppliers and customers. Through information collection and exchange from the external sources, ITSCA provides firms with the ability to work with their suppliers to develop appropriate systems and infrastructure requirements for them (Feeny and Willcocks, 1998), and to manage customer relationships by providing support, solutions, and/or customer service (Bharadwaj, 2000). Capabilities in respect of working with and managing these relationships among external partners are valuable organisational assets, leading to competitive advantage and superior firm performance.

ITSCA includes a broad range of technologies that are being used by firms to manage their supply chains. Although there are differences between service supply chains and more traditional supply chains, many critical areas in manufacturing supply chains remain equally important in the services context, such as supplier relationship management, customer relationship management, and demand management (Sengupta *et al*., 2006). The related technologies are, therefore, addressed in this study (see Question 8 in Appendix 1.2). While many more technologies exist, this selection is based on the literature appropriate to the research and practising communities, and relates nicely to the technologies that most firms are utilising to advance their supply chain competency, such as web-based/EDI applications, advanced planning and scheduling, supplier relationship management, and customer relationship management systems, etc.

ITSCA includes a selection of related technologies that enable and improve the sharing and exchange of information and data between the focal firm and its supply chain members. The use of such technologies supports a firm's ability to communicate with, and transfer data to and from, its suppliers and customers (e.g., Banker *et al*., 2006a; Bakos and Katsamakas, 2008; Johnson *et al*., 2007). For instance, The Internet and web-based electronic data interchange (EDI) have significantly improved collaboration and integration among supply chain partners, permitting strong information sharing for demand forecasting, order scheduling, and inventory planning (Feeny, 2001). The use of the Internet has had great impact on information exchange between buyers and suppliers (Rabinovich *et al*., 2003), enabling the accessibility of real-time demand information and achievement of inventory visibility (Chopra *et al*., 2001; Lancioni *et al*., 2000). More recently, Mishra *et al*. (2013) confirm that IT capability (including the use of ITSCA) leads to improved inventory efficiency across a wide range of manufacturing and service sectors. With the embedded characteristics to enable information sharing between the focal firm and its supply chain members, ITSCA is expected to have similar effects on facilitating processes for supply chain integration through demand forecasting, production (service delivery) scheduling, and capacity (staff availability) planning and management in the service environment.

This selection of technologies also enables and supports collaboration between the focal firm and its supply chain members. The use of ITSCA enhances a firm's ability to improve collaborative planning (Chen and Paulraj, 2004) and the evaluation of processes and activities conducted with its suppliers and customers (Wu *et al*., 2003). For example, advanced planning systems have been used to leverage the Internet, supply network structure, and distribution network structure. In this respect, such systems as enterprise resource planning (ERP), advanced material requirement planning (MRPⅡ), advanced planning and scheduling, production planning, and production scheduling, all function to support and enhance supply chain communication and visibility. ERP system manages to collect all enterprise data once during the initial transaction, store data centrally, and update data in real time. This ensures that all levels of planning are on the basis of the same data and that the resulting plans realistically reflect the prevailing operating conditions of the firm (Hendricks *et al*. 2007). MRPⅡ systems facilitate and support production planning and order processing, and advanced planning and scheduling systems provide decision support tools for supply chain management (Banker *et al*., 2006a). While such systems are commonly applied in the manufacturing sector, their application in the service sector is also growing (Sengupta *et al*., 2006). Further, the use of purchase management systems which enables service firms to purchase material and services via the Internet (Sengupta *et al*., 2006), fosters inter-firm co-ordination, and integrate their business processes with those of their suppliers (Pearcy and Giunipero, 2008). At the same time, process monitoring systems provide firms with the ability to electronically monitor and analyse their spending and their suppliers' performance (Wiengarten *et al*., 2013).

2.3.2.2. Flexible IT Infrastructure

IT infrastructure, as a capability that influences the strategic use of IT, refers to a firm's ability to deploy shareable platforms that provide the foundation upon which specific IT applications are built and developed (Broadbent and Weill, 1997; Duncan, 1995). Such foundation includes four primary constituents: (1) computing platform (hardware and operating systems), (2) communications network, (3) critical shared data, and (4) core data processing applications (Byrd and Turner, 2000). A firm's IT infrastructure capability captures the extent to which the firm is good at managing data management services and architectures, network communication services, and application portfolio and services (e.g., Bharadwaj, 2000; Broadbent *et al*., 1999b; Ross *et al*., 1996; Weill *et al*., 2002; Sambamurthy *et al*., 2003).

Previous studies recognise that some components of IT infrastructure (e.g., off-the-shelf computer hardware and software) convey no particular strategic benefit due to their lack of rarity and ready mobility (Mata *et al*., 1995; Powell and Dent-Micallef, 1997; Ray *et al*., 2001). Therefore, most of the existing RBV-IS work has attempted to identify the types of IT infrastructure and has focused on the non-imitable aspects IT infrastructure – proprietary, complex, and hard to imitate (Benjamin and Levinson, 1993). Duncan (1995) argues that IT infrastructure is a complex set of technological resources developed over time. The flexibility of IT infrastructure determines the ability of the IS department to respond quickly and cost-effectively to systems demands, which evolve with changes in business processes or strategies, and such resource is heterogeneously valuable or unlikely to be accessible by competing firms. Broadbent and Weill (1997) support the notion that a flexible IT infrastructure enables a firm’s strategic options, and the limitations of the firm’s competitors’ infrastructures, restrict their ability to match efforts.

In this study, flexible IT infrastructure (ITINF) refers to a firm’s ability to deploy a shareable platform that supports a foundation for data management, a communications network, and an application portfolio. A flexible IT infrastructure represents *inside-out IS capabilities* for a firm and these capabilities influence the strategic use of IT. The digitally-enabled supply chain processes require connecting functions at the back end that enable the effective information flow among various units of the firm and across the supply chain (Dong *et al*., 2009). A flexible and superior IT infrastructure provides an integrated platform that enforces standardisation and integration of data and processes (Lu and Ramamurthy, 2011). This level of integration links Web applications with back-office databases and facilitates timely and accurate information gathering and sharing along the value chain (Zhu and Kraemer, 2005).

2.3.2.3 IT Operations Shared Knowledge

Beyond their technological capabilities, firms must possess the ability to understand the business value of IT in the supply chain environment (Armstrong and Sambamurthy, 1999). Building internal relationships between IS and other business areas is an important capability for a firm wishing to pursue improved performance (Wade and Hulland, 2004). Such capability refers to the ability of a firm's management to envision and exploit IT resources to support and enhance business objectives, represented by management's ability to understand the strategic use of IT (Lu and Ramamurthy, 2011).

> *"All the IT people can do is provide the appropriate technology platform, program the systems, and install the equipment. It is the task of line management to make the extremely difficult, but very necessary, changes in personnel, roles, allied systems, and even organization structure required to make today's uses of IT pay off for the company." – Dudley Cooke, Sun's general manager of information systems (Rockart, 1988)*

Rockart (1988) introduces line leadership as an important element of IS management, since line management involvement is required in order to effectively use IT. He argues that as IT has become increasingly significant in business operations, its use should be shaped not only by the IT managers responsible for designing and programming the systems, but also by line managers who are running the business. To effectively operate IT systems, major or radical alterations in business processes are required. Thus, the outcomes of IT applications should be well considered and the requisite process changes should be effectively managed by those who are responsible for the business. Line management, therefore, plays a critical role in terms of the strategic use of IT. In a similar manner, Henderson (1990) documents that IT personnel are viewed as a service team that provides resources and support to line managers in their pursuit of business goals or objectives. To better apply IT in facilitating the achievement of business goals, line managers are required to develop an appreciation and understanding of the technology and the task environment of IT personnel. Thus, the shared knowledge of IT among line managers is crucial in determining the value of IT. In the abstract, Rockart (1988) and Henderson (1990) examined the significance of the development of IT-knowledgeable line managers, confirming that while the shared knowledge from both IT and line sides is important, it is the shared knowledge of line managers concerning IT that enables the strategic use of IT.

Similarly, Boynton *et al*. (1994) use absorptive capacity theory to suggest that the use of IT in an organisation is influenced by the presence of IT-related knowledge that binds the firm's IT and line managers. The theoretical insights of absorptive capacity theory provide a strong basis from which to examine the nature and the significance of line management involvement, and line and IT manager information exchanges and relationships within an organisation. An absorptive capacity refers to an organisation's ability to absorb through its internal knowledge structures, information regarding appropriate innovations so that these innovations can be assimilated and applied in support of operational or strategic tasks within the organisation (Cohen and Levinthal, 1990). In this setting, IT-business knowledge can be viewed as a firm's ability to absorb information through its IT knowledge structures, and to accumulate information regarding appropriate IT functions and innovations so that the knowledge and information related to IT can be assimilated and applied in support of the firm's operations. Therefore, the conjunction of IT and business-related knowledge represents a key component of a firm's absorptive capability. Cohen and Levinthal (1990) point out that there should be a tight intermesh of sub-units within an organisation, to enable cross-functional absorptive capacities. This perhaps echoes the observations of Nelson and Winter (1982), who suggest that an organisation's capabilities do not reside in any single individual, but depend on the collection of activities, interactions and exchanges among a number of individuals. Cohen and Levinthal (1990) argue that this collection represents the internal knowledge structure, the overlapping extent of this knowledge across different business areas, and the interactions among people within an organisation, all of which influence who knows what and who can help with what problem.

In this study, IT operations shared knowledge (ITOSK), is used to reflect the overlapping know-how between IT and line managers. It is defined from the perspective of the line manager and refers to the knowledge that the operations manager possesses about how IT can be effectively used to achieve the supply chain processes and operational activities. IT operations shared knowledge represents *spanning IS capabilities* for a firm, reflecting the extent to which the firm enables management's ability to understand the value of IT investments and the processes of integration and alignment between the IS function and other functional areas of the firm (Lu and Ramamurthy, 2011; Wade and Hulland, 2004). Developed from the shared knowledge construct of Ray *et al*. (2005), IT operations shared knowledge in this study is similar to theirs, but places more emphasis on the line manager's side of the dyad, which allows the research to focus on the influence of line management involvement. In particular, it concentrates on the IT-business knowledge that operations managers possess about the potential opportunities produced from applying IT within their business domain, and the extent to which those managers share a common understanding of the business benefits to be obtained from the use of IT.

2.4 Conclusions

Based on the review of the existing literature, it was initially assumed that all of the above three IS capabilities are valuable in the sense that they have the potential to facilitate supply chain integration and improve operational performance. These three IS capabilities are identified within the framework proposed by Wade and Hulland (2004) and are suited to the supply chain environment. IT for supply chain activities (ITSCA) reflects the capability to manage the external relationships (outside-in). Flexible IT infrastructure (ITINF) capability provides a shareable digital platform and takes advantage of technological advances (outside-in). IT operations shared knowledge (ITOSK) enables a firm to link these outside and inside capabilities into the overall corporate strategy (spanning). In addition, obtaining these capabilities involves developing firm-specific resources (i.e. ITINF and ITOSK) and fostering collaborative relationships in the supply chain (ITSCA), which are not easy to achieve and which are hard for competitors to replicate. In this sense, the existence of these IS capabilities may be viewed as evidence of underlying capabilities that could meet the criteria of ‘uniqueness’ of resources (Bharadwaj, 2000).

The focus of this study is to explore how the three IS capabilities of a firm, discussed within this chapter, could lead to improved operational performance through enhancing supply chain integration processes. The following chapter will review IS capabilities in the context of supply chains and explore the importance of supply chain integration on improving operational performance. The arguments arising by examining each set of IS capabilities, and the development of research hypotheses about the impact of these dimensions of IS capabilities on supply chain integration and operational performance, are detailed and discussed in Chapter Four.

CHAPTER THREE:

SUPPLY CHAIN INTEGRATION

3.1 Introduction

This chapter reviews IS capabilities in the context of supply chains and explore the role of supply chain integration on improving operational performance. Beginning with a recounting of the academic basis of supply chain integration, this chapter discusses the theoretical understanding of supply chain integration and the importance of supply chain integration on operational performance in detail. Furthermore, the final section explores the concept of supply chain integration in the service business with consideration of the distinguishing characteristics of services, including operational performance measures in the service context.

3.2 IS Capabilities in the Supply Chain

According to Davenport (1993:5), a business process is “the specific ordering of work activities across time and space, with a beginning, an end, and clearly identified inputs and outputs”. From the perspective of the RBV, business processes provide a context where the locus of direct resource exploitation is examined. Examples of business processes include order taking, product assembly, and distribution. Most researchers acknowledge that resources, by themselves, cannot lead to competitive advantage. Put differently, resources can only be a source of competitive advantage if they are used to ‘do something;’ for example, if those resources are used and exploited through business processes. Porter (1991:108) states that “resources are not valuable in and of themselves, but they are valuable because they allow firms to perform activities … business processes are the source of competitive advantage". Stalk *et al*. (1992) further document that the building blocks of corporate strategy are business processes, not products nor markets. Ray *et al*. (2004) argue that business processes are the competitive potential in which a firm's resources and capabilities are realised.

A single firm executes a number of business processes to achieve its strategic objectives, thereby raising a range of opportunities for IS resources to improve processes and organisational performance (Porter and Millar, 1985). In the net-enabled organisation (Straub and Watson, 2001), IS may not only enhance individual processes, but may also improve process synthesis and integration across organisational boundaries, linking multiple firms via electronic networks and software applications, and melding their business processes (Basu and Blanning, 2003; Hammer, 2001; Mukhopadhyay and Kekre, 2002; Straub *et al*., 2004). As a result, trading partners increasingly impact upon the generation of IS business value for the focal firm (Bakos and Nault, 1997; Chatfield and Yetton, 2000; Clemons and Row, 1993). Melville *et al*. (2004) adapt the formulation of business processes to the trading partners of a focal firm, providing a conceptual foundation for understanding the impact of trading partner business processes on the generation of value coming from the IS in the focal firm. They propose that the business processes of electronically-connected trading partners shape the focal firm's ability to generate and capture the impacts of IS on organisational performance.

3.3 Definition of Supply Chain Integration

In the context of a supply chain, integration with external partners recognises the importance of establishing close, interactive relationships with customers and suppliers. Although there is an extensive body of research examining the collaborative relationships among a supply chain, the definitions of supply chain integration (SCI) are broad in focus. While some definitions place an emphasis on flows of materials and parts, others focus on flows of information, resources and cash. Some studies have operationalised the concept unidimensionally and focused on managing a supply chain as a single system (e.g., Rosenzweig *et al*., 2003; Cousins and Menguc, 2006), others have broken SCI into internal and external integration (e.g., Pagell, 2004; Campbell and Sankaranl, 2005), and yet others have concentrated only on the external integration (e.g., Frohlich and Westbrook, 2001; Petersen *et al*., 2005; Das *et al*., 2006; Devaraj *et al*., 2007; Koufteros *et al*., 2007; Ragatz *et al*., 2002).

Distinguishing from those studies which ignore the differences between the dimensions of integration, the most recent research in this domain (Flynn *et al*., 2010; Wong *et al*., 2011; Zhao *et al*., 2011; Schoenherr and Swink, 2012) conceptualises supply chain integration as the strategic collaboration of supply chain partners and the collaborative management of inter-organisational and intra-organisational processes that facilitate the effective and efficient flows of products and services, information, money and decisions, with the goal of providing maximum value to the customer.

Behind this definition are some important elements of SCI. Firstly, the importance of strategic collaboration is highlighted. Strategic collaboration is an ongoing partnership to achieve strategic goals of mutual benefit through enabling mutual trust, increasing contract duration, and engendering efficient conflict resolution, and the sharing of information, rewards, and risks (Ellram, 1990). Sanders (2008) argues that strategic co-ordination leads to both operational and strategic benefits. Secondly, inter-organisational and intra-organisational processes are emphasised. Since SCI is comprehensive, various activities are encompassed, including many that are focused on products, delivery, and administrative tasks (Hillebrand and Biemans, 2003; Swink *et al*., 2007). Finally, the nature of SCI as customer-facing is emphasised. In this respect, Flynn *et al*. (2010) state that the primary objective of SCI is to provide maximum value for the customer.

This study focuses on SCI as external integration, namely supplier integration and customer integration, analysing supply chain relationships from the perspective of the focal firm. Following Zhao *et al*. (2011) and Schoenherr and Swink (2012), SCI in this study is defined as the degree to which a firm strategically co-ordinates and collaborates with its supply chain partners (suppliers and customers) to structure their inter-organisational strategies, practices, procedures, and behaviours into synchronised and manageable processes in order to fulfil customer needs. The aim of SCI is to manage supply chain flows in order to reduce costs, improve on-time delivery, reduce lead-times, and improve flexibility (Wiengarten *et al*., 2014).

To this end, SCI involves making strategic alliances with suppliers and customers, such that strategic partnerships are built with its suppliers and customers and strategies are jointly developed in response to market opportunities (Narasimhan and Kim, 2002). Supplier integration involves information sharing and co-ordination between a focal firm and its suppliers, which provides the firm with insights into the processes, capabilities, and constraints of its suppliers, and ultimately engenders more effective planning and forecasting, product and process design, and transaction management (Ragatz *et al*., 2002). Likewise, customer integration involves close collaboration and information sharing activities between a focal firm and its customers, which provides the firm with strategic insights into market expectations and opportunities (Wong *et al*., 2011), and ultimately enables a more efficient and effective response to customer needs (Swink *et al*., 2007).

3.4 Themes of Supply Chain Integration

Important themes in SCI are information sharing, synchronised and collaborative planning, and working together with supply chain members to jointly resolve problems and facilitate operations (Zhao *et al*., 2011). Information is recognised as an important driver of supply chain management through its ability to enable firms to substitute information for different supply chain activities. The types of information shared typically include information related to inventory, sales, and production schedules (Lee and Whang, 2000). Information sharing refers to the exchange of critical, often proprietary, information between supply chain members through media such as face-to-face meetings, telephone, fax, mail, and the Internet (e.g., Mohr and Spekman, 1994; Sanders, 2007). It is absolutely essential for supply chain members to exchange various types of information if they wish to co-ordinate their activities effectively (Kulp *et al*., 2004; Monczka *et al*., 1998). Indeed, Benton and Zhou (2007) reveal that effective information sharing significantly enhances supply chain practices, such as supply chain planning. The types of information exchanged may include, but are not necessarily limited to, inventory and replenishment, consumer research, financial status, growth ability, overhead cost structure, production capacity, or proprietary technology (Kulp *et al*., 2004; Monczka *et al*., 1998; Noordewier *et al*., 1990; Uzzi, 1997). Furthermore, to sustain a successful partnership, information sharing between partners should be frequent, bi-directional, informal, and non-coercive (Mohr *et al*., 1996; Mohr and Nevin, 1990; Mohr and Spekman, 1994).

Collaborative planning refers to collaboration among trading partners to develop various plans such as production planning and scheduling, new product development, inventory replenishment, and promotions and advertisement. They may explicate future contingencies and the resulting duties and responsibilities in the relationship (Claro *et al*., 2003). To obtain improved operational performance, firms in the supply chain often undertake initiatives to co-ordinate and streamline various activities through the active exchange of necessary information (Monczka *et al*., 1998). This is confirmed in previous studies as a helpful strategy since those studies commonly report that collaborative planning and actions relate positively to supply chain and operations outcomes (Kulp *et al*., 2004; Mohr and Spekman, 1994).

Working together with suppliers and customers enables a focal firm to jointly resolve problems with its supply chain members and facilitate its operations. Such co-ordination produces a seamless connection between the firm and its suppliers and customers in such a way that the boundary of activities among the supply chain partners becomes blurred (Stock *et al*., 2000). In turn, connections and linkages with suppliers and customers facilitate the firm’s management of the flow and/or quality of inputs from suppliers to the firm as well as the flow and/or quality of outputs from the firm to the customer (Rungtusanatham *et al*., 2003a).

Along with benefits discussed above, integration activities also involve costs. Expensive technologies and more involved communication protocols may be required for increased levels of integration. Furthermore, as Sorenson (2003) points out, the loss of a degree of independence brought about by integration, has the potential to decrease innovation and cause inflexibility. In this sense, elaborate integration mechanisms may not always be appropriate, depending on the nature of products and competitive priorities of a firm (Fisher, 1997). In general, however, researchers have supposed that the benefits derived from integration activities outweigh their associated costs, leading to overall greater levels of operational performance (Schoenherr and Swink, 2012).

3.5 The Value of Supply Chain Integration

Supply chain integration represents the higher level of supply chain management (Stevens, 1989, 1990; Flynn *et al*., 2010). A substantial number of studies have examined the influence of SCI on performance, producing mixed findings from their empirical efforts. For example, researchers have reported that supplier integration leads to better product development performance (Koufteros *et al*., 2007; Ragatz *et al*., 2002), but significant links between supplier integration and other dimensions of performance have not been empirically supported (Cousins and Menguc, 2006; Flynn *et al*., 2010; Stank *et al*., 2001), and some studies have even reported negative relationships (Narasimhan *et al*., 2010; Swink *et al*., 2007). Das *et al*. (2006:568) discuss the positive and negative effects of supplier integration and go as far as to refer to the concept as “an ambivalent intervention in terms of impact”. Likewise, the findings for customer integration are inconsistent. For example, researchers have found positive relationships with quality, product innovation, and market success (Koufteros *et al*., 2005), logistical performance (Germain and Iyer, 2006), and quality, delivery, flexibility, and cost performance (Wong *et al*., 2011), yet others have been unable to confirm significant links to operational performance (Devaraj *et al*., 2007), or business performance (Flynn *et al*., 2010). Although the findings for the impacts of SCI are inconclusive, the importance of such integration is reflected by some influential SCI studies that only investigate external integration (Frohlich and Westbrook, 2001; Petersen *et al*., 2005; Das *et al*., 2006; Devaraj *et al*., 2007; Wiengarten *et al*., 2014).

3.5.1 Theory: The RBV Approach to Supply Chain Integration

As discussed earlier, the resource based view of the firm (RBV) considers firms as bundles of distinct resources (Wernerfelt, 1984) and suggests that firms are able to generate rents or competitive advantage by developing and holding unique and hard-to-imitate resources and capabilities (Barney, 1991; Day, 1994). Accordingly, a firm's resources include tangible and intangible factors such as physical assets, human capital, and intra- or/and inter-organisational routines and procedures (Menor *et al*., 2001; Roth and Menor, 2003; Sinkovics and Roath, 2004; Swafford *et al*., 2008). While the traditional RBV literature emphasises the firm's internal resources, researchers have started to study the importance of external resources that are available to the firm through its networks (Gulati, 1999; Hunt and Davis, 2008; Zaheer and Bell, 2005). The embeddedness of firms in external relationships produces significant implications for firm performance (Gulati *et al*., 2000). Therefore, the relevance of the RBV to SCI becomes evident because of the engagement of both internal and external resources (Chen *et al*., 2009).

In fact, researchers have long recognised the relevance of the RBV to effective SCI (Chen *et al*., 2009; Das *et al*., 2006; Devaraj *et al*., 2007; Rosenzweig *et al*., 2003; Swink *et al*., 2007; Wang and Wei, 2007; Schoenherr and Swink, 2012). The RBV forwards the notion that firms differentiate themselves by employing their unique resources in distinctive ways that cannot be easily replicated by others (Barney, 1991; Wernerfelt, 1984). Such resources are often developed upon the basis of relation-specific organisational routines (Holweg and Pil, 2008), and tacit-knowledge-intensive processes (Rosenzweig *et al*., 2003). These supply chain researchers have centred on the 'relational' resources associated with SCI. For example, Wang and Wei (2007) note that SCI can serve as a means for creating a system of integrative and effective relational governance for a firm. Through their use of intensive SCI processes, firms can obtain competence that enable them to exploit and acquire unique knowledge, that in turn, can improve transactional efficiencies, solve problems, and identify new product and business opportunities (Rosenzweig *et al*., 2003; Chen *et al*., 2009; Swink *et al*., 2007; Das *et al*., 2006). Additionally, they acquire competence that enables them to develop relationships that translate into lasting performance benefits (Jap, 2001; Schoenherr and Swink, 2012). To develop such organisational competence, a firm typically needs to create effective communication protocols, languages, understandings, and collaborative values that can be shared with its supply chain partners. In this way, the firm can grow and develop its relational and collaborative competence, which is viewed as a key resource that leads to operational and competitive advantages (Cao and Zhang, 2011; Mishra and Shah, 2009).

According to the RBV, when a firm holds resources that are valuable to it, rare to come by, imperfectly mobile, not imitable by competitors, and not substitutable, that firm gains a sustainable competitive advantage. In the context of SCI, the goal of closely integrating operations between a firm and its suppliers and customers, is typically pursued in order to create and co-ordinate the range of processes across the supply chain in a seamless manner that most competitors cannot very easily match (Anderson and Katz, 1998; Lummus *et al*., 1998). Jap (2001) documents that the embeddedness of supply chain partners' assets makes imitation difficult. Similarly, Rungtusanatham *et al*. (2003a) argue that the resulting connections from the linkages with suppliers and customers can potentially render competitive benefits to a firm. More specifically, the extent to which the connections exclude competing firms from forming the same connections with the same critical suppliers and/or customers for the same purpose, should provide competitive advantages to the firm. They further note that as these connections facilitate the management, flow and/or quality of materials into (i.e. raw materials) and out of (i.e. finished goods and services) the firm, the benefits should accrue directly to operational performance.

3.5.2 Supply Chain Integration and Operational Performance

In this study, operational performance refers to how well a firm achieves its operational outcomes compared to its competing firms (Schoenherr and Swink, 2012; Cao and Zhang, 2011). Applying the theoretical foundations cited in the previous section, greater levels of integration with suppliers and customers are expected to have positive influence on operational performance. Integration between supply chain members requires the adoption of practices such as joint planning and forecasting

(Frohlich and Westbrook, 2001), as well as investments in the supply chain relationship (e.g., Johnston *et al*., 2004), and the associated technologies (Das *et al*., 2006). The maintenance of SCI also requires resources. To build and benefit from integration, investments in time and resources are also required so that the chain members can share, acquire, and use knowledge coming from other organisations (Hult *et al*., 2004). In other words, SCI involves organisational routines that are developed among firms in a supply chain. These inter-organisational connections create distinctive pairings of individual capabilities that are built upon tacit and heterogeneous knowledge (Schoenherr and Swink, 2012). For example, higher levels of integration often embrace joint commitments, dedicated relationships, and co-developed systems that may be peculiar to the capabilities, knowledge assets, and other characteristics of specific dyads of supply chain partners (Swink *et al*., 2007).

Accordingly, inter-firm integration can create combinations of unique skills, knowledge, and joint capabilities. Greater integration with suppliers and customers is likely to lead to product quality improvements, as the integration facilitates the focal firm's efforts to solve problems jointly with its supply chain partners, identify challenges quickly, launch communication quickly, and gain a deeper understanding of the interdependencies among supply chain processes (Deming, 1982; Leuschner *et al*., 2013). Additionally, through jointly generating ideas and evaluating these, both suppliers and customers can produce better product design and launch quality (Clark, 1989). Supply chain integration enables the chain members to share information on supply and demand as well as on production plans and forecasts, and hence, the focal firm can benefit in its delivery and flexibility performance by controlling more accurate and up-to-date demand and supply information, more detailed production plans and forecasts, and clearer future trends and directions (Lee *et al*., 1997a). Through integration with suppliers and customers, supply chain partners are more able to understand and anticipate each other's needs, reducing uncertainties (Swink *et al*., 2007), and enabling better performance in terms of quality, delivery, flexibility, and cost (Wong *et al*., 2011).

Supply chain integration supports external routines and processes that collect accurate supply and demand information essential for the co-ordination of a firm's operations tasks, e.g., procurement, production, and logistics (Stank *et al*., 1999). With a low level of supply chain integration, the firm is more likely to receive inaccurate or distorted supply and demand information, which results in poor production plans, high level of inventory, and poor delivery reliability (Lee *et al*., 1997a; Lee and Billington, 1992).

Whether concerned with supplier integration or customer integration, the majority of the existing studies have found a positive relationship between SCI and performance (Gimenez *et al*., 2012). For example, Armistead and Mapes (1993), in their field study of managers from 38 firms in the UK, find that increasing the level of integration does increase operating performance in terms of quality, cost, delivery time, and flexibility. Narasimhan and Jayaram (1998) propose that SCI impacts upon both internal operational performance, and external customer responsiveness, through key causal linkages in a supply chain. And conducting a survey of industrial equipment distributors, Johnson (1999) shows that strategic integration results in enhanced economic rewards for the customer firm. In their seminal work, Frohlich and Westbrook (2001) introduce the concept of 'arcs of integration' in which supplier and customer integration are the fundamental components. They empirically identify that manufacturers with the broadest arcs of SCI demonstrate the highest levels of performance improvement. Specifically, Frohlich and Westbrook (2001) point out that the strong relationship evidenced in the largest arcs of supplier and customer integration, lead to increased market share and profitability. Vickery *et al*. (2003) show positive direct relationships between ACI and customer service; and Gimenez and Ventura (2005) indicate that higher levels of SCI promote better logistics performance. More recently, Wong *et al*. (2011) and Wiengarten *et al*. (2014) also find support in their studies that SCI has positive impacts on cost, delivery, and flexibility performance.

3.6 Supply Chain Integration and the Service Industry

Much of the extensive body of research on supply chain management and firm performance has been conducted in the manufacturing context. As a result, little research has been studied in respect of services. Particularly, few studies have linked supply chain integration to operational performance in services. As in the case of manufacturing, integration along the supply chain is also vitally important for service firms. Hence, the supply chain integration concept would be adapted to the service business, taking into account the distinguishing characteristics of services.

3.6.1 Differences between Manufacturing and Services

The literature has long recognised important differences between manufacturing and services firms (McColgan, 1997). In the case of the latter, the structural difference of a service supply chain basically arises from the unique characteristics of services, which differentiate them from goods. These differences change the nature of service operations in practice. Notably, Frohlich and Westbrook (2002) summarise numerous unique characteristics of service operations that are rarely found in manufacturing, as being: customer participation, intangibility, inseparability of production and consumption, heterogeneity, perishability, and labour intensity (Nie and Kellogg, 1999).

1. Customer Participation

In one way or the other, customer participation is involved in service products. Direct customer participation in the service process adds complexity, which is generally not found in the manufacturing context (Chase and Tansik, 1983). Moreover, the direct participation of customers means that service firms tend to have many more physical sites than manufacturers, and such wide geographic dispersion creates unique challenges (Frohlich and Westbrook, 2002).

2. Intangibility

Intangibility is often cited as another fundamental distinguishing characteristic of services, since a service cannot be seen, touched or tasted in the same manner as a manufactured product (Fitzsimmons and Fitzsimmons, 2001; Lovelock, 1981; Parasuraman *et al*., 1985). The intangibility of services is the main reason why a number of logistics activities cannot be applied to service supply chains. An evident example is transportation. In a service supply chain, the physical flow of a service product from the supplier to the producer and then to the consumer is not possible by nature (Gronroos, 1990; Zeithaml and Binter, 1996). The service may be pre-customised and then may be delivered to the consumers via branches or other intermediaries, the service delivery does not constitute a transportation activity as the services are also simultaneous.

3. Simultaneity

Simultaneity reflects the inseparability of production and consumption whereby customers must be present for the service to be provided. In a service setting, customers usually contribute to the production process, and instant consumption happens simultaneously once the production is realised. This fact presents a major structural difference in service supply chains, in that the service production process usually takes place only when the service provider and the service customer are both present in the service environment and these parties cannot be separated from each other in the production phase (Baltacioglu *et al*., 2007). In this context, although some services may be customised and standardised beforehand, the final service product is never the same for any one consumer. Therefore, each service-providing interface, either a branch or a service employee, serves as a single service factory.

4. Heterogeneity

Heterogeneity addresses the fact that services cannot be easily standardised. Services tend to have higher heterogeneity and, therefore, can be either deliberately or accidentally customised between different service providers and customers, unlike the situation that exists in manufacturing where there is typically a greater standardisation process associated with the product (Frohlich and Westbrook, 2002). So, depending upon customer perceptions, mood, and the service atmosphere, customers very in their experiences of a service each time they are delivered it. This heterogeneous nature of services contributes to create complexity in planning and in analysing the production of services, as well as in the measurement of output (Jones and Hall, 1996).

5. Perishability

Services are perishable and if a service is not consumed when that service is available, there is no opportunity to stock it for future use. Hence, that unused capacity is lost forever, leading to difficulties in managing demand, utilising capacity, planning services, and scheduling labour (Frohlich and Westbrook, 2002). This characteristic makes it impossible to store services in a warehouse, implying the total inapplicability of the warehousing function in service supply chains.

6. Labour Intensive

Service industries are labour intensive. Typically, services are more labour intensive than is the case in manufacturing (Heskett, 1986). While manufacturers can often realise productivity gains through technological innovations (Quinn and Gagnon, 1986), service productivity can be improved by enlarging the involvement of customers in service processes (Fitzsimmons, 1985).

3.6.2 Supply Chain Integration in the Service Industry

Despite the extensive body of research in the supply chain management (SCM) field, the majority of the literature and business applications are concerned with the management of tangible or physical supply chains, and more specifically with the procurement of goods in manufacturing supply chains (Ellram *et al*., 2004; Giannakis, 2011b). Product-based supply chain models, e.g., the Supply Chain Operations Reference (SCOR) model (Supply Chain Council, 2012), and the Global Supply Chain Forum Framework (GSCF) model (Croxton *et al*., 2001), are well established as vehicles for understanding manufacturers and their relationships with supply chain partners. Although placing emphasis on different processes that link the supply chain, these models have the common focus on depicting the physical flow of goods among a supply chain's members. The commonality among manufacturing supply chains is that they involve the movement of goods from suppliers to manufacturers, possibly through a distributor, to the customers. Clearly, manufacturing supply chains can vary in the multiple levels of suppliers, manufacturers, and distributors that they may have as well as in the fact that the flow of goods may be in different directions, but these chains have the common characteristic that they manage the physical flow of goods.

In service supply chains, the obvious common characteristic of managing the flow of goods is lacking. The focus of efficiencies in service supply chains is on management of information flows, capacity, service performance, flexibility of resources and cash flow management (Ellram *et al*., 2004). These issues are quite different from manufacturing supply chains. In addition, human labour forms a significant component of the value delivery process in service supply chains. The traditional approach that physical handling of a product leads to standardised and centralised procedures and controls is not entirely possible in service supply chains, since many of the decisions are taken locally and the variation and uncertainties in outputs are higher in services because of the human involvement (Sengupta *et al*., 2006).

Despite the differences between service supply chains and the more traditional manufacturing supply chains have been highlighted, there are also many areas where there are similarities. For example, demand management, customer relationship management and supplier relationship management are critical factors in manufacturing supply chains that remain equally important in service supply chains (e.g., Sengupta *et al*., 2006; Ellram *et al*., 2004; Baltacioglu *et al*., 2007; Giannakis, 2011b). Be it goods or services, the underlying issues associated with SCM are the same. These relate to how a supply chain can be designed and managed, and how the supply chain's assets and uncertainties can be controlled in order to best meet customer needs in a cost-effective manner (Ellram *et al*., 2004). Although the obvious common characteristic of managing the flow of goods is lacking within services supply chains, one commonality between manufacturing and services is the high degree of uncertainty that exists in these chains. In addition, at least two existing and emerging factors suggest that it is useful to consider services as part of the supply chain, and this perspective provides the potential to apply the traditional manufacturing-oriented supply chain integration strategies to the service industry.

1. Co-ordination of, and Collaboration between, Processes

In designing and delivering services, a large number of independent stakeholders may be involved, and in this respect the various processes undertaken by these different stakeholders need to be co-ordinated. Similar to the production of physical products, the production of services involves the collaboration of several actors, for example, the service providers, the suppliers of other services or resources needed for the design and delivery of these services, and the service clients, all of whom must work together to co-produce value in complex value chains (Giannakis, 2011b).

2. Improved Performance through Process Integration

The adoption of a supply chain perspective in respect of services offers a holistic view of the processes involved in service creation and provision (Narasimhan and Jayaram, 1998). While the processes may differ between the services supply chain and the manufacturing supply chain, the same basic issue exists: there are a host of processes that take place in the supply chain (Ellram *et al*., 2004). In an integrated supply chain, such processes can be effectively coordinated across suppliers and customers in order to best meet the uncertain demands of the customer, leading to improved firm performance (Flynn *et al*., 2010).

This study examines supplier and customer integration from the perspective of information sharing. Sharing information with supply chain partners is important and considered a crucial theme of SCI (Zhao *et al*., 2011). In the manufacturing setting, most related research focuses on information sharing in respect of inventory, forecasting, orders, and production plans (Lee and Wang 1999; Li *et al*., 2005; Zhao *et al*., 2002a). Frohlich and Westbrook (2001) adopt a more robust description of information sharing, similar to that used in the multi-industry context that includes the extent to which firms share information related to inventory levels, demand forecasts, and pricing information. Information flow applies fundamentally to any effective supply chain, as it reduces the uncertainty which can make all types of supply chain extremely risky and reactive (Lee and Billington, 1995; Davis, 1993; Scott and Westbrook, 1991). The traditional manufacturing-oriented supply chain integration strategies, therefore, will be appropriate to the service industry in this study.

3.6.3 Service Operational Performance Measures

In a traditional manufacturing context, operational performance conventionally involves dimensions of cost, quality, delivery, and flexibility (Schmenner and Swink, 1998; Wong *et al*., 2011). In a similar manner, service firms also compete on the basis of cost, quality, delivery, and product and process flexibility (Roth and Van Der Velde, 1991; Safizadeh *et al*., 2003). To improve performance, firms in the service industry focus on both cost reduction and quality improvement (Krishnan *et al*., 1999). As the objective of integrating with suppliers and customers in a supply chain is to synchronise the requirements of the ultimate customer with the flow of products, services, and information along the supply chain in order to reach a balance between maximum customer value and cost (Vickery *et al*., 2003; Flynn *et al*., 2010), this study focuses on cost and quality, the two key performance measurement criteria in operations management, as the process performance outcomes.

In the context of services operations, low cost is often associated with the efficient activities of back-office, where the processes that take advantage of standardisation and automation are expected to enhance the efficiency and effectiveness of operations (Roth and Van Der Velde, 1991; Safizadeh *et al*., 2003). Although quality is multi-dimensional in the manufacturing literature, dimensions of service quality are correlated and make up one construct (Safizadeh *et al*., 2003). This construct incorporates the multiple dimensions related to both internal and external quality. Accordingly, Roth and Van Der Velde (1991) note that internal measures of quality include credibility and responsiveness, while customer perception and reliability are used to measure external quality. Given the intangibility of services and the fact that production and consumption takes place simultaneously, the fulfilment (on-time delivery) should also not be separated from service quality (Parasuraman *et al*., 2005).

3.7 Conclusions

This chapter has reviewed IS capabilities in the context of supply chains, and discussed the importance of SCI in securing operational performance. The body of this chapter explores the concept of SCI in the service business, and argues that traditional manufacturing-oriented supply chain integration strategies can be appropriate to the service industry if consideration is given to the distinguishing characteristics of services. Additionally, services operational performance measures have been further discussed.

In the following chapter, the arguments in respect of each of the IS capabilities are presented, and research hypotheses are developed concerning the impact of the various dimensions of IS capabilities on SCI and operational performance.

CHAPTER FOUR:

RESEARCH MODELS AND HYPOTHESES DEVELOPMENT

4.1 Introduction

This chapter discusses the literature concerning the relationships between each dimension of IS capabilities (IT for supply chain activities, flexible IT infrastructure, and IT operations shared knowledge) and operational performance (cost and quality), and the underlying mechanisms (the processes developed for supplier and customer integration) in services. Additionally, it describes the development of research models and hypotheses regarding the impact of these dimensions of IS capabilities on supply chain integration and operational performance (Models 1–8) in detail.

4.2 Model Development

Despite large yearly investments in IT, and the forecast that worldwide spending in this area will reach $3.8 trillion in 2014 (Gartner, 2013), the information systems (IS) and operations management (OM) literature remains inconclusive regarding the direct benefits IS on a firm's performance. Scholars have applied the RBV of the firm (e.g., Barney, 1991) to argue that IT resources by themselves may not be the VRIN resources held by a firm, and thus it is more useful to focus on how the firm's IS capabilities impact upon its performance (e.g., Bharadwaj, 2000; Santhanam and Hartono, 2003). IS capabilities encompass outside-in, inside-out, and spanning dimensions that allow firms to achieve improved performance (Wade and Hulland, 2004). To evaluate *how* the link between IS and firm performance is created (Devaraj and Kohli, 2003;

Dehning and Richardson, 2002; Tippins and Sohi, 2003), the emerging consensus in the IS research stream has emphasised the importance of investigating the role of IS capabilities in enabling critical organisational processes to improve performance either at process level (Wade and Hulland, 2004) or at firm level (Sambamurthy *et al*., 2003; Mishra *et al*.. 2013).

One of the critical organisational processes in which IS capabilities can play a central role is the integration with external supply chain partners, since these capabilities operate to facilitate such integration. Specifically, research has revealed the value of IT in fostering information flows between the focal firm and its chain partners, and in enabling more effective supply chain management. The studies in question have yielded valuable insights, but since their focus on IS as a highly aggregated concept (e.g., Subramani, 2004; Sanders and Premus, 2005; Zhang and Dhaliwal, 2009) or as one specific type of technology (e.g., Sanders, 2007; Tan *et al*., 2010; Olson and Boyer, 2003), they have resulted in only a limited understanding of the impacts of IS capabilities. In particular, a conceptualisation of how the different dimensions of IS capabilities enable supply chain integration and the resulting influence on the firm's operational performance is lacking (Ray *et al*., 2005; Zhang *et al*., 2011).

Consequently, in this study, theoretical models are built on the existing research linking IS to SCM, and these models complement that research by suggesting specific pathways relating the dimensions of IS capabilities (ITSCA, ITINF and ITOSK) to the processes developed for supply chain integration (supplier and customer) of firms. Further deriving from studies that suggest IS capabilities can help firms understand inter-dependencies in business activities (e.g., Feeny and Willcocks, 1998), this study draws on suggestions that the IS capabilities of a firm enhance the reach and richness of its processes, and this enables the firm to obtain and use high quality information that is timely, current, accurate, complete, and relevant (Sambamurthy *et al*., 2003). In addition, utilising insights from OM research, this study underscores the positive effect of information flows on firms' SCI (e.g., Devaraj *et al*., 2007; Rai *et al*., 2006; Frohlich and Westbrook, 2002; Lee *et al*., 1997a).

In addition to the positive influence of IS capabilities on the SCI of firms, this study theorises how SCI in turn, affects a firm's operational performance (cost and quality).

To formulate the arguments, the research models are built on past OM research on the relationship between SCM and firm operational performance (e.g., Flynn *et al*., 2010; Wong *et al*., 2011). Further, to complete the research models, the indirect effects of IS capabilities on the two metrics of operational performance are evaluated. Indeed, in addition to supplier integration processes (e.g., Frohlich and Westbrook, 2002), IS have been shown to be vital in promoting and sustaining customer integration in terms of managing customer transactions processes (e.g., Tsikriktsis *et al*., 2004), customer connection processes (e.g., Mithas *et al*., 2012), and customer collaboration processes (e.g., Mithas *et al*., 2005).

The following sections propose the indirect effects of IS capabilities (ITSCA, ITINF and ITOSK) on operational performance (cost and quality) through their positive influence on the processes developed for integrating the focal firm with its suppliers and customers (supplier integration, customer transactions, customer connection, and customer collaboration) in a separated manner (see Model 1–8). Detailed discussion of the proposed hypotheses for each model is also presented in the following sections.

4.3 IS Capabilities, Supplier Integration and Operational Performance

4.3.1 IS Capabilities and Their Impact on Supplier Integration

In the context of supply chains, external integration comprises supplier and customer integration. Supplier integration involves strategic information sharing and collaboration between a focal firm and its suppliers with the aim of managing cross-firm business processes (Ettlie and Reza, 1992; Lai *et al*., 2010; Ragatz *et al*., 2002).

High quality information (accurate, timely, complete, and in usable forms) that describes various factors enables supply visibility (Williams *et al*., 2013). Supply-related information commonly includes orders and production schedules (Narasimhan and Das, 2001; Lancioni *et al*., 2000; Li *et al*., 2005), supplier delivery dates and distribution network (Williams *et al*., 2013), demand forecasts (Frohlich and

Westbrook, 2001), and supplier inventory levels (Gavirneni *et al*., 1999). Supplier-oriented information sharing on production and delivery schedules reduces forecast uncertainty and enables more detailed production quantity and timing (Lancioni *et al*., 2000; Wei and Krajewski, 2000; Krajewski and Wei, 2001). Further, sharing demand forecasts from the focal firm provides suppliers with more visibility and facilitates their planning for material and capacity requirements (Lee *et al*., 1997a; Frohlich and Westbrook, 2001). Additionally, when a supplier has access to the focal firm's inventory status, more precise replenishment production and shipment can be scheduled (Devaraj *et al*., 2007).

In the services context, capacity is understood in the same way as inventory in manufacturing, in that it allows a supply chain to increase its production level in order to respond to customer demands (e.g., Ellram *et al*., 2004; Giannakis, 2011a; Anderson *et al*., 2005; Akkermans and Vos, 2003; Akkermans and Voss, 2013). The notion has, therefore, been suggested that adding capacity in services has a similar buffering effect as increasing safety stocks in goods – both allow the supplier to be more responsive and flexible to meet increased customer demands, and both are costly if customer demands are lower than planned . In this sense, similar to a traditional manufacturing supply chain, the service providers must make investments in their processes, assets and staff, differentiating themselves based on the availability and quality of staff or the lack thereof (Bitner, 1995). Further, due to the inability of inventory services, the service sector has less flexibility to deal with uncertain demand (Ellram *et al*., 2004). Information flows in the supply chain, including information sharing and feedback, are thus critically important in services in order to allow for the effective management of this uncertainty surrounding customer demands (Field and Meile, 2008). In particular, Ellram *et al*. (2004) identify information flow as especially vital for the co-ordination of all activities between service providers and supply partners. Similarly, Baltacioglu *et al*. (2007) consider information flow and technology management to be essential for the successful co-ordination of all key functions in the service supply chain.

IS capabilities that enable information to flow freely in real time facilitate the focal firm's efforts to operate seamlessly across boundaries (e.g., Sanders and Premus, 2005). The following sections provide detailed discussions on the relationship between each dimension of IS capabilities and supplier integration.

4.3.1.1 IT for Supply Chain Activities and Supplier Integration

IT for supply chain activities (ITSCA) refers to the extent to which a firm has adopted IT for processing transactions, co-ordinating activities, and facilitating collaboration with suppliers and customers through information sharing. Firms' use of ITSCA has the potential to promote their supplier integration through providing and exchanging efficient, timely, and transparent business information (e.g., Cagliano *et al*., 2003; Devaraj *et al*., 2007).

IT for supply chain activities (ITSCA) enables and improves the sharing and exchange of information and data between the focal firm and its suppliers. The use of ITSCA supports a firm's ability to communicate with, and transfer data to and from, its suppliers (e.g., Banker *et al*., 2006a; Bakos and Katsamakas, 2008; Johnson *et al*., 2007). For instance, The Internet and web-based electronic data interchange (EDI) have significantly improved collaboration and integration among supply chain partners, permitting strong supplier integration for demand forecasting, order scheduling, and inventory planning (Feeny, 2001). The use of the Internet has had great impact on information exchange between buyers and suppliers (Rabinovich *et al*., 2003), enabling the accessibility of real-time demand information and achievement of inventory visibility (Chopra *et al*., 2001; Lancioni *et al*., 2000). More recently, Mishra *et al*. (2013) confirm that IT capability (including the use of ITSCA) leads to improved inventory efficiency across a wide range of manufacturing and service sectors. With the embedded characteristics to enable information sharing between the focal firm and its suppliers, ITSCA is expected to have similar effects on facilitating supplier integration through demand forecasting, production (service delivery) scheduling, and capacity (staff availability) planning and management in the service environment.

In addition, ITSCA enables and supports collaboration between the focal firm and it suppliers. The use of ITSCA enhances a firm's ability to improve collaborative planning (Chen and Paulraj, 2004) and the evaluation of processes and activities conducted with its suppliers (Wu *et al*., 2003). For example, advanced planning systems have been used to leverage the Internet, supply network structure, and distribution network structure. In this respect, such systems as enterprise resource planning (ERP), material requirements planning (MRP), advanced planning and scheduling, and inventory management, all function to support and enhance supply-related communication and visibility (e.g., Hendricks *et al*. 2007; Banker *et al*., 2006a). While such systems are commonly applied in the manufacturing sector, their application in the service sector is also growing (Sengupta *et al*., 2006). Further, the use of purchase management systems which enables firms to purchase material and services via the Internet (Sengupta *et al*., 2006), fosters inter-firm co-ordination, and integrate their business processes with those of their suppliers (Pearcy and Giunipero, 2008). At the same time, process monitoring systems provide firms with the ability to electronically monitor and analyse their spending and their suppliers' performance (Wiengarten *et al*., 2013).

ITSCA also allows firms' suppliers to be better informed about demand in the end-customer markets through information sharing (Xue *et al*., 2013). Suppliers can then develop their own knowledge and capabilities to serve end customers and meet their needs (Anderson *et al*., 2003). By providing the firm with an understanding of each supplier's goals and capabilities, ITSCA facilitates the firm's efforts to achieve goal congruence and seamless collaboration with its suppliers (Jap, 1999). Therefore, the above discussion leads to the first hypothesis of this study:

Hypothesis 1a: *The use of IT for supply chain activities (ITSCA) has a positive influence on the degree of supplier integration*.

4.3.1.2 Flexible IT Infrastructure and Supplier Integration

In this study, flexible IT infrastructure refers to a firm's ability to deploy a shareable platform that supports a foundation for data management, a communications network, and an application portfolio. The flexibility of a firm's IT infrastructure is manifested in the extent to which the firm adopts standards for the components of that IT infrastructure (Ray *et al*., 2005). Standards for hardware, operating systems, communications networks, data, and applications imply that data and applications can be shared and accessed throughout the organisation (Broadbent and Weill, 1997).

A flexible IT infrastructure provides a platform that enforces standardisation and integration of data and processes (Lu and Ramamurthy, 2011), supporting process integration by establishing collaborative connections among separate resources owned by the focal firm and its suppliers. A flexible IT infrastructure also increases information transparency and enables real-time, consistent, and comprehensive information sharing between the focal firm and its suppliers (Dong *et al*., 2009; Lu and Ramamurthy, 2011). For example, free retrieval and flow of data between organisations regardless of location, and improved data transparency between the focal firm and its suppliers is facilitated (Byrd and Turner, 2000). Data on products, processes, customers, performance and capabilities is a key asset in an electronically-connected business environment. Firms strive to manage data assets independently of applications, making them available organisation-wide to promote initiatives concerned with supplier integration in terms of information sharing and collaborative planning (Byrd and Turner, 2000; Sengupta *et al*., 2006).

In addition, through enabling communications networks, a flexible and integrated IT infrastructure can link all points within a firm, and can provide the gateway to electronic interaction with suppliers (Weill *et al*., 2002). Further, through enabling a standardised application portfolio across the firm, a flexible IT infrastructure provides a firm with the ability to share any type of information across any technology component (Byrd and Turner, 2000). Infrastructure applications that are standard across the firm support and consolidate internal IT applications into a shared-services group or a common application run independently, thereby encouraging integrated operations within the organisation and with other organisations (Weill *et al*., 2002). Therefore,

Hypothesis 1b: *Flexible IT infrastructure (ITINF) has a positive influence on the degree of supplier integration*.

4.3.1.3 IT Operations Shared Knowledge and Supplier Integration

In this study, IT operations shared knowledge refers to the knowledge that the operations manager possesses about how IT can be effectively used to achieve the supply chain processes and operations activities. IT operations shared knowledge is the ability of a firm's management to deploy IT-related information and knowledge to support and enhance operational objectives. This capability reflects the extent to which the firm enables management's ability to understand the value of IT investments and the processes of integration and alignment between the IS function and other functional areas of the firm (Lu and Ramamurthy, 2011; Wade and Hulland, 2004). Previous studies have well documented the importance of IS alignment with business strategy (e.g., Chan *et al*., 1997; Reich and Benbasat, 1996; Bharadwaj, 2000), and recognised how essential it is to build relationships internally within the firm between the IS function and other business areas. For example, a partnership between IT and business managers leads to effective IT–business joint decision-making, more strategic applications, and greater buy-in and, consequently produces better implementation (Weill and Ross, 2004).

Clearly, operations managers' shared knowledge of IT influences the level of alignment between the IS and other functional areas of a firm, enabling effective information sharing and relationship building across the firm's internal business functions (Reich and Benbasat, 2000). A firm with a high level of internal communication and co-ordination will be more capable of achieving a high level of external integration (e.g., Flynn *et al*., 2010; Zhao *et al*., 2011). Previous literature on supply chain integration has indicated that internal integration, i.e. integration across departments, leads to external integration, which in turn leads to improved performance (Pagell, 2004; Zhao *et al*., 2011). From the perspective of organisational capability, a firm with a high level of internal communication and co-ordination capabilities is better able to secure a high level of external integration (Zhao *et al*., 2011). In respect of information sharing, effectiveness between internal business functions facilitates the firm's understanding of its suppliers. For example, Stank *et al*. (2001b) find that information sharing between internal departments is related to external co-operation with partners. Further, Carr and Kaynak (2007) support the claim that information sharing within the firm positively influences information sharing between the firm and its suppliers. In the area of strategic collaboration, a high level of interaction between different functional areas within the firm leads to consistency of its business objectives and practices (Swink *et al*., 2005, 2007), point to a high level of integration with its external suppliers. Within the context of IS, this would suggest that IT operations knowledge that supports integration within business areas would support the development of capabilities that would help integrate business processes with suppliers. Therefore,

Hypothesis 1c: *IT operations shared knowledge (ITOSK) has a positive influence on the degree of supplier integration*.

4.3.2 The Mediating Effect of Supplier Integration on Cost Performance (Model 1)

The Influence of Supplier Integration on Cost Performance

Existing research offers explanations for the link between supplier integration and cost performance. In an integrated supply chain, there is enhanced information sharing, co-ordination and a resulting synergy between the focal firm and its suppliers. A strong strategic partnership with suppliers facilitates their understanding and anticipation of the focal firm's needs, and can thus, prepare suppliers to better meet the firm's changing requirements (Flynn *et al*., 2010). Sharing information with suppliers also enables the focal firm to effectively manage the level of inventory, thereby protecting itself against supply disruptions and bullwhip effects, which amplify demand uncertainty across the firms up the value chain (Lee *et al*., 1997a). Subsequently, supplier integration enables the focal firm to enjoy decreased lead times and reduced inventory levels, which in turn, significantly reduces costs (Baltacioglu *et al*., 2007).

In the service context, while the transfer of goods is lacking, the transfer of the service using the supplier's service assets and staff is present. In essence, purchasing a service represents a transfer of the service supplier's capacity to its customer in the form of a service (Ellram *et al*., 2004). In this setting, service stock-outs are mainly driven by the under-estimation of future demand and lack of sufficient capacity on the day that customers actually arrive in the process (Frohlich and Westbrook, 2002). Therefore, the role of capacity in services is to act as a buffer to smooth service delivery in response to demand fluctuations (Ellram *et al*., 2004). Supplier integration supports routines and processes that collect supply information essential for the collaboration with suppliers (Stank *et al*., 1999). With a high level of information sharing and collaborative planning with suppliers, a focal firm is more likely to receive accurate supply information, which will lead to better service delivery plans and reduced inventory and capacity costs (Lockstrom *et al*., 2010). Thus, supplier integration also enables service providers to exploit economies in service delivery and minimise service costs (Baltacioglu *et al*., 2007).

The argument that supplier integration leads to better cost performance is further supported by transaction cost economics (Williamson, 1975). Through building long-term relationships and integrating inter-organisational processes, supplier integration decreases the focal firm's transaction costs with its suppliers (Zhao *et al*., 2008). In particular, supplier integration reduces the search costs associated with gathering information to identify and evaluate potential partners, since during such integration, long-term relationships with suppliers are established. And because of its ability to establish such relationships with suppliers, supplier integration also reduces contracting costs by decreasing the cost of negotiating and writing contractual agreements (Williamson, 1991, 1993).

Defined by Baron and Kenny (1986), the function of a mediator variable represents the generative mechanism through which the predict variable is able to influence the dependent variable. In general, a mediator is functional in the extent to which it accounts for the relation between the predictor and the outcome. In this section, supplier integration as a mediator variable explains how each dimension of IS capabilities has a relationship with cost performance. Supplier integration is seen as the underlying cause of the relationship between IS capabilities and cost performance, in which IS capabilities have an influence on the level of supplier integration which consequently brings about the difference in cost performance.

4.3.2.1 IT for Supply Chain Activities, Supplier Integration and Cost Performance

IT for supply chain activities (ITSCA) can promote supplier integration by reducing the transaction costs and uncertainties between a firm and its suppliers (Sanders, 2007; Clemons *et al*., 1993; Mukhopadhyay and Kekre, 2002). As a resource, supplier integration is the mechanism by which the use of ITSCA acts to improve a firm's cost performance. Supported by transaction cost economics, ITSCA have been shown to decrease transaction costs, including co-ordination costs associated with the direct costs of integrated decisions (Nooteboom, 1992), and transaction risk, which is the risk of being exploited in the relationship (Clemons and Row, 1992; Clemons *et al*., 1993). In addition, a firm's use of ITSCA provides seamless integration of information flows which increases the accuracy of supply information for planning and scheduling. IT-enabled sharing of information with the focal firm's suppliers facilitates the firm's ability to cope with uncertainties and changing demand (Sengupta *et al*., 2006; Dong *et al*., 2009). As discussed, inventory or capacity is often associated with management uncertainty (Anand and Ward, 2004; Ellram *et al*., 2004). ITSCA can provide accurate and timely exchange of information that mitigates uncertainty in decision-making (Strader *et al*., 1999), so that the material movement or service delivery can be co-ordinated between the focal firm and its suppliers, thereby resulting in reduced inventory or capacity costs. For example, the use of the Internet and web-enabled systems for procurement can be expected to increase efficiency through enabling a tighter balancing of demand and supply, and through reducing the costs of both finding the right suppliers and transacting with them (Wu *et al*., 2003).

The cost savings in service delivery are also attributable to the efficiency of labour productivity (Safizadeh *et al*., 2003). Supplier integration facilitated by ITSCA supports cost-efficient ways of delivering services by enhancing the co-ordination efficiency of the supply chain (Xue *et al*., 2013). For example, the use of ERP systems has replaced complex and sometimes manual interfaces between different systems with standardised, cross-functional transaction automation (Hendricks *et al*., 2007). The improvement in transaction timeliness and accuracy also enhances the productivity of staff (Saldanha *et al*., 2013), as they are assisted in discharging their responsibilities by the visibility of supply assets and availability of other staff. Put differently, ITSCA supports accurate communication and information sharing between the firm and its suppliers, consequently providing the focal firm with a better understanding and visibility of supply assets and staff availability. This enables the firm to arrange for various supply sources of goods and services, as well as to manage functional processes, including contract management, supplier evaluation, procurement, and negotiations with suppliers (Baltacioglu *et al*., 2007). Such involvement with suppliers facilitates the focal firm's efforts to visualise the availability and stock-outs of assets and capacity on the supply side, thereby allowing it to adjust staff working plans to minimise the 'idle time' of staff working on out-of-stock service delivery. This capability, in turn, result in improved efficiency and cost reduction in terms of high labour productivity. In short, a firm's ability to use ITSCA enables it to benefit from information sharing and collaboration between itself and its suppliers, and the outcome of this is better cost performance. Thus,

Hypothesis 2a: *Supplier integration is positively related to cost performance and mediates the IT for supply chain activities (ITSCA)–cost relationship*.

4.3.2.2 Flexible IT Infrastructure, Supplier Integration and Cost Performance

Through enabling the free retrieval and flow of data, communications networks, and standardised application portfolios, flexible IT infrastructure increases information transparency and enables real-time, consistent, and comprehensive information sharing between the focal firm and its suppliers (Dong *et al*., 2009; Lu and Ramamurthy, 2011). Possessing both accurate and real-time information about inventory and material requirements, the firm can perform cost-effective trans-shipment of goods and reduce inventory holding costs in a manufacturing context (Lee, 2002). As discussed earlier, accurate and real-time information concerning supply assets and capacity is also an enabler of cost-effective management in respect of staff availability for service delivery in service supply chains.

Flexible IT infrastructure also improves co-ordination efficiency between the focal firm and its suppliers. The supply chain literature suggests that efficient co-ordination is a critical enabler in terms of reducing the 'bullwhip effect', which often causes either excessive or inadequate inventory-holding in the firm, thereby compromising cost efficiency (Lee *et al*., 1997a). In a service context, excessive or inadequate capacity-holding is equally expensive for the service provider (Ellram *et al*., 2004). By streamlining information flows and substituting information for inventory, flexible IT infrastructure contributes to increased supply chain efficiency and reduced costs (Milgrom and Roberts, 1988; Zhu and Kraemer, 2005). In short, flexible IT infrastructure enables accurate and in-time information flow among various business function areas of the firm and between the focal firm and supply partners, and the enhanced supplier integration in turn leads to improved cost performance. This discussion leads to the following hypothesis:

Hypothesis 2b: *Supplier integration is positively related to cost performance and mediates the flexible IT infrastructure (ITINF)–cost relationship*.

4.3.2.3 IT Operations Shared Knowledge, Supplier Integration and Cost Performance

As discussed earlier, IT operations shared knowledge is an important capability that enables the firm to conceive, effectively implement, and use IT for information sharing and collaboration between different functions within the firm. Previous literature on supply chain integration has indicated that internal integration, i.e. integration across departments, leads to external integration, which in turn promotes improved cost performance (Zhao *et al*., 2011).

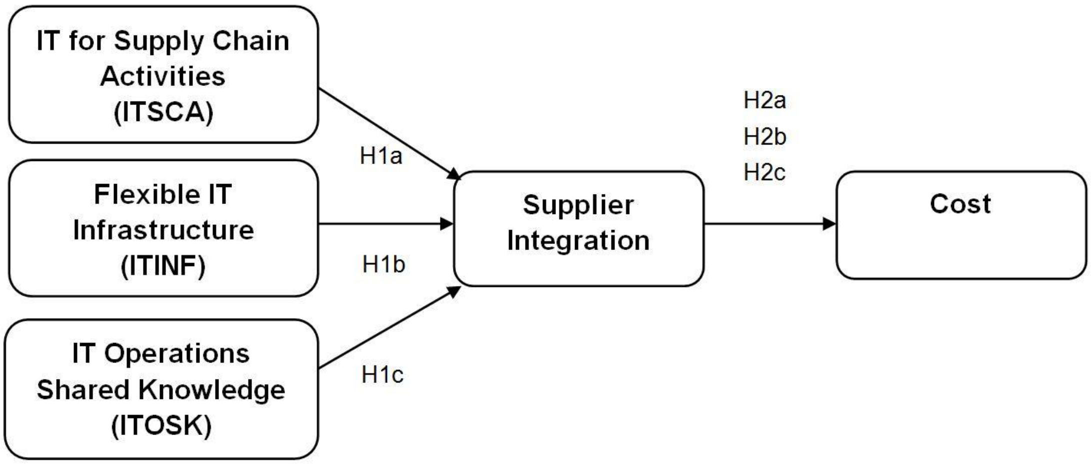
IT operations shared knowledge is the ability to absorb through the organisation’s IT knowledge structures, information regarding appropriate IT functions and innovations so that the information and knowledge related to IT can be assimilated and applied in support of operational tasks. Firms that already enjoy well-established capability in respect of integrating data and sharing information among their internal functional areas, can more readily add functional modules to link with external suppliers (Zhao *et al*., 2011). For example, the firm’s ability to perform real-time searching of operating, inventory or service capability data, supports its attempts to share such data with its supply partners accurately in real time. Accurate and timely information sharing between the firm and its suppliers increases the firm's visibility of supply assets and capability (Williams *et al*., 2013), and eventually reduces inventory or the capability holding costs of the firm. Furthermore, information sharing within a firm is necessary to enable the business functions within the company to identify critical issues regarding suppliers (Bhatt, 2000; Crocitto and Youssef, 2003).

In short, IT operations shared knowledge will improve a firm's ability to integrate with its suppliers, and this circumstance will subsequently improve cost performance. Put differently, the link between IT operations knowledge and cost is mediated by the extent to which suppliers are integrated with the focal organisation. Thus,

Hypothesis 2c: *Supplier integration is positively related to cost performance and mediates the IT operations shared knowledge (ITOSK)–cost relationship*.

Summarising, Research Model 1 shows the proposed indirect effects of each dimension of IS capabilities (ITSCA, ITINF and ITOSK) on cost performance through its positive effects on supplier integration (see Figure 4.1).

Figure 4.1: Research Model 1



4.3.3 The Mediating Effect of Supplier Integration on Quality Performance (Model 2)

Similar to the manufacturing sector, the service sector also competes on the basis of quality (Safizadeh *et al*., 2003; Prajogo *et al*., 2014). Because the nature of the service sector is such that its products are mostly intangible, the notion of quality in service firms is different from that in manufacturing organisations (Krishnan *et al*., 1999). Service quality is “the delivery of excellent or superior service relative to customer expectations” (Zeithaml *et al*., 1996:117). Drawing on the debate in the literature about assessing the quality performance of service firms (Roth and Van Der Velde, 1991), service quality is attributed to external service quality, and internal service quality. The former embodies the firm’s capabilities to hold services in stock, to deliver a consistent level of quality, to make on-time delivery, and to the quality levels perceived by customers in their interaction with the service provider. The latter (internal service quality), includes quality-related timely and accurate information.

In the supply chain context, the establishment of supplier integration enables the exchange of information about products (goods or services), processes, schedules, and capabilities, and such intelligence facilitates firms’ efforts to develop their production plans and provide service on time, thereby contributing to improved service delivery performance (Flynn *et al*., 2010). As discussed earlier, a strong strategic partnership with suppliers provides suppliers with a more comprehensive understanding of the focal firm’s needs, which they can in fact, learn to anticipate. Through the development of such a good appreciation of the focal firm’s operations, suppliers achieve a high level of customer service (Flynn *et al*., 2010). Due to the nature of the service delivery process, suppliers play a dominant role in the service supply chain. Indeed, it is critical that services are created and delivered collaboratively and efficiently if a firm wishes to aspire to improved service quality (Baltacioglu *et al*., 2007). Given the intangibility of services and the fact that production and consumption takes place simultaneously, any failure in the supply side may simultaneously turn into a failure in service delivery (Baltacioglu *et al*., 2007). To prevent such an occurrence, the focal firm must strive for accurate information sharing and collaborative planning between itself and its suppliers. In other words, supplier integration is a critical enabler of improved service quality performance.

In this section, supplier integration as a mediator variable explains how each dimension of IS capabilities has a relationship with quality performance. Supplier integration is seen as the underlying cause of the relationship between IS capabilities and quality performance, which is seen in the fact that IS capabilities have an influence on the level of supplier integration and this promotes the difference in quality performance.

4.3.3.1 IT for Supply Chain Activities, Supplier Integration and Quality Performance

IT for supply chain activities (ITSCA) increases supplier integration through accurate and timely information sharing, and the increased degree of supply-side integration facilitates the firm's ability to respond to demand changes, and can enable greater efficiency in the allocation of resources required in order to improve quality performance (Saldanha *et al*., 2013). ITSCA-enabled sharing of information with the focal firm's suppliers enhances the transparency of the focal firm's service processes and the timeliness of service delivery (Xue *et al*., 2013). It is recognised that timeliness and the assurance of service delivery are important measures of quality in services (Roth and Van Der Velde, 1991). In addition, because customer perceptions result from their evaluations of the actual service against their expectations (Devaraj *et al*., 2002), the transparency of service processes makes customers develop more appropriate expectations of service. Through helping firms establish rational customer expectations, the supplier integration facilitated by ITSCA improves the quality perceived by customers (Xue *et al*., 2013).

Furthermore, firms can better match supply with customer demand and anticipate changes in the marketplace through IT-based sharing of information with suppliers (Li *et al*., 2006). For example, supply chain management (SCM) systems provide a firm with the real-time planning capability required to react quickly to supply changes (Hendricks *et al*., 2007). Co-ordinated planning and flow of information among supply chain partners can mitigate the 'bullwhip effect' (Lee *et al*., 1997a). The rich literature in OM has recognised the benefits of better supplier planning and co-ordination (e.g., Cachon and Fisher, 2000; Cheung and Lee, 2002; Milner and Kouvelis, 2002). ITSCA-enabled supplier planning and co-ordination are known to reduce forecasting and planning errors, leading to improved levels of inventory and service capacity management, which in turn assist in meeting customer demand. Possessing the appropriate level of staff availability can help a firm to accelerate its service delivery and reduce customer waiting times. In short, ITSCA enables information sharing and collaboration between the focal firm and its suppliers, which helps the firm in its efforts to efficiently manage its service capacity and delivery process, in turn resulting in improved quality performance in terms of on-time delivery, accurate service, improved perceived quality and reduced customer wait times. Thus,

Hypothesis 3a: *Supplier integration is positively related to quality performance and mediates the IT for supply chain activities (ITSCA)–quality relationship*.

4.3.3.2 Flexible IT Infrastructure, Supplier Integration and Quality Performance

As discussed earlier, through enabling free retrieval and flow of data, communications networks, and a standardised application portfolio, flexible IT infrastructure increases information transparency and enables real-time, consistent, and comprehensive information sharing between the focal firm and it suppliers (Dong *et al*., 2009; Lu and Ramamurthy, 2011). Because services are hard to evaluate in advance of the purchase, service supply is closely intertwined with the focal firm’s service delivery processes (Ellram *et al*., 2004). The information sharing and collaboration between the firm and suppliers provides the supplier with a thorough understanding of the firm’s business processes, which is needed in order for suppliers to be able to offer the most suitable service assets and staff (Van Der Valk and Rozemeijer, 2009). Through integrating with suppliers, the focal firm can monitor and control the goods and/or services ordered from those suppliers, and this capability enables the firm to improve internal service quality through accurate and timely information.

Simultaneously, a flexible IT infrastructure also enables the firm to respond to frequent and/or unexpected rapid changes because it can deal with disruptions in supply or fluctuations in demand purely by making the necessary internal adjustments (Lu and Ramamurthy, 2011). Such capability leads to improved external service quality. Flexible IT infrastructure services such as firm-wide applications, databases, and common systems are essential to lend the best support possible to supply-side initiatives (Weill *et al*., 2002). With accurate and timely information on the supply side, the firm is able to adjust and use its service assets and staff capacity to fulfil customer demand (Lee, 2002). In addition, a flexible infrastructure allows the firm to quickly accommodate unexpected changes. The use of modular and reusable code allows the firm to quickly reconfigure the platform to enable supply chain and service production capabilities to respond to changes (Overby *et al*., 2006), subsequently improving external service quality by enabling accurate and on-time service delivery, decreasing customer wait times, and strengthening perceived quality.

Hypothesis 3b: *Supplier integration is positively related to quality performance and mediates the flexible IT infrastructure (ITINF)–quality relationship*.

4.3.3.3 IT Operations Shared Knowledge, Supplier Integration and Quality Performance

IT operations shared knowledge supports the firm's integration with its external suppliers by enabling integration across functions within the firm. As discussed earlier, the enhanced information sharing and collaboration with suppliers, contributes both to improved internal and external service quality (Ellram *et al*., 2004).

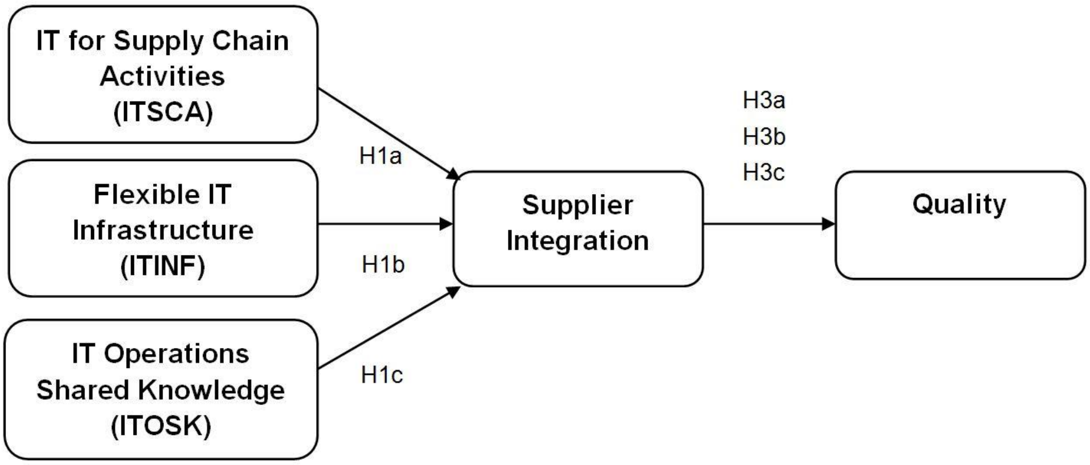
Firms that already enjoy well-established capability for integrating data and sharing information among their internal functional areas can more readily add functional modules to link with external customers (Zhao *et al*., 2011). For example, the firm's ability to perform real-time searching of operating, inventory or service capability data, supports its efforts to share such data with its customers in an accurate and timely fashion, which in turn promotes more appropriate service expectations from customers, and underpins more rational perceptions of quality by customers in the long run.

Additionally, ITOSK enables cross-functional transparency of data and supports the service provider in attempts to utilise the data shared by trading partners more comprehensively (Lu and Ramamurthy, 2011). Such ITOSK-enabled supply information sharing helps service providers to appropriately plan and control their capacity, better understand customer requirements, and closely co-operate with customers, thereby promoting improved and accurate service delivery. The above discussion leads to the following hypothesis:

Hypothesis 3c: *Supplier integration is positively related to quality performance and mediates the IT operations shared knowledge (ITOSK)–quality relationship*.

Summarising, Research Model 2 shows the proposed indirect effects of each dimension of IS capabilities (ITSCA, ITINF and ITOSK) on quality performance through its positive effects on supplier integration (see Figure 4.2).

Figure 4.2: Research Model 2



4.4 IS Capabilities, Customer Integration and Operational Performance

4.4.1 Breaking Down the Customer Integration

Customer integration is commonly referred to as the other dimension of external integration. It involves strategic information sharing and collaboration between a focal firm and its customers with the aim of improving visibility and enabling joint planning (Fisher *et al*., 1994). Customer integration promotes a deeper understanding of market expectations and opportunities, which contributes to the ability to offer a more accurate and quicker response to customer needs and requirements (Swink *et al*., 2007) by matching supply with demand (Lee *et al*., 1997b).

Although there is an extensive body of research on customer integration, almost all the studies in question focus on analysing customer integration as a single construct and explore its performance impact in manufacturing settings (e.g., Flynn *et al*., 2010). In services, customer integration involves the combination of customer resources with the focal firm resources, in order to transform customer resources (Moeller, 2008). According to Fließ and Kleinaltenkamp (2004), customer resources in the context can be the customers themselves (e.g., surgery or theatre), customers' physical possessions (e.g., maintenance services), customers' nominal goods (e.g., banking services), and/or customers' personal data (e.g., tax advice). Integrating of customer resources require processes and forms of collaboration (Kleinaltenkamp *et al*., 2012).

In referring to goods and services, differences in the corresponding processes have been documented in literature. For instant, Grönroos (2006:319) states that "services emerge in an 'open' process where the customers participate … and hence can be directly influenced by the progress of the process. Traditionally, physical goods are produced in 'closed' production processes where the customer only perceives the goods as outcomes of the process". Both goods and services can both be solutions to a specific demand (Stauss, 2005), however direct customer participation in the service process adds complexity, which is generally not found in the manufacturing context (Chase and Tansik, 1983).

In services, customer integration occurs when customers incorporate their resources into the processes of a firm (Lusch *et al*., 2007; Moeller, 2008). Although conceptual frameworks have been identified to show customer integration is valuable in service provision (e.g., Moeller, 2008; Vargo and Lusch, 2004a; 2004b; Vargo, 2008), there is much to learn about the practices of integrating customer resources (Kleinaltenkamp *et al*., 2012). Due to complexity of service process, the determination of value of customer integration may be less straightforward. Customer integration is not only the conceptual function of resources transformation, but also involves multiple processes for different focuses. Thus, customer integration may take place in the fragmented process that customers induce and the value appraisal of customer integration needs to be more process-specific.

As discussed above, customer integration in services is the result of customers themselves, and consequently, identification of specific integration processes in which customer input their resources for transformation is needed in order to better understand the impacts of different customer integration processes. Information sharing is often central to the integration processes (Maglio and Spohrer, 2008), and the role of information technology in enabling such processes is a key issue within service systems research (Breidbach *et al*., 2013).

For the purpose of this study, a process-specific (IS-enabled integration processes between focal firms and their immediate customers) approach is appropriate, and three major types of process are distinguished and classified depending on their focus. Recent research highlights, for manufacturing and service firms, the crucial IS-enabled processes that link firms with their customers, for *customer transactions* (e.g., Tsikriktsis *et al*., 2004), *customer connection* (e.g., Mithas *et al*., 2012), and *customer collaboration* (e.g., Mithas *et al*., 2005):

1. Customer Transactions

IS capabilities have vast potential to facilitate *customer transactions* through enabling the transaction processes between the focal firm and its customers, which in turn allows the firm to be much more efficient in terms of many routine transactions such as order taking, billing, and payment systems (Tsikriktsis *et al*., 2004).

2. Customer Connection

IS capabilities can enhance *customer connection* through enabling customer connectivity via the communication and contact processes outlined, and with such integration comes greater success for the firm in its abilities to develop a good understanding of customer needs and set accurate customer profiles (Mithas *et al*., 2012).

3. Customer Collaboration

IS capabilities can facilitate *customer collaboration* by the sharing of information on demand forecasts and production schedules that dictate supply chain activities (Li *et al*., 2009), enabling collaborative service provision-related activities between the firm and its customers.

The following sections (Part 1–3) detail the research models and hypotheses development for each dimension of customer integration – customer transactions (Part 1), customer connection (Part 2), and customer collaboration (Part 3); using these dimensions as the mediators influencing the relationship between IS capabilities and operational performance.

4.4.2 Part 1: IS Capabilities, Customer Transactions and Operational Performance

4.4.2.1 IS Capabilities and Their Impact on Customer Transactions

In this study, customer transactions relate to transactions and order management activities, which involve levels of information exchange and operational co-ordination between focal firms and their customers. IS capabilities have vast potential to facilitate customer integration in terms of customer transactions through enabling the transaction processes between the focal firm and its customers, which in turn allows the firm to be much more efficient in terms of many routine transactions such as order taking, billing, and payment systems (Tsikriktsis *et al*., 2004). The following sections provide detailed discussions on the relationship between each dimension of IS capabilities and customer transactions.

4.4.2.1.1 IT for Supply Chain Activities and Customer Transactions

In this study, IT for supply chain activities (ITSCA) refers to the extent to which a firm has adopted IT for processing transactions, co-ordinating activities, and facilitating collaboration with suppliers and customers through information sharing. Prior IS research has supported the role of IT as a mechanism to streamline processes and automate transactions, and hence to provide business benefits by accelerating processes, substituting labour, and increasing operation volumes (e.g., Brynjolfsson and Hitt, 1996; Weill and Broadbent, 1998).

Firms' use of IT for supply chain activities (ITSCA) facilitates the automation of the structured and routine processes involved in transactions with customers (Saldanha *et al*., 2013). ITSCA enables digital business transactions between a firm and its customers through Internet-based information technologies. Such transactions include standardised electronic transactions accomplished via Electronic Data Interchange (EDI), as well as transactions executed via the Internet (Thun, 2010).

The use of ITSCA has changed how firms conduct business with their customers in that it brings improved accuracy and timeliness of information exchange (Barua *et al*., 2004; Banker *et al*., 2006a). For example, EDI and web-enabled applications facilitate market responsiveness capabilities by fostering customer involvement in order management processes (Anderson and Lanen, 2002). The Internet has enhanced EDI systems by making them more flexible and affordable to smaller businesses (Lancioni *et al*., 2000; Zhu and Kraemer, 2002; Zhu *et al*., 2004). Nonetheless, many firms have gone beyond the confines of EDI and incorporated a multitude of Internet-based technologies to facilitate the connections between customers and suppliers (Devaraj *et al*., 2007). Additionally, advancements such as web-enabled customer order entry systems, fully integrated order-processing systems, and electronic invoicing systems are known to contribute in boosting customer transactions processes (Mukhopadhyay and Kekre, 2002; Ray *et al*., 2005). In short, ITSCA utilises IT resources as a substitute for repetitive human effort, improving the efficiency of customer transactions. Therefore,

Hypothesis 4a: *The use of IT for supply chain activities (ITSCA) has a positive influence on the degree of customer transactions*.

4.4.2.1.2 Flexible IT Infrastructure and Customer Transactions

Flexible IT infrastructure (ITINF) refers to a firm's ability to deploy a shareable platform that supports a foundation for data management, communications network, and application portfolio. Such an infrastructure provides an integrated platform that enforces standardisation of data and processes, making it possible to achieve timely and accurate information gathering and sharing across business function areas (Lu and Ramamurthy, 2011), which enhances business transactions with data driven by corporate databases (Beheshti and Salehi-Sangari, 2007).

Specifically, a flexible infrastructure helps to improve customer transaction processes by enabling electronic services, such as personal account maintenance, user recognition, and order tracking. Supported by the firm-wide databases, this type of infrastructure facilitates customer transactions by identifying customers upon arrival and retrieving customers' personal account information relating to billing, shipping, frequency of orders for particular products, past purchases and status of orders, and personal preferences in terms of e-mail reminders (Thirumalai and Sinha, 2011). Such ITINF-enabled services decrease the degree of transaction inconvenience that customers might otherwise encounter. To this end, a firm's flexible IT infrastructure promotes effective transaction processes between the firm and its customers by improving transaction convenience to customers. This discussion leads to the following hypothesis:

Hypothesis 4b: *Flexible IT infrastructure (ITINF) has a positive influence on the degree of customer transactions*.

4.4.2.1.3 IT Operations Shared Knowledge and Customer Transactions

IT operations shared knowledge (ITOSK) refers to the knowledge that the operations manager possesses regarding how IT can be used to improve operations processes. Previous research has emphasised the significance of business managers' familiarity with information technologies and their potential business impacts (e.g., Sambamurthy and Zmud, 1999; Bassellier *et al*., 2003). Specifically, line managers are more likely to assume leadership in regard to IT when they have the appropriate IT knowledge (Rockart *et al*., 1996), and IT-competent managers are more willing to build a strong 'relationship asset' between the IT and line managers (Ross *et al*., 1996). Therefore, IT-competent business managers are extrapolated to seek out and partner with IT managers in order to enhance and maximise the value of IT within the business (Bassellier *et al*., 2003). Placed within an operations context, ITOSK reflects the extent to which a firm enables management's ability to understand the value of IT resources (Lu and Ramamurthy, 2011; Wade and Hulland 2004).

Since the accumulation of knowledge can enhance organisations' ability to recognise and assimilate new ideas, as well as their ability to convert this knowledge into further innovations (e.g., Cohen and Levinthal, 1990; Fleming *et al*., 2007), the shared IT knowledge of operations managers ensures the speedy, effective, and sufficient translation of innovative responses that usually require radical changes to transaction possesses (Lu and Ramamurthy, 2011). To this end, operations managers who possess IT shared knowledge are more likely to understand and promote the use of IT innovations for transaction processes with customers. Therefore,

Hypothesis 4c: *IT operations shared knowledge (ITOSK) has a positive influence on the degree of customer transactions*.

4.4.2.2 The Mediating Effect of Customer Transactions on Cost Performance (Model 3)

In this section, customer transactions as a mediator variable explains how each dimension of IS capabilities has a relationship with cost performance. Customer transactions is seen as the underlying cause of the relationship between IS capabilities and cost performance, since IS capabilities have an influence on the level of customer transactions and this results in the difference in cost performance.

4.4.2.2.1 IT for Supply Chain Activities, Customer Transactions and Cost Performance

IT for supply chain activities (ITSCA) can enhance transactions processes associated with order placement, order monitoring, and payment submission by customers (Wu *et al*., 2003). ITSCA-enabled transactions with customers facilitate cost reductions in transactions between buyers and sellers (e.g., Subramani, 2004; Choudhury *et al*., 1998). For example, EDI or web-enabled order systems help to streamline and automate business processes between the focal firm and its customers (Subramani, 2004), reducing the co-ordination costs of exchanging information related to products, price, demand, and product design changes (Grover and Malhotra, 2003). In addition, ITSCA enables the firm to share information in a timely manner, thereby enhancing transaction processes with customers, and subsequently reducing transaction risk by decreasing the cycle time from customer need recognition to delivery of the purchased good or service (Johnson *et al*., 2007; Johnson and Leenders, 2004).

The use of ITSCA provides opportunities for the firm to automate customer transaction processes in order to reduce the internal costs of serving customers (Rust and Lemon, 2001). For example, insurance firms have created real-time quotes, the travel sector has set up online bookings, and almost every major bank has offered an online banking system to complement its traditional branch, ATM, and mail channels (Tsikriktsis *et al*., 2004). Such service transactions enable customers to obtain answers to questions and place orders in a convenient manner, and without having to rely on human response (Thirumalai and Sinha, 2011). In short, ITSCA automates transactions processes with customers and replaces manual tasks with electronic communication, which in turn leads to improved cost performance. Therefore,

Hypothesis 5a: *Customer transactions are positively related to cost performance and mediate the IT for supply chain activities (ITSCA)–cost relationship*.

4.4.2.2.2 Flexible IT Infrastructure, Customer Transactions and Cost Performance

Flexible IT infrastructure (ITINF) enhances customer transactions by accomplishing digital customer order management, enabling the potential of a firm to provide low cost service. A flexible infrastructure can provide accurate product or service information by using data from corporate databases. Through the records of customers' order histories, ITINF-enabled transaction services can provide fast assistance for customer ordering, matching customers' tastes and needs and the products and services that satisfy them from a wide set of alternatives (Thirumalai and Sinha, 2011). Customers are, therefore, able to complete their transactions more efficiently (Srinivasan *et al*., 2002) with minimal needs for human assistance.

The transaction costs perspective highlights the need for service providers to lower the costs incurred by customers in the ordering process (e.g., Grover and Malhotra, 2003;

Chircu and Mahajan, 2006). Using firm-wide databases, ITINF-enabled transactions promote customer ordering processes through electronic services such as customer account maintenance and order tracking. Empowered by the collected customer data, such services can help the firm reduce search costs associated with identifying the right product and service and the seller who can best meet customers' needs (Thirumalai and Sinha, 2011). Service providers follow simple rule-based procedures for transacting with all their customers or customer segments. Once the transaction-related information is collected during a one-time registration process, the need for extensive customer information is minimal (Thirumalai and Sinha, 2011). The above discussion leads to the following hypothesis:

Hypothesis 5b: *Customer transactions are positively related to cost performance and mediate the flexible IT infrastructure (ITINF)–cost relationship*.

4.4.2.2.3 IT Operations Shared Knowledge, Customer Transactions and Cost Performance

IT operations shared knowledge (ITOSK) can enhance customer transactions by promoting the use of IT innovations for transaction processes. Through responding to the requirements of changes in transaction processes in a rapid manner, ITOSK-enabled transaction innovations can create low cost service for the focal firm.

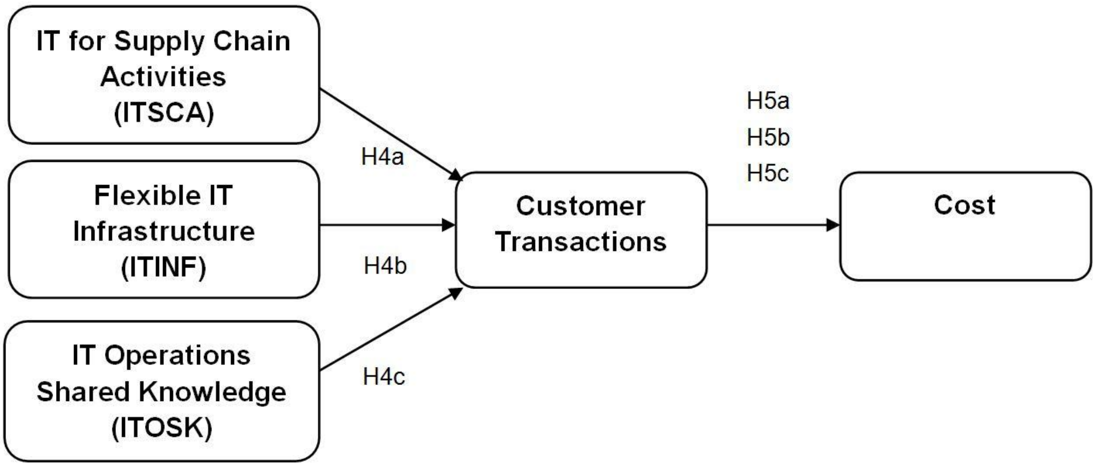
ITOSK can leverage information and web technologies on the basis of knowledge about customer preferences, creating new electronic transaction processes to support the needs of various customer segments (Hu *et al*., 2009). For example, as promised by the use of IT innovations such as time and location-independent services, ITOSK-enabled transaction innovations provide the most obvious form of convenience to customers (Tan *et al*., 2013). Such electronic transactions allow customers to complete the entire order transaction online without resorting to staff assistance, thus leading to lower costs of services.

In the context of web-enabled ordering processes, firms need to lower the purchase-transactions costs associated with executing activities such as billing, shipping, and customer service interactions after customers identify their orders (Thirumalai and Sinha, 2011). ITOSK-enabled innovations in customer transactions permit the firm to reduce such costs by creating a seamless transaction process. For example, the electronic payment service allows customers to use the most convenient online method to transfer funds for their order transactions. The establishment of digital order tracking can estimate the processing time for different kinds of customer transaction, track the progress of uncompleted transactions, and review archival records of completed transactions (Tan *et al.*, 2013). Such innovations in transaction processes enable the firm to provide accountable and transparent transactions to customers in a cost-effective way. Thus,

Hypothesis 5c: *Customer transactions are positively related to cost performance and mediate the IT operations shared knowledge (ITOSK)–cost relationship*.

Summarising, Research Model 3 shows the proposed indirect effects of each dimension of IS capabilities (ITSCA, ITINF and ITOSK) on cost performance through its positive effects on customer transactions (see Figure 4.3).

Figure 4.3: Research Model 3



4.4.2.3 The Mediating Effect of Customer Transactions on Quality Performance (Model 4)

In this section, customer transactions as a mediator variable explains how each dimension of IS capabilities has a relationship with quality performance. Customer transactions is seen as the underlying cause for the relationship between IS capabilities and quality performance, since IS capabilities have an influence on the level of customer transactions and this causes the difference in quality performance.

4.4.2.3.1 IT for Supply Chain Activities, Customer Transactions and Quality Performance

As discussed previously, IT for supply chain activities (ITSCA) promotes and accomplishes transactions processes between a service provider and its customers in terms of order placement, order monitoring, and payment submission, all of which can improve the focal firm's quality performance. Specifically, ITSCA-enabled transactions with customers facilitate improved service quality as perceived by customers (Field *et al*., 2004). For example, through using web-enabled customer order entry, customers can digitally track and enquire about their orders, and can shop without the conventional restraints of time and/or place. Such technologies also allow customers to monitor their orders closely to minimise mistakes and delays, which leads to greater customer-perceived quality (Wu *et al*., 2003).

Moreover, the enhancement in transaction timeliness and accuracy improves service quality through providing information about products, troubleshooting, and service online (Wu *et al*., 2003). For example, web-enabled customer interaction allows customers to easily access products and services, and to obtain replies to enquiries consistently and quickly. To this end, ITSCA-enabled transactions can promote service reliability and credibility through providing products and services information in an accurate and timely manner (Rust and Lemon, 2001). Thus,

Hypothesis 6a: *Customer transactions are positively related to quality performance* *and mediate the IT for supply chain activities (ITSCA)–quality relationship*.

4.4.2.3.2 Flexible IT Infrastructure, Customer Transactions and Quality Performance

Using the firm-wide databases, flexible IT infrastructure (ITINF) enhances customer transactions by enabling digital customer order management, such as customer account maintenance and order tracking. ITINF-enabled transactions help to deliver information content to customers. Using customer records, such transactions can tailor a considered set of products and services from a much broader set of alternatives for customers (Alba *et al*., 1997). To this end, a flexible infrastructure can enhance customer transactions by providing comprehensive, reliable, high quality, and relevant product and service information to customers, improving service quality in terms of credibility and reliability (e.g., Parasuraman *et al*., 2005).

Moreover, ITINF-enabled transactions facilitate improvements in transaction convenience since they decrease the customer's perception of the amount of time and effort required to effect a transaction (Berry *et al*., 2002). Specifically, ITINF-enabled transactions tailor transaction processes (i.e. purchase and delivery) to customers through customer identification and personal account retrieval, providing information on billing, shipping, frequent orders, past orders, status of orders, and personal preferences. Such transaction services simplify ordering processes for the customer and increase information transparency in respect of customer ordering. Because a significant portion of the process is transparent, service customers often simultaneously assess the service process in their quality evaluations (Field *et al*., 2004). A flexible IT infrastructure enables the focal firm to provide enhanced transaction processes for the customer, thereby fostering positive assessments by the customer, of the service quality it is able to deliver. Thus,

Hypothesis 6b: *Customer transactions are positively related to quality performance and mediate the flexible IT infrastructure (ITINF)–quality relationship*.

4.4.2.3.3 IT Operations Shared Knowledge, Customer Transactions and Quality Performance

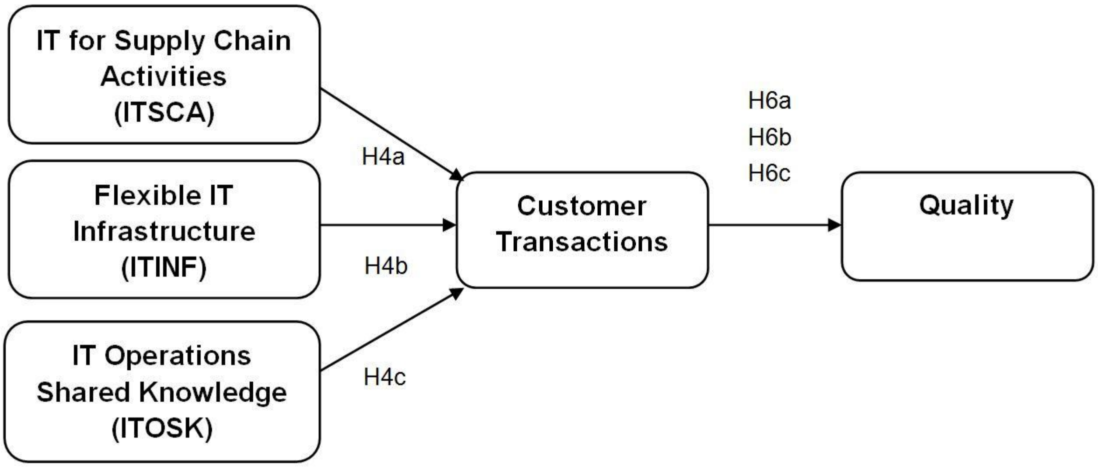
IT operations shared knowledge (ITOSK) can enhance customer transactions by promoting the use of IT innovations within transaction processes. Because they are able to respond quickly to changes in the transaction process, ITOSK-enabled transaction innovations can contribute to improved service quality.

Service firms often adopt innovations because they are driven by the external pressure of the ‘bandwagon’ effect, and many traditional service providers have been forced to switch to electronic transactions for online retailing in the face of upstart competition (Tsikriktsis *et al*., 2004). ITOSK-enabled transaction innovations enable the firm to implement electronic transacting processes with customers (Tsikriktsis *et al*., 2004). ITOSK leverages information and web technologies on the basis of knowledge about customer preferences, creating new electronic transaction processes to support the needs of various customer segments (Hu *et al*., 2009). The digitisation and networking purchase processes enable a variety of customisation approaches to make transactions more appealing to customers (Ansari and Mela, 2003). Based on customer information obtained either previously or in real-time during the transaction processes, the electronic customer transactions are tailored to the customer needs and preferences, and enable firms to customise their offerings for each customer (Thirumalai and Sinha, 2011). This ability to make customised offerings enhances the perceived quality of services from the customer’s perspective (Mithas *et al*., 2005). In short, ITOSK enforces transaction innovations between the focal firm and its customers, helping the firm to tailor its offerings to suit the individual taste of its customers, thereby leading to perceptions of improved service quality among customers. Therefore,

Hypothesis 6c: *Customer transactions are positively related to quality performance and mediate the IT operations shared knowledge (ITOSK)–quality relationship*.

Summarising, Research Model 4 shows the proposed indirect effects of each dimension of IS capabilities (ITSCA, ITINF and ITOSK) on quality performance through its positive influence on customer transactions (see Figure 4.4).

Figure 4.4: Research Model 4



4.4.3 Part 2: IS Capabilities, Customer Connection and Operational Performance

4.4.3.1 IS Capabilities and Their Impact on Customer Connection

In this study, customer connection refers to the communicating and contacting activities in which the firm is involved with its customers. Specifically, these include the process of acquiring and assimilating customer requirements information, and related knowledge. These types of connection are important in the process of integrating with customers, as they help the firm to better understand customers' preferences, and to build relationships with customers (Swink *et al.*, 2007).

Clearly, IS capabilities have vast potential to promote customer integration in terms of customer connection through enabling customer connectivity via the communication and contact processes outlined, and with such integration comes greater success for the firm in its abilities to develop a good understanding of customer needs and set accurate customer profiles (Tsikriktsis *et al.*, 2004; Mithas *et al.*, 2012). The following sections provide detailed discussions on the relationship between each dimensions of IS capabilities and customer connection.

4.4.3.1.1 IT for Supply Chain Activities and Customer Connection

IT for supply chain activities (ITSCA) refers to the extent to which a firm has adopted IT for processing transactions, co-ordinating activities, and facilitating collaboration with suppliers and customers through information sharing. Previous research has highlighted the use of IT in improving customer connection processes by providing easier access to information, and developing more flexibility to respond to customer information requests (e.g., Lederer *et al.*, 2001; Rai *et al.*, 2006).

A firm's use of IT for supply chain activities (ITSCA) promotes its customer connection by digitally enabling the process of acquiring and assimilating customer requirements information and related knowledge. Specifically, ITSCA enables the firm to electronically communicate with customers, and to manage relationships with them (Bharadwaj 2000; Feeny and Willcocks 1998). For example, web-enabled customer interaction technologies provide the firm with an integrated set of functionalities at the customer interface to gather and store customer information and knowledge (Mithas *et al*., 2005). Further, ITSCA can enhance a firm's ability to keep, improve and extend its relationships with customers (Tsikriktsis *et al*., 2004). For example, customer relationship management (CRM) applications facilitate organisational learning about customers by enabling firms to analyse customer purchase behaviour across transactions through different channels and customer touchpoints (Hendricks *et al*., 2007). In short, ITSCA leads to improved customer connection by enabling electronic communication and contact processes with customers. Therefore,

Hypothesis 7a: *The use of IT for supply chain activities (ITSCA) has a positive influence on the degree of customer connection*.

4.4.3.1.2 Flexible IT Infrastructure and Customer Connection

Flexible IT infrastructure (ITINF) refers to a firm's ability to deploy a shareable platform that supports a foundation for data management, communications network, and application portfolio. A flexible IT infrastructure provides an integrated platform that enforces standardisation of data and processes, making possible timely and accurate information gathering and sharing across business functional areas (Lu and Ramamurthy, 2011). Flexible IT infrastructure provides a sharable platform for data warehousing, data mining, and reporting, thereby supporting the processes involved in connecting with customers (Suresh, 2004).

Additionally, flexible IT infrastructure can enhance customer connection by supporting customer data and customer-related information management. A flexible IT infrastructure enables the firm to collect and store customer-related information, and supports the shareability and reusability of information that are necessary for customer connection processes (Basu and Blanning, 2003).

Further, customer information and data that are produced in a shareable manner should promote consistency in the various communication channels that exist between the firm and it customers, since the shared nature of the process ensures the transparent flow of information from one step to another, and reduces confusion arising from information inconsistencies (Rangaswamy and Van Bruggen, 2005).

Supported by the shareable and firm-wide databases, flexible IT infrastructure also facilitates an integrated communication presence, which enables online customer communication for after-sales services such as support for products bought or services delivered in physical stores as well as real-time live chat that provides online customers with access to customer service assistants (Jana, 2007; Oh *et al*., 2012). Therefore, the discussion leads to the following hypothesis:

Hypothesis 7b: *Flexible IT infrastructure (ITINF) has a positive influence on the degree of customer connection*.

4.4.3.1.3 IT Operations Shared Knowledge and Customer Connection

IT operations shared knowledge (ITOSK) refers to the knowledge that the operations manager possesses regarding how IT can be used to improve operations processes. Previous research has emphasised the significance of business managers' familiarity with information technologies and their potential business impacts (e.g., Sambamurthy and Zmud, 1999; Bassellier *et al*., 2003). IT knowledge shared by business managers increases their understanding of IT, enabling them to increase their leadership in the IT domain and show greater support for IT (Chan *et al*., 2006). Specifically, IT-knowledgeable management should be proactive in promoting and supporting IT utilisation. IS literature has highlighted that successful implementation of IT projects requires the co-operation between business and IT departments (e.g., Reich and Benbasat, 2000; Kearns and Lederer, 2003). To promote IT in their business processes, business managers have to work closely with the department responsible for developing IT. Therefore, a business manager's intention to further develop partnerships with the IT departments is considered to play a critical role in successfully implementing IT in business processes (Bassellier *et al*., 2003). Indeed, it is believed that the stronger the relationship between business and IT, the more effectively IT can be deployed in support of business goals (e.g., Chan and Reich, 2007a).

Placed within an operations context, IT knowledge shared by operations managers should promote and support IT utilisation in the firm's communications with customers, hence facilitating customer connection processes. IT-knowledgeable operations managers are more likely to be involved in IT planning for customer connection processes. Furthermore, ITOSK should also ensure that the firm is able to respond swiftly, effectively, and efficiently to changes in customer connection processes, and this entails supporting technological innovation to facilitate those processes. To this end, ITOSK is expected to facilitate the firm's customer connection. Therefore,

Hypothesis 7c: *IT operations shared knowledge (ITOSK) has a positive influence on the degree of customer connection*.

4.4.3.2 The Mediating Effect of Customer Connection on Cost Performance (Model 5)

In this section, customer connection as a mediator variable explains how each dimension of IS capabilities has a relationship with cost performance. Customer connection is seen as the underlying cause of the relationship between IS capabilities and cost performance, since IS capabilities have an influence on the level of customer connection and this causes the difference in cost performance.

4.4.3.2.1 IT for Supply Chain Activities, Customer Connection and Cost Performance

As has been discussed, IT for supply chain activities (ITSCA) provides opportunities to enhance customer connection processes associated with acquiring customer requirement information and related knowledge (Chatterjee *et al.*, 2002). Specifically, ITSCA-enabled connection with customers helps to reduce the service costs of managing relationships with customers. For example, electronic communications can decrease the time taken to reach customers and accelerate responses to customer inquiries (Wu *et al*., 2003). Online presence allows a firm to reach out to new customer bases and segments in a cost-efficient way without the limitations of geography and time (Evans and Wurster, 1997). Web-enabled connection processes can also help lower the cost of material and personnel involved in paper-based communications both within and outside the business unit (Vogelstein and Hjelt, 2001).

Further, ITSCA-enabled customer connection can contribute to reducing capacity holding and monitoring costs by facilitating long-term relationship building with customers (Hendricks *et al*., 2007). For example, the Internet and CRM technologies enable a service firm to collect the appropriate customer information, develop accurate customer profiles, and provide better customer support, all of which can enhance a firm's ability to retain, improve, and extend its relationships with customers (Tsikriktsis *et al*., 2004). When it engages in a long-term relationship with customers, the firm can lower capacity holding and monitoring costs at the same time as improving the response to customer needs, and reducing demand uncertainty (Baltacioglu *et al*., 2007; Rungtusanatham *et al*., 2003a; Zhao *et al*., 2008). The above discussion leads to the following hypothesis:

Hypothesis 8a: *Customer connection is positively related to cost performance and mediates the IT for supply chain activities (ITSCA)–cost relationship*.

4.4.3.2.2 Flexible IT Infrastructure, Customer Connection and Cost Performance

Flexible IT infrastructure enhances customer connection processes by supporting the shareability and reusability of customer data, which can lead to improved cost performance. Specifically, a flexible infrastructure reduces duplication in data entry and maintenance through providing a shareable firm-wide database of customer information. Such a database replaces systems maintained by individual sales people, institutionalises customer relationships, and prevents the loss of organisational customer knowledge when sales people leave the firm (Hendricks *et al*., 2007).

Empowered by the collected customer data, ITINF-enabled customer connection also ensures that the firm can maintain a high level of communication consistency of product or service information, thereby providing customers with access to information available across different channels or interfaces (Oh *et al*., 2012). Such ITINF-enabled communication consistency allows customers to engage in self-service such as ‘online order/in-store pickup’, which reduces the capacity holding and customer service costs (Chatterjee, 2010; Wind and Mahajan, 2002).

Moreover, the establishment of a flexible IT infrastructure enables organisational units to leverage and integrate their resources effectively to address customer needs (Lu and Ramamurthy, 2011). Such resource integration facilitates the firm’s capacity to maintain and deepen relationships with existing customers, and to develop the ability to maintain efficiency and make improvements to its current operations (Hoque *et al*., 2006). As has been discussed, a firm’s long-term relationship with customers leads to cost reduction with decreased demand uncertainty (Baltacioglu *et al*., 2007; Zhao *et al*., 2008). Therefore,

Hypothesis 8b: *Customer connection is positively related to cost performance and mediates the flexible IT infrastructure (ITINF)–cost relationship*.

4.4.3.2.3 IT Operations Shared Knowledge, Customer Connection and Cost Performance

IT operations shared knowledge (ITOSK) can promote and support IT utilisation in customer communication processes and facilitate customer connection. Hence, the use of ITOSK-enabled technologies in customer connection contributes towards improving the cost performance of the service provider.

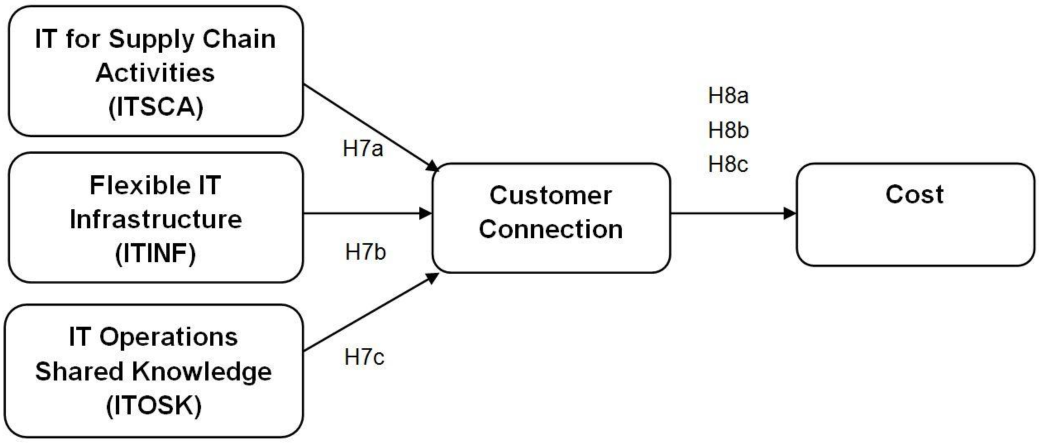
ITOSK ensures that the firm speedily, effectively, and efficiently responds to changes in customer connection processes, and supports technological innovations that facilitate customer connection. Such ITOSK-enabled IT innovations increase the ability of the firm to deploy new technologies to support its customer communications in a cost-efficient manner. For example, the establishment of web-enabled customer interaction forces the firm to provide real-time live chat that gives online customers access to customer service assistants (Jana, 2007), leading to cost reductions which are gained from the increased communication channel efficiencies (Rust and Lemon, 2001).

Through these various customer benefits of IT, ITOSK also supports IT-enabled service innovations that permit even further customer connection. For example, ITOSK can facilitate the firm's efforts to create an integrated communication channel with its customers, where the Website provides after-sales services such as support for products bought in physical stores to assist customers efficiently (Oh *et al*., 2012; Jana, 2007). Using the integrated customer communication channel, ITOSK-enabled service innovation also allows customers to engage in self-service such as 'online order/in-store pickup', which reduces the capacity holding and customer service costs (Chatterjee, 2010). In short, ITOSK enhances the utilisation of IT and supports relative innovations in customer connection processes, which in turn leads to improved cost performance. Therefore,

Hypothesis 8c: *Customer connection is positively related to cost performance and mediates the IT operations shared knowledge (ITOSK)–cost relationship*.

Summarising, Research Model 5 shows the proposed indirect effects of each dimension of IS capabilities (ITSCA, ITINF and ITOSK) on cost performance through its positive influence on customer connection (see Figure 4.5).

Figure 4.5: Research Model 5



4.4.3.3 The Mediating Effect of Customer Connection on Quality Performance (Model 6)

In this section, customer connection as a mediator variable explains how each dimension of IS capabilities relates to quality performance. Customer connection is seen as the underlying cause of the relationship between IS capabilities and quality performance, in which IS capabilities are seen to influence the level of customer connection which subsequently causes the difference in quality performance.

4.4.3.3.1 IT for Supply Chain Activities, Customer Connection and Quality Performance

IT for supply chain activities (ITSCA) can enhance and accomplish connection processes between a service firm and its customers in terms of acquiring customer requirements information, and related knowledge. Customer connection processes that are ITSCA-enabled allow a service firm to develop a good understanding of its customer needs and to focus efforts on meeting those needs, thereby precipitating improved service quality (Ellram *et al*., 2004; Zeithaml and Bitner 2003).

Information gathering of consumer research and consumer desires acts to facilitate a firm’s efforts to generate products and services that better match the needs of end customers. Boosted by information exchanges on consumer needs, ITSCA-enabled customer connection processes present firms with the ability to get closer to product or service end-users, in order to complement their existing knowledge about consumer preferences, problems with existing products, and the features or services which their customers still require (Kulp *et al*., 2004). For example, CRM applications enable a firm to record relevant information about each customer transaction. Once captured, such customer information can be processed and converted into customer knowledge, using the information-processing rules and organisational policies (Mithas *et al*., 2005). Customer knowledge that has been captured across service encounters can then be made available for all future transactions, enabling the firm to improve the accuracy of its customer profiles and to respond to any customer need in a contextual manner (Tsikriktsis *et al*., 2004). With accurate customer profiles, the service provider is able to enhance service quality by being responsive to customer requirements, and this in turn, increases the perception among customers that the services they are receiving are performed accurately and dependably, and can thus, be relied upon. Consequently,

Hypothesis 9a: *Customer connection is positively related to quality performance and mediates the IT for supply chain activities (ITSCA)–quality relationship*.

4.4.3.3.2 Flexible IT Infrastructure, Customer Connection and Quality Performance

Flexible IT infrastructure (ITINF) enhances customer connection processes by facilitating the accessibility of customer information and data across the firm. With such accessibility, a firm can leverage its stock of accumulated knowledge and experience for the purposes of effective customer relationship management (Lu and Ramamurthy, 2011). ITINF-enabled customer connection empowers the firm such that it becomes more familiar with the customer data management issues involved in initiating, maintaining, and terminating a customer relationship. This familiarity enables the firm to leverage its collection of customer data to customise offerings and respond to customer needs (Mithas *et al*., 2005). A firm’s ability to satisfy the needs of current customers will lead to improved service quality (Connor, 2007).

The establishment of a flexible IT infrastructure also helps a firm to leverage its customer knowledge effectively to address customers’ evolving needs (Sambamurthy *et al*., 2003). ITINF-enabled customer connection enables the sharing of a firm’s accumulated customer knowledge with its customers, thereby encouraging customers to service themselves through selecting the service and its delivery to suit their needs (Prahalad *et al*., 2000). This ability to self-select service features provides additional opportunities for the firm to deepen its customer knowledge and to address its customers’ evolving needs (Mithas *et al*., 2005). With enhanced customer knowledge, the service firm is more likely to improve its service quality in terms of increasing reliability, and hence, customers will perceive that the service is performed accurately and dependably, and that the firm responds well to customer requirements. Therefore,

Hypothesis 9b: *Customer connection is positively related to quality performance and mediates the flexible IT infrastructure (ITINF)–quality relationship*.

4.4.3.3.3 IT Operations Shared Knowledge, Customer Connection and Quality Performance

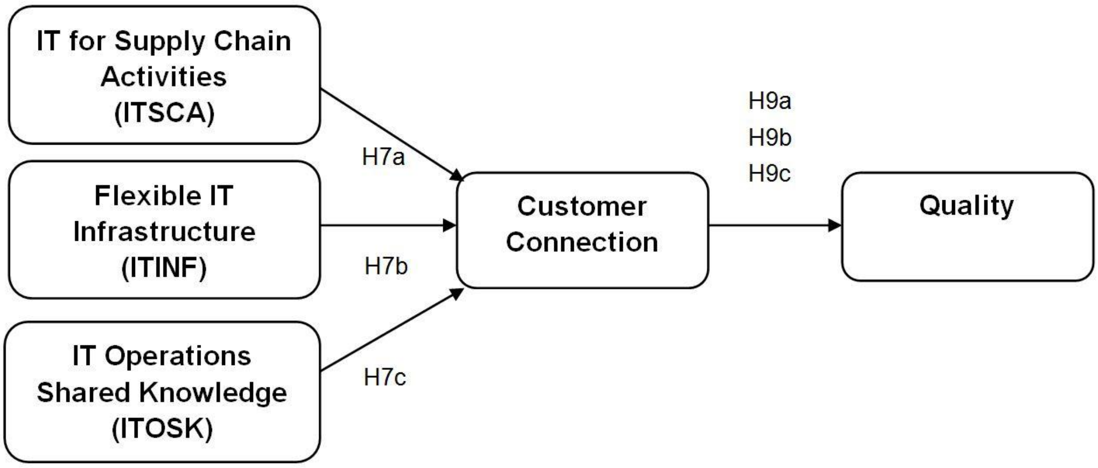
IT operations shared knowledge (ITOSK) has the potential to promote and support IT utilisation in customer communication processes, and to facilitate customer connection. ITOSK-enabled technologies utilisation in customer connection contributes to improved quality performance of the service provider. For example, the use of online customer service processes enables the firm to respond to customer requirements in a quick, accurate and dependable way, increasing service reliability (Zeithaml *et al*., 2002).

ITOSK ensures that a firm responds speedily, effectively, and efficiently, to changes in customer connection processes, and supports technological innovations in respect of connecting customers. Such ITOSK-enabled IT innovations increase the firm’s ability to deploy new technologies to support its customer communications, resulting in increases in the levels of quality perceived by customers. For example, using web-enabled customer interaction, the firm can help its customers to better understand their own needs, and can simultaneously facilitate the firm’s ability to customise service content and procedures according to individual requirements (Tan *et al*., 2013). The implementation of online customisation also provides the service firm with an economical way to empower customers to participate in the product or service design and to create purchases that better fit their needs (Alba *et al*., 1997; Wind and Rangaswamy, 2001). Customised offerings enhance the perceived quality of services from a customer’s point of view (Mithas *et al*., 2005). In short, ITOSK enforces connection innovations between the focal firm and its customers, helping the firm to tailor its offerings to suit the individual taste of its customers, an outcome which subsequently leads to improved service quality as perceived by customers. Therefore,

Hypothesis 9c: *Customer connection is positively related to quality performance and mediates the IT operations shared knowledge (ITOSK)–quality relationship*.

Summarising, Research Model 6 shows the proposed indirect effects of each dimensions of IS capabilities (ITSCA, ITINF and ITOSK) on quality performance through its positive influence on customer connection (see Figure 4.6).

Figure 4.6: Research Model 6



4.4.4 Part 3: IS Capabilities, Customer Collaboration and Operational Performance

4.4.4.1 IS Capabilities and Their Impact on Customer Collaboration

In this study, customer collaboration refers to collaborative service provision-related activities in respect of planning, forecasting, and scheduling, between the firm and its customers. This includes information sharing of real-time point-of-sales data, sales forecasts, production and service schedules, and service capacity planning. IS capabilities have vast potential to facilitate customer integration in terms of customer collaboration by the sharing of information on demand forecasts and production schedules that dictate supply chain activities (Li *et al*., 2009). The following sections provide detailed discussions on the relationship between each dimensions of IS capabilities and customer collaboration.

4.4.4.1.1 IT for Supply Chain Activities and Customer Collaboration

IT for supply chain activities (ITSCA) refers to the extent to which a firm has adopted IT for processing transactions, co-ordinating activities, and facilitating collaboration with suppliers and customers through information sharing. The use of IT resources has significantly improved collaboration between firms and their customers permitting strong customer integration in terms of demand forecasting, capacity planning, and order scheduling (e.g., Feeny, 2001; Sanders, 2007).

A firm’s use of IT for supply chain activities enhances its customer collaboration through promoting information sharing and exchange between the firm and its customers regarding forecasting, planning, and scheduling processes. For example, the use of the Internet and web-enabled technologies has had a great impact on the information exchange between buyers and sellers (Rabinovich *et al*., 2003; Rai and Tang, 2010). In keeping with this body of work, recent research calls attention to the role of the Internet in amplifying the sharing and dissemination of real-time information, processes, and resources among collaborating partners (e.g., Konsynski and Tiwana, 2004; Rosenzweig, 2009; Rosenzweig *et al*., 2011; Nyaga *et al*., 2010). Such technologies enable the firm to access real-time demand information and achieve demand visibility (Sanders, 2007).

Since planning instability is magnified up service supply chains, being able to control this amplification is vital for the service provider (Akkermans and Vos, 2003; Akkermans and Voss, 2013). Successful customer collaboration in services, therefore, relies on the use of ITSCA and involves shared data between planning and controlling (i.e. backlog variability; Anderson *et al*., 2005). The use of ERP systems enables the firm to collect all enterprise data once during the initial transaction, store this centrally, and update it in real time. This ensures that all levels of planning are on the basis of the same data and that the resulting plans realistically reflect the prevailing operating conditions of the firm (Hendricks *et al*., 2007). The above discussion leads to the following hypothesis:

Hypothesis 10a: *The use of IT for supply chain activities (ITSCA) has a positive influence on the degree of customer collaboration*.

4.4.4.1.2 Flexible IT Infrastructure and Customer Collaboration

As has been discussed, flexible IT infrastructure (ITINF) refers to a firm's ability to deploy a shareable platform that supports a foundation for data management, communications network, and application portfolio. A flexible IT infrastructure provides an integrated platform that enforces the standardisation of data and processes, making possible timely and accurate information gathering and sharing across business function areas (Lu and Ramamurthy, 2011).This in turn, enables a sharable platform for the sharing and exchange of information and data in supporting the processes of collaborative activities with customers.

It has been argued that the nature of collaboration is on the basis of shared databases and groupware (Banker *et al*., 2006b). The frequency and intensity of collaborative activities depend on several factors, such as data definition, ease of access, data availability, and missing data (Davis *et al*., 2001). In a firm where collaborative activities are not structured, that firm's ability to collaborate effectively is impeded due to the lack of an integrated platform and appropriate standards to exchange information and data (Banker *et al*., 2006b).

A flexible IT infrastructure provides the firm with an integrated platform that enforces data and processes standardisation and integration, thus facilitating timely and accurate information gathering and sharing (Lu and Ramamurthy, 2011). Sharing of real-time, consistent, and comprehensive information enables efficient collaboration between the firm and its customers (Rosenzweig, 2009). As has been argued, the increased demand visibility through information sharing helps the service firm to implement appropriate capacity planning and deliver a fast response to the unexpected, preventing a bullwhip-type effect in services (Akkermans and Voss, 2013). To this end, ITINF is expected to enhance customer collaboration in service firms in terms of providing an integrated platform for real-time and consistent sharing and exchange of information and data. This discussion leads to the following hypothesis:

Hypothesis 10b: *Flexible IT infrastructure (ITINF) has a positive influence on the degree of customer collaboration*.

4.4.4.1.3 IT Operations Shared Knowledge and Customer Collaboration

In this study, IT operations shared knowledge (ITOSK) refers to the knowledge that the operations manager possesses regarding how IT can be used to improve operations processes.

It has been argued that line managers' understanding of the value of IT for business processes plays an important role in influencing an organisation's IT use (Bassellier *et al*., 2003). The accumulation of knowledge enforces a firm's ability to recognise and assimilate new ideas, as well as its capability to convert this knowledge into further innovations (Cohen and Levinthal, 1990). Line managers with IT shared knowledge, are therefore, more likely to understand and promote the use of new IT innovations, which is critical given the rapid changes and advances in the use of IT technology

(Bassellier *et al*., 2003).

With an appreciation of how new IT could help customer collaboration, ITOSK would enable and promote the use of new IT innovations for demand forecasting and scheduling processes with customers. For example, the adoption of SCM systems develops a firm's real-time planning capability such that it can react quickly to demand changes (Hendricks *et al*., 2007). Further, recent research has showcased the benefit that the deployment of web-enabled forecasting and scheduling systems can help the service provider to better plan its capacity. For instance, online appointment systems are used by many service businesses for estimating future demand and requests from their customers; clinical scheduling systems enable healthcare service providers to track pre-registered patients and schedule appropriate staff in order to avoid delays in clinical procedures (Devaraj *et al*., 2013).

Going beyond the improved flow of information, IT operations shared knowledge would, over time, engender specialised IT-enabled routines and/or standard operating procedures, which facilitate more efficient and effective collaboration between service firms and their customers in terms of capacity planning and demands requirements. This discussion leads to the following hypothesis:

Hypothesis 10c: *IT operations shared knowledge (ITOSK) has a positive influence on the degree of customer collaboration*.

4.4.4.2 The Mediating Effect of Customer Collaboration on Cost Performance (Model 7)

In this section, customer collaboration as a mediator variable explains how each dimension of IS capabilities has a relationship with cost performance. Customer collaboration is seen as the underlying cause of the relationship between IS capabilities and cost performance, in which IS capabilities have an influence on the level of customer collaboration, and causes the difference in cost performance.

4.4.4.2.1 IT for Supply Chain Activities, Customer Collaboration and Cost Performance

The use of IT for supply chain activities (ITSCA) enhances a firm's customer collaboration through promoting information sharing and exchange between the firm and its customers regarding forecasting, planning, and scheduling processes. Such ITSCA-enabled processes for customer collaboration are associated with better cost performance.

A key difference between service and manufacturing supply chains in the way that they deal with variability, is the role of work backlogs (Akkermans and Vos, 2003). Service supply chains typically buffer with spare and/or flexible capacity, since buffering with inventory is not possible in services (Ellram *et al*., 2004). In any service system, a disturbance in demand will lead to a growth in backlog, unless capacity can be adjusted instantly (Akkermans and Voss, 2013). It has been argued that bullwhip effects in services are associated with major fluctuations in workload, and in particular, with unexpected peaks. With a sustained growth in workload after a certain delay, the accumulated backlog of work would become larger than staff could handle, leading to lower productivity and more errors (Akkermans and Voss, 2013).

As has been found in manufacturing supply chains, information sharing through IS capabilities can benefit the focal firm, and forms the core foundation of supply chain collaboration (e.g., Lee and Whang, 2000), resulting in positive performance impacts that include labour productivity and inventory optimisation (e.g., Saldanha *et al*., 2013; Tallon, 2007). ITSCA-enabled collaborative activities with customers are expected to facilitate service firms' efforts to reduce delay in information processes by decreasing the time that it takes the firm to notice the capacity requirements, and decreasing the variability of staff workloads. Regular workloads and small variations in the workload lead to improved cost performance in terms of high labour productivity. Moreover, ITSCA-enabled customer collaboration is also expected to help service firms reduce capacity variance by enhancing demand visibility and decreasing uncertainty with accurate and reliable forecasts. Reduced capacity variation will result in a decreased bullwhip effect as well as decreased hiring, training, firing and other personnel costs associated with varying capacity (Anderson *et al*., 2005). This leads to the following hypothesis:

Hypothesis 11a: *Customer collaboration is positively related to cost performance and mediates the IT for supply chain activities (ITSCA)–cost relationship*.

4.4.4.2.2 Flexible IT Infrastructure, Customer Collaboration and Cost Performance

As argued earlier, flexible IT infrastructure (ITINF) enhances customer collaboration in service firms by providing an integrated platform for real-time and consistent sharing and exchange of information and data. The increased demand visibility through information sharing facilitates the service provider's attempts to implement appropriate capacity planning and fast response to the unexpected, thereby preventing a bullwhip-type effect in services (Akkermans and Voss, 2013).

A flexible IT infrastructure enables the firm to computerise its business processes (Banker *et al*., 2010). When a business function is computerised, the firm can more easily access related information as the data is only a few clicks away (Wilkinson *et al*., 2000). Further, a firm's flexible infrastructure ensures platform compatibility which enables the firm to share any type of information across any technology component throughout the whole firm (Duncan, 1995; Chung *et al*., 2003). Such IT compatibility makes data, information, and knowledge readily available within the firm (Tapscott and Caston, 1993).

Recently, Akkermans and Voss (2013) have argued that the data available to management, and the way in which it is used, is critical for service firms wishing to implement appropriate capacity planning for customers. They explain that a lack of backlog data will result in longer delays in the reaction to problems, thereby leading to amplification of backlogs. To this end, a flexible IT infrastructure would provide an integrated platform for real-time and consistent sharing and exchange of demand information between the firm and its customers, thus enhancing the accurate and timely data available to management for matching the service provider's capacity with its customer demands. Such ITINF-enabled customer collaboration in turn, leads to higher labour productivity and lower service cost by decreasing backlogs and capacity variance. Therefore,

Hypothesis 11b: *Customer collaboration is positively related to cost performance and mediates the flexible IT infrastructure (ITINF)–cost relationship*.

4.4.4.2.3 IT Operations Shared Knowledge, Customer Collaboration and Cost Performance

IT operations shared knowledge (ITOSK) engenders specialised IT-enabled routines and/or standard operating procedures, which facilitate attempts by service firms and their customers to work together more efficiently and effectively in terms of capacity planning and demands requirements. Efficient ITOSK-enabled customer collaboration streamlines collaborative capacity planning processes and results in improved cost performance.

As discussed earlier, ITOSK would enable and promote the use of new IT innovations for demand forecasting and scheduling processes with customers. ITOSK-enabled innovations such as web-enabled scheduling systems, enable staff to log into the scheduling system, identify open slots, and self-schedule working hours. Such activities avoid bottlenecks in the service provision processes. In addition, staff can track histories of customer demands and requirements, thereby reducing the need for unnecessary inquiries that can prolong a customer's stay in the system. Furthermore, the implementation of ERP systems will improve co-ordination among different business functions in the service firm, and result in efficiency gains (Shang and Seddon, 2002).

ITOSK allows service firms to enhance customer collaboration processes by supporting and promoting new IT innovations for collaborative activities. Such

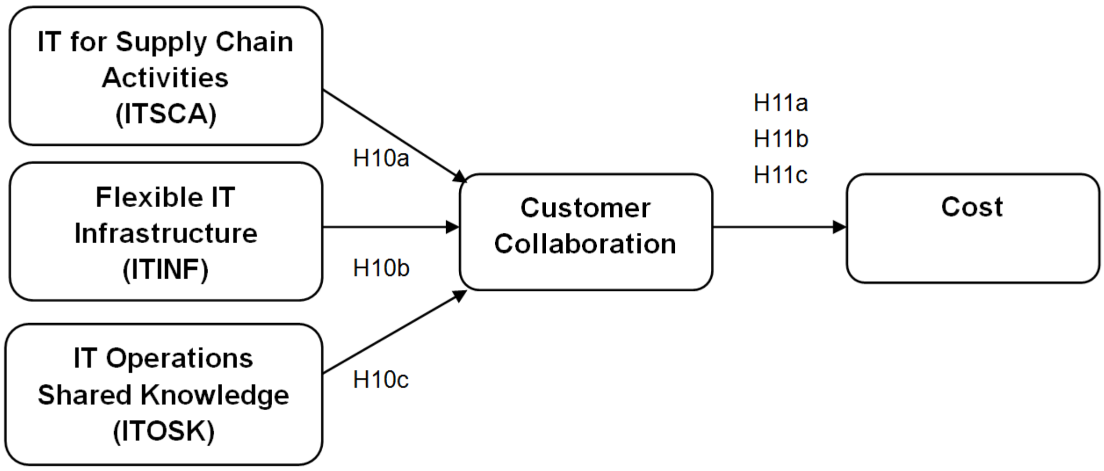
ITOSK-enabled innovations facilitate service providers' efforts to obtain increased visibility of customer demands and changes in requirements, leading to appropriate capacity planning. As has been discussed, matching capacity with customer demands appropriately ensures that the service provider can enjoy high labour productivity in terms of reduced backlogs and the bullwhip effect (Akkermans and Voss, 2013).

Moreover, ITOSK provides the service provider with the ability to absorb, through the organisation's IT knowledge structures, information regarding appropriate IT functions and innovations so that the information and knowledge related to IT can be assimilated and applied in support of customer collaboration. To this end, ITOSK would empower service firms to achieve internal process efficiencies through IT-enabled tracking and recording of capacity used in service provision. Efficient service providers are able to schedule and perform a greater number of procedures, and efficiently move customers through their systems, consequently being able to better manage and adjust their capacity to optimise the use of human and physical resources (Sampson and Spring, 2012; Devaraj *et al*., 2013). Therefore,

Hypothesis 11c: *Customer collaboration is positively related to cost performance and mediates the IT operations shared knowledge (ITOSK)–cost relationship*.

Summarising, Research Model 7 shows the proposed indirect effects of each dimension of IS capabilities (ITSCA, ITINF and ITOSK) on cost performance through its positive influence on customer collaboration (see Figure 4.7).

Figure 4.7: Research Model 7



4.4.4.3 The Mediating Effect of Customer Collaboration on Quality Performance (Model 8)

In this section, customer collaboration as a mediator variable explains how each dimension of IS capabilities has a relationship with quality performance. Customer collaboration is seen as the underlying cause of the relationship between IS capabilities and quality performance, in which IS capabilities have an influence on the level of customer collaboration, thereby causing the difference in quality performance.

4.4.4.3.1 IT for Supply Chain Activities, Customer Collaboration and Quality Performance

The use of IT for supply chain activities (ITSCA) enhances a firm's customer collaboration through promoting information sharing and exchange between the firm and its customers regarding forecasting, planning, and scheduling processes. Such ITSCA-enabled processes for customer collaboration are associated with improved quality performance.

As has been discussed, a disturbance in demand will lead to a growth in backlog. As backlog of work accumulates, more errors occur, leading to drops in service quality. Specifically, customers tend to be patient when they can talk about their issues with helpful, understanding, and polite agents who are clearly doing their best to be responsive to their needs. As backlogs grow, simultaneously staff morale decreases, and agents have neither the time nor the expertise to address customers properly. When a tipping point has been passed, customer patience and goodwill rapidly evaporates, calls increase, and complaints swiftly escalate (Akkermans and Voss, 2013). The increase in communication time and the fact that the customer spends longer time in the system than desired by the firm, may lead to decreased service quality in terms of reliability, credibility, and responsiveness (Soteriou and Chase, 1998).

By enhancing demand visibility and decreasing uncertainty with the generation of accurate and reliable forecasts, ITSCA-enabled collaborative activities with customers are expected to rapidly provide information on capacity requirements and enable the service firm to reduce the variability of staff workloads. Regular workloads and small variations in the workload ensure that staff manage their tasks comfortably, leading to improved service quality in terms of consistently meeting customers' requirements. Therefore,

Hypothesis 12a: *Customer collaboration is positively related to quality performance and mediates the IT for supply chain activities (ITSCA)–quality relationship*.

4.4.4.3.2 Flexible IT Infrastructure, Customer Collaboration and Quality Performance

Flexible IT infrastructure (ITINF) enhances customer collaboration in service firms by providing an integrated platform for real-time and consistent sharing and exchange of information and data. The increased demand visibility acquired through information sharing facilitates the service provider's implementation of appropriate capacity planning and fast response times to the unexpected, thus preventing a bullwhip-type effect in services (Akkermans and Voss, 2013).

As has been discussed, a flexible IT infrastructure enables computerised and standard business processes for the firm to share information throughout the whole organisation, making data, information, and knowledge readily available within the firm (Chung *et al*., 2003; Banker *et al*., 2010). ITINF therefore, enables customer collaboration processes by providing an integrated platform for sharing accurate and timely data concerning customer demands, leading to appropriate capacity planning and demand management, such as adding additional capacity through scheduling more employees (Pullman and Thompson, 2003).

It has been argued that the lack of an integrated platform and appropriate standards to exchange information and data impedes a firm's ability to effectively collaborate

(Banker *et al.*, 2006b). In line with this notion, a recent study has highlighted the importance of data availability in implementing appropriate capacity planning for customers in services (Akkermans and Voss, 2013). In that study, data such as backlogged orders and subsequent workload were found to be available on a routine basis and had provided warnings of problems (Akkermans and Voss, 2013). However, without a structured and integrated platform, the management may have very limited or no access to such data. In such case, where no data are available at the managerial level, efficient capacity planning is denied, since when the backlogs eventually come through it is impossible to rapidly install the capacity required (Akkermans and Voss, 2013). This scenario results in longer waiting times and increased contact times spent by customers as they remain within the system. In this sense, ITINF enables critical data sharing across the whole firm through providing an integrated and shareable platform, which in turn enables the service provider to sustain a consistent level of service by appropriate capacity planning. Thus,

Hypothesis 12b: *Customer collaboration is positively related to quality performance and mediates the flexible IT infrastructure (ITINF)–quality relationship*.

4.4.4.3.3 IT Operations Shared Knowledge, Customer Collaboration and Quality Performance

As discussed earlier, IT operations shared knowledge (ITOSK) engenders specialised IT-enabled routines and/or standard operating procedures, which facilitate efforts by the service firms and their customers to work together more efficiently and effectively in terms of capacity planning and demands requirements. ITOSK supports the generation of efficient IT innovations for customer collaboration processes and results in improved quality performance in terms of better meeting customer requirements.

Customers' requirements and expectations change over time; therefore, a service provider is required to be ready to update his/her system in a timely fashion in order to meet the changing demand of customers (Beheshti and Salehi-Sangari, 2007). From the service provider's perspective, it is desirable to design and deliver an apt quality offering that has the potential to meet customer requirements, such offering being based on the provider's understanding of customer demands (Cho and Menor, 2010; Roth and Menor, 2003). On the demand side, service customers are very likely to have strong opinions about how the service should be designed; for instance, ideas about the process by which it should be delivered (Sampson and Spring, 2012).

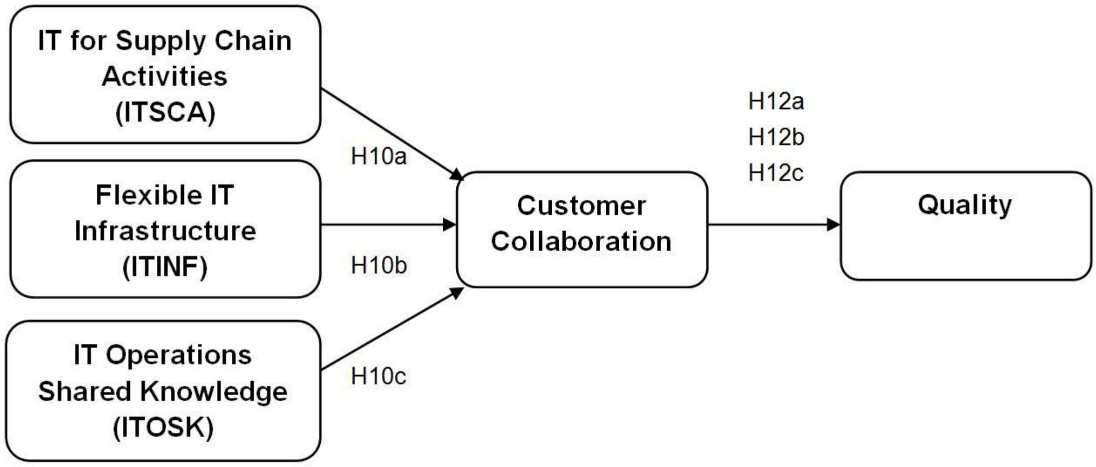
Given the understanding of how IT can be used to help the service provider better meet customer requirements, ITOSK-enabled innovations such as web-enabled self-service systems. automatically place customers in a co-production role, thus changing the nature of service delivery dramatically (Bitner *et al.*, 2010). Such a shift leads to customers having quality perceptions that relate to their own abilities and performance, and those perceptions influence their overall assessment of service quality (Parasuraman *et al*., 2005). Specifically, customers' participation in services delivery contributes to their own satisfaction and the ultimate quality of the services they receive, since effective customer participation can increase the likelihood that customer requirements are met, and that the benefits customers are seeking are actually attained (Bitner *et al*., 1997). In these cases, ITOSK-enabled innovations make it possible for customers to become an integral part of the service, and provide them with the technical support necessary for them to perform their roles effectively in order to achieve the desired service outcome.

In short, ITOSK supports and promotes IT innovations for the service firm to efficiently collaborate with its customers. Such ITOSK-enabled technology innovations have significantly influenced how the service provider captures the changing requirements of customers, enabling the provider to better understand customers' new needs as well as to improve the design and delivery of services to meet them. Therefore,

Hypothesis 12c: *Customer collaboration is positively related to quality performance and mediates the IT operations shared knowledge (ITOSK)–quality relationship*.

Summarising, Research Model 8 shows the proposed indirect effects of each dimensions of IS capabilities (ITSCA, ITINF and ITOSK) on quality performance through its positive influence on customer collaboration (see Figure 4.8).

Figure 4.8: Research Model 8



4.5 Conclusions

This chapter has discussed the arguments produced in respect of the relationships between each dimension of IS capabilities (IT for supply chain activities, flexible IT infrastructure, and IT operations shared knowledge) and operational performance (cost and quality), and the underlying mechanisms (the processes developed for supplier and customer integration, namely supplier integration, customer transactions, customer connection, and customer collaboration) in services. In total, eight research models have been presented (Models 1–8) and the development of the proposed hypotheses for each model has been discussed in detail. The next chapter describes and explains the research methodology that has been selected for the testing of these hypotheses.

CHAPTER FIVE:

RESEARCH DESIGN AND METHODOLOGY

5.1 Introduction

This chapter describes the research design and methodology used to test the research models proposed in Chapter Four, and details the test instruments employed. As has been described in Chapters Two, Three and Four, a thorough study of the literature has been conducted in order to identify key issues and to gain insight into the areas of IS capabilities and operational performance. Hypotheses have been developed regarding the relationships between IS capabilities, supply chain integration, and operational performance in a services context. To scientifically investigate such relationships, a rigorous, systematic, and appropriate research design and methodology will be employed in this study.

The development and implementation of the research tool selected to study the research problem are detailed in the chapter, as also is the testing and validation of the research instrument used to collect data from the selected sample. To test the proposed hypotheses, quantitative research methods are chosen to analyse the data collected from a web survey. A discussion of the specific research approach adopted in this study is provided in the following section.

5.2 Research Method

This study aims to investigate the relationships among three dimensions of IS capabilities (IT for supply chain activities, flexible IT infrastructure, and IT operations shared knowledge), supply chain integration (supplier integration, customer transactions, customer connection, and customer collaboration), and operational performance (cost and quality) in services, with a special focus on the mediation effect of supply chain integration. In order to draw meaningful conclusions, it is essential to apply the most appropriate research methodology. This section outlines the rationale for the approach selected.

The purpose of this study is to understand the effects of IS capabilities on supply chain integration and operational performance in service firms. To achieve this purpose and to ensure the generalisability of the findings, it is necessary to collect data from a range of sectors within the service industry. This section discusses the rationale for the selection of a survey approach as the research instrument.

The survey has been a useful research tool for a long time since it encompasses a number of research techniques, and has the advantages of broad coverage and wide application (Saunders *et al*., 2009). It has become a popular and common approach in business and management research (Bryman and Bell, 2009). Surveys enjoy such popularity as they allow the collection of data from a sizeable population in a highly economical way, and the data gathered from this approach can be used to suggest possible reasons for particular relationships between variables and produce models of these relationships. When sampling is used, it is possible to generate findings that are representative of the whole population (Saunders *et al*., 2009).

Specifically, the survey has been viewed as the most commonly used research design in fields of both operations management (OM) (e.g., Flynn *et al*., 1990; Rungtusanatham *et al*., 2003b), and information systems (IS) (e.g., Newsted *et al*., 1998), and the implementation of survey-based research has been generally accepted as being specifically suitable for testing the relationships among variables in both fields (Zhang *et al*., 2011). To this end, the use of survey as the research method is appropriate in terms of: *(a)* it is in line with the research of IS and OM; *(b)* it will lend meaningful input to the current literature of both fields; and *(c)* it will provide a powerful tool for generalising findings and deriving suggestions for application in the context of services; as will be discussed herein.

By its nature, survey research requires the researcher to take particular care of the development of the survey tool. As mentioned earlier, a survey involves data collection by administering a standardised questionnaire to a sample of respondents. In order to be able to compare responses given by different subjects, survey questions must be standardised, and carefully prepared to evaluate relationships between variables. Since the information is being collected from a fraction of the population, the sample for the survey must be carefully selected in order to ensure that findings can be meaningfully generalised to the population as a whole (Malhotra and Grover, 1998). In this study, the population is comprised of UK service establishments. The sample determination is an integral and significant part of the survey development since it must be carefully chosen to represent the true distribution of the respondents to the survey.

Responses to questionnaires may be obtained in a written form, as for mail surveys, or electronically, as for web surveys. In their book, Dillman *et al*. (2009:195-196) point out that "the beauty of a web survey is that once it is launched it can, in principle, be completed very quickly by a large number of people and at low cost". Surveying by web questionnaire has enormous advantages over other survey techniques. The cost savings are particularly appealing, as the method essentially eliminates the costs, such as interview wages, long-distance charges, postage, and printing that are associated with telephone and mail surveys. In addition, the web survey provides high levels of convenience to respondents who can complete the questionnaire at their leisure. As a result of the advancement of computer and web technologies, the use of the Internet for surveying has increased dramatically during the past decade. The widespread use of email and the Internet through high-speed connections in almost every UK work organisation makes it possible for surveys to be conducted on the web without concern about people being unable to respond. For these reasons, this study adopted the web survey as a method of reaching companies in the service sector in the UK, and essentially, to distribute the questionnaire.

Although the desired respondents to this study were considered to possess sufficient technological capabilities to complete a web survey, it is important to acknowledge that some people may still not be familiar with survey completion on the web. Furthermore, the web survey presents another challenge associated with the fact that the web is an unsafe environment feared by some respondents, a fact which may result in a low response rate. These challenges and the possible procedures to limit them are addressed in the following sections.

As has been discussed, a survey approach was selected as the research tool. The following sections details the methods used to develop and administer the questionnaire and procedures followed to ensure the reliability and validity of the instrument.

5.3 Survey Development

A survey approach was designed and applied in this study. A questionnaire that is completed by respondents themselves is one of the main instruments for gathering data when using a survey design. When using surveys, it is extremely important for researchers to emphasise, and therefore, properly specify, the independent, dependent and extraneous variables. Consequently, the questions and variables included in a survey need careful conceptualisation and a sound measurement scale (Bryman and Bell, 2009).

In this study, great efforts have been made to ensure the reliability and validity of the questionnaire. The survey was developed in several stages. Initially, the survey questions were formulated involving IS capabilities, supply chain integration, and operational performance based on an extensive review of the literature (Chapters Two and Three). Next, the preliminary questions were pilot-tested with MBA students at Durham University Business School to collect feedback and suggestions for improvement and clarity. Finally, as a result of the pilot test, a few minor changes to the instrument were made to refine the questionnaire.

5.3.1 Pilot Study

A pilot study is a small-scale study that is performed prior to the full-scale research in order to identify any problems that the research design may have and to rectify them before implementing the major study (Polit and Beck, 2005). Typically, pilot studies are conducted on a small group of respondents that are as similar as possible to the target population. It has been argued that pilot tests have been deployed for different purposes, including assessing the likely success of a research approach, testing the internal validity of a questionnaire, and providing evidence for a funding body that further, full-scale research is valuable (Holloway, 1997). In this study, the role of the pilot study was to determine the reliability and internal validity of the questionnaire, as it can assist in identifying ambiguous or unnecessary questions, as well as indicating items that do not exhibit internal validity and that should, therefore, be discarded.

The preliminary questionnaire was sent to a group of fifty-eight (58) randomly-selected MBA students at Durham University Business School. Thirty-nine (39) completed questionnaires were received, and the responses were tested using SPSS 19.0. Three main statistical tests were conducted to test the internal validity of the questionnaire and the reliability of the constructs.

Reliability refers to the level of consistency between the measuring items of a single variable (Hair *et al*., 2009). There are a number of diagnostic measures of reliability (Robinson *et al*., 1991). Item-to-total correlation measures the influence of each item on the summated scale score. An item-to-total correlation value higher than 0.5 is considered to indicate internal consistency. The item-to-total reliability test on the pilot study indicated three items with corrected correlations lower than 0.4, which were therefore removed from the questionnaire. All remaining items with corrected correlation values above 0.6 were retained (Churchill, 1979). Table 5.1 shows a summary of results.

Table 5.1: Summary of pilot study test

Variables	ITINF	ITOSK	SI	CT	CCnt	CClb	C	Q
Original no. of items	3	3	10	3	4	4	4	7
Refined no. of items	2	3	10	3	3	4	3	7

Cronbach's alpha (α) measures the reliability coefficient and evaluates the consistency of the entire scale. It is commonly agreed that a Cronbach's α value greater than 0.7 is considered to be an acceptable indication of reliability (Hair *et al*., 2009). These two tests were deployed in the pilot study. Cronbach's α values for all items in the pilot study were higher than 0.7, which confirms both the internal consistency of the items, and that the constructs were reliable.

In the pilot study, the MBA students also provided feedback and suggestions for improvement and clarity of the questions. Finally, as a result of the pilot test, minor changes were made to refine the instrument.

5.3.2 Web Questionnaire Design

Prior to the distribution of a final questionnaire, it is crucial to consider the best methods by which to administer the survey in order to secure highest response rate. This study followed the web survey design guidelines detailed by Dillman *et al*. (2009). The web questionnaire was given careful consideration in order to allow for ease of comprehension and completion. Specifically, attention was paid to ensuring clear layout of questions and consistent page layout across screens. This design process was assisted by the suggestions offered during the pilot study phase as explained in section 5.3.1.

For both mail and web survey approaches, Dillman *et al*. (2009) divide the survey process into two main stages: questionnaire design and questionnaire administration, and advocate that suitable and equal consideration should be given to the selection of the accompanying techniques in order to motivate respondents to complete the questionnaire, to facilitate their efforts, and to return it to the researcher. To improve the response rate, the researcher applied the following techniques that include the use of both non-monetary and monetary rewards.

Provide information about the survey: providing potential respondents with information about a survey and how its findings will benefit them and others, can encourage survey participation (Groves *et al*., 1992). In this study, a brief introduction to the research and the questionnaire was provided in the initial email invitation. This includes the aim of the study and the benefits that might accrue from obtaining responses, and therefore, from the overall results of the research.

Financial incentive: the appropriate use of prepaid token financial incentives contributes to improved response rates in web surveys (Dillman *et al*., 2009). In this study, the electronic gift certificate was selected as the incentive to motivate responses to complete and submit the questionnaire. In the initial email invitation, potential respondents were informed that they would receive a £5 Amazon.co.uk gift certificate via email upon receiving their completed web questionnaires.

5.4 Sample and Data Collection

The data were collected via a web survey sent to 1,158 service establishments in the UK, sampled from the Dun and Bradstreet (D&B) database. Consistent with the existing OM research on UK services (e.g., Frohlich and Westbrook, 2002), the sample frame included firms from eight service sectors: (1) education; (2) hotels and restaurants; (3) banks, insurance and other financial institutions; (4) wholesale and retail trade; (5) business activities; (6) transport, storage and communications; (7) health and social work; and (8) other services.

To ensure that the respondent had the expertise to accurately respond to the questions, the survey was focused on senior managers as key informants with titles such as 'Vice President,' 'Manager,' 'Director' or 'Head', and with the functional area of 'Operations'. 153 respondents (98% of the total respondents, see Table 5.2) identified themselves as Operations Managers, Operations Directors, Head of Operations, or Operations Executives, thus indicating that the respondents were knowledge upper-management professionals in the operations function of their organisations.
The survey was than administered following the procedures consistent with the web survey implementation of Dillman *et al*. (2009):

Personalisation: personalising all contacts in a web survey is important as it establishes a connection between the surveyor and the respondent. In this study, all operations contacts were personally contacted, by including titles, names, specific positions, and firm names. In order to increase personalisation, the emails were sent to their individual business email account.

Initial email invitation: this involved emailing the 'questionnaire package' to the managers. In this package, a survey invitation that included the uniform resource locator (URL) of the web questionnaire and instructions on how to access it, along with a description of the research and the importance of response, was emailed to each manager. The detailed and specific instruction about how to access and complete the survey was included to facilitate the efforts of those respondents who may have been unfamiliar with the web survey. All emails were sent from the official university email account of the author, in order to increase credibility. An example of the initial email invitation is shown in Appendix 1.1.

Multiple contacts: sending multiple contacts to potential respondents of a web survey is the most effective way to improve response rates (Cook *et al*., 2000). Hence, an initial survey invitation is generally followed up with a number of reminder emails. Since it is relatively inexpensive to send additional contacts via email, a researcher can often leave the final decision on the number of follow-ups to send until well into the fielding process. In this study, a four follow-up contact strategy was used following the advice provided by Olsen *et al*. (2005). After two weeks of the initial invitation, three reminder emails were sent to the respondents.

A total of 1,158 questionnaires were originally sent to the respondents. After removing 15 returned surveys due to company policies not to respond, the original pool of respondents reduced to 1,143, and of these 159 returned questionnaires. Of these, three incomplete questionnaires were excluded due to a large amount of missing data (see section 6.2, page 122). Eventually, 156 were accepted on the basis of the selection criteria described earlier. This sample size is sufficient to run the main statistical tests of the study. The response rate of 13.6% is consistent with response rates achieved in similar studies in the field (e.g., Carey *et al*., 2011). Further sample characteristics are provided in Table 5.2.

Table 5.2: Sample characteristics

	Frequency	%
Industry		
1 Education	7	4.5
2 Hotels and restaurants	11	7.1
3 Banks, insurance companies, and other financial institutions	12	7.7
4 Wholesale and retail trade	35	22.4
5 Business activities including real estate and renting	40	25.6
6 Transport, storage and communications	23	14.7
7 Health and social work	14	9.0
8 Other services	14	9.0
Total	*156*	*100.0*
Firm Size		
Less than 100	15	9.6
100 – 199	39	25.0
200 – 499	45	28.8
500 – 999	32	20.5
1000 or more	25	16.0
Total	*156*	*100.0*
Respondent Job Title		
Operations Manager	38	24.4
Operations Director	68	43.6
Head of Operations	21	13.5
Executive/VP - Operations	26	16.7
Other	3	1.9
Total	*156*	*100.0*

5.5 Non-Response Bias

Non-response bias refers to a situation where a marked difference of opinions between responses and non-responses emerges, and where the opinions of non-responses are systematically different from the responses. The standard approach to test for non-response bias is to compare the early wave of returned surveys to the late wave (Armstrong and Overton, 1977). In this study, to examine possible non-response bias, the responses were grouped into two categories: early responses (returned within the first month, N=60), and late responses (returned within the following months, N=96). To test for the presence of a significant difference between these two groups of responses, two statistical techniques were used due to their statistical power and robustness.

The Mann-Whitney U test establishes differences between two independent groups, which allows assessing whether two groups of data belong to the same distribution. The null hypothesis is that there is no difference between the two groups of data, that is, the two groups have equal probability distribution. The test includes the calculation of *U*, and a significant value of *U* ($p < .05$) leads to the rejection of the null hypothesis. The Kolmogorov-Smirnov Z test examines whether two groups of data have been drawn from the same population. The test includes the calculation of *Z*, with the null hypothesis that the two groups are drawn from the same distribution. Again, a significant value of *Z* ($p < .05$) leads to the rejection of the null hypothesis.

The results of these two tests are presented in Table 5.3. Both tests reveal that neither the dependent nor independent factors have a significance level less than .05, and therefore, the null hypothesis is supported. Results of the tests suggest that the two groups of data (early and late responses) in this study can be considered to draw from the same population, which indicates that the non-response bias is minimal.

Table 5.3: Test statistics of Mann-Whitney U and Kolmogorov-Smirnov Z tests for non-response bias

	ITSCA	ITINF	ITOSK	Supplier Integration	Customer Transactions	Customer Connection	Customer Collaboration	Cost	Quality
Mann-Whitney U	2815	2653.5	2550	2404	2868.5	2753.5	2748.5	2401.5	2643
Asymp. Sig. (2-tailed)	.812	.405	.228	.083	.966	.644	.630	.079	.387
Kolmogorov-Smirnov Z	.557	.671	.620	1.266	1.203	.760	.608	1.304	.670
Asymp. Sig. (2-tailed)	.916	.759	.836	.081	.111	.611	.854	.067	.611

5.6 Common Method Bias

Since data were collected from a single person at a single point in time, strong efforts have been made to design and test the questionnaire thoroughly to minimise the possibility of common method bias. Both of the procedural remedies and *ex post* empirical testing were engaged. Firstly, Harman's single-factor test (1976) was applied (Table 5.4). All measuring items were analysed together, and no single factor accounted for the majority of the variance (greater than 50%). In addition, the un-rotated factor analysis demonstrated eight factors with eigenvalues higher than 1, consistent with the findings of exploratory factor analysis. Despite the fact that this study was based on a single source of informants, the results of the single-factor test indicated that common method bias was not considered an issue for this data set (Podsakoff *et al.*, 2003).

Table 5.4: Single-factor test for common method bias

Total Variance Explained						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	12.683	36.237	36.237	12.683	36.237	36.237
2	4.289	12.255	48.491			
3	3.038	8.680	57.171			
4	2.199	6.282	63.454			
5	1.823	5.208	68.661			
6	1.560	4.456	73.117			
7	1.348	3.853	76.970			
8	1.018	2.908	79.878			

Extraction Method: Principal Component Analysis.

Rotation Method: None

Secondly, objective data was obtained for comparison purposes. The questionnaire gathered information on the number of employees and cost performance with respect to low cost service and high labour productivity. This study also drew upon objective data from annual reports and compared these to the survey responses. Unfortunately, due to the make-up of the sample (from both public and private firms), such data were available for only a limited sub-sample. However, since the survey also collected information on employment and cost performance, it is possible to compare the survey responses with the objective data.

Collection of data on the number of employees used a 5-point interval measure. Following Lages *et al*. (2013), coding of the employment data from the annual reports utilised the same interval, revealing correlations between, and the subjective and objective measures of .678, p<.01 (sample size of 66). In addition, while objective data on a comparison of cost performance among firms was unavailable, it is possible to compare perceptual cost performance with objective profit. To rate their cost performance, respondents were asked to indicate how well they perform when compared to their competitors in the industry. Naturally, respondents would compare relative performance with the profit of the competition as it would be difficult for them to know much about their competitors' costs. The EBITDA margin (Earnings Before Interest, Taxes, Depreciation and Amortization; financial year 2011/2012) was used as the measure of profit. Coding of EBITDA margins used a 7-point scale with the average industrial EBITDA margin as the 'middle option'. Table 5.5 shows that the correlations between the objective percent EBITDA margins (financial year 2011/2012) and the corresponding perceptual cost performance items (low cost service, and high labour productivity) are positive and significant (.347 and .371, respectively). Together, the procedural and empirical approaches are considered to suggest that common method bias is minimal.

Table 5.5: Post hoc performance matrix

Cost Performance Variable	**EBITDA margins (62 firms)**
Provide low cost service	.347**
High labour productivity	.371**

** p<.01

5.7 Measures

The survey scales were either established scales or developed from the extant literature (Table 5.6). *IT for supply chain activities* is represented in the survey by measuring the extent of implementation of 20 different types of process-level IT applications used in the service industry (Ray *et al*., 2004, 2005; Rai *et al*., 2006; Tsikriktsis *et al*., 2004; Sengupta *et al*., 2006; Thun, 2010). Consistent with prior IS and OM research (e.g., Banker *et al*., 2006a; Heim and Peng, 2010; Kulp *et al*., 2004; Saldanha *et al*., 2013), the extent of implementation (adoption) of each type of IT application is measured on a 2-point scale indicating whether or not it is currently used based on the data provided by operations managers. For each firm, therefore, the values of IT applications (sum of the number of applications) represent the extent of implementation (Hitt *et al*., 2002).

Flexible IT infrastructure was measured using a two-item scale on a 1-7 Likert scale (from 'Strongly Disagree' to 'Strongly Agree'). Adapted from Ray *et al*. (2005), Chen *et al*. (2009), and Lu and Ramamurthy (2011), the scale assessed the degree to which the firm has established corporate rules and standards for hardware and operating systems to ensure platform compatibility; and has identified and standardised data to be shared across systems and operations departments.

IT operations shared knowledge was measured using a three-item scale on a 1-7 Likert scale (from 'Strongly Disagree' to 'Strongly Agree'). Adapted from Ray *et al*. (2005), and Bassellier *et al*. (2003), the scale asked respondents to indicate the extent to which they agreed that there is a common understanding between IT and operations managers regarding how to use IT to improve operational performance.

Supplier integration was assessed using a ten-item scale on a 1-7 Likert scale (from 'Not at all' to 'Extensive') developed by Sengupta *et al*. (2006) and Flynn *et al*.

(2010). Respondents were asked to indicate the extent of integration or information sharing between their firms and suppliers.

Customer transactions was assessed using a three-item scale on a 1-7 Likert scale (from ‘Not at all’ to ‘Extensive’) developed by Tsikriktsis *et al*. (2004), and Rosenzweig (2009). Respondents were asked to indicate the extent of integration or information sharing between their firms and customers on transactions processes.

Customer connection was assessed using a three-item scale on a 1-7 Likert scale (from ‘Not at all’ to ‘Extensive’) developed by Kulp *et al*. (2004), and Baltacioglu *et al*. (2007). Respondents were asked to indicate the extent of integration or information sharing between their firms and customers on connection processes.

Customer collaboration was assessed using a four-item scale on a 1-7 Likert scale (from ‘Not at all’ to ‘Extensive’) developed by Tsikriktsis *et al*. (2004), and Rosenzweig (2009). Respondents were asked to indicate the extent of integration or information sharing between their firms and customers on collaboration processes.

Cost performance, following Safizadeh *et al*. (2003), and Giannakis (2011a), used a three-item scale on a 1-7 Likert scale (from ‘Much Worse than Competition’ to ‘Much Better than Competition) to measure cost performance. Respondents were asked to rate their cost performance as compared to their competitors’ performance in the industry in the areas of low cost service, high labour productivity, and cost effectiveness of process technology.

Quality performance, following Safizadeh *et al*. (2003), and Parasuraman *et al*. (2005), was measured using a seven-item scale on a 1-7 Likert scale (from ‘Much Worse than Competition’ to ‘Much Better than Competition’). Respondents were asked to rate their quality performance as compared to their competitors’ performance in the industry in the terms of service reliability, perceived quality, credibility, responsiveness, and conformance. Given the nature of a service product, speed of service, and perform promised service on time, were placed as two additional items to measure service quality performance.

In measuring operational performance, the respondents were asked to rate their relative performance compared to other firms in the industry (e.g., Prajogo *et al*., 2014; Tang and Rai, 2012; Lee and Choi, 2003, Drew, 1997; Kroes and Ghosh, 2010). The measures of operational performance included cost (Q15) and quality (Q16).

The survey instrument captured the cost performance via three elements which are widely used in previous research: low cost service, productivity and cost effectiveness. These three items have been used and closely linked in past empirical studies, not only in manufacturing sectors (e.g., Boyer and Lewis, 2002; Ward and Duray, 2000), but also among service establishments (e.g., Poister et al., 2013; Rust and Huang, 2012; Safizadeh *et al*., 2003). In the survey instrument, the higher the score for cost performance implies that firms are capable of achieving lower costs and better productivity in their operations. Put differently, this is a measure that captures the level of adherence to cost goals and objectives.

Because the sample comprises firms across the service industry, the measure of quality performance was derived from the literature on service quality. The scale for quality performance was measured by seven items, incorporating the multiple dimensions related to both internal and external quality. Accordingly, Roth and Van Der Velde (1991) note that internal measures of quality include credibility and responsiveness, while customer perception, conformance quality and reliability are used to measure external quality. Given the intangibility of services and the fact that production and consumption takes place simultaneously, the fulfilment (perform promised service on-time) and speed of service should also not be separated from service quality (Parasuraman *et al*., 2005; Sousa and Voss, 2006).

Control variables – It has been widely noted that larger firms may have more resources and may be in a better position to enjoy performance gains due to their ability to garner economies of scale (e.g., Hitt *et al*., 2002; Rai *et al*., 2006; Chen *et al*., 2009). To account for such relationships, firm size was controlled for as the number of employees. Further, since the salient features of industries (technological change, regulation, IT standards, etc.) can shape how IS are used within focal firm business processes to achieve performance impacts (Melville *et al*., 2004), seven additional dummy variables were used to control for the specific impact of different industries (education; hotels and restaurants; banks, insurance and other financials; wholesale and retail trade; business activities; transport, storage and communications; and health and social work).

Table 5.6: Constructs and supporting literature

Constructs	**Supporting References**
IT for Supply Chain Activities (ITSCA)	
1. Enterprise Resource Planning (ERP) system	Sengupta *et al*., 2006;
2. Advanced Material Requirement Planning (MRP) II system	Tsikriktsis *et al*., 2004;
3. Advanced planning and scheduling	Ray *et al*. 2004, 2005;
4. Production planning system	Rai *et al*., 2006;
5. Production scheduling system	Thun, 2010;
6. Process monitoring system	Mithas *et al*., 2012
7. Supplier account management system	
8. Supply chain management system	
9. Inventory management system	
10. Purchase management system	
11. Web-enabled Invoices and/or payments	
12. Collaborative business forecasting with suppliers	
13. Scanning/imaging technology	
14. Network with agents/brokers	
15. Web-enabled customer interaction	
16. Call tracking/customer relationship management system	
17. Computer Telephony Integration (CTI)	
18. Customer-service expert/knowledge-based system	
19. Web-enabled customer order entry	
20. Collaborative business forecasting with customers	

Flexible IT Infrastructure (ITINF)	
1. Established corporate rules and standards	Ray *et al*. 2005;
2. Identified and standardised data	Chen *et al*., 2009;
	Lu and Ramamurthy, 2011
IT Operations Shared Knowledge (ITOSK)	
1. IT Managers understand operations process	Ray *et al*., 2005;
2. IT Managers understand operations strategies	Bassellier *et al*., 2003
3. Common understanding between IT and Operations managers	
Supplier Integration	
1. Information exchange with our suppliers	Sengupta *et al*., 2006;
2. Quick ordering systems with our suppliers	Ellram *et al*., 2004;
3. Strategic partnership with our suppliers	Baltacioglu *et al*., 2007;
4. Participation level of our suppliers in the design stage	Flynn *et al*., 2010
5. Suppliers share their production and delivery schedule with us	
6. Supplier shares inventory/staffing availability (or data) with us	
7. We share production plans with our suppliers	
8. We share demand forecasts with our suppliers	
9. We share inventory/staffing levels (or data) with our suppliers	
10. We help our suppliers to improve their process	
Customer Transactions	
1. Linkage with our customers through information networks	Tsikriktsis *et al*., 2004;
2. Computerisation for our customers' ordering	Rosenzweig, 2009
3. Quick ordering systems with our customers	
Customer Connection	
1. Communication with our customers	Kulp *et al*., 2004;
2. Follow-up with our customers for feedback	Droge *et al*., 2004;
3. Frequency of period contacts with our customers	Ellram *et al*., 2004;
	Baltacioglu *et al*., 2007
Customer Collaboration	
1. Customers share Point of Sales information with us	Tsikriktsis *et al*., 2004;
2. Customers share demand forecasts with us	Rosenzweig, 2009
3. We share the production plan with customers	
4. We share inventory/staffing availability (or data) with customers	
Cost	
1. Provide low cost service	Safizadeh *et al*., 2003;
2. High labour productivity	Giannakis, 2011a;
3. Cost effectiveness of process technology	Prajogo *et al*., 2014

Quality	
1. Provide consistent level of service (reliability)	Roth and Van Der Velde,
2. Perceived quality (customer's perception)	1991
3. Provide accurate information (credibility)	Safizadeh *et al*., 2003;
4. Provide timely information (responsiveness)	Parasuraman *et al*., 2005;
5. Conformance (degree to which service meets standards)	Sousa and Voss, 2006;
6. Speed of service/reduce wait times	Voss *et al*., 2004;
7. Perform promised service on time	Prajogo *et al*., 2014

5.8 Conclusions

This chapter has detailed the approach and methodology that has been adopted for the investigation of the research hypotheses described in Chapter Four. A web survey has been selected as the research method, which allows the collection of data for testing relationships between variables. The body of this chapter details the specific considerations taken in the design and administration of the survey. The questions and items were developed from a study of the literature and refined through a pilot study. The resulting final form of the questionnaire was administered according to the web survey implementation guidelines of Dillman *et al*. (2009), which describes the best practices required to ensure a high response rate. This chapter also discusses the sample population and the specific sample frame determined for this study.

The following chapter presents the results of the survey, and the subsequent data analysis which was performed on these responses.

CHAPTER SIX:

DATA ANALYSIS

6.1 Introduction

The aim of this study is to investigate the effects of three dimensions of IS capabilities on supply chain integration (supplier integration, customer transactions, customer connection, and customer collaboration) and operational performance (cost and quality) in services, as discussed in Chapter Four. In order to explore these relationships, a research methodology was carefully designed to collect data from UK service establishments using a web survey, as discussed in Chapter Five. This chapter presents the data which was obtained from the web questionnaire, and describes the statistical analysis of that data. Description of results and hypothesis testing is provided in Chapter Seven.

The data collected from the web questionnaire was statistically analysed using the statistical package for social science (SPSS 19) software. Initially, it was screened for missing data and outliers, and subsequently a descriptive analysis of the derived independent, mediator, and dependent variables was undertaken. The data was then tested for its adherence to the assumptions of important statistical tests. Next, the use of exploratory factor analysis is described in detail, as well as testing for the validity and reliability of the data.

6.2 Screening the Data for Missing Data and Outliers

To draw conclusions about hypotheses, the data collected from the respondents is analysed via the use of various statistical tests. However, in order to subject data to these tests, some basic assumptions must be met for the test to be accurate. In this section, the investigation of the determination of missing data and outliers is reported.

At the stage of questionnaire design, great effort was made to ensure the clarity, specificity and simplicity of the survey questions in order to minimise the possibility of missing data. To satisfy the need for a complete set of data that would guarantee accurate statistical analysis, a strict criterion was applied in selecting which returned questionnaires to accept. Three incomplete questionnaires were rejected after the respondents refused to provide any information on their supply chain and firm performance ('supply chain integration' and 'operational performance' sections in the questionnaire) due to the firm policy or for confidential and security reasons. In addition, it is important to double check and cross check the typed-in data in the statistical software package against the original data to ensure correct data entry. Through employing this degree of rigour, 156 completed data sets were eventually accepted. Completed questionnaires have benefits in terms of the flexibility provided by the use of many statistical techniques and the potential to provide strong indications for generalisability. (Hair *et al*., 2009). Adopting the approach of only accepting questionnaires with complete data does raise the possibility of achieving lower statistical power as the sample size is reduced due to the removal of some cases, but this did not prove to be the case in this study as there were very low levels of missing data and a negligible amount of amputated data during the selection stage (only three cases were removed).

Outliers are observations with unusually high or low values, which can have a marked effect on any type of empirical analysis and might lead to unrepresentative conclusions. In this study, the questionnaire was designed using a 7-point Likert scale which asked respondents to give a number between 1 and 7. This design restricts the range of possible answers, and therefore reduces the possibility of outliers in the data sets. After entering data and screening for missing data, the research applied explorative analysis to detect outliers. No outliers were found after exploring the data.

6.3 Descriptive Statistics and Analysis

Before undertaking the data analysis, it is important to gain an understanding of the sample population as a whole. In order to do this, descriptive statistics are useful in summarising the characteristics of the respondents, including the mean, standard deviation, range, skewness and kurtosis (Cohan and Holliday, 1996). The aim of this study is to investigate the relationship between the independent variables and each of the dependent variables, through the impact of the mediator variables. In this section, descriptive statistics relating to these variables are discussed in detail.

6.3.1 Independent Variables

Three independent variables were selected in this study to indicate different dimensions of IS capabilities: IT for supply chain activities (ITSCA), flexible IT infrastructure (ITINF), and IT operations shared knowledge (ITOSK), as detailed in Chapter Five (section 5.7). This section describes the analysis of frequencies in respect of each of the independent variables in order to obtain an understanding of how firms view their IS capabilities in terms of these three dimensions.

IT for Supply Chain Activities

The first independent variable, IT for supply chain activities (ITSCA), was represented in this study by measuring the extent of implementation of 20 different types of process-level IT applications that are used in services (e.g., Ray *et al*., 2004, 2005; Sengupta *et al*., 2006) see Table 6.1. Respondents (operations managers) were asked to indicate whether or not the IT applications identified in the questionnaire had been implemented in their firms, and to do this on a two-point scale, indicating at the same time, whether or not each application was currently used in their firms. For each firm, therefore, the values of IT applications (the total number of applications) represent the extent of implementation (Hitt *et al*., 2002).

Table 6.1: Statistical analysis of independent variable – ITSCA

IT for Supply Chain Activities	Frequency			
	Yes	*%*	No	*%*
1. Enterprise Resource Planning (ERP) system	64	*41*	92	*59*
2. Advanced Material Requirement Planning (MRP) II system	21	*13.5*	135	*86.5*
3. Advanced planning and scheduling	67	*42.9*	89	*57.1*
4. Production planning system	45	*28.8*	111	*71.2*
5. Production scheduling system	48	*30.8*	108	*69.2*
6. Process monitoring system	37	*23.7*	119	*76.3*
7. Supplier account management system	101	*64.7*	55	*35.3*
8. Supply chain management system	78	*50*	78	*50*
9. Inventory management system	98	*62.8*	58	*37.2*
10. Purchase management system	119	*76.3*	37	*23.7*
11. Web-enabled Invoices and/or payments	88	*56.4*	68	*43.6*
12. Collaborative business forecasting with suppliers	25	*16*	131	*84*
13. Scanning/imaging technology	103	*66*	53	*34*
14. Network with agents/brokers	49	*31.4*	107	*68.6*
15. Web-enabled customer interaction	90	*57.7*	66	*42.3*
16. Call tracking/customer relationship management system	77	*49.4*	79	*50.6*
17. Computer Telephony Integration (CTI)	55	*35.3*	101	*64.7*
18. Customer-service expert/knowledge-based system	35	*22.4*	121	*77.6*
19. Web-enabled customer order entry	54	*34.6*	102	*65.4*
20. Collaborative business forecasting with customers	12	*7.7*	144	*92.3*

Flexible IT Infrastructure

The second independent variable, flexible IT infrastructure (ITINF), was measured using a two-item scale. Respondents were asked to rate their IT infrastructure on a

7-point Likert scale ranging from 'Strongly Disagree' to 'Strongly Agree'. Table 6.2 shows the statistical analysis of the two items related to the ITINF. The frequencies analyses for each item are presented in Appendix 6.1.

Table 6.2: Statistical analysis of independent variable – ITINF

Items	Mean Std. Deviation	Skewness Std. Error	Kurtosis Std. Error
ITINF_1 Established corporate rules and standards	4.75 1.431	-.354 .194	-.138 .386
ITINF_2 Identified and standardised data	4.65 1.445	-.312 .194	-.246 .386

IT Operations Shared Knowledge

The third independent variable, IT operations shared knowledge (ITOSK), was measured using a three-item scale. Respondents were asked to rate their IT shared knowledge on a 7-point Likert scale ranging from 'Strongly Disagree' to 'Strongly Agree'. Table 6.3 shows the statistical analysis of the three items related to ITOSK. The frequencies analyses for each item are presented in Appendix 6.2.

Table 6.3: Statistical analysis of independent variable – ITOSK

Items	Mean Std. Deviation	Skewness Std. Error	Kurtosis Std. Error
ITOSK_1 IT Managers understand operations process	4.69 1.488	-.291 .194	-.426 .386
ITOSK_2 IT Managers understand operations strategies	4.60 1.564	-.229 .194	-.525 .386
ITOSK_3 Common understanding IT-Operations managers	4.41 1.502	-.045 .194	-.598 .386

6.3.2 Mediator Variables

In this study, four mediator variables were selected to indicate different dimensions of supply chain integration: supplier integration, customer transactions, customer connection, and customer collaboration, as discussed in Chapter Four. This section describes the frequencies analysis for each of the mediator variables in order to obtain an understanding of how firms view their supply chain integration in terms of these four dimensions.

Supplier Integration

The first mediator variable, supplier integration, was assessed using a ten-item scale. Respondents were asked to rate their supplier integration on a 7-point Likert scale ranging from 'Not at all' to 'Extensive'. Table 6.4 shows the statistical analysis of the ten items related to supplier integration. The frequencies analyses for each item are presented in Appendix 6.3.

Table 6.4: Statistical analysis of mediator variable – Supplier Integration

Items	Mean Std. Deviation	Skewness Std. Error	Kurtosis Std. Error
SI_1 Information exchange with our suppliers	3.54	.358	-.643
	1.652	.194	.386
SI_2 Quick ordering systems with our suppliers	3.72	.181	-.677
	1.649	.194	.386
SI_3 Strategic partnership with our suppliers	4.04	-.055	-.721
	1.620	.194	.386
SI_4 Participation level of our suppliers in the design	3.75	-.066	-.914
stage	1.699	.194	.386
SI_5 Our suppliers share their production and	3.89	-.079	-.734
delivery schedule with us	1.668	.194	.386
SI_6 Our suppliers share inventory/staffing	3.64	-.008	-.828
availability (or data) with us	1.634	.194	.386
SI_7 We share our production plans with our	3.72	-.001	-.606
suppliers	1.613	.194	.386
SI_8 We share our demand forecasts with our	3.94	-.051	-.810
suppliers	1.705	.194	.386
SI_9 We share our inventory/staffing levels (or data)	3.59	-.010	-.663
with our suppliers	1.565	.194	.386
SI_10 We help our suppliers to improve their process	4.06	-.123	-.747
	1.705	.194	.386

Customer Transactions

The second mediator variable, customer transactions, was assessed using a three-item scale. Respondents were asked to rate their customer connectivity on a 7-point Likert scale ranging from 'Not at all' to 'Extensive'. Table 6.5 shows the statistical analysis of the three items related to customer transactions. The frequencies analyses for each item are presented in Appendix 6.4.

Table 6.5: Statistical analysis of mediator variable – Customer Transactions

Items	Mean Std. Deviation	Skewness Std. Error	Kurtosis Std. Error
CT_1 Linkage with our customers through information networks	4.10 1.521	-.019 .194	-.432 .386
CT_2 Computerisation for our customers' ordering	4.02 1.656	-.031 .194	-.730 .386
CT_3 Quick ordering systems with our customers	4.11 1.648	-.063 .194	-.799 .386

Customer Connection

The third mediator variable, customer connection, was assessed using a three-item scale. Respondents were asked to rate their customer contact on a 7-point Likert scale ranging from 'Not at all' to 'Extensive'. Table 6.6 shows the statistical analysis of the three items related to customer connection. The frequencies analyses for each item are presented in Appendix 6.5.

Table 6.6: Statistical analysis of mediator variable – Customer Connection

Items	Mean Std. Deviation	Skewness Std. Error	Kurtosis Std. Error
CCnt_1 Communication with our customers	4.52 1.496	-.178 .194	-.658 .386
CCnt_2 Follow-up with our customers for feedback	4.37 1.508	-.208 .194	-.520 .386
CCnt_3 Frequency of period contacts with our customers	4.40 1.581	-.203 .194	-.613 .386

Customer Collaboration

The last mediator variable, customer collaboration, was assessed using a four-item scale. Respondents were asked to rate their customer collaboration on a 7-point Likert scale ranging from 'Not at all' to 'Extensive'. Table 6.7 shows the statistical analysis of the four items related to customer collaboration. The frequencies analyses for each item are presented in Appendix 6.6.

Collaboration involves the accumulation of transaction-specific information, language, and know-how by supply chain members over time (Dyer and Singh, 1998; Williamson, 1985). When engaged in customer collaboration, the focal firm typically has rapid access to relevant historical and current information of its customers.

In terms of customer information, a firm's ability to capture transactions and connect them to specific customers determinates the amount of information available for sharing. To this end, firms have gradually increased the usage of electronic point-of-sale scanners and technology combined with shopper identification cards to capture detailed individual customer information in business sectors including retail, restaurants and hotels, and financial services (Ramaseshan et al. 2006).

In service sectors, point-of-sale information also keeps track of sales, labour and payments, and can generated data in book keeping (Weber and Kantamneni, 2002). For instance, point-of-sale information is usually shared between front counter registers and kitchen through displays in restaurant businesses, showing records in ordering taking, deleting, recall etc (Thompson, 2011).

Table 6.7: Statistical analysis of mediator variable – Customer Collaboration

Items	Mean Std. Deviation	Skewness Std. Error	Kurtosis Std. Error
CClb_1 Customers share Point of Sales information with us	3.70 1.648	.213 .194	-.617 .386
CClb_2 Customers share demand forecasts with us	3.57 1.554	.170 .194	-.662 .386
CClb_3 We share our production plan with customers	3.58 1.545	.183 .194	-.656 .386
CClb_4 We share our inventory/staffing availability (or data) with customers	3.31 1.440	.260 .194	-.393 .386

6.3.3 Dependent Variables

In this study two dependent variables were selected to indicate operational performance: cost and quality performance, as discussed in Chapter Three. This section describes the frequencies analysis for each of the dependent variables in order to obtain an understanding of how firms view their operational performance in terms of these two dimensions.

Cost

The first dependent variable, cost, was assessed using a three-item scale. Respondents were asked to rate their cost performance as compared to their competitors' performance in the industry on a 7-point Likert scale ranging from 'Much Worse than Competition' to 'Much Better than Competition'. Table 6.8 shows the statistical analysis of the three items related to cost performance. The frequencies analyses for each item are presented in Appendix 6.7.

Table 6.8: Statistical analysis of dependent variable – Cost

Items	Mean Std. Deviation	Skewness Std. Error	Kurtosis Std. Error
Cost_1 Provide low cost service	4.53	.213	-.264
	1.287	.194	.386
Cost_2 High labour productivity	4.76	-.052	.015
	1.209	.194	.386
Cost_3 Cost effectiveness of process technology	4.65	-.068	-.302
	1.196	.194	.386

Quality

The other dependent variable, quality, was assessed using a seven-item scale. Respondents were asked to rate their quality performance as compared to their competitors' performance in the industry on a 7-point Likert scale ranging from 'Much Worse than Competition' to 'Much Better than Competition'. Table 6.9 shows the statistical analysis of the seven items related to quality performance. The frequencies analyses for each item are presented in Appendix 6.8.

Table 6.9: Statistical analysis of dependent variable – Quality

Items	Mean Std. Deviation	Skewness Std. Error	Kurtosis Std. Error
Quality_1 Provide consistent level of service	5.20	-.215	.214
(reliability)	1.144	.194	.386
Quality_2 Perceived quality (customer's perception)	5.20	-.247	.154
	1.166	.194	.386
Quality_3 Provide accurate information (credibility)	5.13	-.302	.519
	1.084	.194	.386
Quality_4 Provide timely information	5.05	-.279	.369
(responsiveness)	1.100	.194	.386
Quality_5 Conformance (degree to which service	5.14	-.325	.148
meets standards)	1.183	.194	.386
Quality_6 Speed of service/reduce wait times	4.74	.063	-.198
	1.185	.194	.386
Quality_7 Perform promised service on time	4.95	-.204	-.349
	1.248	.194	.386

6.3.4 Control Variables

Firm Size

Firm size, controlled for as the number of employees, was assessed using a 5-point Likert scale, ranging from ‘less than 100’ to ‘100 or more’, as described in section 5.7 (see Table 5.2, page 111). This scale asked respondents to indicate the number of employees currently in their firms. Table 6.10 shows the majority of respondents (65.4%) were from firms with 200 employees or more, whereas the rest 34.6% of the respondents’ firms had less than 200 employees.

Table 6.10: Statistical analysis of control variable – Firm Size

Items	Mean Std. Deviation	Skewness Std. Error	Kurtosis Std. Error
Firm Size (Number of Employees)	3.08 1.218	.056 .194	-.937 .386

Type of Industry

Seven additional dummy variables were used to control for the specific impact of seven different industries (education; hotels and restaurants; banks, insurance and other financial institutions; wholesale and retail trade; business activities; transport, storage and communications; and health and social work). The industry ‘other services’ was used as the reference category for dummy coding. Table 6.11 summarises the variables and their values.

Table 6.11: Summary of variables and scale values

Variable Type	Variable Name	Scale Values
Independent Variables	IT for Supply Chain Activities	Sum of applications
	Flexible IT Infrastructure	Summated scale of 2 measurement items
	IT Operations Shared Knowledge	Summated scale of 3 measurement items

Mediator Variables	Supplier Integration	Summated scale of 10 measurement items
	Customer Transactions	Summated scale of 3 measurement items
	Customer Connection	Summated scale of 3 measurement items
	Customer Collaboration	Summated scale of 4 measurement items
Dependent Variables	Cost Performance	Summated scale of 3 measurement items
	Quality Performance	Summated scale of 7 measurement items
Control Variables	Firm Size Type of Industries	5-point Likert scale 7 dummy variables

6.4 Testing Assumptions of Factor Analysis and Multiple Regression

Before running statistical programmes relating to factor analysis and multiple regression, it is essential to test some basic assumptions to confirm the robustness of data (Hair *et al*., 2009). Testing assumptions prior to statistical analysis is important as statistical programmes can often produce results even when assumptions are breached, which leads to distortions and biases in the analysis and subsequent conclusions. In this connection, investigations were performed to detect any violation of the main assumptions of factor analysis and multiple regressions – the assumption of normality, and homogeneity of variance. Any breach of these assumptions might lead to erroneous conclusions as the result of concerning non-significant relationships or research bias (Hair *et al*., 2009). The following paragraphs show the tests for normality and homogeneity of variance.

6.4.1 Normality

Normality, which describes the shape of a distribution of scores in comparison to the normal distribution, is the most fundamental assumption of parametric tests. To employ statistical techniques such as factor analysis and regression analysis, it is important that scores are normally distributed (Pallant, 2010). Normality can be checked by a number of measures, among which are the values of skewness and kurtosis. Skewness is a measure of how symmetrically the scores are distributed about the mean. A skewness value of 0 indicates a normal distribution. Positive values of skewness indicate a cluster of scores on the left of the distribution, whereas negative values indicate a cluster on the right. A kurtosis value of 0 indicates a normal distribution. Positive values of kurtosis indicate a peaked distribution, whereas negative values indicate a flat distribution.

Normality is often determined by the statistic values *z* for the skewness and kurtosis, which are a measure of the values of skewness or kurtosis divided by their respective standard errors. The *z* values for skewness and kurtosis are calculated as:

$$Z_{\text{skewness}} = \frac{S - 0}{\text{SE}_{\text{skewness}}}$$

$$Z_{\text{kurtosis}} = \frac{K - 0}{\text{SE}_{\text{kurtosis}}}$$

Where *S* is the skewness value, *K* is the kurtosis value and SE is the standard error in the above equations (Field, 2009). Hair *et al*. (2009) suggest that an absolute *z* value greater than the specified critical value indicates a non-normal distribution in terms of that characteristic, and the most commonly used critical values are ±1.96 (significant at $p < .05$). In addition, a rule of thumb suggests that a variable is reasonably close to normal if its skewness and kurtosis have values between –1.0 and +1.0 (Field, 2009), and a distribution with a an absolute value of skewness between 0 and .5 is considered as a fairly symmetrical distribution (Bulmer, 1979). In this study therefore, the critical value of z = 1.96 was used to determine that the assumption of normality can be met confidently.

In addition to statistical tests of normality, graphical analysis was also used to assess normality. The normal probability plots for each set of variables were examined and the results are presented in Appendix 6.9.

The normality of all variables must be tested in order to employ statistical analysis. Firstly, the independent variables were tested, these describing the three components of IS capabilities – IT for supply chain activities (ITSCA), flexible IT infrastructure (ITINF), and IT operations shared knowledge (ITOSK). Tests for normality of the independent variables are presented in Table 6.12. For each independent variable, the absolute z values of skewness and kurtosis are both less than 1.96, which indicates normality. The distribution of ITSCA is skewed towards smaller values and flat. The distributions of ITINF and ITOSK are skewed towards bigger values and are also flat. Graphical plots of the distributions (Appendix 6.9.1) also support the above findings of normality.

Table 6.12: Normality of independent variables

Independent Variables	Mean	Std. Deviation	Skewness	Std. Error	*Z* Skewness	Kurtosis	Std. Error	*Z* Kurtosis
ITSCA	8.12	3.406	.185	.194	.95	-.558	.386	-1.45
ITINF	4.70	1.348	-.330	.194	-1.70	-.105	.386	-.27
ITOSK	4.57	1.419	-.145	.194	-.75	-.533	.386	-1.38

Secondly, mediator variables describing four aspects of supply chain integration (supplier integration, customer transactions, customer connection, and customer collaboration) were tested for normality. Results are presented in Table 6.13. For each mediator variable, the absolute z values of skewness and kurtosis are both less than 1.96, which indicates normality. The distributions of supplier integration, customer transactions, and customer connection are skewed towards bigger values and are flat. The distribution of customer collaboration is skewed towards smaller values and is also flat. The above observations of normality are further supported by graphical plots of the distributions (Appendix 6.9.2).

Table 6.13: Normality of mediator variables

Mediator Variables	Mean	Std. Deviation	Skewness	Std. Error	*Z* Skewness	Kurtosis	Std. Error	*Z* Kurtosis
Supplier Integration	3.79	1.353	-.100	.194	-.52	-.368	.386	-.95
Customer Transactions	4.08	1.434	-.035	.194	-.18	-.601	.386	-1.56
Customer Connection	4.43	1.445	-.223	.194	-1.15	-.743	.386	-1.92
Customer Collaboration	3.54	1.398	.184	.194	.95	-.433	.386	-1.12

Then, the dependent variables (cost and quality performances) were tested for normality. The results are presented in Table 6.14. For each dependent variable, the absolute z values of skewness and kurtosis are both less than 1.96, which indicates normality. The distribution of cost performance is skewed towards relatively smaller values and is flat. The distribution of quality performance is skewed towards bigger values but pointed. The above observations of normality are further supported by the graphical distribution plots (Appendix 6.9.3).

Table 6.14: Normality of dependent variables

Dependent Variables	Mean	Std. Deviation	Skewness	Std. Error	*Z* Skewness	Kurtosis	Std. Error	*Z* Kurtosis
Cost	4.65	1.042	.011	.194	.05	-.026	.386	-.07
Quality	5.06	1.032	-.354	.194	-1.82	.549	.386	1.42

Finally, the test for normality of control variables is presented in Table 6.15. The skewness value of firm size (.056) indicates an elegant shape close to normal distribution. In addition, its skewness and kurtosis both fell between -1.0 and +1.0. Thus, it is sufficient to say that firm size is reasonably normally distributed, but relatively flat. Additionally, the graphical plots of distribution (Appendix 6.9.4) support the above findings of normality. Type of industry was not involved in the normality test since this is a categorical variable.

Table 6.15: Normality of control variables

Control Variables	Mean	Std. Deviation	Skewness	Std. Error	*Z* Skewness	Kurtosis	Std. Error	*Z* Kurtosis
Firm Size (No. employees)	3.08	1.218	.056	.194	.13	-.937	.386	-2.43

6.4.2 Homogeneity of Variance

Homoscedasticity refers to the assumption related to dependent relationships of variables, which means that dependent variable(s) and predictor variable(s) share equal levels of variance. It is crucial that the distribution of responses for the dependent variables is not concentrated in only a limited region of the independent variables (Hair *et al.*, 2009). For the relationship to be described as homoscedastic, the variance of the dependent variable values must be approximately equal at each value of the dependent variables. To establish homoscedasticity, two tests are commonly used: graphs for two metric variables, and Levene's test for groups of data. Levene's test examines the null hypothesis that the variance in different groups is equal, with a non-significant value ($p > .05$) being interpreted as homogeneity of variance.

In this study, the homogeneity of variance of the data was assessed by the two methods discussed above. The normal probability plot (P-P) of the regression standardised residual and the scatterplot of the standardised residuals requested as part of the model testing, were used to inspect this data set (see Appendix 7.2). For each model, the normal P-P plots exhibit points falling reasonably along the diagonal line, suggesting that no substantial deviation from normality is present. The scatterplots demonstrate that the residuals were approximately centralised and roughly rectangularly distributed, indicating homoscedasticity of this data set (Pallant, 2010). The results of Levene's test are presented in section 7.4 (see page 196).

To sum up, in this section, the tests and measures to ensure that the data meet the assumptions and requirements of subsequent statistical tests, have been discussed in detail. These tests have been applied to the final data sets of this study. The results show that the final data have no missing data or outliers that might lead to erroneous analysis or cause misleading results. In addition to being subjected to factor analysis and regression analysis, the data are required to meet the assumptions of normality and homogeneity of variance. A number of methods have been used to test these assumptions and the results indicate that the data is normally distributed and homoscedastic. The satisfaction of the assumptions and requirements thus ensures that subsequent statistical analysis can proceed, and this is discussed in the following sections.

6.5 Exploratory Factor Analysis

Factor analysis is used to reduce data. Generally speaking, factor analysis analyses the structure of the inter-relationships among a large set of variables and summarises the data by defining a smaller set of factors which are highly inter-correlated by definition. The factors are, therefore, assumed to represent the dimensions within the data. There are two types of factor analysis: exploratory and confirmatory. Exploratory factor analysis is often used to explore and gather information about the inter-relationships among a group of variables. On the other hand, confirmatory factor analysis is used to confirm and test relationships among a group of variables that are already specified (Hair *et al*., 2009). In the case of this study, the relationships among variables have not been previously defined in services and thus, exploratory factor analysis was employed to identify the underlying relationships among the variables. The main purpose of applying factor analysis in this study is to examine the proposed research framework and the underlying relationships as well as to reduce the data into a smaller set of factors (constructs) for further statistical analysis.

There are two factor analysis techniques: principal components analysis (PCA), and factor analysis (FA). These two approaches share many similarities and are largely inter-changeable. However, they do differ in terms of the underlying statistical models: in principal components analysis all of the variance in original variables is analysed, whereas in factor analysis only the shared variance is used. Researchers have recommended the principal components analysis approach for a number of reasons, such as mathematical simplicity, its ability to reduce factor indeterminacy (Stevens, 1996), and its ability to provide an empirical summary of the data set (Tabachnick and Fidell, 2012). Following their suggestions, principal components analysis was adopted in this study.

Exploratory factor analysis was primarily used to reduce the data collected from the surveys to a smaller and manageable number of factors (constructs). Variables loading on the same factor belong to the same group and can, therefore, be computed into one scale representing the same construct. This process enables these variables to be further used in subsequent regression analysis and allows a group of variables, rather than only one, to be used to represent the concept. The computation of variables was achieved by averaging the values of variables obtained in each group. The new variables (resultant values of each group) were used in the subsequent regression analysis. Additionally, factor analysis assisted in the evaluation of construct validity, examining reliability, and testing for common method bias.

6.5.1 Variables Used for Factor Analysis

All of the variables (items) for the measurements of flexible IT infrastructure, IT operations shared knowledge, supplier integration, customer transactions, customer connection, customer collaboration, cost, and quality, were included in the factor analysis. Following the guidelines of Hair *et al*. (2009) that it is prudent to avoid non-metric variables in factor analysis, measurement items for IT for supply chain activities were not included as they are all non-metric variables.

6.5.2 Assessment of the Suitability for Factor Analysis

The first step in employing factor analysis is to examine the suitability of the data for that process, and this involves considering two main issues – sample size, and the strength of the relationships among the variables (the factorability of the data). Regarding the sample size, the literature generally recommends a minimum N of 100 observations (Gorsuch, 1983; Kline, 1979; Hair *et al*., 2009), and the minimum ratio of observations to items should be five (Gorsuch, 1983; Hair *et al*., 2009). In this study, factor analysis was performed on 156 observations and 35 items, with the observations to items ratio (4.46) slightly lower than 5. MacCallum *et al*. (1999) suggest that the minimum sample size or the minimum ratio of observations to items in factor analysis is not invariant across studies, but that the level of the community is a most important and critical index. They argue that with consistently high communities (all higher than .6), the impact of sample size, observations to items ratio, and other aspects of design, are greatly reduced in factor analysis. In the case of this study, communities were in the range of .651 to .932 (see Appendix 6.10.1) – all higher than .6, suggesting that the data is appropriate for factor analysis to be performed.

Testing for the factorability of the data requires first loading all of the data into a statistical software package (SPSS 19 was used for this study), then applying two statistical techniques – the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy, and Bartlett's Test of Sphericity. With a KMO value higher than .6 and Bartlett's Test of Sphericity being significant ($p < .05$), factor analysis is considered to be suitable (Tabachnick and Fidell, 2012). The statistics in this study relating to the KMO, and Bartlett's Test of Sphericity are presented in Table 6.16. The results confirmed the suitability of the data for factor analysis, with the KMO statistic (.886) and Bartlett's Test of Sphericity (5626.883, $p < .000$).

Table 6.16: KMO and Bartlett's test of Sphericity

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.886
Bartlett's Test of Sphericity	Approx. Chi-Square	5626.883
	df	595
	Sig.	.000

Additionally, another means of assessing the relationships among variables and the factorability of the data is the measure of sampling adequacy (MSA). While the KMO measure of sampling adequacy provides an overall measure of all the variables (items), the MSA provides information about individual variables in factor analysis. The value of MSA for each variable is an index identifying if the individual variable falls in an accepted range. For the appropriateness of factor analysis, the MSA values must exceed .5, with the values of higher than .7 being desired and higher than .8 being meritorious (Hair *et al*., 2009). The results of variable-specific MSA analysis for the data are showed in Appendix 6.10.2. In this study, the MSA values of all the variables were higher than .7, with a great amount of values higher than .8. This test further confirmed the factorability of the data.

Factorability also requires that there are sufficient correlations among variables. Variables or items measuring the same underlying dimension of the data are expected to correlate with each other. For factor analysis to be considered appropriate, the correlation matrix should show at least some correlation values of .3 or above (Pallant, 2010). Scanning the correlation matrix for this data set, as presented in Appendix 6.10.3, a majority of correlation values were greater than .3, which provided further confirmation that factor analysis was a suitable statistical method for use with this set of data.

6.5.3 Factor Extraction

Following confirmation of the appropriateness of the data set for factor analysis, the next step of factor extraction was performed. Factor extraction describes the determination of the smallest number of factors required to suitably represent the relationships among variables. The most common approach to extract the number of underlying factors is principal components analysis (Pallant, 2010). To determine the number of factors, Kaiser’s criterion and Catell’s scree test are most helpful and commonly used techniques. A combination of these two techniques was applied in this study.

Kaiser’s criterion, or the eigenvalue, separates factors that should be retained from those that should be discarded. This criterion is based on the idea that the amount of variance that is accounted for by a factor is calculated by the eigenvalues, and only factors with an eigenvalue higher than 1 can be retained for further factor analysis (Kaiser, 1960). The results of the eigenvalue test, as shown in Table 6.17, indicate an extraction of eight factors with eigenvalues greater than 1 in this data set. The eight extracted components (factors) explained 79.878% of the total variance. These factors relate to supplier integration, quality, customer collaboration, IT operations shared knowledge (ITOSK), customer connection, cost, flexible IT infrastructure (ITINF), and customer transactions respectively.

Table 6.17: Factor extraction

Components (Factors)	Eigenvalues	% of Variance Explained	Cumulative %
1 Supplier Integration	12.683	36.237	36.237
2 Quality	4.289	12.255	48.491
3 Customer Collaboration	3.038	8.680	57.171
4 ITOSK	2.199	6.282	63.454
5 Customer Connection	1.823	5.208	68.661
6 Cost	1.560	4.456	73.117
7 ITINF	1.348	3.853	76.970
8 Customer Transactions	1.018	2.908	79.878

Extraction Method: Principal Component Analysis.

Catell's scree test investigates the potential factors by plotting the eigenvalues for each factor and inspecting the resulting curve (Catell, 1966). Generally, there is a steep drop in the curve before an elbow followed by a plateau in the values. It is commonly recommended to retain all factors with eigenvalues above the elbow where the curve changes shape, as these factors are those which contribute mostly to explaining the variance in the data. Figure 6.1 shows the scree plot for this data set. The elbow occurs at component number 8, indicating that the first eight factors should be retained (Costello and Osborne, 2005). The results of the scree test are consistent with the findings of Kaiser' criterion – a selection of eight factors.

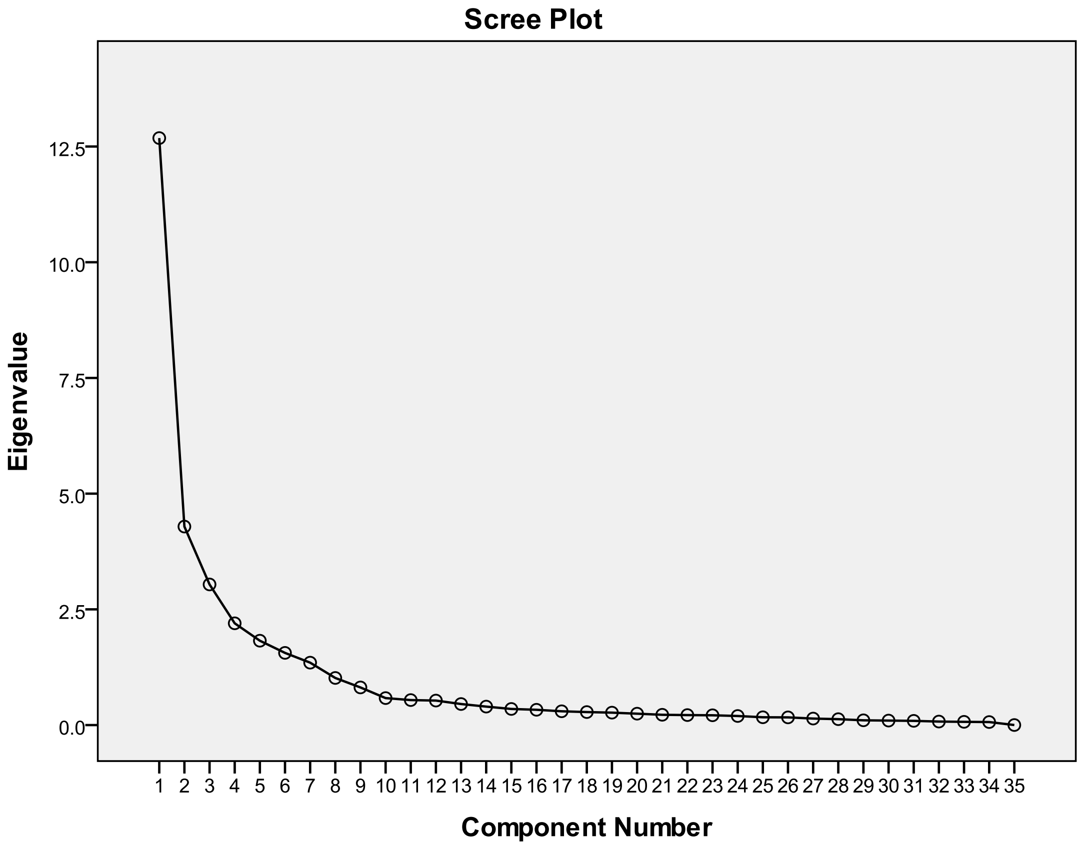


Figure 6.1 Scree plot

6.5.4 Factor Rotation

Following the determination of the number of factors, those factors are rotated in order to be interpreted. In factor rotation, the reference axes of the factors are rotated about the origin to achieve a simpler and more meaningful factor pattern by redistributing the variance. Orthogonal or oblique factor rotations are two main approaches in rotation. An orthogonal rotation maintains an angle of 90 degrees between the axes, with the assumption that the underlying factors are uncorrelated. An oblique rotation, on the other hand, is not constrained to be orthogonal and assumes that the underlying factors are correlated. The choice of factor rotation methods is based on a consideration of whether the factors are related or independent. Hair *et al*., (2009) recommend that oblique rotation methods are best suitable to obtain a set of factors that are theoretically related. This is applicable in this study, as the underlying factors (constructs) are expected to be related, as demonstrated in Models 1–8 in Chapter Four. For this data set, Direct Oblimin oblique rotation, the most common approach to achieve oblique rotation, was used. The suggestion from Hair *et al*., (2009) is that factor loadings with absolute values of .5 or greater are practically significant, and Table 6.18 indicates high loadings of each item on the corresponding extracted factors in Pattern Matrix. All factor loadings were considerably above .6 and are, therefore, considered significant. Details of measurement items are shown in Table 5.6 (see page 118). For some situations where values in the pattern matrix may be suppressed due to correlations among the factors, it is advised to check the structure mix for further confirmation (Field, 2009). In this data set, values in the structure matrix (see Appendix 6.10.4) are in the range of .699 to .961, providing further confirmation of significance.

All items were analysed together at the same time for factor analysis. The 35 items were then reduced to eight factors: flexible IT infrastructure, IT operations shared knowledge, supplier integration, customer transactions, customer connection, customer collaboration, cost, and quality. These resulting factors represent the grouped variables to be used in the further statistical analysis. When using summated scales, grouped variables are computed into a single composite measure as the only predictor of the construct (Hair *et al*., 2009). Through performing factor analysis, all of the variables which load highly on one factor belong to the same group and it is, therefore, comfortable to summate these variables into a single scale to represent the construct. The common approach of summated scales is to average the scores of the variables. For this study, the resulting summated scales were used as the replacement variable in subsequent analysis.

Table 6.18: Factor loadings in pattern matrix

Constructs	Items	1	2	3	4	5	6	7	8
1 Flexible IT	ITINF_1	-.010	.094	-.045	.020	.012	.024	**.904**	.053
Infrastructure	ITINF_2	.080	-.049	-.028	.015	-.029	.058	**.903**	.019
2 IT Operations	ITOSK_1	.003	.008	-.074	**.887**	-.051	.061	.039	.010
Shared Knowledge	ITOSK_2	-.007	-.008	.008	**.953**	-.063	.066	-.055	-.049
	ITOSK_3	.073	.057	.026	**.866**	.073	-.057	.080	.114
3 Supplier	SI_1	**.661**	-.041	-.016	-.078	.089	.152	-.011	.396
Integration	SI_2	**.653**	.074	-.063	.003	.029	.110	-.151	.324
	SI_3	**.827**	.110	-.055	-.151	-.103	.060	.010	.036
	SI_4	**.828**	.074	.020	.085	.000	-.040	.000	-.103
	SI_5	**.766**	.012	.079	.091	-.014	.007	.054	-.029
	SI_6	**.827**	.028	.045	.132	.110	-.096	.055	.015
	SI_7	**.776**	-.032	.161	.053	-.027	.039	.075	-.066
	SI_8	**.699**	-.071	.147	.053	-.163	.081	.092	-.108
	SI_9	**.724**	.044	.131	.052	-.134	-.137	.092	-.245
	SI_10	**.833**	-.003	-.055	.047	-.095	.029	.021	.053
4 Customer	CT_1	-.020	.214	.152	-.027	-.091	.019	.053	.733
Transactions	CT_2	-.016	.044	.079	.079	-.178	-.078	.071	.816
	CT_3	.044	-.087	.156	.146	-.237	.099	-.087	.619
5 Customer	CCnt_1	-.024	.080	-.079	.065	**-.889**	.033	-.022	.127
Connection	CCnt_2	.064	.047	.029	-.006	**-.845**	-.014	.069	.088
	CCnt_3	.070	.007	.075	.016	**-.883**	.027	.012	-.012
6 Customer	CClb_1	-.060	-.079	**.839**	-.095	-.125	.049	.035	.049
Collaboration	CClb_2	.032	.068	**.939**	.025	.001	-.012	-.043	-.030
	CClb_3	.028	.065	**.942**	.027	.002	-.017	-.043	-.023
	CClb_4	.094	.004	**.784**	.026	.125	.048	-.035	.136
7 Cost Performance	Cost_1	-.030	-.021	-.031	-.021	-.006	**.855**	.120	-.062
	Cost_2	.023	.150	.022	-.028	-.029	**.800**	-.058	.033
	Cost_3	.013	.049	.128	.208	-.010	**.715**	-.003	-.045
8 Quality	Quality_1	.062	**.873**	-.007	-.009	-.057	.084	-.007	-.036
Performance	Quality_2	.048	**.896**	-.035	.001	-.095	-.052	-.084	-.101
	Quality_3	-.062	**.952**	.031	-.007	-.022	-.039	.053	-.017
	Quality_4	-.019	**.921**	.040	-.008	.033	-.020	.081	.048
	Quality_5	-.009	**.885**	-.021	.068	.083	.018	.045	.059
	Quality_6	.056	**.705**	.005	.000	-.055	.180	-.057	.014
	Quality_7	.008	**.808**	.035	.020	-.003	.042	.019	.082

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalisation.

6.6 Reliability and Validity

Reliability is a measurement of the internal consistency of a questionnaire. It assesses the degree of consistency between measuring items and the construct. High reliability is achieved by a strong correlation of items to items as well as items to the construct. Cronbach's alpha (α) is the most widely used measure to assess reliability, which examines the consistency of the entire scale. A high value of α indicates strong correlations among items. A lower limit for α value of .7 is generally accepted to assess the reliability (Hair *et al*., 2009). Additionally, Hair *et al*. (2009) suggest that item-to-total correlation is another approach to measure the correlation between each item and the total scale score. A correlation value greater than .5 indicates reliability.

The results of Cronbach's α and item-to-total correlation are presented in Table 6.19. For this data set, the Cronbach's alphas ranged from .801 to .956, consistent with De Vellis (2003), who noted that alpha levels above .7 are acceptable and above .8 are preferable, indicating reliability of the constructs. The item-to-total correlations for each item are all greater than .6, which further exhibits the reliability.

Table 6.19: Statistical measures of reliability of the constructs

Constructs	Items	Item-Total Correlation	Cronbach's α
Flexible IT Infrastructure	ITINF_1	.759	.863
	ITINF_2	.759	
IT Operations Shared Knowledge	ITOSK_1	.837	.928
	ITOSK_2	.914	
	ITOSK_3	.808	
Supplier Integration	SI_1	.656	.946
	SI_2	.651	
	SI_3	.799	
	SI_4	.805	
	SI_5	.802	
	SI_6	.809	
	SI_7	.838	
	SI_8	.791	

	SI_9	.731	
	SI_10	.846	
Customer Transactions	CT_1	.743	.870
	CT_2	.798	
	CT_3	.717	
Customer Connection	CCnt_1	.878	.940
	CCnt_2	.874	
	CCnt_3	.876	
Customer Collaboration	CClb_1	.735	.924
	CClb_2	.925	
	CClb_3	.926	
	CClb_4	.727	
Cost Performance	Cost_1	.581	.801
	Cost_2	.706	
	Cost_3	.658	
Quality Performance	Quality_1	.909	.956
	Quality_2	.829	
	Quality_3	.902	
	Quality_4	.889	
	Quality_5	.842	
	Quality_6	.762	
	Quality_7	.821	

Throughout this study, every effort has been made to ensure the reliability and validity of the research. The reliability (internal consistency) of the scales has been discussed in detail above. The assessment of scale validity is the next step. Validity refers to a measure assessing the degree to which a scale accurately represents a concept, and this can be assessed in two ways to establish convergent validity and discriminant validity. Convergent validity examines the extent to which two measures under the same concept are correlated, while discriminant validity measures the degree to which two concepts which are similar are distinct from each other. Convergent and discriminant validity can be assessed by inspecting the loadings of exploratory factor analysis shown in Table 6.18. For each item loading on the same factor, it can be asserted that high factor loadings for one factor confirm convergent validity of that scale, whereas low factor loadings for other factors indicate discriminant validity compared to other scales. To determine discriminant validity, items should load significantly only on one factor, and correlations among factors should be lower than .7. For each factor in this data set, items strongly loaded on the same factor and factor loading are all greater than .6, exceeding the required significant threshold of .45 for a sample size of 150 (Hair *et al*., 2009), and thus indicating high convergent validity. Considering the pattern matrix (Table 6.18), it can be seen that items significantly loading on the same factor have very low loadings for all other factors and that no cross-loadings were found. In addition, no correlations among factors are higher than .389 (see Table 6.20), suggesting high discriminant validity of this data set.

Table 6.20: Factor correlation matrix

Component Correlation Matrix								
Component	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	1							
2	.284	1						
3	.378	.158	1					
4	.330	.242	.210	1				
5	-.289	-.349	-.325	-.246	1			
6	.218	.389	.200	.211	-.211	1		
7	.219	.169	-.047	.271	-.194	.120	1	
8	.204	.212	.225	.088	-.268	.259	-.061	1

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalisation.

6.7 Conclusions

This chapter has described the statistical analysis of the data obtained from the web questionnaire. The descriptive statistics relating to the sample confirmed that the firms surveyed in this study represent a good cross-section of the population of interest. Assumption testing confirmed that the data was suitable for subsequent statistical analysis. Exploratory factor analysis was also deemed appropriate as a vehicle for reducing the data to factors (constructs), which corresponded to the dependent and independent variables proposed in the research models. The final section of this chapter has analysed the reliability and validity of the questionnaire, all of which demonstrated that the instrument is appropriate for this study, and that conclusions drawn from the data can be considered to be valid.

In the next step of the analysis, the hypothesised research models are formally tested by using mediated multiple regression, and the results of hypothesis testing are described in the following chapter.

CHAPTER SEVEN:

RESULTS

7.1 Introduction

This study investigates the effects of IS capabilities (IT for supply chain activities, flexible IT infrastructure, and IT operations shared knowledge) on operational performance (cost and quality), and hypothesises that such effects are mediated through the processes developed for supply chain integration (supplier integration, customer transactions, customer connection, and customer collaboration) in services. The previous chapter describes the statistics of factor analysis which confirmed the categorisation of measurement items in the survey and provided information for the variables: two dependent variables relating to operational performance, four mediator variables relating to supply chain integration, and two of the independent variables indicating flexible IT infrastructure, and IT operations shared knowledge. As discussed in section 6.5.1 (see page 138), only one independent variable, IT for supply chain activities, was excluded from factor analysis because its measurement items were all non-metric. In order to test the relationships between these variables, multiple regression analysis was performed. This chapter illustrates the procedures required in performing regression analysis and explains the results in detail.

7.2 Hierarchical Multiple Regression

In hierarchical multiple regression, the relationship of a set of independent variables and the dependent variable, is evaluated after a previous set of independent variables have been controlled for (Pallant, 2010). The rationale behind this approach is to assess whether the new set of independent variables add power to the prediction of the dependent variable. The hierarchical approach works by controlling the effect of the first block of independent variables to assess how well the next block of independent variables predicts the dependent variable and the relative contribution in explaining the variance (Tabachnik and Fidell, 2013). The aim of this study is to test the effects of mediator variables (supplier integration, customer transactions, customer connection, and customer collaboration) on the relationships between independent variables (IT for supply chain activities, flexible IT infrastructure, and IT operations shared knowledge), and dependent variables (cost and quality). Such effects are much easier and clearer to test after controlling for the effect of firm size and type of industry, both of which are believed to have some impact on the dependent variables. Therefore, hierarchical regression is appropriate for this study.

In order to fulfil the assumptions of multiple regression, the following issues have been reviewed. In this study, the ratio of participants to number of predictor variables (three independent variables and four mediator variables) is 22 (156/7), which is greater than the recommended ratio value of 15 (Stevens, 1996), thereby suggesting an appropriate sample size to allow for generalisation of the result.

Variance inflation factors (VIFs) were examined to test for multicollinearity. All VIFs ranged from 1.180 to 3.265. As there are no coefficients with VIFs greater than 10, it is reasonable to conclude that the data set is not affected by any multicollinearity issues (Pallant, 2010).

As discussed earlier, no outliers presented in the data (see section 6.2, page 122), and tests of normality (see section 6.4.1, page 132) and homoscedasticity (see section 6.4.2, page 135) indicated that none of the assumptions of multiple regression were violated. The data set was, therefore, deemed suitable for multiple regression.

Eight models were designed to test the relationships between the independent, mediator, and dependent variables. In the following sections, each model is presented in detail and the findings briefly evaluated. In-depth discussion of the results and the conclusions drawn from these are presented in Chapter Eight.

7.3 Test of Mediation

This section examines whether the level of supply chain integration (supplier integration, customer transactions, customer connection, and customer collaboration) mediates the relationship of IS capabilities (IT for supply chain activities, flexible IT infrastructure, and IT operations shared knowledge), and operational performance (cost and quality) in services.

Following Carey *et al*. (2011), mediated multiple regression is used to test the hypothesised model. According to Baron and Kenny (1986), three equations are required to test for mediation.

1. Step 1, regressing each mediator variable (supplier integration, customer transactions, customer connection, and customer collaboration) on independent variables (IT for supply chain activities, flexible IT infrastructure, and IT operations shared knowledge);
2. Step 2, regressing each dependent variable (cost and quality) on the independent variables;

3. Step 3, regressing each dependent variable on both the independent variables and the mediator variable.

To establish mediation, effects must be significant in the first and second equations. The mediator must impact upon the dependent variable in the third equations, with the effect of the independent variable on the dependent variable reduced by adding the mediator in the model.

7.3.1 Model 1: IS Capabilities, Supplier Integration, and Cost Performance

The first model tests whether the level of supplier integration mediates the effects of IT for supply chain activities (ITSCA), flexible IT infrastructure (ITINF), and IT operations shared knowledge (ITOSK) on cost performance, and whether firm size and type of industry would have any predictive power on cost. The following section details the regression equations and model specification designed to test this model.

7.3.1.1 Model Specification (Model 1)

This section details the assessment of the relationship among the mediator variable (supplier integration), independent variables (ITSCA, ITINF, and ITOSK), and the dependent variable (cost). The relationship was controlled by firm size (measured by the number of employees) and type of industry (seven dummy variables were used to control for the specific impact of different industries: education; hotels and restaurants; banks, insurance and other financial institutions; wholesale and retail trade; business activities; transport, storage and communications; and health and social work). The following regression model was formulated to test the proposed hypotheses:

Step one:

$$\mathrm{SI}_a = \beta_{a0} + \beta_{a1}\mathrm{IN1} + \beta_{a2}\mathrm{IN2} + \beta_{a3}\mathrm{IN3} + \beta_{a4}\mathrm{IN4} + \beta_{a5}\mathrm{IN5} + \beta_{a6}\mathrm{IN6} + \beta_{a7}\mathrm{IN7} + \beta_{a8}\mathrm{FS} + \beta_{a9}\mathrm{ITSCA} + \beta_{a10}\mathrm{ITINF} + \beta_{a11}\mathrm{ITOSK} + \varepsilon_{a1}$$

Step two:

$$\mathrm{C}_a = \beta_{a0'} + \beta_{a12}\mathrm{IN1} + \beta_{a13}\mathrm{IN2} + \beta_{a14}\mathrm{IN3} + \beta_{a15}\mathrm{IN4} + \beta_{a16}\mathrm{IN5} + \beta_{a17}\mathrm{IN6} + \beta_{a18}\mathrm{IN7} + \beta_{a19}\mathrm{FS} + \beta_{a20}\mathrm{ITSCA} + \beta_{a21}\mathrm{ITINF} + \beta_{a22}\mathrm{ITOSK} + \varepsilon_{a2}$$

Step three:

$$\mathrm{C}_a = \beta_{a0''} + \beta_{a23}\mathrm{IN1} + \beta_{a24}\mathrm{IN2} + \beta_{a25}\mathrm{IN3} + \beta_{a26}\mathrm{IN4} + \beta_{a27}\mathrm{IN5} + \beta_{a28}\mathrm{IN6} + \beta_{a29}\mathrm{IN7} + \beta_{a30}\mathrm{FS} + \beta_{a31}\mathrm{ITSCA} + \beta_{a32}\mathrm{ITINF} + \beta_{a33}\mathrm{ITOSK} + \beta_{a34}\mathrm{SI} + \varepsilon_{a3}$$

Where:

C: Cost
SI: Supplier integration
ITSCA: IT for supply chain activities
ITINF: flexible IT infrastructure
ITOSK: IT operations shared knowledge
$\beta_{a0}, \beta_{a0'}, \beta_{a0''}$: Constants
$\beta_{a1} \sim \beta_{a34}$: Coefficients
$\varepsilon_{a1} \sim \varepsilon_{a3}$: Errors
IN1: Education
IN2: Hotels and restaurants
IN3: Banks, insurance and other financials
IN4: Wholesale and retail trade
IN5: Business activities
IN6: Transport, storage and communications
IN7: Health and social work
FS: Firm size

7.3.1.2 Model Results (Model 1)

The model was tested by using the sum value for ITSCA (one of the independent variables); the summated scales for ITINF and ITOSK (the remaining two independent variables), supplier integration (the mediator variable), cost (the dependent variable), and firm size (one control variable); and dummy variables for industries (the other control variables). The correlations matrix (Table 7.1a) was inspected to reveal the correlations among the variables. Results show that most correlations were positive, but small. ITINF correlated with ITOSK (.338, p<.01). Supplier integration significantly and positively correlated with ITSCA (.240), ITINF

(.302), and ITOSK (.419). Additionally, there were some negative correlations among control variables. However, all these correlations were small, ranging from .001 to .419, suggesting that multicollinearity among the independent variables is unlikely to be an issue in this data set. Multicollinearity is a problem when the independent variables have a bivariate correlation higher than .9 (Pallant, 2010). In addition, cost positively correlated with ITSCA (.218), ITINF (.225), ITOSK (.326), and supplier integration (.328), with the significance level of $p<.01$. These correlations indicated that this data set is appropriate for reliable testing of the responses through hierarchical multiple regression.

In addition, the tolerance and variance inflation factors (VIF) were tested to further examine multicollinearity. The correlation matrix is a useful tool for inspecting bivariate multicollinearity, while the tolerance and VIF examine multicollinearity by regressing each independent variable on all other variables. To determine the presence of multicollinearity, the commonly accepted levels are tolerance values less than .10 or VIF values higher than 10 (Hair *et al*., 2009). The statistics relating to the multicollinearity tests for Model 1 are presented in Appendix 7.1.1. The tolerance coefficients of all the independent variables were greater than .10 (in a range from .314 to .847). Correspondingly, the VIF statistics were lower than 10 (in a range from 1.180 to 3.182). These results indicated that the inter-correlations among the independent variables did not exist, and therefore, multicollinearity is unlikely to an issue in this data set.

Table 7.1a: Correlations matrix and descriptive statistics (Model 1)

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13
1 ITSCA	8.12	3.406	1												
2 ITINF	4.70	1.348	.023	1											
3 ITOSK	4.57	1.419	.120	.338**	1										
4 Supper integration	3.79	1.353	.240**	.302**	.419**	1									
5 Cost	4.65	1.042	.218**	.225**	.326**	.328**	1								
6 IN1 Education	.04	.208	.084	.003	-.058	-.053	.004	1							
7 IN2 Hotels	.07	.257	.050	-.097	.031	-.102	-.083	-.060	1						
8 IN3 Banks	.08	.267	-.265**	.190*	.026	-.012	.083	-.063	-.080	1					
9 IN4 Wholesale	.22	.419	.113	.035	.055	.047	.065	-.117	-.148	-.155	1				
10 IN5 Business	.26	.438	-.189*	.001	-.008	-.037	-.044	-.127	-.162*	-.170*	-.316**	1			
11 IN6 Transport	.15	.356	.231**	.080	.106	.093	.043	-.090	-.115	-.120	-.224**	-.244**	1		
12 IN7 Health	.09	.287	-.176*	-.096	-.205*	.019	-.087	-.068	-.086	-.091	-.169*	-.184*	-.131	1	
13 Firm Size	3.08	1.218	.198*	-.132	-.120	.133	-.029	.062	.043	.000	-.227**	-.198*	.240**	.108	1

* p<.05
** p<.01

Another issue that might affect the predictive power of the model is the problem of autocorrelation. In a regression analysis, it is assumed that the residual terms of any two observations are independent of each other, which can be described as a lack of autocorrelation. To check this assumption, the test for independent errors was performed. Durbin-Watson is a measure that tests for the presence of serial correlations between residuals. When a Durbin-Watson statistic is close to 2 and between 1 and 3, it is conservatively considered to indicate no serial correlation and the independence of observations (Field, 2009). The results of Durbin-Watson tests for this model show that the statistics fell well within the acceptable range, suggesting that the assumption of independent errors was met in this data set (Appendix 7.1.1).

Results of Regression Analysis for Mediation (Model 1)

The regression results of Model 1 are presented in Table 7.1b. Following the steps of mediated multiple regression, the examination of three equations (see section 7.3.1.1, page 152) was performed. Hierarchical multiple regression was used to test the ability of the direct effects (ITSCA, ITINF, and ITOSK) and the mediating effect (supplier integration) to predict levels of cost performance, after controlling for the influence of industries and firm size.

In step one, seven industries and firm size were entered into block 1 of the regression model, explaining 4.1% of the variance in supplier integration. This contribution was not statistically significant and the model as a whole was not significant either. However, after adding ITSCA, ITINF, and ITOSK into the second block of the regression model, the total variance explained by the model as a whole was 30.3%. The three direct effects explained an additional 26.2% of the variance in supplier integration and this change was significant ($p<.001$). The F statistic (5.698, $p<.001$) indicated a significant fit of the data overall. For the standardised coefficients, all control variables were weak and non-significant with the exception of firm size (.188, $p<.05$). On the other hand, the standardised coefficients of ITSCA (.200, $p<.05$), ITINF (.195, p<.05), and ITOSK (.379, p<.001) were larger and significant. The differences between the two blocks were evidenced in the change of the overall significance, from non-significance to a significance of p<.001.

Table 7.1b: Results of regression analysis for mediation (Model 1)

	Supplier Integration		Cost		
		Step 1		Step 2	Step 3
	β	β	β	β	β
Controls					
Industry1 Education	-.042	-.035	.004	.014	.020
Industry2 Hotels	-.079	-.077	-.078	-.071	-.057
Industry3 Banks	.012	.023	.074	.126	.122
Industry4 Wholesale	.098	.076	.042	.039	.025
Industry5 Business	.031	.077	-.041	.025	.011
Industry6 Transport	.080	-.008	.039	-.016	-.014
Industry7 Health	.028	.150	-.080	.036	.008
Firm Size	.145	.188*	-.025	-.014	-.048
Direct effects					
ITSCA		.200*		.232**	.196*
ITINF		.195*		.099	.064
ITOSK		.379***		.269**	.201*
Mediating effect					
Supplier Integration					.181*
ΔR^2	.041	.262***	.027	.149***	.172***
Overall R^2	.041	.303	.027	.175	.198
Adjusted R^2	-.011	.250	-.026	.112	.131
Overall model F	.782	5.698***	.502	2.783**	2.947**

* p<.05
** p<.01
*** p<.001

In step two, control variables were entered into block 1 of the regression model, explaining 2.7% of the variance in cost performance. This contribution was not statistically significant and the model as a whole was not significant either. After adding ITSCA, ITINF, and ITOSK into the second block of the regression model, the total variance explained by the model as a whole was 17.5%. The three direct effects explained an additional 14.9% of the variance in cost performance and this change was significant (p<.001). The F statistic (2.783, p<.01) indicated a significant fit of the data overall. For the standardised coefficients, all control variables were weak and non-significant. On the other hand, the standardised coefficients of ITSCA (.232, p<.01) and ITOSK (.269, p<.01) were statistically significant, whereas ITINF was non-significant. The differences between the two blocks were evidenced in the change of the overall significance, from non-significance to a significance of p<.01.

In step three, control variables were entered into block 1 of the regression model as in step two, explaining 2.7% of the variance in cost performance. This contribution was not statistically significant and the model as a whole was not significant either. After adding ITSCA, ITINF, and ITOSK and supplier integration into the second block of the regression model, the total variance explained by the model as a whole was 19.8%. The three direct effects and the mediating effect explained an additional 17.2% of the variance in cost performance and this change was significant (p<.001). The F statistic (2.947, p<.01) indicated a significant fit of the data overall. For the standardised coefficients, all control variables were weak and non-significant. On the other hand, the standardised coefficients of ITSCA (.196, p<.05), ITOSK (.201, p<.05), and supplier integration (.181, p<.05) were statistically significant, whereas ITINF was non-significant again. The differences between the two blocks were evidenced in the change of the overall significance, from non-significance to a significance of p<.01.

In light of the above discussion, results of the analysis in step 1 show support for **Hypothesis 1a:** the ability to use ITSCA (β=.200, p<.05) was positively and significantly related to supplier integration; **H1b:** ITINF (β=.195, p<.05) was positively and significantly related to supplier integration; and **H1c:** ITOSK (β=.379, p<.001) was positively and significantly related to supplier integration. **H2a** requires that supplier integration mediates the relationship between ITSCA and cost performance. The results in steps 2 and 3 indicate that supplier integration was positively related to cost performance (β=.181, $p<.05$), with the previously significant ITSCA–cost performance relationship (β=.232, $p<.01$) becoming less significant (β=.196, $p<.05$), providing evidence of partial mediation and thus partial support for **H2a**. There was no significant relationship between ITINF and cost performance, and thus no support was found for **H2b**. **H2c** requires that supplier integration mediates the relationship between ITOSK and cost performance. The results indicate that supplier integration was positively related to cost performance (β=.181, $p<.05$), with the previously significant ITOSK–cost performance relationship (β=.269, $p<.01$) becoming less significant (β=.201, $p<.05$), providing evidence of partial mediation and thus, partial support for **H2c**. A summary of results is provided in Table 7.1c. These results are discussed in detail in the following Chapter Eight.

Table 7.1c: Summary of results (Model 1)

Hypotheses	***Results***
H1a: The ability to use IT for supply chain activities (ITSCA) has a positive influence on the degree of supplier integration.	*Supported*
H1b: Flexible IT infrastructure (ITINF) has a positive influence on the degree of supplier integration.	*Supported*
H1c: IT operations shared knowledge (ITOSK) has a positive influence on the degree of supplier integration.	*Supported*
H2a: Supplier integration is positively related to cost performance and mediates the ITSCA–cost relationship.	*Partially supported*
H2b: Supplier integration is positively related to cost performance and mediates the ITINF–cost relationship.	*Not supported*
H2c: Supplier integration is positively related to cost performance and mediates the ITOSK–cost relationship.	*Partially supported*

7.3.2 Model 2: IS Capabilities, Supplier Integration, and Quality Performance

The second model tests whether the level of supplier integration mediates the effects of IT for supply chain activities, flexible IT infrastructure, and IT operations shared knowledge, on quality performance, and whether firm size and type of industry would have any predictive power in respect of quality. The following section details the regression equations and model specification designed to test this model.

7.3.2.1 Model Specification (Model 2)

This section details the assessment of the relationship among the mediator variable (supplier integration), independent variables (ITSCA, ITINF, and ITOSK) and the dependent variable (quality). The relationship was controlled by firm size (measured by the number of employees) and type of industry: seven dummy variables were used to control for the specific impact of different industries (education; hotels and restaurants; banks, insurance and other financials; wholesale and retail trade; business activities; transport, storage and communications; and health and social work). The following regression model was formulated to test the proposed hypotheses:

Step one:

$$\mathrm{SI}_b = \beta_{b0} + \beta_{b1}\mathrm{IN1} + \beta_{b2}\mathrm{IN2} + \beta_{b3}\mathrm{IN3} + \beta_{b4}\mathrm{IN4} + \beta_{b5}\mathrm{IN5} + \beta_{b6}\mathrm{IN6} + \beta_{b7}\mathrm{IN7} + \beta_{b8}\mathrm{FS} + \beta_{b9}\mathrm{ITSCA} + \beta_{b10}\mathrm{ITINF} + \beta_{b11}\mathrm{ITOSK} + \varepsilon_{b1}$$

Step two:

$$\mathrm{Q}_b = \beta_{b0'} + \beta_{b12}\mathrm{IN1} + \beta_{b13}\mathrm{IN2} + \beta_{b14}\mathrm{IN3} + \beta_{b15}\mathrm{IN4} + \beta_{b16}\mathrm{IN5} + \beta_{b17}\mathrm{IN6} + \beta_{b18}\mathrm{IN7} + \beta_{b19}\mathrm{FS} + \beta_{b20}\mathrm{ITSCA} + \beta_{b21}\mathrm{ITINF} + \beta_{b22}\mathrm{ITOSK} + \varepsilon_{b2}$$

Step three:

$$\mathrm{Q}_b = \beta_{b0''} + \beta_{b23}\mathrm{IN1} + \beta_{b24}\mathrm{IN2} + \beta_{b25}\mathrm{IN3} + \beta_{b26}\mathrm{IN4} + \beta_{b27}\mathrm{IN5} + \beta_{b28}\mathrm{IN6} + \beta_{b29}\mathrm{IN7} + \beta_{b30}\mathrm{FS} + \beta_{b31}\mathrm{ITSCA} + \beta_{b32}\mathrm{ITINF} + \beta_{b33}\mathrm{ITOSK} + \beta_{b34}\mathrm{SI} + \varepsilon_{b3}$$

Where:

Q: Quality
SI: Supplier integration
ITSCA: IT for supply chain activities
ITINF: flexible IT infrastructure
ITOSK: IT operations shared knowledge
$\beta_{b0}, \beta_{b0'}, \beta_{b0''}$: Constants
$\beta_{b1} \sim \beta_{b34}$: Coefficients
$\varepsilon_{b1} \sim \varepsilon_{b3}$: Errors

IN1: Education
IN2: Hotels and restaurants
IN3: Banks, insurance and other financials
IN4: Wholesale and retail trade
IN5: Business activities
IN6: Transport, storage and communications
IN7: Health and social work
FS: Firm size

7.3.2.2 Model Results (Model 2)

The correlations matrix (Table 7.2a) was inspected to reveal the correlations among the variables. Results show that most correlations were positive, but small. ITINF correlated with ITOSK (.338, $p<.01$). Supplier integration significantly and positively correlated with ITSCA (.240), ITINF (.302), and ITOSK (.419). Additionally, there were some negative correlations among control variables. However, all these correlations were small, ranging from .001 to .419, suggesting that multicollinearity among the independent variables is unlikely to be an issue in this data set. Multicollinearity would be a problem if the independent variables had a bivariate correlation higher than .9 (Pallant, 2010). In addition, quality positively correlated with ITSCA (.199, $p<.05$), ITINF (.241, $p<.01$), ITOSK (.308, $p<.01$), and supplier integration (.369, $p<.01$). These correlations indicated that this data set is appropriate for reliable testing of the responses through hierarchical multiple regression.

Further, tests for multicollinearity and autocorrelation were performed for this model, and the results indicated that multicollinearity is unlikely to an issue, and that the assumption of independent errors was met in this data set (see Appendix 7.1.2).

Table 7.2a: Correlations matrix and descriptive statistics (Model 2)

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13
1 ITSCA	8.12	3.406	1												
2 ITINF	4.70	1.348	.023	1											
3 ITOSK	4.57	1.419	.120	.338**	1										
4 Supper integration	3.79	1.353	.240**	.302**	.419**	1									
5 Quality	5.06	1.032	.199*	.241**	.308**	.369**	1								
6 IN1 Education	.04	.208	.084	.003	-.058	-.053	-.064	1							
7 IN2 Hotels	.07	.257	.050	-.097	.031	-.102	-.075	-.060	1						
8 IN3 Banks	.08	.267	-.265**	.190*	.026	-.012	-.027	-.063	-.080	1					
9 IN4 Wholesale	.22	.419	.113	.035	.055	.047	.080	-.117	-.148	-.155	1				
10 IN5 Business	.26	.438	-.189*	.001	-.008	-.037	-.081	-.127	-.162*	-.170*	-.316**	1			
11 IN6 Transport	.15	.356	.231**	.080	.106	.093	.089	-.090	-.115	-.120	-.224**	-.244**	1		
12 IN7 Health	.09	.287	-.176*	-.096	-.205*	.019	-.046	-.068	-.086	-.091	-.169*	-.184*	-.131	1	
13 Firm Size	3.08	1.218	.198*	-.132	-.120	.133	-.151	.062	.043	.000	-.227**	-.198*	.240**	.108	1

* p<.05

** p<.01

Results of Regression Analysis for Mediation (Model 2)

Regression results of Model 2 are presented in Table 7.2b. Hierarchical multiple regression was used to test the ability of the direct effects (ITSCA, ITINF, and ITOSK), and the mediating effect (supplier integration) to predict levels of quality performance, after controlling for the influence of industries and firm size.

Table 7.2b: Results of regression analysis for mediation (Model 2)

	Supplier Integration		**Quality**		
		Step 1		**Step 2**	**Step 3**
	β	β	β	β	β
Controls					
Industry1 Education	-.042	-.035	-.122	-.121	-.111
Industry2 Hotels	-.079	-.077	-.151	-.147	-.125
Industry3 Banks	.012	.023	-.118	-.098	-.105
Industry4 Wholesale	.098	.076	-.118	-.134	-.155
Industry5 Business	.031	.077	-.242	-.201	-.222
Industry6 Transport	.080	-.008	-.008	-.069	-.067
Industry7 Health	.028	.150	-.123	-.034	-.075
Firm Size	.145	.188*	-.196*	-.177*	-.229**
Direct effects					
ITSCA		.200*		.183*	.127
ITINF		.195*		.150	.096
ITOSK		.379***		.221**	.115
Mediating effect					
Supplier Integration					.279**
Δ R^2	.041	.262***	.067	.123***	.177***
Overall R^2	.041	.303	.067	.189	.244
Adjusted R^2	-.011	.250	.016	.128	.180
Overall model F	.782	5.698***	1.317	3.061**	3.837***

* p<.05

** p<.01

*** p<.001

Following the steps of mediated multiple regression, the examination of three equations (see section 7.3.2.1, page 160) was performed as specified earlier. In step 1, results of the analysis show support for **Hypotheses 1a**, **1b** and **1c**, as discussed earlier. Steps 2 and 3 show the results for **H3a**, **3b** and **3c**. Supplier integration was positively related to quality performance (β=.279, $p<.01$), with the previously significant ITSCA–quality performance relationship (β=.183, $p<.05$) losing is significance (β=.127, ns), providing evidence of full mediation and thus, full support for **H3a**. Again, there was no significant relationship between ITINF and quality performance, and hence, no support was found for **H3b**. Supplier integration was positively related to quality performance (β=.279, $p<.01$), with the previously significant ITOSK–quality performance relationship (β=.211, $p<.01$) no longer significant (β=.115, ns), providing evidence of full mediation and consequently, full support for **H3c**. A summary of results is provided in Table 7.2c.

Table 7.2c: Summary of results (Model 2)

Hypotheses	***Results***
H1a: The ability to use IT for supply chain activities (ITSCA) has a positive influence on the degree of supplier integration.	*Supported*
H1b: Flexible IT infrastructure (ITINF) has a positive influence on the degree of supplier integration.	*Supported*
H1c: IT operations shared knowledge (ITOSK) has a positive influence on the degree of supplier integration.	*Supported*
H3a: Supplier integration is positively related to quality performance and mediates the ITSCA–quality relationship.	*Fully supported*
H3b: Supplier integration is positively related to quality performance and mediates the ITINF–quality relationship.	*Not supported*
H3c: Supplier integration is positively related to quality performance and mediates the ITOSK–quality relationship.	*Fully supported*

7.3.3 Model 3: IS Capabilities, Customer Transactions, and Cost Performance

The third model tests whether the level of customer transactions mediates the effects of IT for supply chain activities, flexible IT infrastructure, and IT operations shared knowledge, on cost performance, and whether firm size and type of industry would have any predictive power on cost. The following section details the regression equations and model specification designed to test this model.

7.3.3.1 Model Specification (Model 3)

This section details the assessment of the relationship among the mediator variable (customer transactions), independent variables (ITSCA, ITINF, and ITOSK), and the dependent variable (cost). The relationship was controlled by firm size (measured by the number of employees) and type of industry (seven dummy variables were used to control for the specific impact of different industries). The following regression model was formulated to test the proposed hypotheses:

Step one:

$$\mathrm{CT}_c = \beta_{c0} + \beta_{c1}\mathrm{IN1} + \beta_{c2}\mathrm{IN2} + \beta_{c3}\mathrm{IN3} + \beta_{c4}\mathrm{IN4} + \beta_{c5}\mathrm{IN5} + \beta_{c6}\mathrm{IN6} + \beta_{c7}\mathrm{IN7} + \beta_{c8}\mathrm{FS} + \beta_{c9}\mathrm{ITSCA} + \beta_{c10}\mathrm{ITINF} + \beta_{c11}\mathrm{ITOSK} + \varepsilon_{c1}$$

Step two:

$$\mathrm{C}_c = \beta_{c0'} + \beta_{c12}\mathrm{IN1} + \beta_{c13}\mathrm{IN2} + \beta_{c14}\mathrm{IN3} + \beta_{c15}\mathrm{IN4} + \beta_{c16}\mathrm{IN5} + \beta_{c17}\mathrm{IN6} + \beta_{c18}\mathrm{IN7} + \beta_{c19}\mathrm{FS} + \beta_{c20}\mathrm{ITSCA} + \beta_{c21}\mathrm{ITINF} + \beta_{c22}\mathrm{ITOSK} + \varepsilon_{c2}$$

Step three:

$$\mathrm{C}_c = \beta_{c0''} + \beta_{c23}\mathrm{IN1} + \beta_{c24}\mathrm{IN2} + \beta_{c25}\mathrm{IN3} + \beta_{c26}\mathrm{IN4} + \beta_{c27}\mathrm{IN5} + \beta_{c28}\mathrm{IN6} + \beta_{c29}\mathrm{IN7} + \beta_{c30}\mathrm{FS} + \beta_{c31}\mathrm{ITSCA} + \beta_{c32}\mathrm{ITINF} + \beta_{c33}\mathrm{ITOSK} + \beta_{c34}\mathrm{CT} + \varepsilon_{c3}$$

Where:

C: Cost
CT: Customer Transactions
ITSCA: IT for supply chain activities
ITINF: flexible IT infrastructure
ITOSK: IT operations shared knowledge
$\beta_{c0}, \beta_{c0'}, \beta_{c0''}$: Constants
$\beta_{c1} \sim \beta_{c34}$: Coefficients
$\varepsilon_{c1} \sim \varepsilon_{c3}$: Errors

IN1: Education
IN2: Hotels and restaurants
IN3: Banks, insurance and other financials
IN4: Wholesale and retail trade
IN5: Business activities
IN6: Transport, storage and communications
IN7: Health and social work
FS: Firm size

7.3.3.2 Model Results (Model 3)

The correlations matrix (Table 7.3a) was inspected to reveal the correlations among the variables. Results show that most correlations were positive, but small. ITINF correlated with ITOSK (.338, $p<.01$). Customer transactions significantly and positively correlated with ITSCA (.310) and ITOSK (.272). Additionally, there were some negative correlations among control variables. However, all these correlations were small, ranging from .001 to .374, suggesting that multicollinearity among the independent variables is unlikely to be an issue in this data set. Multicollinearity would be a problem if the independent variables had a bivariate correlation higher than .9 (Pallant, 2010). In addition, cost positively correlated with ITSCA (.218), ITINF (.225), ITOSK (.326), and customer transactions (.374), with the significance level of $p<.01$. These correlations indicated that this data set is appropriate for reliable testing of the responses through hierarchical multiple regression.

Further, tests for multicollinearity and autocorrelation were performed for this model, and the results indicated that multicollinearity is unlikely to an issue, and that the assumption of independent errors was met in this data set (see Appendix 7.1.3).

Table 7.3a: Correlations matrix and descriptive statistics (Model 3)

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13
1 ITSCA	8.12	3.406	1												
2 ITINF	4.70	1.348	.023	1											
3 ITOSK	4.57	1.419	.120	.338**	1										
4 Customer Transactions	4.08	1.434	.310**	.073	.272**	1									
5 Cost	4.65	1.042	.218**	.225**	.326**	.374**	1								
6 IN1 Education	.04	.208	.084	.003	-.058	.017	.004	1							
7 IN2 Hotels	.07	.257	.050	-.097	.031	-.056	-.083	-.060	1						
8 IN3 Banks	.08	.267	-.265**	.190*	.026	-.145	.083	-.063	-.080	1					
9 IN4 Wholesale	.22	.419	.113	.035	.055	.000	.065	-.117	-.148	-.155	1				
10 IN5 Business	.26	.438	-.189*	.001	-.008	-.028	-.044	-.127	-.162*	-.170*	-.316**	1			
11 IN6 Transport	.15	.356	.231**	.080	.106	.155	.043	-.090	-.115	-.120	-.224**	-.244**	1		
12 IN7 Health	.09	.287	-.176*	-.096	-.205*	-.122	-.087	-.068	-.086	-.091	-.169*	-.184*	-.131	1	
13 Firm Size	3.08	1.218	.198*	-.132	-.120	.134	-.029	.062	.043	.000	-.227**	-.198*	.240**	.108	1

* p<.05

** p<.01

Results of Regression Analysis for Mediation (Model 3)

Regression results of Model 3 are presented in Table7.3b. Hierarchical multiple regression was used to test the ability of the direct effects (ITSCA, ITINF, and ITOSK) and the mediating effect (customer transactions) to predict levels of cost performance, after controlling for the influence of industries and firm size.

Table 7.3b: Results of regression analysis for mediation (Model 3)

	Customer Transactions		**Cost**		
		Step 1		**Step 2**	**Step 3**
	β	β	β	β	β
Controls					
Industry1 Education	-.075	-.059	.004	.014	.031
Industry2 Hotels	-.162	-.153	-.078	-.071	-.024
Industry3 Banks	-.243*	-.175	.074	.126	.179
Industry4 Wholesale	-.153	-.143	.042	.039	.082
Industry5 Business	-.185	-.113	-.041	.025	.059
Industry6 Transport	-.037	-.068	.039	-.016	.005
Industry7 Health	-.239*	-.131	-.080	.036	.075
Firm Size	.109	.110	-.025	-.014	-.047
Direct effects					
ITSCA		.212*		.232**	.168*
ITINF		.015		.099	.095
ITOSK		.248**		.269**	.195*
Mediating effect					
Customer Transactions					.302***
ΔR^2	.086	.104**	.027	.149***	.222***
Overall R^2	.086	.190	.027	.175	.249
Adjusted R^2	.036	.129	-.026	.112	.186
Overall model F	1.733	3.079**	.502	2.783**	3.952***

* p<.05
** p<.01
*** p<.001

Following the steps of mediated multiple regression, the examination of three equations (see section 7.3.3.1 on page 164) was performed as specified earlier.

Results of the analysis in step 1 show support for **Hypothesis 4a:** the ability to use ITSCA (β=.212, $p<.05$) was positively and significantly related to customer transactions; and **H4c:** ITOSK (β=.248, $p<.01$) was positively and significantly related to customer transactions. No significant relationship between ITINF and customer transactions (β=.015, ns) was found, and therefore, there was no support for **H4b**. **H5a** requires that customer transactions mediate the relationship between ITSCA and cost performance. The results in steps 2 and 3 indicate that customer transactions were positively related to cost performance (β=.302, $p<.001$), with the previously significant ITSCA–cost performance relationship (β=.232, $p<.01$) becoming less significant (β=.168, $p<.05$), providing evidence of partial mediation and thus, partial support for **H5a**. There was no significant relationship between ITINF and cost performance, and consequently, no support was found for **H5b**. **H5c** requires that customer transactions mediate the relationship between ITOSK and cost performance. The results indicate that customer transactions were positively related to cost performance (β=.302, $p<.001$), with the previously significant ITOSK–cost performance relationship (β=.269, $p<.01$) becoming less significant (β=.195, $p<.05$), providing evidence of partial mediation and thus, partially supporting **H5c**. A summary of results is provided in Table 7.3c.

Table 7.3c: Summary of results (Model 3)

Hypotheses	***Results***
H4a: The ability to use IT for supply chain activities (ITSCA) has a positive influence on the degree of customer transactions.	*Supported*
H4b: Flexible IT infrastructure (ITINF) has a positive influence on the degree of customer transactions.	*Not supported*
H4c: IT operations shared knowledge (ITOSK) has a positive influence on the degree of customer transactions.	*Supported*
H5a: Customer transactions are positively related to cost performance and mediate the ITSCA–cost relationship.	*Partially supported*
H5b: Customer transactions are positively related to cost performance and mediate the ITINF–cost relationship.	*Not supported*
H5c: Customer transactions are positively related to cost performance and mediate the ITOSK–cost relationship.	*Partially supported*

7.3.4 Model 4: IS Capabilities, Customer Transactions, and Quality Performance

The fourth model tests whether the level of customer transactions mediates the effects of IT for supply chain activities, flexible IT infrastructure, and IT operations shared knowledge, on quality performance, and whether firm size and type of industry would have any predictive power on quality. The following section details the regression equations and model specification designed to test this model.

7.3.4.1 Model Specification (Model 4)

This section details the assessment of the relationship among the mediator variable (customer transactions), independent variables (ITSCA, ITINF, and ITOSK), and the dependent variable (quality). The relationship was controlled by firm size (measured by the number of employees) and type of industry (seven dummy variables were used to control for the specific impact of different industries: education; hotels and restaurants; banks, insurance and other financials; wholesale and retail trade; business activities; transport, storage and communications; and health and social work). The following regression model was formulated to test the proposed hypotheses:

Step one:

$$\mathrm{CT}_{d} = \beta_{d0} + \beta_{d1}\mathrm{IN1} + \beta_{d2}\mathrm{IN2} + \beta_{d3}\mathrm{IN3} + \beta_{d4}\mathrm{IN4} + \beta_{d5}\mathrm{IN5} + \beta_{d6}\mathrm{IN6} + \beta_{d7}\mathrm{IN7} + \beta_{d8}\mathrm{FS} + \beta_{d9}\mathrm{ITSCA} + \beta_{d10}\mathrm{ITINF} + \beta_{d11}\mathrm{ITOSK} + \varepsilon_{d1}$$

Step two:

$$\mathrm{C}_{d} = \beta_{d0'} + \beta_{d12}\mathrm{IN1} + \beta_{d13}\mathrm{IN2} + \beta_{d14}\mathrm{IN3} + \beta_{d15}\mathrm{IN4} + \beta_{d16}\mathrm{IN5} + \beta_{d17}\mathrm{IN6} + \beta_{d18}\mathrm{IN7} + \beta_{d19}\mathrm{FS} + \beta_{d20}\mathrm{ITSCA} + \beta_{d21}\mathrm{ITINF} + \beta_{d22}\mathrm{ITOSK} + \varepsilon_{d2}$$

Step three:

$$\mathrm{C}_{d} = \beta_{d0''} + \beta_{d23}\mathrm{IN1} + \beta_{d24}\mathrm{IN2} + \beta_{d25}\mathrm{IN3} + \beta_{d26}\mathrm{IN4} + \beta_{d27}\mathrm{IN5} + \beta_{d28}\mathrm{IN6} + \beta_{d29}\mathrm{IN7} + \beta_{d30}\mathrm{FS} + \beta_{d31}\mathrm{ITSCA} + \beta_{d32}\mathrm{ITINF} + \beta_{d33}\mathrm{ITOSK} + \beta_{d34}\mathrm{CT} + \varepsilon_{d3}$$

Where:

Q: Quality
CT: Customer Transactions
ITSCA: IT for supply chain activities
ITINF: flexible IT infrastructure
ITOSK: IT operations shared knowledge
$\beta_{d0}, \beta_{d0'}, \beta_{d0''}$: Constants
$\beta_{d1} \sim \beta_{d34}$: Coefficients
$\varepsilon_{d1} \sim \varepsilon_{d3}$: Errors

IN1: Education
IN2: Hotels and restaurants
IN3: Banks, insurance and other financials
IN4: Wholesale and retail trade
IN5: Business activities
IN6: Transport, storage and communications
IN7: Health and social work
FS: Firm size

7.3.4.2 Model Results (Model 4)

The correlations matrix (Table 7.4a) was inspected to reveal the correlations among the variables. Results show that most correlations were positive, but small. ITINF correlated with ITOSK (.338, $p<.01$). Customer transactions significantly and positively correlated with ITSCA (.310) and ITOSK (.272). Additionally, there were some negative correlations among control variables. However, all these correlations were small, ranging from .001 to .376, suggesting that multicollinearity among the independent variables is unlikely to be an issue in this data set. Multicollinearity would be a problem when the independent variables have a bivariate correlation higher than .9 (Pallant, 2010). In addition, quality positively correlated with ITSCA (.199, $p<.05$), ITINF (.241, $p<.01$), ITOSK (.308, $p<.01$), and customer transactions (.376, $p<.01$). These correlations indicated that this data set is appropriate for reliable testing of the responses through hierarchical multiple regression.

Further, tests for multicollinearity and autocorrelation were performed for this model, and the results indicated that multicollinearity is unlikely to an issue, and that the assumption of independent errors was met in this data set (see Appendix 7.1.4).

Table 7.4a: Correlations matrix and descriptive statistics (Model 4)

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13
1 ITSCA	8.12	3.406	1												
2 ITINF	4.70	1.348	.023	1											
3 ITOSK	4.57	1.419	.120	.338**	1										
4 Customer Transactions	4.08	1.434	.310**	.073	.272**	1									
5 Quality	5.06	1.032	.199*	.241**	.308**	.376**	1								
6 IN1 Education	.04	.208	.084	.003	-.058	.017	-.064	1							
7 IN2 Hotels	.07	.257	.050	-.097	.031	-.056	-.075	-.060	1						
8 IN3 Banks	.08	.267	-.265**	.190*	.026	-.145	-.027	-.063	-.080	1					
9 IN4 Wholesale	.22	.419	.113	.035	.055	.000	.080	-.117	-.148	-.155	1				
10 IN5 Business	.26	.438	-.189*	.001	-.008	-.028	-.081	-.127	-.162*	-.170*	-.316**	1			
11 IN6 Transport	.15	.356	.231**	.080	.106	.155	.089	-.090	-.115	-.120	-.224**	-.244**	1		
12 IN7 Health	.09	.287	-.176*	-.096	-.205*	-.122	-.046	-.068	-.086	-.091	-.169*	-.184*	-.131	1	
13 Firm Size	3.08	1.218	.198*	-.132	-.120	.134	-.151	.062	.043	.000	-.227**	-.198*	.240**	.108	1

* p<.05

** p<.01

Results of Regression Analysis for Mediation (Model 4)

Regression results of Model 4 are presented in Table 7.4b. Hierarchical multiple regression was used to test the ability of the direct effects (ITSCA, ITINF, and ITOSK) and the mediating effect (customer transactions) to predict levels of quality performance, after controlling for the influence of industries and firm size.

Table 7.4b: Results of regression analysis for mediation (Model 4)

	Customer Transactions		Quality		
		Step 1		Step 2	Step 3
	β	β	β	β	β
Controls					
Industry1 Education	-.075	-.059	-.122	-.121	-.102
Industry2 Hotels	-.162	-.153	-.151	-.147	-.099
Industry3 Banks	-.243*	-.175	-.118	-.098	-.043
Industry4 Wholesale	-.153	-.143	-.118	-.134	-.089
Industry5 Business	-.185	-.113	-.242	-.201	-.166
Industry6 Transport	-.037	-.068	-.008	-.069	-.048
Industry7 Health	-.239*	-.131	-.123	-.034	.007
Firm Size	.109	.110	-.196*	-.177*	-.211*
Direct effects					
ITSCA		.212*		.183*	.117
ITINF		.015		.150	.146
ITOSK		.248**		.221**	.143
Mediating effect					
Customer Transactions					.312***
ΔR^2	.086	.104**	.067	.123***	.201***
Overall R^2	.086	.190	.067	.189	.268
Adjusted R^2	.036	.129	.016	.128	.207
Overall model F	1.733	3.079**	1.317	3.061**	4.370***

* p<.05
** p<.01
*** p<.001

Results of the analysis in step 1 show support for **Hypotheses 4a** and **H4c**, but no support for **H4b** as discussed earlier. Steps 2 and 3 show the results for **H6a**, **H6b and H6c**. Customer transactions were positively related to quality performance (β=.312, p<.001), with the previously significant ITSCA–quality performance relationship (β=.183, p<.05) losing significance (β=.117, ns), providing evidence of full mediation, and thus, full support for **H6a**. Again, there was no significant relationship between ITINF and quality performance, and thus, no support was found for **H6b**. Customer transactions were positively related to quality performance (β=.312, p<.001), with the previously significant ITOSK–quality performance relationship (β=.211, p<.01) no longer significant (β=.143, ns), providing evidence of full mediation and hence, full support for **H6c**. A summary of results is provided in Table 7.4c.

Table 7.4c: Summary of results (Model 4)

Hypotheses	***Results***
H4a: The ability to use IT for supply chain activities (ITSCA) has a positive influence on the degree of customer transactions.	*Supported*
H4b: Flexible IT infrastructure (ITINF) has a positive influence on the degree of customer transactions.	*Not supported*
H4c: IT operations shared knowledge (ITOSK) has a positive influence on the degree of customer transactions.	*Supported*
H6a: Customer transactions are positively related to quality performance and mediate the ITSCA–quality relationship.	*Fully supported*
H6b: Customer transactions are positively related to quality performance and mediate the ITINF–quality relationship.	*Not supported*
H6c: Customer transactions are positively related to quality performance and mediate the ITOSK–quality relationship.	*Fully supported*

7.3.5 Model 5: IS Capabilities, Customer Connection, and Cost Performance

The fifth model tests whether the level of customer connection mediates the effects of IT for supply chain activities, flexible IT infrastructure, and IT operations shared knowledge, on cost performance, and whether firm size and type of industry would have any predictive power on cost. The following section details the regression equations and model specification that designed to test this model.

7.3.5.1 Model Specification (Model 5)

This section details the assessment of the relationship among the mediator variable (customer connection), independent variables (ITSCA, ITINF, and ITOSK), and the dependent variable (cost). The relationship was controlled by firm size (measured by the number of employees) and type of industry (seven dummy variables were used to control for the specific impact of different industries: education; hotels and restaurants; banks, insurance and other financials; wholesale and retail trade; business activities; transport, storage and communications; and health and social work). The following regression model was formulated to test the proposed hypotheses:

Step one:

$$\mathrm{CCnt}_e = \beta_{e0} + \beta_{e1}\mathrm{IN1} + \beta_{e2}\mathrm{IN2} + \beta_{e3}\mathrm{IN3} + \beta_{e4}\mathrm{IN4} + \beta_{e5}\mathrm{IN5} + \beta_{e6}\mathrm{IN6} + \beta_{e7}\mathrm{IN7} + \beta_{e8}\mathrm{FS} + \beta_{e9}\mathrm{ITSCA} + \beta_{e10}\mathrm{ITINF} + \beta_{e11}\mathrm{ITOSK} + \varepsilon_{e1}$$

Step two:

$$\mathrm{C}_e = \beta_{e0'} + \beta_{e12}\mathrm{IN1} + \beta_{e13}\mathrm{IN2} + \beta_{e14}\mathrm{IN3} + \beta_{e15}\mathrm{IN4} + \beta_{e16}\mathrm{IN5} + \beta_{e17}\mathrm{IN6} + \beta_{e18}\mathrm{IN7} + \beta_{e19}\mathrm{FS} + \beta_{e20}\mathrm{ITSCA} + \beta_{e21}\mathrm{ITINF} + \beta_{e22}\mathrm{ITOSK} + \varepsilon_{e2}$$

Step three:

$$\mathrm{C}_e = \beta_{e0''} + \beta_{e23}\mathrm{IN1} + \beta_{e24}\mathrm{IN2} + \beta_{e25}\mathrm{IN3} + \beta_{e26}\mathrm{IN4} + \beta_{e27}\mathrm{IN5} + \beta_{e28}\mathrm{IN6} + \beta_{e29}\mathrm{IN7} + \beta_{e30}\mathrm{FS} + \beta_{e31}\mathrm{ITSCA} + \beta_{e32}\mathrm{ITINF} + \beta_{e33}\mathrm{ITOSK} + \beta_{e34}\mathrm{CCnt} + \varepsilon_{e3}$$

Where:

C: Cost
CCnt: Customer connection
ITSCA: IT for supply chain activities
ITINF: flexible IT infrastructure
ITOSK: IT operations shared knowledge
$\beta_{e0}, \beta_{e0'}, \beta_{e0''}$: Constants
$\beta_{e1} \sim \beta_{e34}$: Coefficients
$\varepsilon_{e1} \sim \varepsilon_{e3}$: Errors

IN1: Education
IN2: Hotels and restaurants
IN3: Banks, insurance and other financials
IN4: Wholesale and retail trade
IN5: Business activities
IN6: Transport, storage and communications
IN7: Health and social work
FS: Firm size

7.3.5.2 Model Results (Model 5)

The correlations matrix (Table 7.5a) was inspected to reveal the correlations among the variables. Results show that most correlations were positive, but small. ITINF correlated with ITOSK (.338, p<.01). Customer connection significantly and positively correlated with ITSCA (.310), ITINF (.265), and ITOSK (.335). Additionally, there were some negative correlations among control variables. However, all these correlations were small, ranging from .001 to .338, suggesting that multicollinearity among the independent variables is unlikely to be an issue in this data set. Multicollinearity would be a problem if the independent variables had a bivariate correlation higher than .9 (Pallant, 2010). In addition, cost positively correlated with ITSCA (.218), ITINF (.225), ITOSK (.326), and customer connection (.322), with the significance level of p<.01. These correlations indicated that this data set is appropriate for reliable testing of the responses through hierarchical multiple regression.

Further, tests for multicollinearity and autocorrelation were performed for this model, and the results indicated that multicollinearity is unlikely to an issue, and that the assumption of independent errors was met in this data set (see Appendix 7.1.5).

Table 7.5a: Correlations matrix and descriptive statistics (Model 5)

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13
1 ITSCA	8.12	3.406	1												
2 ITINF	4.70	1.348	.023	1											
3 ITOSK	4.57	1.419	.120	.338**	1										
4 Customer Connection	4.43	1.445	.310**	.265**	.335**	1									
5 Cost	4.65	1.042	.218**	.225**	.326**	.322**	1								
6 IN1 Education	.04	.208	.084	.003	-.058	-.194*	.004	1							
7 IN2 Hotels	.07	.257	.050	-.097	.031	-.088	-.083	-.060	1						
8 IN3 Banks	.08	.267	-.265**	.190*	.026	-.131	.083	-.063	-.080	1					
9 IN4 Wholesale	.22	.419	.113	.035	.055	-.005	.065	-.117	-.148	-.155	1				
10 IN5 Business	.26	.438	-.189*	.001	-.008	-.006	-.044	-.127	-.162*	-.170*	-.316**	1			
11 IN6 Transport	.15	.356	.231**	.080	.106	.202*	.043	-.090	-.115	-.120	-.224**	-.244**	1		
12 IN7 Health	.09	.287	-.176*	-.096	-.205*	-.006	-.087	-.068	-.086	-.091	-.169*	-.184*	-.131	1	
13 Firm Size	3.08	1.218	.198*	-.132	-.120	-.008	-.029	.062	.043	.000	-.227**	-.198*	.240**	.108	1

* p<.05

** p<.01

Results of Regression Analysis for Mediation (Model 5)

Regression results of Model 5 are presented in Table 7.5b. Hierarchical multiple regression was used to test the ability of the direct effects (ITSCA, ITINF, and ITOSK) and the mediating effect (customer connection) to predict levels of cost performance, after controlling for the influence of industries and firm size.

Table 7.5b: Results of regression analysis for mediation (Model 5)

	Customer Connection		**Cost**		
		Step 1		**Step 2**	**Step 3**
	β	β	β	β	β
Controls					
Industry1 Education	-.262**	-.263**	.004	.014	.070
Industry2 Hotels	-.179	-.170	-.078	-.071	-.034
Industry3 Banks	-.225*	-.187	.074	.126	.166
Industry4 Wholesale	-.177	-.196	.042	.039	.081
Industry5 Business	-.183	-.123	-.041	.025	.052
Industry6 Transport	.046	-.030	.039	-.016	-.009
Industry7 Health	-.111	.006	-.080	.036	.034
Firm Size	-.060	-.046	-.025	-.014	-.004
Direct effects					
ITSCA		.274**		.232**	.173
ITINF		.202*		.099	.056
ITOSK		.237**		.269**	.218*
Mediating effect					
Customer Connection					.216*
Δ R^2	.109*	.196***	.027	.149***	.181***
Overall R^2	.109	.304	.027	.175	.208
Adjusted R^2	.060	.251	-.026	.112	.141
Overall model F	2.238*	5.723***	.502	2.783**	3.123**

* p<.05
** p<.01
*** p<.001

Results of the analysis in step 1 show support for **Hypothesis 7a:** the ability to use ITSCA (β=.274, p<.01) was positively and significantly related to customer connection; **H7b:** ITINF (β=.202, p<.05) was positively and significantly related to customer connection; and **H7c:** ITOSK (β=.237, p<.01) was positively and significantly related to customer connection. **H8a** requires that customer connection mediates the relationship between ITSCA and cost performance. The results in steps 2 and 3 indicate that customer connection was positively related to cost performance (β=.216, p<.05), with the previously significant ITSCA–cost performance relationship (β=.232, p<.01) no longer significant (β=.173, ns), providing evidence of full mediation and thus, full support for **H8a**. There was no significant relationship between ITINF and cost performance, and hence, no support was found for **H8b**. **H8c** requires that customer connection mediates the relationship between ITOSK and cost performance. The results indicate that customer connection was positively related to cost performance (β=.216, p<.05), with the previously significant ITOSK–cost performance relationship (β=.269, p<.01) becoming less significant (β=.218, p<.05), providing evidence of partial mediation and consequently, partial support for **H8c**. A summary of results is provided in Table 7.5c.

Table 7.5c: Summary of results (Model 5)

Hypotheses	***Results***
H7a: The ability to use IT for supply chain activities (ITSCA) has a positive influence on the degree of customer connection.	*Supported*
H7b: Flexible IT infrastructure (ITINF) has a positive influence on the degree of customer connection.	*Supported*
H7c: IT operations shared knowledge (ITOSK) has a positive influence on the degree of customer connection.	*Supported*
H8a: Customer connection is positively related to cost performance and mediates the ITSCA–cost relationship.	*Fully supported*
H8b: Customer connection is positively related to cost performance and mediates the ITINF–cost relationship.	*Not supported*
H8c: Customer connection is positively related to cost performance and mediates the ITOSK–cost relationship.	*Partially supported*

7.3.6 Model 6: IS Capabilities, Customer Connection, and Quality Performance

The sixth model tests whether the level of customer connection mediates the effects of IT for supply chain activities, flexible IT infrastructure, and IT operations shared knowledge, on quality performance, and whether firm size and type of industry would have any predictive power on quality. The following section details the regression equations and model specification designed to test this model.

7.3.6.1 Model Specification (Model 6)

This section details the assessment of the relationship among the mediator variable (customer connection), independent variables (ITSCA, ITINF, and ITOSK), and the dependent variable (quality). The relationship was controlled by firm size (measured by the number of employees) and type of industry (seven dummy variables were used to control for the specific impact of different industries: education; hotels and restaurants; banks, insurance and other financials; wholesale and retail trade; business activities; transport, storage and communications; and health and social work). The following regression model was formulated to test the proposed hypotheses:

Step one:

$$\begin{aligned}\mathrm{CCnt}_f = {} & \beta_{f0} + \beta_{f1}\mathrm{IN1} + \beta_{f2}\mathrm{IN2} + \beta_{f3}\mathrm{IN3} + \beta_{f4}\mathrm{IN4} + \beta_{f5}\mathrm{IN5} + \beta_{f6}\mathrm{IN6} + \beta_{f7}\mathrm{IN7} \\ & + \beta_{f8}\mathrm{FS} + \beta_{f9}\mathrm{ITSCA} + \beta_{f10}\mathrm{ITINF} + \beta_{f11}\mathrm{ITOSK} + \varepsilon_{f1}\end{aligned}$$

Step two:

$$\begin{aligned}\mathrm{Q}_f = {} & \beta_{f0'} + \beta_{f12}\mathrm{IN1} + \beta_{f13}\mathrm{IN2} + \beta_{f14}\mathrm{IN3} + \beta_{f15}\mathrm{IN4} + \beta_{f16}\mathrm{IN5} + \beta_{f17}\mathrm{IN6} \\ & + \beta_{f18}\mathrm{IN7} + \beta_{f19}\mathrm{FS} + \beta_{f20}\mathrm{ITSCA} + \beta_{f21}\mathrm{ITINF} + \beta_{f22}\mathrm{ITOSK} + \varepsilon_{f2}\end{aligned}$$

Step three:

$$\begin{aligned}\mathrm{Q}_f = {} & \beta_{f0''} + \beta_{f23}\mathrm{IN1} + \beta_{f24}\mathrm{IN2} + \beta_{f25}\mathrm{IN3} + \beta_{f26}\mathrm{IN4} + \beta_{f27}\mathrm{IN5} + \beta_{f28}\mathrm{IN6} \\ & + \beta_{f29}\mathrm{IN7} + \beta_{f30}\mathrm{FS} + \beta_{f31}\mathrm{ITSCA} + \beta_{f32}\mathrm{ITINF} + \beta_{f33}\mathrm{ITOSK} \\ & + \beta_{f34}\mathrm{CCnt} + \varepsilon_{f3}\end{aligned}$$

Where:

Q: Quality
CCnt: Customer connection
ITSCA: IT for supply chain activities
ITINF: flexible IT infrastructure
ITOSK: IT operations shared knowledge
$\beta_{f0}, \beta_{f0'}, \beta_{f0''}$: Constants
$\beta_{f1} \sim \beta_{f34}$: Coefficients
$\varepsilon_{f1} \sim \varepsilon_{f3}$: Errors

IN1: Education
IN2: Hotels and restaurants
IN3: Banks, insurance and other financials
IN4: Wholesale and retail trade
IN5: Business activities
IN6: Transport, storage and communications
IN7: Health and social work
FS: Firm size

7.3.6.2 Model Results (Model 6)

The correlations matrix (Table 7.6a) was inspected to reveal the correlations among the variables. Results show that most correlations were positive, but small. ITINF correlated with ITOSK (.338, $p<.01$). Customer connection significantly and positively correlated with ITSCA (.310), ITINF (.265), and ITOSK (.335). Additionally, there were some negative correlations among control variables. However, all these correlations were small, ranging from .001 to .441, suggesting that multicollinearity among the independent variables is unlikely to be an issue in this data set. Multicollinearity would be a problem if the independent variables were to have a bivariate correlation higher than .9 (Pallant, 2010). In addition, quality positively correlated with ITSCA (.199, $p<.05$), ITINF (.241, $p<.01$), ITOSK (.308, $p<.01$), and customer connection (.441, $p<.01$). These correlations indicated that this data set is appropriate for reliable testing of the responses through hierarchical multiple regression.

Further, tests for multicollinearity and autocorrelation were performed for this model, and the results indicated that multicollinearity is unlikely to an issue, and that the assumption of independent errors was met in this data set (see Appendix 7.1.6).

Table 7.6a: Correlations matrix and descriptive statistics (Model 6)

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13
1 ITSCA	8.12	3.406	1												
2 ITINF	4.70	1.348	.023	1											
3 ITOSK	4.57	1.419	.120	.338**	1										
4 Customer Connection	4.43	1.445	.310**	.265**	.335**	1									
5 Quality	5.06	1.032	.199*	.241**	.308**	.441**	1								
6 IN1 Education	.04	.208	.084	.003	-.058	-.194*	-.064	1							
7 IN2 Hotels	.07	.257	.050	-.097	.031	-.088	-.075	-.060	1						
8 IN3 Banks	.08	.267	-.265**	.190*	.026	-.131	-.027	-.063	-.080	1					
9 IN4 Wholesale	.22	.419	.113	.035	.055	-.005	.080	-.117	-.148	-.155	1				
10 IN5 Business	.26	.438	-.189*	.001	-.008	-.006	-.081	-.127	-.162*	-.170*	-.316**	1			
11 IN6 Transport	.15	.356	.231**	.080	.106	.202*	.089	-.090	-.115	-.120	-.224**	-.244**	1		
12 IN7 Health	.09	.287	-.176*	-.096	-.205*	-.006	-.046	-.068	-.086	-.091	-.169*	-.184*	-.131	1	
13 Firm Size	3.08	1.218	.198*	-.132	-.120	-.008	-.151	.062	.043	.000	-.227**	-.198*	.240**	.108	1

* p<.05

** p<.01

Results of Regression Analysis for Mediation (Model 6)

Regression results of Model 6 are presented in Table 7.6b. Hierarchical multiple regression was used to test the ability of the direct effects (ITSCA, ITINF, and ITOSK) and the mediating effect (customer connection) to predict levels of quality performance, after controlling for the influence of industries and firm size.

Table 7.6b: Results of regression analysis for mediation (Model 6)

	Customer Connection			**Quality**	
		Step 1		**Step 2**	**Step 3**
	β	β	β	β	β
Controls					
Industry1 Education	-.262**	-.263**	-.122	-.121	-.033
Industry2 Hotels	-.179	-.170	-.151	-.147	-.090
Industry3 Banks	-.225*	-.187	-.118	-.098	-.036
Industry4 Wholesale	-.177	-.196	-.118	-.134	-.069
Industry5 Business	-.183	-.123	-.242	-.201	-.160
Industry6 Transport	.046	-.030	-.008	-.069	-.059
Industry7 Health	-.111	.006	-.123	-.034	-.036
Firm Size	-.060	-.046	-.196*	-.177*	-.161*
Direct effects					
ITSCA		.274**		.183*	.092
ITINF		.202*		.150	.083
ITOSK		.237**		.221**	.142
Mediating effect					
Customer Connection					.333***
ΔR^2	.109*	.196***	.067	.123***	.200***
Overall R^2	.109	.304	.067	.189	.266
Adjusted R^2	.060	.251	.016	.128	.205
Overall model F	2.238*	5.723***	1.317	3.061**	4.329***

* p<.05

** p<.01

*** p<.001

In step 1, results of the analysis show support for **Hypotheses 7a**, **H7b** and **H7c**, as discussed earlier. Steps 2 and 3 show the results for **H9a**, **H 9b** and **H 9c**. Customer connection was positively related to quality performance (β=.333, p<.001), with the previously significant ITSCA–quality performance relationship (β=.183, p<.05) losing its significance (β=.092, ns), providing evidence of full mediation and thus, full support for **H9a**. Again, there was no significant relationship between ITINF and quality performance, and hence, no support was found for **H9b**. Customer connection was positively related to quality performance (β=.333, p<.001), with the previously significant ITOSK–quality performance relationship (β=.211, p<.01) no longer being significant (β=.142, ns), providing evidence of full mediation and thus, full support for **H9c**. A summary of results is provided in Table 7.6c.

Table 7.6c: Summary of results (Model 6)

Hypotheses	***Results***
H7a: The ability to use IT for supply chain activities (ITSCA) has a positive influence on the degree of customer connection.	*Supported*
H7b: Flexible IT infrastructure (ITINF) has a positive influence on the degree of customer connection.	*Supported*
H7c: IT operations shared knowledge (ITOSK) has a positive influence on the degree of customer connection.	*Supported*
H9a: Customer connection is positively related to quality performance and mediates the ITSCA–quality relationship.	*Fully supported*
H9b: Customer connection is positively related to quality performance and mediates the ITINF–quality relationship.	*Not supported*
H9c: Customer connection is positively related to quality performance and mediates the ITOSK–quality relationship.	*Fully supported*

7.3.7 Model 7: IS Capabilities, Customer Collaboration, and Cost Performance

The seventh model tests whether the level of customer collaboration mediates the effects of IT for supply chain activities, flexible IT infrastructure, and IT operations shared knowledge, on cost performance, and whether firm size and type of industry would have any predictive power on cost. The following section details the regression equations and model specification designed to test this model.

7.3.7.1 Model Specification (Model 7)

This section details the assessment of the relationship among the mediator variable (customer collaboration), independent variables (ITSCA, ITINF, and ITOSK), and the dependent variable (cost). The relationship was controlled by firm size (measured by the number of employees) and type of industry (seven dummy variables were used to control for the specific impact of different industries: education; hotels and restaurants; banks, insurance and other financials; wholesale and retail trade; business activities; transport, storage and communications; and health and social work). The following regression model was formulated to test the proposed hypotheses:

Step one:

$$\mathrm{CClb}_g = \beta_{g0} + \beta_{g1}\mathrm{IN1} + \beta_{g2}\mathrm{IN2} + \beta_{g3}\mathrm{IN3} + \beta_{g4}\mathrm{IN4} + \beta_{g5}\mathrm{IN5} + \beta_{g6}\mathrm{IN6} + \beta_{g7}\mathrm{IN7} + \beta_{g8}\mathrm{FS} + \beta_{g9}\mathrm{ITSCA} + \beta_{g10}\mathrm{ITINF} + \beta_{g11}\mathrm{ITOSK} + \varepsilon_{g1}$$

Step two:

$$\mathrm{C}_g = \beta_{g0'} + \beta_{g12}\mathrm{IN1} + \beta_{g13}\mathrm{IN2} + \beta_{g14}\mathrm{IN3} + \beta_{g15}\mathrm{IN4} + \beta_{g16}\mathrm{IN5} + \beta_{g17}\mathrm{IN6} + \beta_{g18}\mathrm{IN7} + \beta_{g19}\mathrm{FS} + \beta_{g20}\mathrm{ITSCA} + \beta_{g21}\mathrm{ITINF} + \beta_{g22}\mathrm{ITOSK} + \varepsilon_{g2}$$

Step three:

$$\mathrm{C}_g = \beta_{g0''} + \beta_{g23}\mathrm{IN1} + \beta_{g24}\mathrm{IN2} + \beta_{g25}\mathrm{IN3} + \beta_{g26}\mathrm{IN4} + \beta_{g27}\mathrm{IN5} + \beta_{g28}\mathrm{IN6} + \beta_{g29}\mathrm{IN7} + \beta_{g30}\mathrm{FS} + \beta_{g31}\mathrm{ITSCA} + \beta_{g32}\mathrm{ITINF} + \beta_{g33}\mathrm{ITOSK} + \beta_{g34}\mathrm{CClb} + \varepsilon_{g3}$$

Where:

C: Cost
CClb: Customer collaboration
ITSCA: IT for supply chain activities
ITINF: flexible IT infrastructure
ITOSK: IT operations shared knowledge
$\beta_{g0}, \beta_{g0'}, \beta_{g0''}$: Constants
$\beta_{g1} \sim \beta_{g34}$: Coefficients
$\varepsilon_{g1} \sim \varepsilon_{g3}$: Errors
IN1: Education
IN2: Hotels and restaurants
IN3: Banks, insurance and other financials
IN4: Wholesale and retail trade
IN5: Business activities
IN6: Transport, storage and communications
IN7: Health and social work
FS: Firm size

7.3.7.2 Model Results (Model 7)

The correlations matrix (Table 7.7a) was inspected to reveal the correlations among the variables. Results show that most correlations were positive, but small. ITINF correlated with ITOSK (.338, $p<.01$). Customer collaboration significantly and positively correlated with ITOSK (.226). Additionally, there were some negative correlations among control variables. However, all these correlations were small, ranging from .001 to .338, suggesting that multicollinearity among the independent variables is unlikely to be an issue in this data set. Multicollinearity would be a problem if the independent variables had a bivariate correlation higher than .9 (Pallant, 2010). In addition, cost positively correlated with ITSCA (.218), ITINF (.225), ITOSK (.326), and customer collaboration (.275), with the significance level of $p<.01$. These correlations indicated that this data set is appropriate for reliable testing of the responses through hierarchical multiple regression.

Further, tests for multicollinearity and autocorrelation were performed for this model, and the results indicated that multicollinearity is unlikely to an issue, and that the assumption of independent errors was met in this data set (see Appendix 7.1.7).

Table 7.7a: Correlations matrix and descriptive statistics (Model 7)

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13
1 ITSCA	8.12	3.406	1												
2 ITINF	4.70	1.348	.023	1											
3 ITOSK	4.57	1.419	.120	.338**	1										
4 Customer Collaboration	3.54	1.398	.154	-.045	.226**	1									
5 Cost	4.65	1.042	.218**	.225**	.326**	.275**	1								
6 IN1 Education	.04	.208	.084	.003	-.058	.066	.004	1							
7 IN2 Hotels	.07	.257	.050	-.097	.031	-.026	-.083	-.060	1						
8 IN3 Banks	.08	.267	-.265**	.190*	.026	.052	.083	-.063	-.080	1					
9 IN4 Wholesale	.22	.419	.113	.035	.055	-.049	.065	-.117	-.148	-.155	1				
10 IN5 Business	.26	.438	-.189*	.001	-.008	-.006	-.044	-.127	-.162*	-.170*	-.316**	1			
11 IN6 Transport	.15	.356	.231**	.080	.106	.027	.043	-.090	-.115	-.120	-.224**	-.244**	1		
12 IN7 Health	.09	.287	-.176*	-.096	-.205*	.063	-.087	-.068	-.086	-.091	-.169*	-.184*	-.131	1	
13 Firm Size	3.08	1.218	.198*	-.132	-.120	.159*	-.029	.062	.043	.000	-.227**	-.198*	.240**	.108	1

* p<.05
** p<.01

Results of Regression Analysis for Mediation (Model 7)

Regression results of Model 7 are presented in Table 7.7b. Hierarchical multiple regression was used to test the ability of the direct effects (ITSCA, ITINF, and ITOSK) and the mediating effect (customer collaboration) to predict levels of cost performance, after controlling for the influence of industries and firm size.

Table 7.7b: Results of regression analysis for mediation (Model 7)

	Customer Collaboration		**Cost**		
		Step 1		**Step 2**	**Step 3**
	β	β	β	β	β
Controls					
Industry1 Education	.128	.165	.004	.014	-.021
Industry2 Hotels	.062	.071	-.078	-.071	-.086
Industry3 Banks	.145	.256*	.074	.126	.072
Industry4 Wholesale	.145	.185	.042	.039	.000
Industry5 Business	.180	.277*	-.041	.025	-.033
Industry6 Transport	.117	.122	.039	-.016	-.041
Industry7 Health	.145	.266*	-.080	.036	-.021
Firm Size	.173*	.163	-.025	-.014	-.048
Direct effects					
ITSCA		.188*		.232**	.193*
ITINF		-.167*		.099	.134
ITOSK		.314***		.269**	.203*
Mediating effect					
Customer Collaboration					.211*
ΔR^2	.046	.119***	.027	.149***	.186***
Overall R^2	.046	.165	.027	.175	.212
Adjusted R^2	-.006	.101	-.026	.112	.146
Overall model F	.890	2.587**	.502	2.783**	3.215***

* $p<.05$
** $p<.01$
*** $p<.001$

Results of the analysis in step 1 show support for **H10a:** the ability to use ITSCA (β=.188, p<.05) was positively and significantly related to customer collaboration; and **H10c:** ITOSK (β=.314, p<.001) was positively and significantly related to customer collaboration. While ITINF (β= -.167, p<.05) was significantly related to customer collaboration, this relationship was negative, and therefore, no support was forthcoming for **H10b**. **H11a** requires that customer collaboration mediates the relationship between ITSCA and cost performance. The results in steps 2 and 3 indicate that customer collaboration was positively related to cost performance (β=.211, p<.05), with the previously significant ITSCA–cost performance relationship (β=.232, p<.01) becoming less significant (β=.193, p<.05), providing evidence of partial mediation and thus, partial support for **H11a**. There was no significant relationship between ITINF and cost performance, and hence, no support was found for **H11b**. **H11c** requires that customer collaboration mediates the relationship between ITOSK and cost performance. The results indicate that customer collaboration was positively related to cost performance (β=.211, p<.05), with the previously significant ITOSK–cost performance relationship (β=.269, p<.01) becoming less significant (β=.203, p<.05), providing evidence of partial mediation and thus, partial support for **H11c**. A summary of results is provided in Table 7.7c.

Table 7.7c: Summary of results (Model 7)

Hypotheses	***Results***
H10a: The ability to use IT for supply chain activities (ITSCA) has a positive influence on the degree of customer collaboration.	*Supported*
H10b: Flexible IT infrastructure (ITINF) has a positive influence on the degree of customer collaboration.	*Not supported*
H10c: IT operations shared knowledge (ITOSK) has a positive influence on the degree of customer collaboration.	*Supported*
H11a: Customer collaboration is positively related to cost performance and mediates the ITSCA–cost relationship.	*Partially supported*
H11b: Customer collaboration is positively related to cost performance and mediates the ITINF–cost relationship.	*Not supported*
H11c: Customer collaboration is positively related to cost performance and mediates the ITOSK–cost relationship.	*Partially supported*

7.3.8 Model 8: IS Capabilities, Customer Collaboration, and Quality Performance

The eighth model tests whether the level of customer collaboration mediates the effects of IT for supply chain activities, flexible IT infrastructure, and IT operations shared knowledge, on quality performance, and whether firm size and type of industry have any predictive power on quality. The following section details the regression equations and model specification designed to test this model.

7.3.8.1 Model Specification (Model 8)

This section details the assessment of the relationship among the mediator variable (customer collaboration), independent variables (ITSCA, ITINF, and ITOSK) and the dependent variable (quality). The relationship was controlled by firm size (measured by the number of employees) and type of industry (seven dummy variables were used to control for the specific impact of different industries). The following regression model was formulated to test the proposed hypotheses:

Step one:

$$\begin{aligned}\mathrm{CClb}_h = {} & \beta_{h0} + \beta_{h1}\mathrm{IN1} + \beta_{h2}\mathrm{IN2} + \beta_{h3}\mathrm{IN3} + \beta_{h4}\mathrm{IN4} + \beta_{h5}\mathrm{IN5} + \beta_{h6}\mathrm{IN6} + \beta_{h7}\mathrm{IN7} \\ & + \beta_{h8}\mathrm{FS} + \beta_{h9}\mathrm{ITSCA} + \beta_{h10}\mathrm{ITINF} + \beta_{h11}\mathrm{ITOSK} + \varepsilon_{h1}\end{aligned}$$

Step two:

$$\begin{aligned}\mathrm{Q}_h = {} & \beta_{h0'} + \beta_{h12}\mathrm{IN1} + \beta_{h13}\mathrm{IN2} + \beta_{h14}\mathrm{IN3} + \beta_{h15}\mathrm{IN4} + \beta_{h16}\mathrm{IN5} + \beta_{h17}\mathrm{IN6} \\ & + \beta_{h18}\mathrm{IN7} + \beta_{h19}\mathrm{FS} + \beta_{h20}\mathrm{ITSCA} + \beta_{h21}\mathrm{ITINF} + \beta_{h22}\mathrm{ITOSK} + \varepsilon_{h2}\end{aligned}$$

Step three:

$$\begin{aligned}\mathrm{Q}_h = {} & \beta_{h0''} + \beta_{h23}\mathrm{IN1} + \beta_{h24}\mathrm{IN2} + \beta_{h25}\mathrm{IN3} + \beta_{h26}\mathrm{IN4} + \beta_{h27}\mathrm{IN5} + \beta_{h28}\mathrm{IN6} \\ & + \beta_{h29}\mathrm{IN7} + \beta_{h30}\mathrm{FS} + \beta_{h31}\mathrm{ITSCA} + \beta_{h32}\mathrm{ITINF} + \beta_{h33}\mathrm{ITOSK} \\ & + \beta_{h34}\mathrm{CClb} + \varepsilon_{h3}\end{aligned}$$

Where:

Q: Quality
CClb: Customer collaboration
ITSCA: IT for supply chain activities
ITINF: flexible IT infrastructure
ITOSK: IT operations shared knowledge
$\beta_{h0}, \beta_{h0'}, \beta_{h0''}$: Constants
$\beta_{h1} \sim \beta_{h34}$: Coefficients
$\varepsilon_{h1} \sim \varepsilon_{h3}$: Errors

IN1: Education
IN2: Hotels and restaurants
IN3: Banks, insurance and other financials
IN4: Wholesale and retail trade
IN5: Business activities
IN6: Transport, storage and communications
IN7: Health and social work
FS: Firm size

7.3.8.2 Model Results (Model 8)

The correlations matrix (Table 7.8a) was inspected to reveal the correlations among the variables. Results show that most correlations were positive, but small. ITINF correlated with ITOSK (.338, $p<.01$). Customer collaboration significantly and positively correlated with ITOSK (.226). Additionally, there were some negative correlations among control variables. However, all these correlations were small, ranging from .001 to .338, suggesting that multicollinearity among the independent variables is unlikely to be an issue in this data set. Multicollinearity would be a problem if the independent variables had a bivariate correlation higher than .9 (Pallant, 2010). In addition, quality positively correlated with ITSCA (.199, $p<.05$), ITINF (.241, $p<.01$), ITOSK (.308, $p<.01$), and customer collaboration (.210, $p<.01$). These correlations indicated that this data set is appropriate for reliable testing of the responses through hierarchical multiple regression.

Further, tests for multicollinearity and autocorrelation were performed for this model, and the results indicated that multicollinearity is unlikely to an issue, and that the assumption of independent errors was met in this data set (see Appendix 7.1.8).

Table 7.8a: Correlations matrix and descriptive statistics (Model 8)

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13
1 ITSCA	8.12	3.406	1												
2 ITINF	4.70	1.348	.023	1											
3 ITOSK	4.57	1.419	.120	.338**	1										
4 Customer Collaboration	3.54	1.398	.154	-.045	.226**	1									
5 Quality	5.06	1.032	.199*	.241**	.308**	.210**	1								
6 IN1 Education	.04	.208	.084	.003	-.058	.066	-.064	1							
7 IN2 Hotels	.07	.257	.050	-.097	.031	-.026	-.075	-.060	1						
8 IN3 Banks	.08	.267	-.265**	.190*	.026	.052	-.027	-.063	-.080	1					
9 IN4 Wholesale	.22	.419	.113	.035	.055	-.049	.080	-.117	-.148	-.155	1				
10 IN5 Business	.26	.438	-.189*	.001	-.008	-.006	-.081	-.127	-.162*	-.170*	-.316**	1			
11 IN6 Transport	.15	.356	.231**	.080	.106	.027	.089	-.090	-.115	-.120	-.224**	-.244**	1		
12 IN7 Health	.09	.287	-.176*	-.096	-.205*	.063	-.046	-.068	-.086	-.091	-.169*	-.184*	-.131	1	
13 Firm Size	3.08	1.218	.198*	-.132	-.120	.159*	-.151	.062	.043	.000	-.227**	-.198*	.240**	.108	1

* p<.05

** p<.01

Results of Regression Analysis for Mediation (Model 8)

Regression results of Model 8 are presented in Table 7.8b. Hierarchical multiple regression was used to test the ability of the direct effects (ITSCA, ITINF, and ITOSK) and the mediating effect (customer collaboration), to predict levels of quality performance, after controlling for the influence of industries and firm size.

Table 7.8b: Results of regression analysis for mediation (Model 8)

	Customer Collaboration		Quality		
		Step 1		Step 2	Step 3
	β	β	β	β	β
Controls					
Industry1 Education	.128	.165	-.122	-.121	-.155
Industry2 Hotels	.062	.071	-.151	-.147	-.162
Industry3 Banks	.145	.256*	-.118	-.098	-.151
Industry4 Wholesale	.145	.185	-.118	-.134	-.172
Industry5 Business	.180	.277*	-.242	-.201	-.258
Industry6 Transport	.117	.122	-.008	-.069	-.095
Industry7 Health	.145	.266*	-.123	-.034	-.089
Firm Size	.173*	.163	-.196*	-.177*	-.210*
Direct effects					
ITSCA		.188*		.183*	.144
ITINF		-.167*		.150	.185*
ITOSK		.314***		.221**	.156
Mediating effect					
Customer Collaboration					.207*
ΔR^2	.046	.119***	.067	.123***	.158***
Overall R^2	.046	.165	.067	.189	.225
Adjusted R^2	-.006	.101	.016	.128	.160
Overall model F	.890	2.587**	1.317	3.061**	3.464***

* p<.05
** p<.01
*** p<.001

Results of the analysis in step 1 show support for **Hypotheses 10a** and **H10c**, but no support for **H10b**, as discussed earlier. Steps 2 and 3 show the results for **H12a**, **H12b** and **H12c**. Customer collaboration was positively related to quality performance (β=.207, $p<.05$), with the previously significant ITSCA–quality performance relationship (β=.183, $p<.05$) losing its significance (β=.144, ns), providing evidence of full mediation and thus full support for **H12a**. Step 2 shows there was no significant relationship between ITINF and quality performance, and thus, no support was found for **H12b**. Customer collaboration was positively related to quality performance (β=.207, $p<.05$), with the previously significant ITOSK–quality performance relationship (β=.211, $p<.01$) no longer being significant (β=.156, ns), providing evidence of full mediation and thus, full support for **H12c**. A summary of results is provided in Table 7.8c.

Table 7.8c: Summary of results (Model 8)

Hypotheses	***Results***
H10a: The ability to use IT for supply chain activities (ITSCA) has a positive influence on the degree of customer collaboration.	*Supported*
H10b: Flexible IT infrastructure (ITINF) has a positive influence on the degree of customer collaboration.	*Not supported*
H10c: IT operations shared knowledge (ITOSK) has a positive influence on the degree of customer collaboration.	*Supported*
H12a: Customer collaboration is positively related to quality performance and mediates the ITSCA–quality relationship.	*Fully supported*
H12b: Customer collaboration is positively related to quality performance and mediates the ITINF–quality relationship.	*Not supported*
H12c: Customer collaboration is positively related to quality performance and mediates the ITOSK–quality relationship.	*Fully supported*

Additional Test for Mediation

In this study, four mediators are tested in a separate manner in order to allow to investigate the specific effort of each mediator (supplier integration, customer transactions, customer connection, or customer collaboration) on the relationships between each dimensions of IS capabilities and cost and quality performance. Such approach is consistent with the guidelines of pervious research that multiple mediators is suitable be tested separately (e.g., Kenny *et al*., 1998; Wang *et al*., 2013). The correlation matrix was inspected to reveal the correlations among the mediators (Appendix 7.4). Results show that the different mediators are not too highly correlated and reasonable independent (Kenny *et al*., 1998).

MEDIATE test (Hayes and Preacher, 2014) was used to conduct mediation analysis (single and multiple mediators) with a set of independent variables. As an additional test for mediation, MEDIATE estimates the total, direct, and indirect effects of independent variable or variables on dependent variable through a proposed mediator variable or set of mediator variables. MEDIATE allows multiple independent variables and provides omnibus tests for direct, indirect and total effects for independent variables (X) as set, or the group variable coded with X when is multi-categorical. Inferences for indirect effects can be based on either percentile bootstrap confidence intervals or Monte Carlo confidence intervals.

The MEDIATE test lends additional support for the mediated relationships hypothesised through a change in significance of the indirect effect. Firstly, the results showed evidence of the role of supplier integration in mediating ITSCA and ITOSK to cost and quality performance. Specifically, the indirect effects of ITSCA and ITOSK on cost (.0111 and .0505 respectively) and quality (.0169 and .0769 respective) through supplier integration as mediator variable have been further indicated in the test (see Appendix 7.4.1 for detail). Secondly, the results supported the role of customer transactions in mediating ITSCA and ITOSK to cost and quality performance. More specifically, the indirect effects of ITSCA and ITOSK on cost (.0196 and .0550 respectively) and quality (.0201 and .0563 respective) through customer transactions as mediator variable have been further indicated in the test (see Appendix 7.4.2 for detail). Thirdly, the results further illustrated the mediating effect of customer connection on the relationships between ITSCA and ITOSK, and cost and quality performance. The indirect effects of ITSCA and ITOSK on cost and quality through customer connection as mediator variable have been further indicated in the test (see Appendix 7.4.3 for detail). Finally, the results showed support of customer collaboration in mediating ITSCA and ITOSK to cost and quality performance. Details on the direct and indirect effect of ITSCA and ITOSK on cost and quality through customer collaboration as mediator variable are represented in Appendix 7.4.4. In sum, MEDIATE used as an additional test for mediation further supported the results that have been found in the mediated multiple analysis.

7.3.9 Validation of Results

To validate the results of the regression models, split-sample validation was employed using a random number generator. For this study, the total sample was divided into two groups, with one group representing 75% of the respondents and the other one representing the remaining 25% (Hair *et al*., 2009). The model is considered to be validated, since the results of the 75% split sub-sample and the full data set share a high level of similarity in terms of R^2 and R^2 change. Results of split-sample validation tests are presented in Appendix 7.3.

The results of the validation tests demonstrate significant comparable R^2 and R^2 change (all with $p<.05$) values for the 75% split-sample as well as for the full data set. This indicates that the overall model fit of the split sample is similar to that of the full data set, and therefore, implies that the results of the regressions can be utilised to predict outcomes for data sets other than the sample used in this study, and that the findings can be generalised to the wider population.

7.3.10 Summary

In this study, hierarchical regression analysis has been used to test the proposed hypotheses. Eight models were designed to assess the relationships among IS capabilities (IT for supply chain activities, flexible IT infrastructure, and IT operations shared knowledge), supply chain integration (supplier integration, customer transactions, customer connection, and customer collaboration), and operational performance (cost and quality). The regression analysis has revealed that supply chain integration (supplier integration, customer transactions, customer connection, and customer collaboration) partially or fully mediates the relationships of IT for supply chain activities/IT operations shared knowledge, and operational performance (cost and quality), while no mediation was found for the flexible IT infrastructure–operational performance. These findings will be further discussed in detail in the following chapter.

For the statistically significant models, the values of R^2 ranged from .109 to .304, which are good for models with three or four main independent variables accounting for the variance in the respective dependent variables. In addition, the R^2 statistics are consistent with the reports of other studies in the area (Flynn *et al*., 2010, Devaraj *et al*., 2007).

7.4 Analysis of Variance

This study focuses on the effects of mediator variables (supplier integration, customer transactions, customer connection, and customer collaboration) on the relationships between IS capabilities (IT for supply chain activities, flexible IT infrastructure, and IT operations shared knowledge), and operational performance (cost and quality). However, the distribution of responses could be affected by some other factors – most notably the categorical factor of type of industry. Analysis of variance is useful to assess the effect of this factor in order to determine whether such a characteristic has significant impacts on the responses.

Industry Effect

In this study, the sample was drawn from service establishments in the UK. Responses were collected from eight industries: education; hotels and restaurants; banks, insurance and other financials; wholesale and retail trade; business activities; transport, storage and communications; health and social work and other service (other service was used as the reference category for dummy coding). The frequencies analysis for the responses is presented in Table 5.2 (see page 111), and results have been discussed in section 5.4. It is conceivable that surveys from different industries will show different responses. Industry characteristics (technological change, IT standards, regulation and other factors) can shape how IS capabilities are used in the focal firm to generate business value (Melville *et al.*, 2004). In this study, however, all the responses were from organisations within the service industry, and despite representing different sectors of that industry, they all shared the service concept. Hence, it can be assumed that in this study, operational performance enabled by IS capabilities is generic across sectors.

To confirm this assumption, analysis of variance (ANOVA) was used to test whether the responses in this study vary across industrial sectors. ANOVA compares the variance between different groups with the variability within each group (Pallant, 2010). If the responses are not affected by industries, it would be expected that the variance between different industries reflects the variance within the industry groupings.

Before performing the analysis of variance, it is crucial to assess the homogeneity of variance, which examines whether the variance in the dependent variable is similar across the range of values of the independent variable. Levene's test was applied to assess the homogeneity of variance, with a significant p value less than .05 indicating heterogeneity of variance. The results of Levene's test for the two dependent variables are presented in Table 7.9. Each variable has a p value greater than .05, suggesting the homogeneity of variance in the data set.

Table 7.9: Test of homogeneity of variances

Dependent Variables	Levene Statistic	Sig.
Cost	.534	.808
Quality	.780	.605

After confirming the appropriateness of the data for analysis of variance, a one-way between-groups analysis of variance was performed to explore the impact of industries on each dependent variable. Table 7.10 shows that analysis of variance reveals no statistically significant difference between the groups. The results indicate that there is no significant difference among the mean scores on cost and quality for different industrial sectors. This justifies the use of all responses as a whole, rather than separating them into specific types of industry, when conducting the statistical analysis.

Table 7.10: Analysis of variance across industries

		Sum of Squares	df	Mean Square	F	Sig.
Cost	Between Groups	4.384	7	.626	.566	.783
	Within Groups	163.767	148	1.107		
	Total	168.151	155			
Quality	Between Groups	5.673	7	.810	.752	.628
	Within Groups	159.509	148	1.078		
	Total	165.182	155			

7.5 Conclusions

This study investigates the effects of IS capabilities (IT for supply chain activities, flexible IT infrastructure, and IT operations shared knowledge) on operational performance (cost and quality), and hypothesises that such effects are mediated through the processes developed for supply chain integration (supplier integration, customer transactions, customer connection, and customer collaboration) in services. In order to test the relationships between these variables, multiple regression analysis was performed. The results of hypotheses testing, validation of the results, and the analysis of variance, have been presented and justified.

The following chapter contains a discussion of the results reported in this chapter, and compares these findings to those reported in the literature. Notably, these results allow for conclusions to be drawn regarding the eight research models.

CHAPTER EIGHT:

DISCUSSION

8.1 Introduction

This study is concerned with understanding the relationships between IS capabilities, supply chain integration, and operational performance in a service context. In order to test these relationships, a survey was designed as described in Chapter Five, and responses collected from a range of UK service establishments. The data obtained was subjected to statistical analysis as detailed in Chapters Six and Seven. This chapter contains a discussion of results from these analyses.

The main body of this chapter focuses on the hypothesis testing, and a discussion of the results in the light of previous findings in the literature. In this chapter, discussion of the results of hypotheses testing is presented in four sections based on the focus of each mediator variable (supplier integration, customer transactions, customer connection, and customer collaboration).

8.2 Discussion of Findings

Firms invest considerable tangible and intangible resources in managing their information systems and supply chain. Therefore, both IS and OM researchers have sought to understand the link between IS capabilities and supply chain management. Although many important insights have emerged from research on this topic, important questions remain unexplored. In particular, a key issue that remains elusive relates to the relationship between IS capabilities and firm performance. In this study, eight research models were developed and tested to explain the relationships between IS capabilities, supply chain management, and firm performance in terms of cost and quality. The following sections provide detailed discussion on each model.

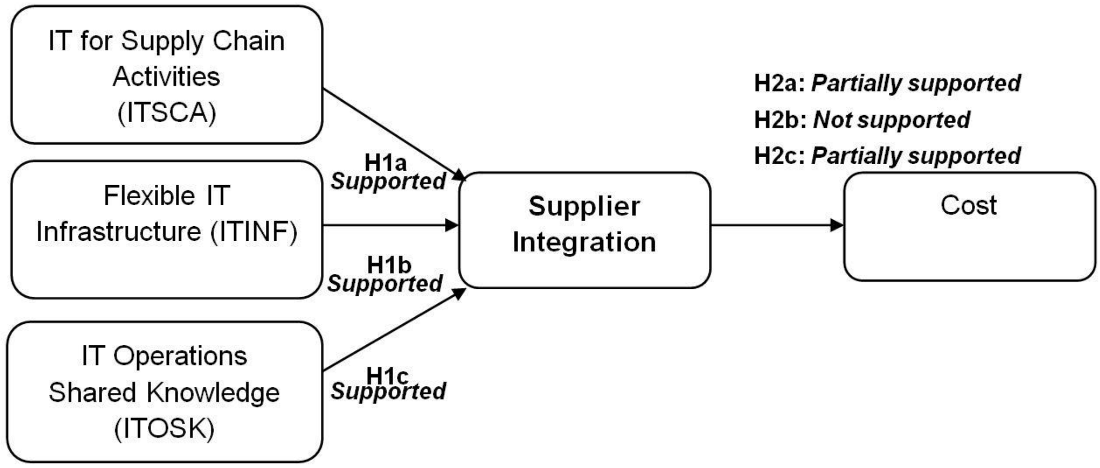
8.2.1 IS Capabilities, Supplier Integration, and Operational Performance (Models 1 and 2)

This section interprets the results of the analysis on the effect of IS capabilities on supplier integration and operational performance. In this study, operational performance is not one-dimensional, and the hypotheses in this connection have separately examined cost (Model 1) and quality (Model 2). This section begins with a brief review of findings of Models 1 and 2, which is followed by a discussion of these findings with respect to previous literature.

8.2.1.1 Summary of Findings (Models 1 and 2)

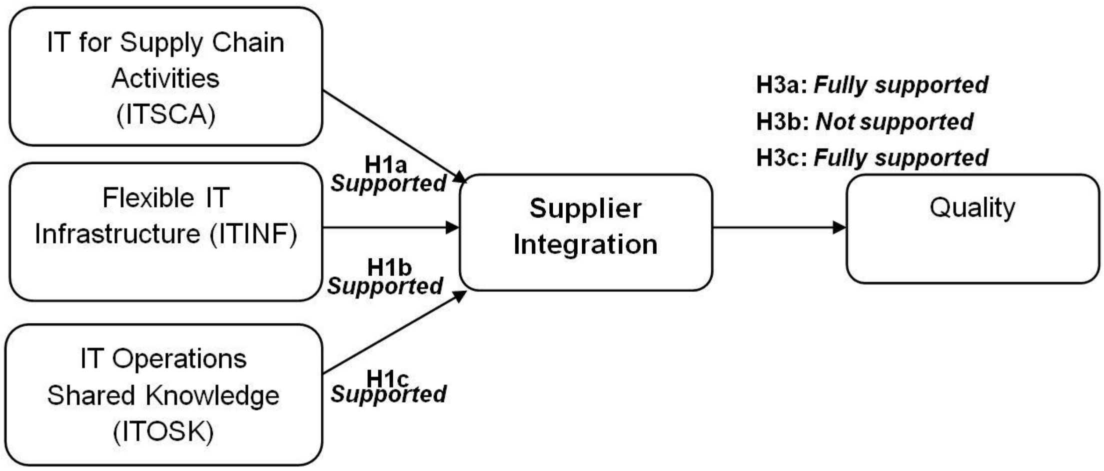
As discussed in the previous chapters, nine hypotheses have been developed to examine the relationships between IS capabilities and operational performance, focusing on supplier integration as the underlying mechanism. Supplier integration that involves strategic information sharing and collaboration between a service provider and its suppliers has been found to lead to better cost performance and to be able to mediate the relationships between IS capabilities and cost. The results of hypothesis testing of Model 1 are presented in Figure 8.1.

Figure 8.1: Results of hypothesis testing – Model 1



In addition, supplier integration has also been found to improve quality performance of service firms and to be able to mediate the relationships between IS capabilities and service quality. Figure 8.2 shows the results of the hypothesis testing of Model 2.

Figure 8.2: Results of hypothesis testing – Model 2



8.2.1.2 Discussion of Findings (Models 1 and 2)

In developing the research models (Models 1 and 2), it has been explained how different dimensions of IS capabilities enable information sharing and collaboration between firms and their suppliers. Such dimensions enhance cost and quality performance, through generating improvements in supplier integration. The models were assessed using data collected from 156 UK service firms. Overall, the models, analysis, and results provide important insights and have significant managerial implications.

Firstly, evidence was found that a firm's IS capabilities have a significantly positive effect on supplier integration in a service context. IT for supply chain activities (ITSCA) in this study includes a range of technologies in the supply chain context that selected on the basis of appropriate literature and related nicely to the technologies that most firms are utilising to advance their supply chain competency across manufacturing and service sectors. The results of descriptive analysis of ITSCA showed evidence of the application of advanced planning systems in the service sector. Specifically, the implementation of ERP, MRPⅡ, and advanced planning and scheduling systems in the respondent firms is 41%, 13.5% and 42.9% respectively (see Table 6.1 for detail). This finding is in line with previous research that states the growing implementation of such advanced planning systems (e.g., Frohlich and Westbrook, 2002; Sengupta *et al*., 2006; Zuckerman, 2005), and further suggests a growing managerial focus on SCM using advanced planning systems to leverage the Internet, supply network structure and distribution network structure in service sector. One possible explanation for this finding may be the case that services are lagging several years behind manufacturing in terms of IS-enabled integration of the processes that extend their organisational boundaries. Advanced planning systems are commonly used in the manufacturing sector to enhance supply, production and delivery related communication and transparency, thus many services are just as aggressive as manufacturers at implementing the typical advanced planning systems, such as ERP, MRPⅡ, and advanced planning and scheduling systems, to enhance process excellence. Furthermore, the analysis shows that the use of ITSCA positively influences the degree of supplier integration. Consistent with previous research (e.g., Devaraj *et al.*, 2007), this result provides support for the idea that ITSCA facilitates supply integration through the provision and exchange of efficient, timely, and transparent business information.

Support was also found that flexible IT infrastructure (ITINF) provides a platform that enforces standardisation and integration of data and processes, increasing information transparency and enabling real-time, consistent, and comprehensive information sharing between the focal firm and its suppliers (Dong *et al.*, 2009; Lu and Ramamurthy, 2011).

Similarly, the results show that IT operations shared knowledge (ITOSK) is positively associated with the degree of supplier integration. This result is consistent with the findings in previous studies that operations managers' shared knowledge of IT influences the level of alignment between the IS and other functional areas of a firm, thereby enabling effective information sharing and relationship building between a firm's internal business functions (Reich and Benbasat, 2000). A firm with a high level of internal communication and co-ordination is more capable of achieving a high level of external integration (Zhao *et al.*, 2011). These findings suggest that a service firm with comprehensive abilities to use IS, benefits from a higher degree of supplier integration. Information systems enhance information visibility across firm boundaries and allow for better information sharing with suppliers, thus improving supplier integration.

Secondly, the results of Model 1 confirm that ITSCA and supplier integration had a positive effect upon service providers' cost performance, and that the effect of ITSCA on cost performance was partially mediated by supplier integration. Supplier integration was also found to partially mediate the ITOSK–cost relationship. In other words, when service firms have the ability to use ITSCA and ITOSK, low cost performance can be achieved, through supplier integration.

In addition to the effect on cost performance, Model 2 posits that supplier integration has a positive influence upon firms' quality performance, and mediates the relationships between IS capabilities and quality performance. It has been found that supplier integration acts to mediate the relationship between ITSCA and quality performance. Specifically, supplier integration fully mediates the ITSCA–quality performance relationship. The results also support the idea that supplier integration fully mediates the ITOSK–quality performance relationship. In other words, supplier integration, involving information sharing and collaboration with suppliers, is the means by which the intrinsic value of ITSCA and ITOSK is translated into improved quality performance.

Together, these results provide support for the process-based view advanced by both IS and OM scholars who argue for a positive effect of IS capabilities on firms' performance through their ability to enable organisational processes (e.g., Wade and Hulland, 2004; Mithas *et al*., 2011). With respect to research in IS, the findings take a step forwards quelling concerns about the business value of IT, and they contribute to work focused on how IT impacts firm performance. Indeed, these results provide robust evidence for supplier integration as a mechanism through which IS capabilities impact upon cost and quality performance of firms. Additionally, from an OM perspective, these findings add to the emerging body of literature linking supplier integration to the operational performance (cost and quality) of service firms. In particular, Models 1 and 2 examine the relationships between supplier integration and the relative performance in services. Such relationships have attracted considerable attention in the traditional manufacturing setting, and this study contributes to the knowledge on this area from a service sector perspective.

No evidence was found for the effect of supplier integration on the flexible IT infrastructure–cost relationship. Flexible IT infrastructure (ITINF) did not directly cause reductions in cost, and thus, the necessary conditions for mediation were not met. Similarly, no effect of supplier integration on the ITINF–quality relationship was found. These findings may suggest that the business value of a firm's flexible IT infrastructure is not associated with performance that is measured by cost and quality, thereby seeming to underscore and clarify the argument that a flexible IT infrastructure is a firm-wide resource (Lu and Ramamurthy, 2011). Indeed, a flexible IT infrastructure is considered to combine the firm's shared data and information systems into a platform for all business processes (Weill *et al*., 2002). Consequently, whilst a flexible IT infrastructure has no significant positive impact on the relative operational performance, it is likely that it may have a positive influence on some other processes within the firm (Ray *et al*., 2005). An alternative explanation may be that the flexible IT infrastructure embedded within one particular firm is likely 'common' and not difficult to implement by others in the service industry; thus, it may be the case that ITINF alone is not sufficient in realising the relative operational benefits in service firms. This may be a result of the limitation of available options of a flexible infrastructure in the service industry. Ray *et al*. (2005) suggest that infrastructure flexibility may be less important in a mature service sector, such as the insurance industry, since the options available with a flexible infrastructure are not very valuable.

8.2.1.3 Practical Implications (Models 1 and 2)

As previously noted research into service supply chains is still relatively new. This study provides an empirical analysis into the relationships between the processes developed for supplier integration and operational performance in the services sector. Several important implications may be drawn for the service sector firms.

First, operational performance – cost and quality – is positively affected by greater information sharing among supply chain partners. This result was expected since information sharing is one of main tenets of SCM. Practitioners can benefit from the results of Models 1 and 2 by noting the importance of supplier integration in forming relationships between dimensions of IS capabilities and cost and quality performance. In particular, the relationships found between supplier integration and the relative operational performances in services are based on the exchange of information rather than goods, as is common in traditional manufacturing supply chains (e.g., Flynn *et al*., 2010). These results empirically indicate that the lessons learned about the role of supplier integration in SCM research can be applied to the service sector. Therefore, the findings will help managers in service firms to recognise the operational impact of building the level of integration with their suppliers. Higher levels of collaboration and transparency concerning staff availability, inventory, demand forecasts, price and retail promotions should improve operational performance and reduce disruptions in the network. Specifically, services should not be viewed as a single homogeneous category in this context. For example, there are differences between retailers that hold some physical inventory and consulting firms whose costs are dominated by personnel expenditures. In this sense, managers must use caution when attempting to benchmark integration processes across service sectors. It is important for service firms to consider the impact of sector-specific considerations when building the level of supplier integration.

In addition, the findings regarding the impact of the different dimensions of IS capabilities add to the growing, yet nascent, body of IS research on the evaluation of IS business value. In particular, prior studies of such area have mainly focused on IS capabilities as a highly aggregated concept (e.g., Subramani, 2004; Zhang and Dhaliwal, 2009). In contrast, Models 1 and 2 have investigated the effects on cost and quality performance from three dimensions of IS capabilities. The analysis provides evidence that certain IS capabilities – IT for supply chain activities (ITSCA) and IT operations shared knowledge (ITOSK) – do facilitate service firms in their efforts to improve their cost and quality performance. As such, these results will help managers to clarify the performance implications of each dimension of their IS capabilities and should motivate increased managerial attention toward IS development within the firm.

When operations managers are aware of what the IT department can do, they are more likely to take initiatives that would help integrate with suppliers and subsequently improve the perceived quality of their services. Operations and IT managers therefore, are recommended to systematise the sharing of information on IT capabilities and to do so at a strategic level. More specifically, one would recommend be that initiatives and technologies associated with sharing of information with suppliers are developed and implemented in a way that allows operations managers to fully achieve their potential. As common sense as this recommendation may be, both the variance of our data and anecdotal evidence suggest that this strategy is not frequently implemented.

Moreover, the findings suggest that as managers consider the benefits of IS capabilities, it is important for them to be cognisant of supplier integration as a powerful mechanism, through which IS capabilities can improve the relative operational performance. The analysis of Models 1 and 2 provides empirical support for prescriptions of the existing research on the indirect role of IT in firm performance (e.g., Devaraj *et al*., 2007; Tan *et al*., 2010) from a service sector perspective. The results suggest that managers in service firms should also take account of the indirect role of IS capabilities in their firm performance, and the strength of the mediating role of supplier integration. Indeed, service firms that embark on strategies aimed at developing and leveraging their IS capabilities, should at the same time implement processes that encourage supplier integration. More specifically, a higher degree of supplier integration is associated with better operational results. Given the intangibility of services and the fact that production and consumption takes place simultaneously, any failure in the supply side may simultaneously turn into a failure in service delivery. Therefore, a greater level of supply-related information sharing and collaborative service delivery would lead to improved performance for the on-time delivery and customer's perceived quality dimensions of service performance. As a result, the increased attention to supplier integration should lead to higher operational performance.

8.2.1.4 Summary

In summarising, Models 1 and 2 develop an understanding of the link between IS capabilities, supplier integration, and cost, and quality performance in service contexts. Taken together, the results of these two models underscore that it is useful for both academics and managers to consider the role of supplier integration when evaluating the influence of IS capabilities on operational performance.

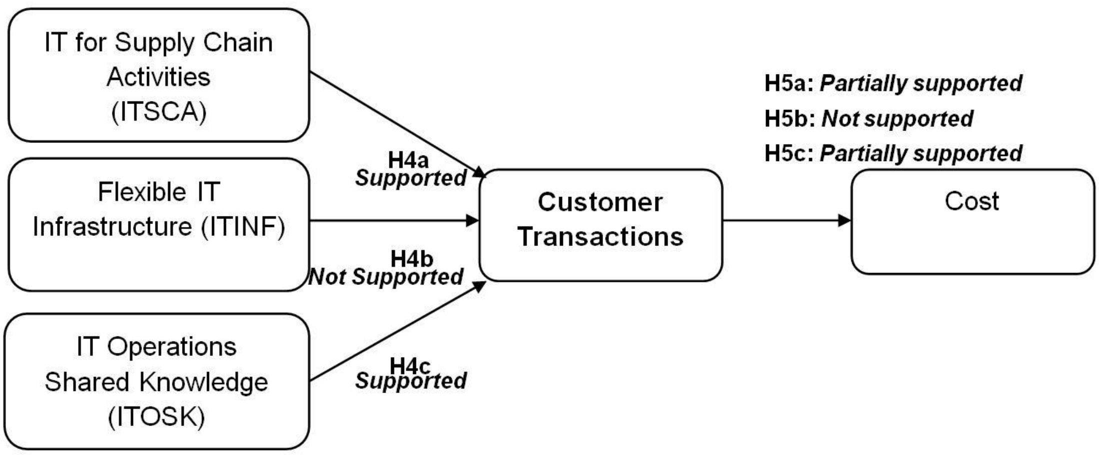
8.2.2 IS Capabilities, Customer Transactions, and Operational Performance (Models 3 and 4)

This section interprets the results of the analysis on the effect of IS capabilities on customer transactions and operational performance. As has been discussed, operational performance is not one-dimensional in this study and hypotheses have separately examined cost (Model 3), and quality (Model 4). This section begins with a brief review of the findings of Models 3 and 4, and continues with a discussion of these findings with respect to previous literature.

8.2.2.1 Summary of Findings (Models 3 and 4)

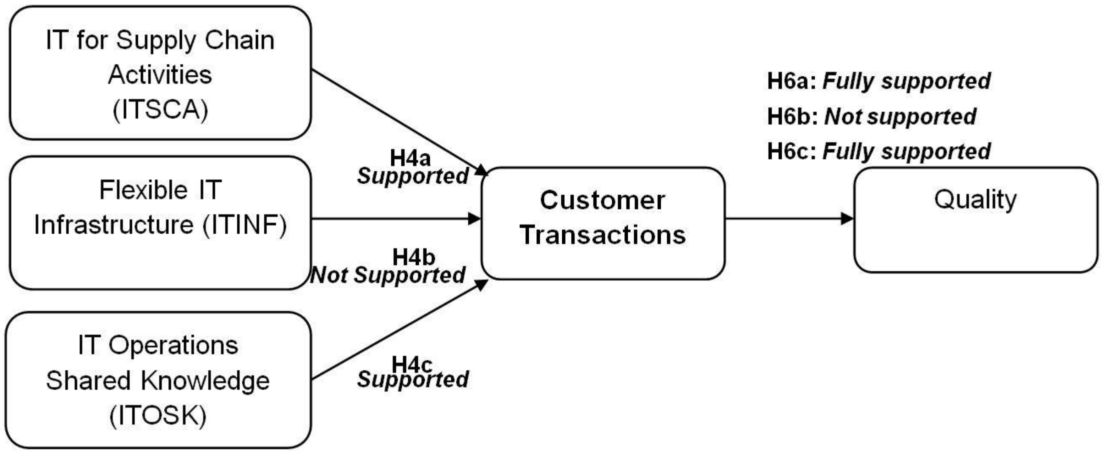
Models 3 and 4 contained nine hypotheses in total, examining the relationships between IS capabilities and operational performance, and focusing on customer transactions as the underlying mechanism. Customer transactions that relate to transactions and order management activities and involve levels of information exchange and operational co-ordination between a service provider and its customers, have been found to improve cost performance and to be able to mediate the relationships between IS capabilities and cost performance (Model 3). Figure 8.3 shows the results of hypotheses testing of Model 3.

Figure 8.3: Results of hypothesis testing – Model 3



In addition to the effect on cost performance, customer transactions have been found to be positively associated with service quality and to be able to mediate such relationships between IS capabilities and quality performance (Model 4). The results are illustrated in Figure 8.4.

Figure 8.4: Results of hypothesis testing – Model 4



8.2.2.2 Discussion of Findings (Models 3 and 4)

In the development of Models 3 and 4, it has been explained how different dimensions of IS capabilities can enable transaction processes between service firms and their customers. Such dimensions raise cost and quality performance, through their use of improved processes concerned with the integration of customer transactions. Assessed using data collected from 156 UK service firms, Models 3 and 4 generate results which when analysed provide important insights and have significant managerial implications.

Firstly, evidence was found that certain dimensions of IS capabilities have significantly positive effects on customer transaction processes integration in service contexts. The analysis shows that IT for supply chain activities (ITSCA) positively influences the amount of customer transactions. Consistent with previous research (e.g., Tsikriktsis *et al*., 2004; Ray *et al*., 2005; McAfee and Brynjolfsson, 2008), this result provides support for the idea that ITSCA facilitates customer transaction processes by automating the structured and routine procedures associated with customer transactions. Furthermore, the results show that IT operations shared knowledge (ITOSK) is positively linked with the volume of customer transactions. This result is consistent with the findings in previous studies that operations managers' shared knowledge of IT reflects the extent to which a firm enables management's ability to understand the value of IT resources (e.g., Lu and Ramamurthy, 2011). Since the accumulation of knowledge can enhance organisations' ability to recognise and assimilate new ideas, as well as their ability to convert this knowledge into further innovations (e.g., Cohen and Levinthal, 1990; Fleming *et al*., 2007), the shared IT knowledge of operations managers ensures the speedy, effective, and sufficient translation of innovative responses to customer transaction possesses.

Further, the results of Model 3 confirm that ITSCA and customer transactions had a positive effect on service providers' cost performance, and that the effect of ITSCA on cost performance was partially mediated by customer transactions. Customer transactions were also found to partially mediate the ITOSK–cost relationship. In other words, when service firms have the ability to use ITSCA and ITOSK, low cost performance can be achieved, through improved customer transaction processes.

In addition to the effect on cost performance, Model 4 posits that customer transactions have positive effects on firms' quality performance, and mediate the relationships between IS capabilities and quality performance. It has been found that customer transactions act to mediate the relationship between ITSCA and quality performance. Specifically, customer transactions fully mediate the ITSCA–quality performance relationship. The results also support the contention that customer transactions fully mediate the ITOSK–quality performance link. Put differently, customer transactions, involving information sharing and operational co-ordination in respect of customer transactions and order management activities, is the means by which the intrinsic value of ITSCA and ITOSK is translated into improved quality performance.

Together with the results of Models 1 and 2, the results of Models 3 and 4 also provide support for the process-based view adopted by both IS and OM scholars, who argue that the effect of IS capabilities on firms' performance emanates from the fact that they enable effective organisational processes (e.g., Wade and Hulland, 2004; Mithas *et al*., 2011). Whilst the findings of Models 3 and 4 take a step towards quelling concerns about the business value of IT, and contribute to work focused on how IT impacts firm performance, they also provide robust evidence that customer transactions act as a mechanism through which IS capabilities impact upon the cost and quality performance of firms. In addition, from an OM perspective, these findings add to the emerging body of literature linking customer transactions to the operational performance (cost and quality) of service firms. In particular, Models 3 and 4 examine the relationships between customer transactions (as a dimension of customer integration) and the relative performance in services, which contributes to the knowledge on the customer integration–operational performance relationship from a service sector perspective.

No support was found for the relationship between flexible IT infrastructure (ITINF) and customer transactions. This may be an outcome of the fact that flexible ITINF is neither rare nor costly to imitate and that most service providers already have such an infrastructure in place. That said, one way or another, ITINF-enabled services (i.e. billing information, frequently ordered list of products, etc.) do decrease the transaction inconvenience that customers might encounter, even though they may not be a 'unique' resource that enables a service firm to integrate transaction processes with its customers. Further, no evidence was found for the effect of customer transactions on the ITINF–cost relationship, it being demonstrated that ITINF did not directly produce any reduction in cost, and thus, the necessary conditions for mediation were not met. In the same way, no effect of customer transactions on the ITINF–quality relationship was found. Similar to the previous discussion on ITINF, these findings may suggest that the business value of a firm's flexible IT infrastructure is not associated with performance that is measured by cost and quality. That said, these results do not argue that service firms should not develop a flexible IT infrastructure. Clearly, whilst a flexible IT infrastructure has no significant positive impact on the relative operational performance, it is likely that it may have a positive impact on some other processes within the firm (Ray *et al*., 2005). As suggested earlier, a flexible infrastructure may not be rare or costly to imitate, and most service firms may already have one in place or be easily able to acquire one, and thus ITINF, by itself, is unlikely to improve the relative operational performance.

8.2.2.3 Practical Implications (Models 3 and 4)

Practitioners can benefit from the results of Models 3 and 4 by noting the importance of integrating transaction processes with customers in forming relationships between different dimensions of IS capabilities and cost and quality performance. In particular, the relationships found between customer transactions and the relative operational performance in services are based on the exchange of information rather than goods, which is the commonly-found situation in traditional manufacturing supply chains (e.g., Flynn *et al*., 2010). These results empirically indicate that the lessons learned about the role of customer integration in terms of transaction processes in traditional SCM research can be applied to the service sector. Therefore, the findings will help managers in service firms to recognise the operational impact of integrating transaction processes with customers. Higher levels of customer transactions integration should improve operational performance and the efficiencies of customer orders.

In addition to investigating the effects of different dimensions of IS capabilities (ITSCA and ITOSK) on cost and quality performance, the findings of Models 3 and 4 suggest that as managers consider the benefits of IS capabilities, it is important for them to be cognisant of the fact that integrating transaction processes with customers through such capabilities (ITSCA and ITOSK) is a useful mechanism, through which they can improve relative operational performance. Consistent with previous models, the analysis of Models 3 and 4 provides empirical support for prescriptions of the existing research on the indirect role of IT in firm performance (e.g., Devaraj *et al*., 2007; Tan *et al*., 2010) from a service sector perspective. The results suggest that managers in service firms should also take into account, the indirect role of IS capabilities in their firms' performance, and the strength of the mediating role of integrated customer transactions. Indeed, service firms that embark on efforts to develop and leverage their IS capabilities should, at the same time, implement processes that encourage customer transaction processes integration.

8.2.2.4 Summary

In summarising, Models 3 and 4 develop an understanding of the link between IS capabilities, customer transactions, and cost and quality performance in service contexts. Taken together, the results of these two models underscore that it is useful for both academics and managers to consider the role of customer transaction processes integration when evaluating the influence of IS capabilities on operational performance.

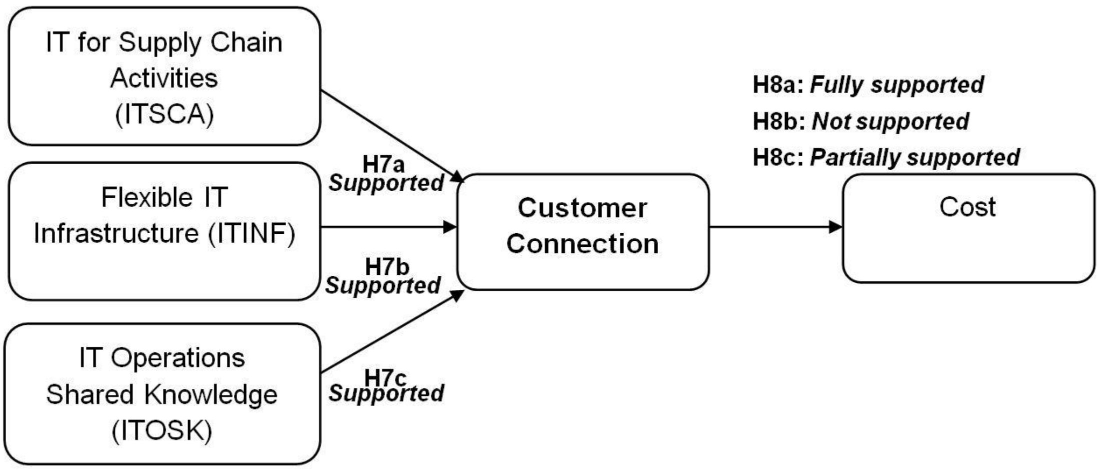
8.2.3 IS Capabilities, Customer Connection, and Operational Performance (Models 5 and 6)

This section interprets the results of the analysis of the data concerned with the effect of IS capabilities on customer connection and operational performance. As has been discussed, in this study, operational performance is not one-dimensional, and hypotheses have separately examined cost (Model 5) and quality (Model 6). This section begins with a brief review of the findings of Models 5 and 6, which is then followed by a discussion of these findings with respect to previous literature.

8.2.3.1 Summary of Findings (Models 5 and 6)

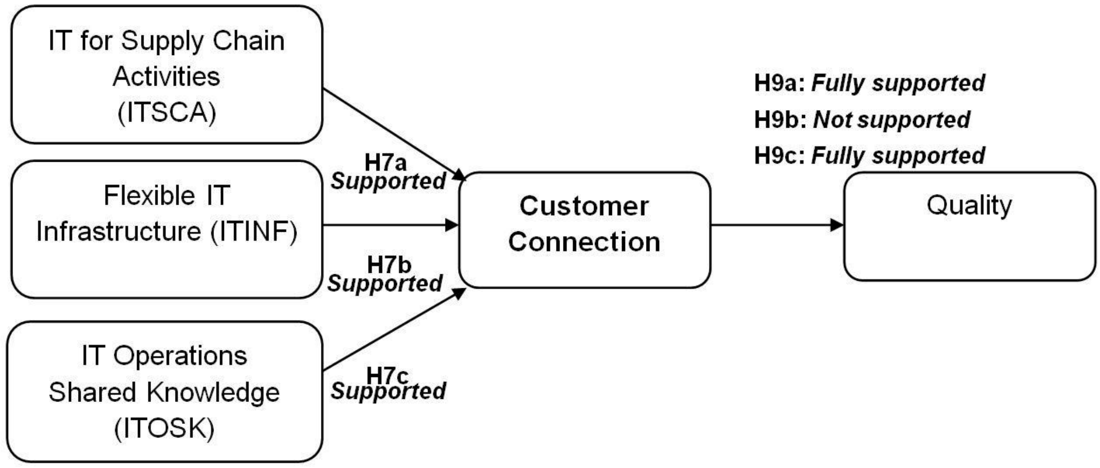
Models 5 and 6 contained nine hypotheses in total, examining the relationships between IS capabilities and operational performance, focusing on customer connection as the underlying mechanism. Customer connection that relates to the communication and contacting activities in which the firm is engaged with its customers, and which includes the process of acquiring and assimilating customer requirements information and related knowledge, has been found to improve cost performance and to be able to mediate the relationships between IS capabilities and cost performance (Model 5). Figure 8.5 shows the results of the hypotheses testing.

Figure 8.5: Results of hypothesis testing – Model 5



In addition to the effect on cost performance, customer connection has been found to be positively associated with service quality and to be able to mediate such relationships between IS capabilities and quality performance (Model 6), as illustrated in the results depicted in Figure 8.6.

Figure 8.6: Results of hypothesis testing – Model 6



8.2.3.2 Discussion of Findings (Models 5 and 6)

In the development of Models 5 and 6, it has been explained how different dimensions of IS capabilities enable communication and contacting activities between firms and their customers. Such dimensions enhance cost and quality performance, through improvements in the integration processes in respect of customer connection. The models were assessed using data collected from 156 UK service firms. Overall, the models, analysis, and results provide important insights and have significant managerial implications.

Firstly, evidence was found that all the three dimensions of IS capabilities have significantly positive effects on customer connection processes integration in service contexts. The analysis reveals that IT for supply chain activities (ITSCA) positively influences the degree of customer connection. Consistent with previous research (e.g., Mithas *et al*., 2005), this result provides support for the idea that ITSCA facilitates customer connection and communicating activities by digitally enabling the process of acquiring and assimilating customer requirements information and related knowledge. Support was also found for the argument that flexible IT infrastructure (ITINF) provides a platform that enforces standardisation and integration of data and processes, enabling connection processes between service providers and their customers by providing an integrated communication presence. Similarly, the results show that IT operations shared knowledge (ITOSK) is positively associated with the degree of customer connection. This result is consistent with the findings in previous research that operations managers' shared knowledge of IT reflects the extent to which a firm enables management's ability to understand the value of IT resources (e.g., Lu and Ramamurthy, 2011). The shared IT knowledge of operations managers promotes and supports IT utilisation in the communications with customers, hence facilitating customer connection processes.

Further, the results in respect of Model 5 confirm that ITSCA and customer connection had a positive effect on service providers' cost performance, and that the effect of ITSCA on cost performance was fully mediated by customer connection. Customer connection was further found to partially mediate the ITOSK–cost relationship. In other words, when service firms have the ability to use ITSCA and ITOSK, low cost performance can be achieved, through improved processes of customer connection.

In addition to the effect on cost performance, Model 6 posits that customer connection has a positive effect on firms' quality performance and mediates the relationships between IS capabilities and quality performance. It has been found that customer connection acts to mediate the relationship between ITSCA and quality performance. Specifically, customer connection fully mediates the ITSCA–quality performance relationship. The results also indicate that customer connection fully mediates the

ITOSK–quality performance relationship. Put differently, customer connection, involving the acquisition and assimilation of customer requirements information, and related knowledge from customer communication and contacting activities, is the means by which the intrinsic value of ITSCA and ITOSK is translated into improved quality performance.

Together with the results from previous models, those obtained from Models 5 and 6 further support the process-based view asserted by both IS and OM scholars who argue that the effect of IS capabilities on firms' performance is felt through their influence in the area of enabling organisational processes (e.g., Wade and Hulland, 2004; Mithas *et al*., 2011). In addition, the findings obtained from Models 5 and 6 take a step towards reducing the concerns about the business value of IT, and contribute to the literature which concentrates on how IT impacts firm performance, since they provide robust evidence that customer connection processes integration functions as a mechanism through which IS capabilities can positively influence firm's cost and quality performance. Furthermore, from an OM perspective, these findings add to the emerging body of literature linking customer connection to operational performance (cost and quality) of service firms. Particularly, Models 5 and 6 examine the relationships between customer connection (as a dimension of customer integration) and the relative performance in services, which contributes to the knowledge on the customer integration–operational performance relationship from a service sector perspective.

No evidence was found for the effect of customer connection on the flexible IT infrastructure–cost relationship. Flexible IT infrastructure (ITINF) did not directly cause reductions in cost, and hence, the necessary conditions for mediation were not met. In the same way, there was no evidence of any effect of customer connection upon the ITINF–quality relationship. As with the previous discussion on ITINF, it is likely that these findings indicate that the business value of a firm's flexible IT infrastructure is not associated with performance as measured by cost and quality.

Nonetheless, this is not to suggest that service firms should not develop a flexible IT infrastructure, since it is noted (Ray *et al*., 2005) that as a firm-wide resource, ITINF may have a positive impact on some other processes within the firm. An alternative explanation may be that ITINF is neither rare nor costly to imitate, and that most service firms may already have such an infrastructure in place, or be able to acquire one with ease, and thus ITINF, by itself, is unlikely to improve the relative operational performance.

8.2.3.3 Practical Implications (Models 5 and 6)

Practitioners can benefit from the results of Models 5 and 6 by noting the importance of integrating connection processes with customers in forming relationships between different dimensions of IS capabilities and cost and quality performance. In a similar way, the relationships that are found between customer connection and the relative operational performance in services are based on the exchange of information rather than goods, as is the usual situation in traditional manufacturing supply chains (e.g., Flynn *et al*., 2010). These results empirically indicate that the lessons learned about the role of customer integration in terms of connection processes in traditional SCM research can be applied to the service sector. Therefore, the findings will help managers in service firms to recognise the operational impact of integrating connection processes with customers.

In addition to investigating the effects of different dimensions of IS capabilities (ITSCA, ITINF and ITOSK) on cost and quality performance, the findings of Models 5 and 6 suggest that as managers consider the benefits of IS capabilities, it is important for them to be aware that integrating connection processes with customers is a useful vehicle by which IS capabilities can improve the relative operational performance. Consistent with previous models, the analysis of Models 5 and 6 provides empirical support for prescriptions of the existing research on the indirect role of IT in firm performance (e.g., Devaraj *et al*., 2007; Tan *et al*., 2010) from a service sector perspective. The results suggest that manager in service firms should also consider the indirect role of IS capabilities in their firm performance, and the strength of the mediating role of integrated customer connection. Indeed, service firms that decide to develop and leverage their IS capabilities should also implement processes that encourage customer connection processes integration. More specifically, a higher degree of customer connection enables a service firm to collect the appropriate customer information, develop accurate customer profiles, and provide better customer support, all of which can enhance a firm's ability to retain, improve, and extend its relationships with customers. When it engages in a long-term relationship with customers, the firm can lower capacity holding and monitoring costs at the same time as improving the response to customer needs, and reducing demand uncertainty.

8.2.3.4 Summary

In summarising, Models 5 and 6 develop an understanding of the link between IS capabilities, customer connection, and cost and quality performance in service contexts. Taken together, the results of these two models underline the importance of both academics and managers considering the role of customer connection processes integration when evaluating the influence of IS capabilities on operational performance.

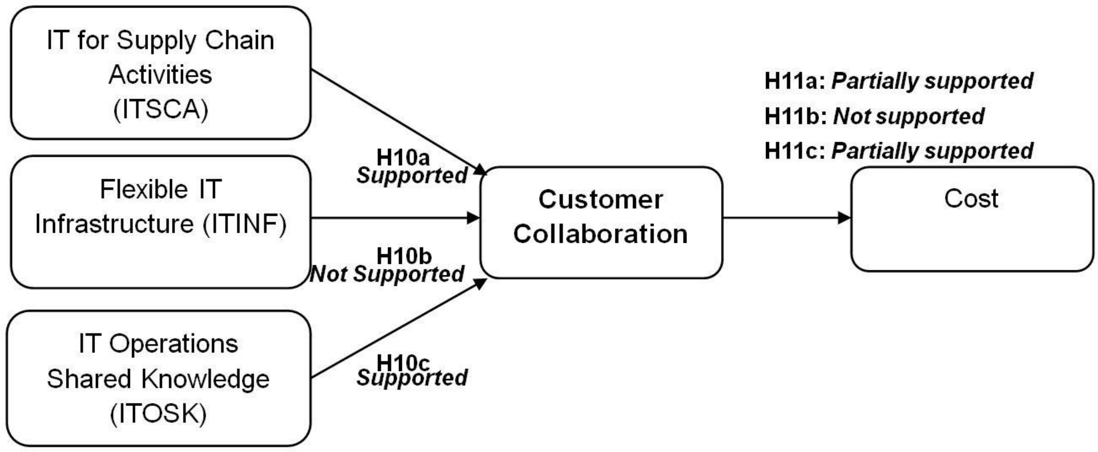
8.2.4 IS Capabilities, Customer Collaboration, and Operational Performance (Models 7 and 8)

This section interprets the results of the analysis on the effect of IS capabilities on customer collaboration and operational performance. As has been discussed, operational performance is not one-dimensional in this study and hypotheses have separately examined cost (Model 7) and quality (Model 8). This section begins with a brief review of the findings of Models 7 and 8, and continues to discuss these findings in the light of existing literature.

8.2.4.1 Summary of Findings (Models 7 and 8)

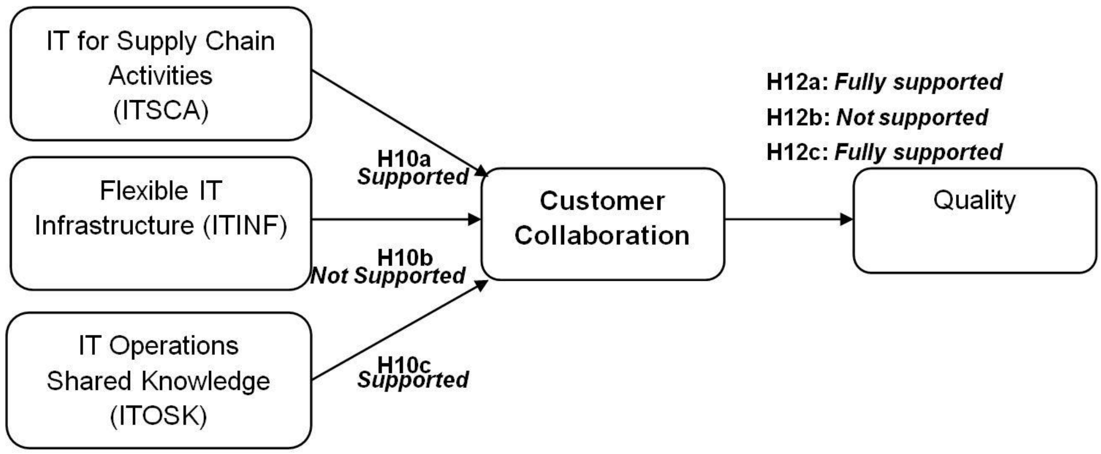
Models 7 and 8 contained nine hypotheses in total, examining the relationships between IS capabilities and operational performance, focusing on customer collaboration as the underlying mechanism. Customer collaboration – that relates to collaborative service provision-related activities concerned with planning, forecasting, and scheduling, between the firm and its customers, and which also includes information sharing of real-time point-of-sales data, sales forecasts, production and service schedules, and service capacity planning – has been found to improve cost performance and to be able to mediate the relationships between IS capabilities and cost performance (Model 7). Figure 8.7 shows the results of the hypotheses testing of Model 7.

Figure 8.7: Results of hypothesis testing – Model 7



In addition to the effect on cost performance, customer collaboration has been found to be positively associated with service quality and to be able to mediate such relationships between IS capabilities and quality performance (Model 8). The results are illustrated in Figure 8.8.

Figure 8.8: Results of hypothesis testing – Model 8



8.2.4.2 Discussion of Findings (Models 7 and 8)

In developing Model 7 and 8, it has been explained how different dimensions of IS capabilities enable collaborative service provision-related activities between service providers and their customers. Such dimensions raise cost and quality performance, through improved integration of the processes involved in customer collaboration. The data collected from 156 UK service firms is used to assess, Models 7 and 8 and the results yield important insights and have significant managerial implications.

Firstly, evidence was found that IT for supply chain activities (ITSCA) positively influences the degree of customer collaboration. Consistent with previous research (e.g., Mithas *et al*., 2005), this outcome provides support for the idea that ITSCA facilitates collaborative customer activities by promoting information sharing and exchange between the firm and its customers regarding demand forecasting, planning, and scheduling processes. Further, the results show that IT operations shared knowledge (ITOSK) is positively associated with the degree of customer collaboration. This result is in line with the findings in previous research that conclude that operations managers' shared knowledge of IT reflects the extent to which a firm enables management's ability to understand the value of IT resources (e.g., Lu and Ramamurthy, 2011). Going beyond the improved flow of information, IT operations shared knowledge would, over time, engender specialised IT-enabled routines and/or standard operating procedures, which facilitate efforts on the part of service firms and their customers to work together more efficiently and effectively in terms of capacity planning and demands requirements.

Further, the results of Model 7 confirm that ITSCA and customer collaboration had positive effects on service providers' cost performance and that the effect of ITSCA on cost performance was partially mediated by customer collaboration. Customer collaboration was also found to partially mediate the ITOSK–cost relationship. In other words, when service firms have the ability to use ITSCA and ITOSK, low cost performance can be achieved, through improved processes of customer collaboration.

In addition to the effect on cost performance, Model 8 posits that customer collaboration has a positive influence upon firms' quality performance and mediates the relationship between IS capabilities and quality performance. It has been found that customer collaboration acts to mediate the relationship between ITSCA and quality performance. Specifically, customer collaboration fully mediates the ITSCA–quality performance link. The results also support the contention that customer collaboration fully mediates the ITOSK–quality performance relationship. Put differently, customer collaboration, involving the sharing of demand planning, forecasting, and scheduling information between the service provider and its customers, is the means by which the intrinsic value of ITSCA and ITOSK is translated into improved quality performance.

Together with the results from the previous models, the findings obtained from the analysis of Models 7 and 8 further provided support for the process-based view advanced by both IS and OM scholars, who argue that the effect of IS capabilities on firms' performance comes as a result of their ability to enable organisational process (e.g., Wade and Hulland, 2004; Mithas *et al*., 2011). With respect to research in IS, the findings of Models 7 and 8 help to allay concerns about the business value of IT, and also contribute to work focused on how IT impacts upon firm performance. Indeed, these results provide robust evidence for customer collaboration as a mechanism through which IS capabilities positively influence cost and quality performance. In addition, from an OM perspective, these findings add to the emerging body of literature linking customer collaboration to the operational performance (cost and quality) of service firms. In particular, Models 7 and 8 examine the relationships between customer collaboration (as a dimension of customer integration) and the relative performance in services, which contributes to the knowledge on the customer integration–operational performance relationship from a service sector perspective.

No support was found for a positive relationship between flexible IT infrastructure (ITINF) and customer collaboration. Interestingly, ITINF was found to be negatively associated with the degree of customer collaboration. A possible explanation is that a flexible IT infrastructure may lead to unintended rigidity in the face of change (Goodhue *et al.*, 2009). Wider access to more information may lead to information overload and limit a firm's ability to take timely actions to changes in customer demand. For example, sharing a broad range of information was found detrimental to quick co-ordination between supply chain entities in the face of change (Gosain *et al.*, 2005).

Further, no evidence was found for the effect of customer collaboration on the ITINF–cost relationship. ITINF did not directly influence cost, and thus, the necessary conditions for mediation were not present. In the same way, no effect of customer collaboration on the ITINF–quality relationship was found. As indiciated in previous discussion concerning ITINF, these findings may suggest that the business value of a firm's flexible IT infrastructure is not associated with performance that is measured by cost and quality. That said, these results do not mean that service firms should not develop a flexible IT infrastructure. Clearly, although a flexible IT infrastructure has no significant positive impact on the relative operational performance, it is likely that it may have a positive impact on some other processes within the firm (Ray *et al.*, 2005). As suggested earlier, a flexible infrastructure may not be rare or costly to imitate, and most service firms may already have one in place or be able to easily acquire one. Consequently, ITINF, by itself, is unlikely to improve the relative operational performance.

8.2.4.3 Practical Implications (Models 7 and 8)

Practitioners can benefit from the results of Models 7 and 8 by noting the importance of integrating collaboration processes with customers in forming relationships between dimensions of IS capabilities and cost and quality performance. In a similar way, the relationships found between customer collaboration and the relative operational performance in services are based on the exchange of information rather than goods, as is common in traditional manufacturing supply chains (e.g., Flynn *et al*., 2010). These results empirically indicate that the lessons learned about the role of customer integration in terms of collaboration processes in traditional SCM research can be applied to the service sector. Therefore, the findings will help managers in service firms to recognise the operational impact of integrating collaboration processes with their customers. Higher level of customer collaboration is associate with reducing service capacity variance by enhancing demand visibility and decreasing uncertainty with accurate and reliable forecasts. Reduced capacity variation will result in decreased hiring, training, firing and other personnel costs associated with varying capacity.

In addition to investigating the effects of different dimensions of IS capabilities (ITSCA and ITOSK) on cost and quality performance, the findings of Models 7 and 8 suggest that as managers consider the benefits of IS capabilities, it is important for them to be cognisant of the need to integrate collaboration processes with customers since this serves to allow IS capabilities to improve the relative operational performance. Consistent with previous models, the analysis of Models 7 and 8 further provides empirical support for prescriptions of the existing research on the indirect role of IT in firm performance (e.g., Devaraj *et al*., 2007; Tan *et al*., 2010) from a service sector perspective. The results suggest that for managers in service firms, it is important to take into account the indirect role of IS capabilities in their firm performance and the strength of the mediating role of integrated customer collaboration. Indeed, service firms that embark on strategies to develop and leverage their IS capabilities should simultaneously implement processes that encourage the integration of customer collaboration processes. More specifically, a higher degree of customer collaboration is associated with better operational results. Collaborative activities with customers facilitate service firms' efforts to reduce delay in information processes by decreasing the time that it takes the firm to notice the capacity requirements, and decreasing the variability of staff workloads. Regular workloads and small variations in the workload lead to improved cost performance in terms of high labour productivity.

8.2.4.4 Summary

In summarising, Models 7 and 8 develop an understanding of the link between IS capabilities, customer collaboration, and cost and quality performance in a service context. Taken together, the results of these two models underscore that it is useful for both academics and managers to consider the role of customer collaboration when evaluating the influence of IS capabilities on operational performance.

8.3 Conclusions

This chapter has presented a detailed discussion of the findings of this study. The main body of this chapter has focused on the results of hypothesis testing, and provided a discussion of these results in the light of previous findings in the literature. The discussion of differences between the models and their contributions, has been organised in four sections based on the focus of each mediator variable (supplier integration, customer transactions, customer connection, and customer collaboration).

In the next chapter, which is the final chapter of this thesis, the results presented throughout the thesis are drawn together and provide a conclusion to this study. The contributions of the study, its limitations, and potential areas for future research are also considered.

CHAPTER NINE:

CONCLUSIONS

9.1 Introduction

The business value of IT has proved to be an important paradigm of the current age, and worthy of the academic attention it has received. Researchers have employed various approaches to assess the mechanisms through which IT business value is generated and to what extent its magnitude is estimated. As discussed in *Chapter Two*, this study has applied the resource-based view of the firm (RBV) as the primary theory to discuss the operational performance impacts of IS capabilities. A typology of IS capabilities has been proposed. To understand the relationships between IS capabilities and operational performance in the supply chain context, *Chapter Three* has provided a recounting of the academic basis of supply chain integration. The SCI concept has been argued within this study as being capable of adapting to the service business, taking into account the distinguishing characteristics of services. *Chapter Four* has discussed the arguments in favour of examining the relationships between each dimension of IS capabilities and operational performance, and the underlying mechanisms (the processes developed for supplier and customer integration) in services. On the basis of the proposed research models and hypotheses, a web survey was selected as the research method for data collection, as described in *Chapter Five*. Following the data collection and collation, statistical analysis was described in *Chapter Six* and hierarchical multiple regression tests were performed in *Chapter Seven*. *Chapter Eight* contains a discussion of the results.

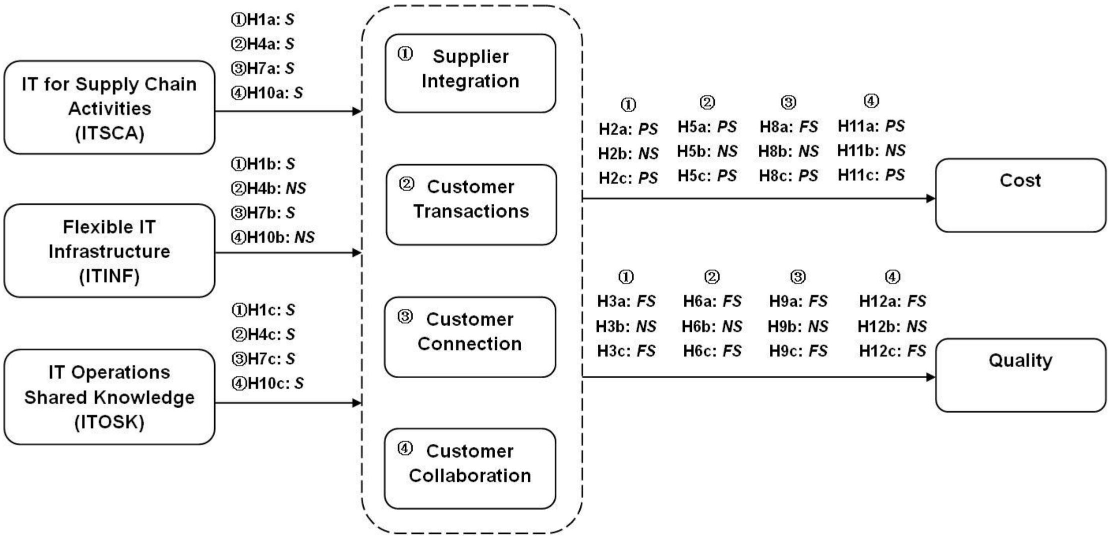
This chapter contains an overview of the results presented in this study, and general discussion of the meaning of these findings. It then provides a discussion of the implications for both theory and practice, the limitations of the study, and the scope for future research.

9.2 Overview of the Study

Despite large yearly investments in information technology (IT), with worldwide spending forecast to reach $3.8 trillion in 2014 (Gartner, 2013), the information systems (IS) and operations management (OM) literature remains inconclusive regarding its direct benefits on a firm's performance. To advance the understanding of such IT–performance relationships, at least three opportunities remain. First, the resource-based view (Barney, 1991) argues that a firm’s IT resources by themselves may not be sufficiently “unique”, and thus, it is more useful to focus on how IS capabilities impact performance (e.g., Santhanam and Hartono, 2003). Although IS researchers have conceptualised several dimensions of IS capabilities (see Wade and Hulland 2004), very few studies have empirically measured these capabilities and assessed their significance for firm performance. In the OM field, researchers have also showed great interests in studying information systems, but most of them have focused on IS as a highly aggregated concept (e.g., Subramani, 2004; Sanders and Premus, 2005; Zhang and Dhaliwal, 2009) or as one specific type of technology (e.g., Sanders, 2007; Tan *et al*., 2010; Olson and Boyer, 2003). This has resulted in a limited understanding of how different dimensions of IS capabilities can impact on supply chain management and operational performance. Second, despite significant progress in answering the question of how information technology contributes to firm performance (Dedrick *et al*. 2003; Wade and Hulland 2004), the role and articulation of "the underlying mechanisms" through which IS capabilities improve firm performance remain unclear (Bharadwaj, 2000; Mithas *et al*., 2011). Finally, from an empirical perspective, much of the prior research linking IS with supply chain management and firm performance has been conducted in the manufacturing context. As a result, little such research has been studied in respect of services.

This study has focused on gaining a better understanding of the relationships between IS capabilities and operational performance, and the role of supply chain integration processes as "the underlying mechanisms". This enhanced understanding has been achieved by measuring the effects of three dimensions of IS capabilities (IT for supply chain activities, flexible IT infrastructure, and IT operations shared knowledge) on a service provider's operational performance as measured by cost and quality. The underlying mechanisms have been studied by investigating the mediating role of the processes developed for supplier and customer integration, namely, supplier integration, customer transactions, customer connection, and customer collaboration. On the basis of the theoretical arguments developed through Chapters Two to Four, eight research models and relative hypotheses were proposed which described the relationships between IS capabilities, the four types of supply chain integration processes, and the two types of operational performance. Data was collected by conducting a web survey of firms across the UK service sector. The proposed hypotheses were tested by hierarchical regression analysis, as depicted in Figure 9.1. The results of hypotheses testing allow the identification of a number of performance impacts of IS capabilities and supply chain integration processes in service contexts.

Figure 9.1: Summary of results (Models 1–8)



S: Supported *PS: Partially supported*
NS: Not Supported *FS: Fully supported*

As has been discussed in Chapter Two, IS capabilities in this study refer to firm-specific IT assets and abilities that influence how post-implementation IT applications and IT-related resources are used in the supply chain environment. IS capabilities are classified into three dimensions, namely, IT for supply chain activities, flexible IT infrastructure, and IT operations shared knowledge, derived from the work of Wade and Hulland (2004) on the typology of IS resources. These IS capabilities have been documented to be valuable for a firm in terms of fostering information flows between the focal firm and its suppliers and customers, and enabling more effective supply chain management, as discussed in Chapter Four. Further deriving from studies that suggest IS capabilities can help firms understand inter-dependencies in business activities (e.g., Feeny and Willcocks, 1998), this study draws on suggestions that the IS capabilities of a firm enhance the reach and richness of its processes, and this enables the firm to obtain and use high quality information that is timely, current, accurate, complete, and relevant (Sambamurthy *et al*., 2003). In addition, utilising insights from OM research, this study underscores the positive effect of information flows on firms' supply chain integration processes (e.g., Devaraj *et al*., 2007; Rai *et al*., 2006; Frohlich and Westbrook, 2002; Lee *et al*., 1997a). As a result, all of the three IS capabilities are expected to be valuable in the sense that they have the potential to facilitate supply chain integration and improve operational performance.

According to the results, this study has been able to identify the impacts of different dimensions of IS capabilities on supply chain integration processes in service contexts. IT for supply chain activities (ITSCA) and IT operations shared knowledge (ITOSK) were found to positively influence all the four types of processes developed for supplier and customer integration that this study investigated, namely, supplier integration, customer transactions, customer connection, and customer collaboration. While flexible IT infrastructure (ITINF) was not found to support customer transactions and customer collaboration, it does facilitate a service firm's efforts to achieve greater supplier integration and customer connection integration. This suggests that, when considering the business value of IS capabilities in the supply chain context, one must appreciate that IS capabilities vary in their ability to contribute to the processes involved in supply chain integration. It is, therefore, necessary to take account of a comprehensive range of individual factors when examining the impacts of IS capabilities in SCM.

In addition to the positive influence of IS capabilities on firm's supply chain integration, this study has theorised how SCI in turn, affects a firm's operational performance (cost and quality), as discussed in Chapter Three. To formulate the arguments, the research models have been built on past OM research on the relationship between SCM and firm operational performance (e.g., Flynn *et al*., 2010; Wong *et al*., 2011) as discussed in Chapter Four. And to complete the research models, the indirect effects of IS capabilities on the two metrics of operational performance are evaluated. Indeed, in addition to supplier integration processes (e.g., Frohlich and Westbrook, 2002), IS have been shown to be vital in promoting and sustaining customer integration processes in terms of managing customer transactions (e.g., Tsikriktsis *et al*., 2004), customer connection (e.g., Mithas *et al*., 2012), and customer collaboration (e.g., Mithas *et al*., 2005).

This study has been able to demonstrate the mediating effects of supply chain integration processes on the relationships between IS capabilities and operational performance. The results revealed that the four types of supply chain integration processes (supplier integration, customer transactions, customer connection, and customer collaboration) can partially mediate the effects of IT for supply chain activities (ITSCA), and IT operations shared knowledge (ITOSK) on cost performance; and can fully mediate the effects of these two dimensions on quality performance. No support was found for any relationships between flexible IT infrastructure and cost or quality performance. This suggests that, the processes developed for supplier and customer integration are able to play an important role in linking ITSCA and ITOSK with operational benefits in services. While the findings may suggest that the business value of a firm's ITINF is not associated with performance as measured by cost and quality, this does not mean that service firms should not develop a flexible IT infrastructure as such infrastructure is likely to have a positive impact on some other processes within the firm (Ray *et al*., 2005).

In sum, this study has revealed a number of important results concerning the relationships between IS capabilities and operational performance, and the mediating roles of supply chain integration processes as the underlying mechanisms. The following sections present the implications of these findings, both for theory and for practice. Limitations of the study are described, and suggestions for future research are outlined.

9.3 Implications of the Study

The theoretical framework of this study, presented in Chapters Two to Four, has been constructed on the basis of an extensive literature research, and has demonstrated the great importance of gaining a better understanding of the IS capabilities–operational performance relationships and the underlying mechanisms. This is the impetus for this research, and is of interest both in academia – to develop knowledge in such a crucial area, and in management – to extend the observed relationships into practice. The following two sections discuss the implications of this study for both theory and practice.

9.3.1 Implications for Theory

In considering implications for theory, it is important to take account of the unique contributions of this study to the body of academic understanding, as well as the future research which may be carried out to advance this understanding. The former is discussed in this section, and the latter is outlined in section 9.5.

This is an inter-disciplinary study, which links the concepts of information systems, supply chain integration, and operational performance, and therefore, makes several valuable contributions to the body of understanding. The direct implication of this inter-disciplinary study is the demonstration that there are indeed significant relationships between these separate concepts in service contexts. The background to this study was the increased interest in both the IS and OM literature, described throughout Chapters Two and Three. This interest has not been far developed from the perspective of the service sector, and in particular in empirical studies.

Specifically, this study makes three contributions to the growing body of IS and OM literature. Firstly, it responds to calls by the resource-based view literature to explore IS capabilities at the business process level (e.g., Ray *et al*., 2004, 2005; Banker *et al*., 2006a), which is in line with the emerging consensus in the OM research stream, to investigate the role of IS capabilities in enabling supply chain processes to improve performance at process level (e.g., Devaraj *et al*., 2007; Rai *et al*., 2006; Tai *et al*., 2010). Since the IS-enabled improvements in process-level performance may dissipate before reflecting in a firm's overall performance (Ray *et al*., 2004), measuring the effectiveness of business process through operational performance (cost and quality) providers a better way to test resource-based logic. Further, this study contributes to the business value of the IS literature by uncovering four important supply chain integration processes that have not received much attention in service contexts in previous research, and showing how these processes leverage IS capabilities and turn them into performance impacts. Specifically, IS capabilities (ITSCA and ITOSK) support firm-specific routines that enable the execution of business processes. Although firms may develop supplier and customer integration processes in different ways, IS capabilities support these integration processes by providing managers with the interface to conceive, develop, and exchange process-specific knowledge. This is also an important contribution to a possible extension to the RBV, since the RBV has been criticised for using path-dependency to explain resource heterogeneity without explicitly discussing 'the mechanisms' by which this occurs (Priem and Butler, 2001).

Secondly, this study develops and empirically validates the measurement scale of IS capabilities in supply chains. In this study, the IS capabilities are reflected in three dimensions, namely and empirically, IT for supply chain activities (ITSCA), IT operations shared knowledge (ITOSK), and flexible IT infrastructure (ITINF). These form the underpinning in the typology provided by Wade and Hulland (2004) and arise through synthesising the academic literature on IS and SCM. This contribution adds to the IS literature by responding to the call from Bhatt and Grover (2005) to identify alternative conceptualisations and empirical validation of IS capabilities. In addition, this contribution responds to the recent call of Zhang *et al*. (2011) to explore a comprehensive range of IS in the SCM research. This study also complements this particular literature by drawing attention to how different dimensions of IS capabilities influence supply chain integration processes in services, in contrast to the focus in prior work on IS as a highly aggregated concept (e.g., Subramani, 2004; Sanders and Premus, 2005; Zhang and Dhaliwal, 2009) or as one specific type of technology (e.g., Sanders, 2007; Tan *et al*., 2010; Olson and Boyer, 2003).

Finally, this study empirically investigates for the first time, the relationships between supply chain integration processes and operational performance in service contexts. This contributes to the literature by conceptualising supply chain integration in the service business context and empirically investigating the role of supply chain integration on the relationships between IS capabilities and operational performance, thereby responding to the research agenda in respect of service contexts, which aims to obtain a better understanding and formalisation of service supply chains and to apply such understanding (e.g., Ellram *et al*., 2004; Giannakis, 2011b). The findings indicate that the processes developed for supply chain integration (supplier integration, customer transactions, customer connection, and customer collaboration) can fully or partially mediate the relationships between IT for supply chain activities, and IT operations shared knowledge on cost and quality performance, whereas there are no relationships between flexible IT infrastructure, and cost and quality performance. Such findings add to the literature by exploring how different processes of supply chain integration can mediate the relationships between IS capabilities and operational performance in service firms.

9.3.2 Implications for Practice

In addition to the theoretical contributions, this study produces important insights for manages in service firms. Firstly, the analysis highlights evidence that certain IS capabilities (IT for supply chain activities, and IT operations shared knowledge) do facilitate service firms' efforts to improve their cost and quality performance. As such, these results will help managers to clarify the performance implications of each dimension of their IS capabilities and should motivate increased managerial attention toward IS development in service organisations. With the uncertainties and concerns about how to value IS, this study suggests that well-developed IS capabilities are important for facilitating development of supply chain integration processes and, in turn, improved operational performance of a service provider. Operations managers need to focus on the use of IT for supply chain activities and the possessing of shared IT knowledge as vital levers for external integration and performance excellence.

Secondly, the analysis indicates that for service firms, various types of processes for supply chain integration should be taken into consideration because of their mediation effects in linking IS capabilities and operational performance. The findings suggest that as managers consider the benefits of IS capabilities, it is important for them to also be aware of various types of supply chain integration processes as powerful mechanisms, through which IS capabilities can improve the relative operational performance. The analysis of proposed research models provides empirical support for prescriptions of the existing research on the indirect role of IT in firm performance (e.g., Devaraj *et al*., 2007; Tan *et al*., 2010) from a service sector perspective. The results suggest that managers in service firms should also take into account the indirect role of IS capabilities in their firm performance and the strength of the mediating role of supply chain integration processes. In other words, service firms that embark on developing and leveraging their IS capabilities should simultaneously implement processes that encourage supplier and customer integration.

Finally, the proposed services' supply chain integration processes offer a new perspective on the way in which processes developed for supplier and customer integration can contribute to operational performance in services. Their greatest value is in their ability to assist operations managers in services to view and assess their supply chain management in a way which resembles that used in traditional SCM. Specifically, practitioners can benefit from the results of this study by noting the importance of supplier integration in forming relationships between dimensions of IS capabilities, and cost and quality performance. In particular, the relationships found between supplier and customer integration and the relative operational performance in services are based on the exchange of information rather than goods, as is common in traditional manufacturing supply chains (e.g., Flynn *et al*., 2010). These results empirically indicate that the lessons learned about the roles of supplier and customer integration in SCM research can be applied to the service sector. Therefore, the findings will help managers in service firms to recognise the operational impact of building the level of integration with their suppliers and customers.

Taken together, when operations managers understand that supply chain integration processes act as a precedent for operational performance and IS capabilities are a fundamental and precedes development of such integration processes, they are more likely to view IS capabilities as important levers for better operational performance.

9.4 Limitations of the Research

While considerable attention has been paid to ensure the validity and reliability of this study, there are limitations. Firstly, the method of data collection in this study was a survey, which is consistent with a number of survey studies of supply chain integration (see for example, Van Der Vaart and Van Donk, 2008; Zhang *et al*., 2011).

This method is a cost-effective way of collecting large quantities of data that avoid interview bias (Roberts, 1999). However, the lack of ability to clarify items to respondents, stands as a main weakness of the survey method. For example, the use of sophisticated terms may be misunderstood. The likelihood of such an occurrence was minimised by using a pilot study to provide feedback on the questionnaire items and to evaluate the responses. Another problem with survey research is that it is hard to control for external factors such as the knowledge limitations of the potential respondents. A cross-sectional survey by its nature, limits the depth of understanding of the value of IS capabilities, since the three dimensions of IS capabilities are complex and develop over time.

Secondly, cause-effect relations cannot be inferred due to the static nature of the survey. Longitudinal settings would enable researchers to explore IS capabilities–operational performance over time, thereby supplying valuable information regarding how supplier and customer integration evolves through the relationship lifecycle.

Thirdly, although this study included firm size, and type of industry as control variables, these control variables provide only an attempt to account for their effects on the dependent variables. Other variables may also impact on the constructs of interest, i.e. the organisational structure, the nature of competition, etc. Accordingly, the results must be judiciously interpreted in order to avoid generalisations, which may prove to be false.

Moreover, the scope of the survey was limited to service establishments in the United Kingdom: although many firms were international, only the practices at the UK firm were considered. Country- or culture-specific differences in service characteristics were not taken into account. It is possible, therefore, that the generalisability of this survey might be affected, and the findings may only describe relationships that are true within the UK or Europe. This study followed the procedure to assess the four proposed mediators in a separate manner. Further simultaneous multiple mediation would enable the researchers to evaluate individual contributions to the overall mediation effect and the independence of the mediation of the effect of the other mediators.

Finally, this study investigated the role of supply chain integration processes as ‘the underlying mechanisms’ from both supplier and customer sides. Given that customers are somehow involved with the service provider when they purchase a service, customer integration in services is much less straightforward than it is in manufacturing settings. This study considered a more process-specific approach to investigate the customer-side integration by breaking down customer integration into three major types (customer transactions, customer connection, and customer collaboration), while supplier-side integration remains a single-dimensional concept.

9.5 Directions for Future Research

This study has demonstrated the relationships between IS capabilities, supply chain integration processes, and operational performance in service contexts. Much remains to be investigated, however, about such relationships. Directions for future research include re-exploring the mediating role of supplier and customer integration processes on the IS capabilities–operational performance relationships in services. In-depth case studies can provide additional evidence to support the findings of this study as well as uncover some of the causal mechanisms behind the processes that have been observed.

Further, although no support was found for the relationships between flexible IT infrastructure (ITINF) and operational performance in this study, such relationships are worthy of examination in future research, which could focus on the impact of

ITINF in situations where infrastructure flexibility is likely to be important (i.e. a rapidly changing industry). Additionally, exploration of whether supply chain integration processes moderate the ITINF–operational performance relationships could be undertaken in order to open other avenues for discussion and further research.

Moreover, future research may consider the mediating mechanisms in a wider context of supply chain integration, i.e. the role of internal integration processes on the IS capabilities–operational performance relationships. Further, this study only focused on cost and quality performance as measures of operational performance, and future research may consider additional measures in this respect.

9.6 Concluding Remarks

This study has developed an integrative framework that links three dimensions of IS capabilities (IT for supply chain activities, flexible IT infrastructure, and IT operations shared knowledge) with four important types of supply chain integration processes (supplier integration, customer transactions, customer connection, and customer collaboration) that mediate the links between IS capabilities and two measures of operational performance (cost and quality). Based on analysis of data collected from UK service establishments, the results provide evidence that IS capabilities (IT for supply chain activities, and IT operations shared knowledge) improve the level of firms' supply chain integration processes and, in turn, leading to higher operational performance (cost and quality). Taken together, these findings highlight the importance of IT for supply chain activities and IT operations shared knowledge to enable supply chain integration processes and to improve operational performance, providing important insights for managers and add to a growing body of literature regarding the interface between IS and OM.

REFERENCES

Akkermans, H.A. and Vos, B. (2003), "Amplification in service supply chains: an exploratory case study from the telecom industry", *Production and Operations Management*, Vol.12 No.2, pp. 204-223.

Akkermans, H. and Voss, C (2013), "The service bullwhip effect", *International Journal of Operations & Production Management*, Vol.33 No.6, pp.765-788.

Alba, J., Lynch, J., Weitz, B., Janiszewski, C, Lutz, R., Sawyer, A., and Wood, S. (1997), "Interactive home shopping: consumer, retailer, and manufacturer incentives to participate in electronic marketplaces", *Journal of Marketing*, Vol.61 No.3, pp. 38-53.

Amit, R. and Schoemaker, P.J.H. (1993), "Strategic Assets and Organizational Rent", *Strategic Management Journal*, Vol.14 No.1, pp. 33-46.

Amit, R. and Zott, C. (2001), "Value creation in e-business", *Strategic Management Journal*, Vol.22 No.6-7, pp. 493-520.

Anand, G. and Ward, P. (2004), "Fit, flexibility and performance in manufacturing: coping with dynamic environments", *Production and Operations Management*, Vol.13 No.4, pp. 369-385.

Anderson, E.G. (2001), "Managing the impact of high market growth and learning on knowledge worker productivity and service quality", *European Journal of Operational Research*, Vol.134 No.3, pp.508-524.

Anderson, E.G. and Morrice, D.J. (2000), "A simulation game for teaching service-oriented supply chain management: does information sharing help managers with service capacity decisions?", *Production and Operations Management*, Vol.9 No.1, pp. 40-55.

Anderson, E.G., Morrice, D.J. and Lundeen, G. (2005), "The physics of capacity and backlog management in service and custom manufacturing supply chains", *System Dynamics Review*, Vol.21 No.3, pp. 217-247.

Anderson, M.C., Banker, R.D. and Ravindran, S. (2003), "The new productivity paradox", *Communications of the ACM*, Vol.46 No.3, pp. 91-94.

Anderson, M.G. and Katz, P.B. (1998), "Strategic sourcing", *International Journal of Logistics Management*, Vol.9 No.1, pp. 1-13.

Anderson, S. and Lanen, W. (2002), "Using electronic data interchange to improve the efficiency of accounting transactions", *Accounting Review*, Vol.77 No.4, pp. 703-729.

Ansari, A. and Mela, C.F. (2003), "E-customization", *Journal of Marketing Research*, Vol.40 No.2, pp. 131-145.

Aral, S. and Weill, P. (2007), “IT assets, organizational capabilities, and firm performance: how resource allocations and organizational differences explain performance variation”, *Organization Science,* Vol.18 No.5, pp. 763-780.

Ariely, D. (2000), “Controlling the information flow: effects on consumers' decision making and preferences”, *Journal of Consumer Research,* Vol.27 No.2, pp. 233-248.

Armistead, C.G. and Mapes, J. (1993), “The impact of supply chain integration on operating performance”, *Logistics Information Management,* Vol.6 No.4, pp. 9-14.

Armstrong, C. and Sambamurthy, V. (1999) “Information technology assimilation in firms: the influence of senior leadership and IT infrastructures”, *Information Systems Research,* Vol.10 No.4, pp. 304-327.

Armstrong, S.J. and Overton, T.S. (1977), “Estimating non-response bias in mail surveys”, *Journal of Marketing Research*, Vol.14, No.3, pp.396-402.

Aviv, Y. (2001), “The effect of collaborative forecasting on supply chain performance”, *Management Science*, Vol.47 No.10, pp. 1326-1343.

Bakos, J.Y., and Nault, B.R. (1997), “Ownership and investment in electronic networks”, *Information Systems Research,* Vol.8 No.4, pp. 321-341.

Bakos, Y. and Katsamakas, E. (2008), “Design and ownership of two-sided networks: implications for internet platforms”, *Journal of Management Information Systems,* Vol.25 No.2, pp. 171-202.

Balasubramanian, S., Konana, P., and Menon, N.M. (2003), “Customer satisfaction in virtual environments: a study of online investing”, *Management Science,* Vol.49 No.7, pp. 871-889.

Baltacioglu, T., Ada, E., Kaplan, M.D., Yurt, O. and Kaplan, Y.C. (2007), “A new framework for service supply chains”, *The Service Industries Journal,* Vol.27 No.2, pp. 105-124.

Banker, R.D., Bardhan, I. and Asdemir, O. (2006b), “Understanding the impact of collaboration software on product design and development”, *Information Systems Research,* Vol.17 No.4, pp.352-373.

Banker, R.D., Bardhan, I., Chang, H. and Lin, S. (2006a), “Plant information systems, manufacturing capabilities, and plant performance”, *MIS Quarterly*, Vol.30 No.2, pp. 315-337.

Banker, R.D., Chang, H. and Kao, Y.C. (2010), “Evaluating cross-organizational impacts of information technology: an empirical analysis”, *European Journal of Information Systems*, Vol.19 No.2, pp.153-167.

Barnett, W.P., Greve, H.R. and Park, D.Y. (1994), "An evolutionary model of organizational performance", *Strategic Management Journal*, Vol. 15 Winter, pp. 11–28.

Barney, J.B. (1986a), "Strategic factor markets: expectations, luck and business strategy", *Management Science*, Vol.32 No.10, pp. 1231-1241.

Barney, J.B. (1986b), "Organizational culture: can it be a source of sustained competitive advantage?", *Academy of Management Review*, Vol.11 No.3, pp. 656-665.

Barney, J.B. (1991), "Firm resources and sustained competitive advantage", *Journal of Management*, Vol. 17 No.1, pp. 99-121.

Barney, J.B. and Clark, D.N. (2007), *Resource-Based Theory: Creating and Sustaining Competitive Advantage*, Oxford University Press, Oxford.

Barney, J.B. and Hansen, M. (1994), "Trustworthiness as a source of competitive advantage", *Strategic Management Journal*, Vol.15 Winter, pp. 175-190.

Barney, J.B. and Wright, P.M. (1998), "On becoming a strategic partner: the role of human resource in gaining competitive advantage", *Human Resource Management*, Vol.37 No.1, pp.31-46.

Baron, R.M. and Kenny, D.A. (1986), "The moderator–mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations", *Journal of Personality and Social Psychology*, Vol.51 No.6, pp. 1173-1182.

Barua, A., Konana, P., Whinston, A.B. and Yin, F. (2004), "An empirical investigation of net-enabled business value", *MIS Quarterly*, Vol.28 No.4, pp. 585-620.

Barua, A., Kriebel, C.H., and Mukhopadhyay, T. (1995), "Information technologies and business value: an analytic and empirical investigation", *Information Systems Research*, Vol.6 No.1, pp. 3- 23.

Barua, A., Whinston, A.B. and Yin, F. (2000), "Value and productivity in the Internet economy", *IEEE Computer*, Vol.33 No.5, pp. 102-105.

Bassellier, G., Benbasat, I. and Reich, B.H. (2003), "The influence of business managers' IT competence on championing IT", *Information Systems Research*, Vol.14 No.4, pp. 317-336.

Basu, A. and Blanning, R.W. (2003), "Synthesis and decomposition of processes in organizations", *Information Systems Research*, Vol.14 No.4, pp. 337-355.

Beheshti, H.M. and Salehi-Sangari, E. (2007), "The benefits of e-business adoption: an empirical study of Swedish SMEs", *Service Business*, Vol.1 No.3, pp. 233-245.

Benjamin, R.I. and Levinson, E.A. (1993), "Framework for managing IT-enabled change", *Sloan Management Review*, Vol.34 No.4, pp. 23-33.

Berry, L.L., Seiders, K. and Grewal, D. (2002), "Understanding service convenience", Journal of Marketing, Vol.66 No.3, pp. 1-17.

Bharadwaj, A. (2000), "A resource-based perspective on information technology capability and firm performance: an empirical investigation", *MIS Quarterly*, Vol.24 No.1, pp. 169-196.

Bharadwaj, A., El Sawy, O., Pavlou, P. and Venkatraman, N. (2013), "Digital business strategy: toward a next generation of insights", *MIS Quarterly*, Vol.37 No.2, pp. 471-482.

Bhatt, G.D. (2000), "An empirical examination of the effects of information systems integration on business process improvement", *International Journal of Operations & Production Management*, Vol.20 No.11, pp. 1331-1359.

Bhatt, G.D. and Grover, V. (2005), "Types of information technology capabilities and their role in competitive advantage: an empirical study", *Journal of Management Information Systems*, Vol.22 No.2, pp. 253-277.

Bitner, M. (1995), "Building service relationships: it's all about promises", *Academy of Marketing Science Journal*, Vol.23 No.4, pp. 246-252.

Bitner, M.J., Brown, S.W. and Gremler, D.D. (2000), "Technology infusion in service encounters", *Journal of the Academy of Marketing Science*, Vol.28 No.1, pp.138-149.

Bitner, M.J., Faranda, W.T., Hubbert, A.R. and Zeithaml, V.A. (1997), "Customer contributions and roles in service delivery", *International Journal of Service Industry Management*, Vol.8 No.3, pp. 193-205.

Bitner, M.J., Zeithaml, V.A. and Gremler, D.D. (2010), "Technology's impact on the gaps model of service quality", in Maglio, P.P., Kieliszewski, C.A. and Spohrer, J. (Eds.), *Handbook of Service Science*, Springer, Berlin, Germany, pp. 197-218.

Bosworth, B.P. and Triplett, J.E. (2004), *Productivity in the US Services Sector: New Sources of Economic Growth*, Brookings Institution Press, Washington, DC.

Bowersox, D.J. and Daugherty, P.J. (1995), "Logistics paradigms: the impact of information technology", *Journal of Business Logistics*, Vol.16 No.1, pp. 65-80.

Bowersox, D.J., Closs, D.J. and Stank, T.P. (2000), "Ten mega-trends that will revolutionize supply chain logistics", *Journal of Business Logistics*, Vol.21 No.2, pp. 1-16.

Boyer, K.K. and Lewis, M.W. (2002), "Competitive priorities: investigating the need for trade-offs in operations strategy", *Production and Operations Management*, Vol.11 No.1, pp.9-20.

Boynton, A.C., Zmud, R.W. and Jacobs, G.C. (1994), "The influence of IT management practice on IT use in large organizations”, *MIS Quarterly*, Vol.18 No.3, pp. 299-318.

Breidbach, C.F., Kolb, D.G. and Srinivasan, A. (2013), “Connectivity in service systems: does technology-enablement impact the ability of a service system to co-create value?”, *Journal of Service Research*, Vol.16 No.3, pp. 428-441.

Broadbent, M. and Weill, P. (1997), “Management by maxim: how business and IT managers can create IT infrastructures,” *Sloan Management Review*, Vol.38 No.3, pp. 77-92.

Broadbent, M., Weill, P. and Neo, B.S. (1999b), “Strategic context and patterns of it infrastructure capability”, *Journal of Strategic Information Systems*, Vol.8 No.2, pp. 157-187.

Broadbent, M., Weill, P. and St. Clair, D. (1999a), “The implications of information technology infrastructure for business process redesign”, *MIS Quarterly*, Vol.23 No.2, pp. 159-182.

Bryman, A. and Bell, E. (2009), *Business Research Methods (3rd ed.)*, Oxford University Press, Oxford.

Brynjolfsson, E. (1993), “The productivity paradox of information technology”, *Communications of the ACM*, Vol.36 No.12, pp. 66-77.

Brynjolfsson, E. and Yang, S. (1996), “Information technology and productivity: a review of the literature”, *Advances in Computers*, Vol.43, pp. 179-214.

Brynjolfsson, E., and Hitt, L. (1996), “Paradox lost? firm-level evidence on the returns to information systems spending”, *Management Science*, Vol.42 No.4, pp. 541-558.

Byrd, T. and Davidson, N. (2003), “Examining possible antecedents of IT impact on the supply chain and its effect on firm performance”, *Information & Management*, Vol. 41 No. 2, pp. 243-255.

Byrd, T.A. and Turner, D.E. (2000), “Measuring the flexibility of information technology infrastructure: exploratory analysis of a construct”, *Journal of Management Information Systems*, Vol.17 No.1, pp. 167-208.

Byrd, T.A. and Turner, D.E. (2000), “Measuring the flexibility of information technology infrastructure: exploratory analysis of a construct”, *Journal of Management Information Systems*, Vol.17 No.1, pp. 167-208.

Cachon, G. and Fisher, M. (2000), “Supply chain inventory management and the value of shared information”, *Management Science*, Vol.46 No.8, pp. 1032-1048.

Cachon, G.P. and Lariviere, M.A. (2001), “Contracting to assure supply: how to share demand forecasts in a supply chain”, *Management Science*, Vol.47, No.5, pp. 629-646.

Cagliano, R., Caniato, F. and Spina, G. (2003), “E-business strategy: how companies are shaping their supply chain through the internet”, *International Journal of Operations & Production Management,* Vol.23 No.10, pp. 1142-1162.

Cai, S., Jun, M. and Yang, Z. (2010), “Implementing supply chain information integration in China: the role of institutional forces and trust”, *Journal of Operations Management,* Vol.28 No.3, pp. 257-268.

Campbell, J. and Sankaranl, J. (2005), “An inductive framework for enhancing supply chain integration”, *International Journal of Production Research,* Vol.43 No.16, pp. 3321-3351.

Cao, M., and Zhang, Q. (2011), “Supply chain collaboration: impact on collaborative advantage and firm performance”, *Journal of Operations Management,* Vol.29 No.3, pp. 163-180.

Capron, L., and Hulland, J. (1999), “Redeployment of brands, sales forces, and general marketing management expertise following horizontal acquisitions: a resource-based view”, *Journal of Marketing,* Vol.63 No.2, pp. 41-54.

Carey, S., Lawson, B. and Krause, D.R. (2011), “Social capital configuration, legal bonds and performance in buyer–supplier relationships”, *Journal of Operations Management,* Vol.29 No.4, pp. 277-288.

Carr, A.S. and Kaynak, H. (2007), “Communication methods, information sharing, supplier development and performance”, *International Journal of Operations & Production Management,* Vol.27 No.4, pp. 346-370.

Chan, Y.E. and Reich, B.H. (2007a), “IT alignment: what have we learned?”, *Journal of Information Technology,* Vol.22 No.4, pp.297-315.

Chan, Y.E. and Reich, B.H. (2007b), “IT alignment: an annotated bibliography”, *Journal of Information Technology,* Vol.22 No.4, pp.316-396.

Chan, Y.E., Huff, S.L., Barclay, D.W. and Copeland, D.G. (1997), “Business strategic orientation, information systems strategic orientation, and strategic alignment”, *Information Systems Research,* Vol.8 No.2 , pp. 125-147.

Chan, Y.E., Sabherwal, R. and Thatcher, J.B. (2006), “Antecedents and outcomes of strategic is alignment: an empirical investigation”, *IEEE Transaction on Engineering Management,* Vol.51 No.3, pp. 27-47.

Chase, R.B. and Tansik, D.A. (1983), ”A customer contact model for organizational design”, *Management Science,* Vol.29 No.9, pp. 1037-1050.

Chatfield, A.T. and Yetton, P. (2000), “Strategic payoff from EDI as a function of EDI embeddedness”, *Journal of Management Information Systems,* Vol.16 No.4, pp. 195-224.

Chatterjee, D., Grewal, R., and Sambamurthy, V. (2002), “Shaping up for e-commerce: institutional enablers of the organizational assimilation of web technologies”, *MIS Quarterly*, Vol.26 No.2, pp. 65-89.

Chatterjee, P. (2010), "Causes and consequences of 'order online pick up in-store' shopping behaviour", *The International Review of Retail, Distribution and Consumer Research*, Vol.20 No.4, pp. 431-448.

Chen, F., Drezner, Z., Ryan, J.K. and Simchi-Levi, D. (2000), "Quantifying the bullwhip effect in a simple supply chain: the impact of forecasting, lead times, and information", *Management Science*, Vol.46 No. 3, pp. 436-443.

Chen, H., Daugherty, P.J. and Landry, T.D. (2009), "Supply chain process integration: a theoretical framework", *Journal of Business Logistics*, Vol.30 No.2, pp. 27-46.

Chen, I.J. and Paulraj, A. (2004), "Towards a theory of supply chain management: the constructs and measurements", *Journal of Operations Management*, Vol.22 No.2, pp. 119-150.

Chen, J.S. and Tsou, H.T. (2012), "Performance effects of IT capability, service process innovation, and the mediating role of customer service", *Journal of Engineering and Technology Management*, Vol.29 No.1, pp. 71-94.

Chen, J.S., Tsou, H.T. and Huang, A.Y.H. (2009), "Service delivery innovation: antecedents and impact on firm performance", *Journal of Service Research*, Vol.12 No.1, pp. 36-55.

Cheng, Z. and Nault, B. (2007), "Industry level supplier-driven IT spillovers", *Management Science*, Vol.53 No.8, pp. 1199-1216.

Chesbrough, H. and Spohrer, J. (2006), "A research manifesto for services science", *Communications of the ACM*, Vol.49 No.7, pp.35-40.

Cheung, K.L. and Lee, H.L. (2002), "The inventory benefit of shipment coordination and stock rebalancing in a supply chain", *Management Science*, Vol.48 No.3, pp. 300-306.

Chircu, A. and Mahajan, V. (2006), "Managing electronic commerce retail transaction costs for customer value", *Decision Support Systems*, Vol.42 No.2, pp. 898-914.

Cho, Y.K. and Menor, L.J. (2010), "Toward a provider-based view on the design and delivery of quality e-service encounters", *Journal of Service Research*, Vol.13 No.1, pp.83-95.

Chopra, S., Dougan, D. and Taylor, G. (2001), "B2B e-commerce opportunities", *Supply Chain Management Review*, Vol.5 No.3, pp. 50-58.

Choudhury, V., Hartzel, K.S. and Konsynski, B.R. (1998), "Uses and consequences of electronic markets: an empirical investigation in the aircraft parts industry", *MIS Quarterly*, Vol.22 No.4, pp. 471-507.

Chung, S.H., Rainer Jr., R.K. and Lewis, B.R. (2003), "The impact of information technology infrastructure flexibility on strategic alignment and applications implementations", *Communications of the Association for Information Systems*, Vol.11, pp.191-206.

Clark, K.B. (1989), "Project scope and project performance: the effect of parts strategy and supplier involvement on product development", *Management Science*, Vol.35 No.10, pp. 1247-1263.

Claro, D.P., Hagelaar, G. and Omta, O. (2003), "The determinants of relational governance and performance: how to manage business relationship?", *Industrial Marketing Management*, Vol.32 No.8, pp. 703-716.

Clemons, E. and Row, M.C. (1992), "Information technology and industrial cooperation: the changing economics of coordination and ownership" *Journal of Management Information Systems*, Vol.9 No.2, pp. 9-28.

Clemons, E.K. (1986), "Information systems for sustainable competitive advantage", *Information & Management*, Vol.11 No.3, pp.131-136.

Clemons, E.K. (1991), "Corporate strategies for information technology: a resource-based approach", *Computer*, Vol.24 No.11, pp. 23-32.

Clemons, E.K. and Row, M.C. (1991), "Sustaining IT advantage: the role of structural differences", *MIS Quarterly*, Vol.15 No.3, pp. 275- 292.

Clemons, E.K. and Row, M.C. (1993), "Limits to interfirm coordination through information technology: results of a field study in consumer packaged goods distribution", *Journal of Management Information Systems*, Vol.10 No.1, pp. 73-95.

Clemons, E.K., Reddi, S.P. and Row, M.C. (1993), "The impact of information technology on the organization of economic activity: the 'move to the middle' hypothesis", *Journal of Management Information Systems*, Vol.10 No.2, pp. 9-35.

Cohen, W.M. and Levinthal, D.A. (1990), "Absorptive capacity: a new perspective on learning and innovation", *Administrative Science Quarterly*, Vol.35 No.1, pp. 128-152.

Connor, T. (2007), "Market orientation and performance", *Strategic Management Journal*, Vol.28 No.9, pp. 957-959.

Cook, C., Heath, F. and Thompson, R.L. (2000), "A meta-analysis of response rates in Web- or internet-based surveys", *Educational and Psychological Measurement*, Vol.60 No.6, pp.821-836.

Cousins, P.D. and Menguc, B. (2006), "The implications of socialization and integration in supply chain management", *Journal of Operations Management*, Vol.24 No.5, pp. 604-620.

Crocitto, M. and Youssef, M. (2003), "The human side of organizational agility", *Industrial Management & Data Systems*, Vol.103 No.6, pp. 388-397.

Croxton, K.L., Garcia-Dastugue, S.J., Lambert, D.M. and Rogers, D.L. (2001), "The supply chain management process", *The International Journal of Logistics Management*, Vol.12 No.2, pp. 13-36.

Da Silveira, G. and Cagliano, R. (2006), "The relationship between interorganizational information systems and operations performance", *International Journal of Operations & Production Management*, Vol. 26 No. 3, pp. 232-253.

Das, A., Narasimhan, R. and Talluri, S. (2006), "Supplier integration – finding an optimal configuration", *Journal of Operations Management*, Vol.24 No.5, pp.563-582.

Davenport, T. H. (1993), *Process Innovation: Reengineering Work through Information Technology*, Harvard Business School Press, Cambridge, MA.

Davenport, T. H. (1998), "Putting the enterprise into the enterprise system", *Harvard Business Review*, Vol.46 No.4, pp. 121-131.

Davenport, T.H., Harris, J.G. and Kohli, A.K. (2001), "How do they know their customers so well?", *MIT Sloan Management Review*, Vol.42 No.2, pp. 63-73.

Davis, J.G., Subramanian, E., Konda, S., Granger, H., Collins, M. and Westerberg, A.W. (2001), "Creating shared information spaces to support collaborative design work", *Information Systems Frontiers*, Vol.3 No.3, pp. 377-392.

Davis, T. (1993), "Effective supply chain management," *Sloan Management Review*, Vol.34 No.4, pp. 35-46.

Day, G. (1994), "The capabilities of market-driven organizations", *Journal of Marketing*, Vol.58 No.4, pp. 37-52.

De Vaus, D. (2002), *Surveys in Social Research (5th ed.)*, Routledge, London.

De Vellis, R.F. (2003), *Scale Development: Theory and Applications (2nd ed.)*, Sage Publications, Newbury Park, CA.

Dedrick, J., Gurbaxani, V. and Kraemer, K.L. (2003), "Information technology and economic performance: a critical review of the empirical evidence", *ACM Computing Surveys*, Vol.35 No.1, pp. 1-28.

Dehning, B. and Richardson, V.J. (2002), "Returns on investments in information technology: a research synthesis". *Journal of Information Systems Management*, Vol.16 No.1, pp. 7-30.

Dehning, B., Richardson, V. and Zmud, R. (2007), "The financial performance effects of IT-based supply chain management systems in manufacturing firms", *Journal of Operations Management*, Vol. 25 No. 4, pp. 806-824.

Deming, W.E. (1982), *Quality, Productivity, and Competitive Position*, Massachusetts Institute of Technology, Center for Advanced Engineering Study, Cambridge.

Demsetz, H. (1973), "Industry structure, market rivalry, and public policy", *Journal of Law and Economics*, Vol.16 No.1, pp. 1-9.

Devaraj, S. and Kohli, R. (2000), "Information technology payoff in the healthcare industry: a longitudinal study", *Journal of Management Information Systems*, Vol.16 No.4, pp. 41-67.

Devaraj, S. and Kohli, R. (2003), "Performance impacts of information technology: is actual usage the missing link", *Management Science*, Vol.49 No.3, pp. 273-289.

Devaraj, S., Fan, M. and Kohli, R. (2002), "Antecedents of B2C channel satisfaction and preference: validating e-commerce metrics", *Information Systems Research*, Vol.13 No.3, pp. 316-333.

Devaraj, S., Krajewski, L. and Wei, J.C. (2007), "Impact of eBusiness technologies on operational performance: the role of production information integration in the supply chain", *Journal of Operations Management*, Vol.25 No.6, pp. 1199-1216.

Devaraj, S., Ow, T.T. and Kohli, R. (2013), "Examining the impact of information technology and patient flow on healthcare performance: a theory of swift and even flow (TSEF) perspective", *Journal of Operations Management*, Vol. 31, pp. 181-192.

Dierickx, I. and Cool, K. (1989), "Asset stock accumulation and sustainability of competitive advantage", *Management Science*, Vol. 35 No.12, pp. 1504-1511.

Dillman, D.A., Smyth, J.D. and Christian, L.M. (2009), *Internet, mail, and mixed-mode surveys: the tailored design method (3rd ed.)*, John Wiley & Sons, Hoboken, NJ.

Dong, S.T., Xu, S.X. and Zhu, K.X. (2009), "Information technology in supply chains: the value of IT-enabled resources under competition", *Information Systems Research*, Vol.20 No.1, pp. 18-32.

Drew, S. (1997), "From knowledge to action: the impact of benchmarking on organizational performance", *Long Range Planning*, Vol.30 No.3, pp.427-441.

Droge, C., Jayaram, J. and Vickery, S.K. (2004), "The effects of internal versus external integration practices on time-based performance and overall firm performance", *Journal of Operations Management*, Vol.22 No.6, pp. 557-573.

Duncan, N. B. (1995) "Capturing flexibility of information technology infrastructure: a study of resource characteristics and their measure", *Journal of Management Information Systems*, Vol.12 No.2, pp. 37-57.

Dyer, J.H. and Singh, H. (1998), "The relational view: cooperative strategy and sources of interorganizational competitive advantage", *Academy of Management Review*, Vol.23 No.4, pp.660-679.

Ellram, L.M. (1990), "The supplier selection decision in strategic partnerships", *Journal of Purchasing and Materials Management*, Vol.26 No.4, pp. 8-14.

Ellram, L.M., Tate, W.L. and Billington, C. (2004), "Understanding and managing the services supply chain", *Journal of Supply Chain Management*, Vol.40 No.4, pp. 17-32.

Ellram, L.M., Tate, W.L. and Billington, C. (2007), "Services supply management: the next frontier for improved organizational performance", *California Management Review*, Vol.49 No.4, pp. 44-66.

Ettlie, J.E. and Reza, E. (1992), "Organizational integration and process innovation", *Academy of Management Journal*, Vol.35 No.4, pp. 795-827.

Evans, P.B. and Wurster, T.S. (1997), "Strategy and the new economics of information", *Harvard Business Review*, Vol.75 No.5, pp. 70-83.

Faems, D., Van Looy, B. and Debackere, K. (2005), "Interorganization collaboration and innovation: toward a portfolio approach," *Journal of Product Innovation Management*, Vol.22 No.3, pp. 238-250.

Farjoun, M. (1998), "The independent and joint effect of the skill and physical bases of relatedness in diversification", *Strategic Management Journal*, Vol.19 No.7, pp. 611-630.

Feeny, D. (2001), "Making business sense of the e-opportunity", *MIT Sloan Management Review*, Vol.42 No.2, pp. 41-51.

Feeny, D.F. and Willcocks, L.P. (1998), "Core IS capabilities for exploiting information technology", *Sloan Management Review*, Vol.39 No.3, pp. 9-21.

Field, J. and Meile, L. (2008), "Supplier relations and supply chain performance in financial services processes", *International Journal of Operations & Production Management*, Vol.28 No.2, pp. 185-206.

Field, J.M., Heim, G.R. and Sinha, K.K. (2004), "Managing quality in the e-service system: development and application of a process model", *Production and Operations Management*, Vol.13 No.4, pp.291-306.

Fisher, M.L. (1997), "What is the right supply chain for your product?", *Harvard Business Review*, Vol.75 No.2, pp. 105-116.

Fisher, M.L., Hammond, J.H., Obermeyer, W.R. and Raman, A. (1994), "Making supply meet demand in an uncertain world", *Harvard Business Review*, Vol.72 No.3, pp. 83-93.

Fitzsimmons, J.A. (1985), "Consumer participation and productivity in service operations", *Interfaces*, Vol.15 No.3, pp. 60-67.

Fitzsimmons, J.A. and Fitzsimmons, M.J. (2001), *Service Management: Operations, Strategy, and Information Technology (3rd ed.),* Irwin/McGraw-Hill, Boston, MA.

Fleming, L., Chen, D. and Mingo, S. (2007), "Collaborative brokerage, generative creativity, and creative success", *Administration Science Quarterly*, Vol. 52, pp. 443-75.

Fließ, S. and Kleinaltenkamp, M. (2004), "Blueprinting the service company managing service processes efficiently", *Journal of Business Research*, Vol.57 No.4, pp. 392-404.

Flynn, B.B., Huo, B. and Zhao, X. (2010), "The impact of supply chain integration on performance: a contingency and configuration approach", *Journal of Operations Management*, Vol.28 No.1, pp.58-71.

Flynn, B.B., Sakakibara, S., Schroeder, R.G., Bates, K.A. and Flynn, E.J. (1990), "Empirical research methods in operations management", *Journal of Operations Management*, Vol.9 No.2, pp.250-284.

Ford, D. (2011), "IMP and service-dominant logic: divergence, convergence and development", *Industrial Marketing Management*, Vol.40 No.2, pp. 231-239.

Fornell, C. (1992), "A national customer satisfaction barometer: the Swedish experience", *Journal of Marketing*, Vol.56 No.1, pp. 6-22.

Francalanci, C. and Galal, H. (1998), "Information technology and worker composition: determinants of productivity in the life insurance industry", *MIS Quarterly*, Vol.22 No.2, pp. 227-241.

Frohlich, M. and Westbrook, R. (2002), "Demand chain management in manufacturing and services: web-based integration, drivers and performance", *Journal of Operations Management*, Vol.20 No.6, pp. 729-745.

Frohlich, M.T. and Westbrook, R. (2001), "Arcs of integration: an international study of supply chain strategies" *Journal of Operations Management*, Vol.19 No.2, pp. 185-200.

Frohlich, M.T. and Westbrook, R. (2002), "Demand chain management in manufacturing and services: web-based integration, drivers and performance", *Journal of Operations Management*, Vol.20, No.4, pp.729-745.

Fynes, B., Voss, C. and De Burca, S. (2005), "The impact of supply chain relationship dynamics on manufacturing performance", *International Journal of Operations & Production*, Vol. 25 No.1, pp. 6-19.

Gaiardelli, P., Saccani, N. and Songini, L. (2007), "Performance measurement systems in the after-sales service: an integrated framework", *International Journal of Business Performance Measurement*, Vol.9 No.2, pp. 145-171.

Gartner (2013), "Gartner says worldwide IT spending on pace to reach $3.7 trillion in 2013", available at http://www.gartner.com/newsroom/id/2537815 (accessed 03 January 2014).

Gavirneni, S. Kapuscinski, R. and Tayur, S. (1999), "Value of information in capacitated supply chains", *Management Science*, Vol.45 No.1, pp. 16-24.

Germain, R. and Iyer, K.N.S. (2006), "The integration of internal and downstream integration and its association with performance", *Journal of Business Logistics*, Vol.27 No.2, pp. 25-52.

Giannakis, M. (2011a), "Management of service supply chains with a service-oriented reference model: the case of management consulting", *Supply Chain Management: An International Journal*, Vol.16 No.5, pp. 346-361.

Giannakis, M. (2011b), "Conceptualizing and managing service supply chains", *The Service Industries Journal*, Vol.31, No.11, pp. 1809-1823.

Giannakis, M. and Croom, S. (2004), "Toward the development of a supply chain management paradigm: a conceptual framework", *Journal of Supply Chain Management*, Vol.40 No.1, pp. 27-37.

Gimenez, C. and Ventura, E. (2005), "Logistics-production, logistics-marketing and external integration: their impact on performance", *International Journal of Operations & Production Management*, Vol.25 No.1, pp. 20-38.

Gimenez, C., Van Der Vaart, T. and Van Donk, D.P. (2012), "Supply chain integration and performance: the moderating effect of supply complexity", *International Journal of Operations & Production Management*, Vol.32 No.5, pp. 583-610.

Goodhue, D.L., Chen, D.Q., Boudreau, M.C., Davis, A. and Cochran, J.D. (2009), "Addressing business agility challenges with enterprise systems", *MIS Quarterly Executive*, Vol.8 No.2, pp.73-87.

Goodman, B. and Steadman, R. (2002), "Services: business demand rivals consumer demand in driving job growth", *Monthly Labor Review*, Vol.125 No.4, pp. 3-9.

Gosain, S., Malhotra, A. and El Sawy, O.A. (2005), "Coordinating for flexibility in e-business supply chains", *Journal of Management Information Systems*, Vol.21 No.3, pp. 7-45.

Gronroos, C. (1990), *Service Management and Marketing: Managing the Moments of Truth in Service Competition*, Maxwell Macmillan, Singapore.

Grönroos, C. (2006), "Adopting a service logic for marketing", *Marketing Theory,* Vol.6 No.3, pp. 317-333.

Grover, V. and Malhotra, M.K. (2003), "Transaction cost framework in operations and supply chain management research: theory and measurement", Journal of Operations Management, Vol.21 No.4, pp. 457-473.

Groves, R.M., Cialdini, R.B. and Couper, M.P. (1992), "Understanding the decision to participate in a survey", *The Public Opinion Quarterly*, Vol.56 No.4, pp.475-495.

Gulati, R. (1999), "Network location and learning: the influence of network resources and firm capabilities on alliance formation", *Strategic Management Journal*, Vol.20, No.5, pp. 397-420.

Gulati, R., Nohria, N. and Zaheer, A. (2000), "Strategic networks", *Strategic Management Journal*, Vol.21, No.3, pp. 203-215.

Hair, J.F., Black, W.C., Babin, B.J. and Anderson, R.E. (2009), *Multivariate Data Analysis (7th ed.),* Prentice-Hall, NJ.

Hammer, M. (2001), "The Superefficient Company", *Harvard Business Review,* Vol.79 No.8, pp. 82-91.

Harman, H.H. (1976), *Modern Factor Analysis (3rd ed.),* University of Chicago, Chicago, IL.

Harvey, J. (1998), "Service quality: a tutorial", *Journal of Operations Management,* Vol.16 No.5, pp. 583-597.

Hayes, A.F. and Preacher, K.J. (2014), "Statistical mediation analysis with a multicategorical independent variable", *British Journal of Mathematical and Statistical Psychology,* Vol.67 No.3, pp.451-470.

Heim, G. and Peng, D. (2010), "The impact of information technology use on plant structure, practices, and performance: an Exploratory study" *Journal of Operations Management,* Vol.28 No.2, pp. 144-162.

Henderson, J.C. (1990), "Plugging into strategic partnerships: the critical IS connection", *Sloan Management Review*, Vol.31, No.3, pp. 7-18.

Henderson, R. and Cockburn I. (1994), "Measuring competence? Exploring firm effects in pharmaceutical research", *Strategic Management Journal,* Vol.15 Winter, pp. 63-84.

Hendricks, K.B., Singhal, V.R. and Stratman, J.K. (2007), "The impact of enterprise systems on corporate performance: a study of ERP, SCM, and CRM system implementations", *Journal of Operations Management*, Vol.25 No.1, pp. 65-82.

Heracleous, L. and Wirtz, J. (2010), "Singapore Airlines' balancing act", *Harvard Business Review,* Vol. 88 NO.7/8, pp.145-149.

Heskett, J.L. (1986), *Managing in the Service Economy,* Harvard Business School Press, Boston.

Hillebrand, B. and Biemans, W.G. (2003), "The relationship between internal and external cooperation: literature review and propositions", *Journal of Business Research,* Vol.56 No.9, pp. 735-743.

Hitt, L.M., and Brynjolfsson, E. (1996), "Productivity, business profitability, and consumer surplus: three different measures of information technology value", *MIS Quarterly,* Vol.20 No.2, pp. 121-142.

Hitt, L.M., Wu, D.J. and Zhou, X. (2002), "Investment in enterprise resource planning: business impact and productivity measures", *Journal of Management Information Systems,* Vol.19 No.1, pp. 71-98.

Hitt, M.A. and Ireland, R.D. (1985a), "Corporate distinctive competence, strategy, industry and performance", *Strategic Management Journal,* Vol. 6 No.3, pp. 273-293.

Hitt, M.A. and Ireland, R.D. (1985b), "Strategy, contextual factors, and performance", *Human Relations,* Vol.38 No.8, pp. 793-812.

Hitt, M.A. and Ireland, R.D. (1986), "Relationships among corporate level distinctive competencies, diversification strategy, corporate structure and performance", *Journal of Management Studies*, Vol.23 No.4, pp. 401-416.

Holloway, I. (1997), *Basic Concepts for Qualitative Research*, Blackwell Science, Oxford.

Holweg, M. and Pil, F.K. (2008), "Theoretical perspectives on the coordination of supply chains", *Journal of Operations Management*, Vol.26 No.3, pp. 389-406.

Hoque, F., Sambamurthy, V., Zmud, R., Trainer, T. and Wilson, C. (2006), *Strategic Positions, Winning the 3-Legged Race: when Business and Technology Run Together*. Prentice Hall, Upper Saddle River, NJ, pp. 29-52.

Hrebiniak, L.G. and Snow, C.C. (1982), "Top-management agreement and organizational performance", *Human Relations*, Vol.35 No.12, pp. 1139-1157.

Hsieh, J.J.P.A., Rai, A. and Xu, S.X. (2011), "Extracting business value from it: a sensemaking perspective of post-adoptive use", *Management Science,* Vol.57 No.11, pp. 2018-2039.

Hu, M.M.L., Horng, J.S. and Sun, C.Y.H. (2009), "Hospitality teams: knowledge sharing and service innovation performance", *Tourism Management,* Vol. 30 No.1, pp. 41-50.

Huan, S.H., Sheoran, S.K. and Wang, G. (2004), "A review and analysis of supply chain operations reference (SCOR) model", *Supply Chain Management: An International Journal,* Vol.9 No.1, pp. 23-29.

Hult, G.T.M., Ketchen Jr., D.J. and Slater, S.F. (2004), "Information processing, knowledge management, and strategic supply chain performance", *Academy of Management Journal*, Vol.47 No.3, pp. 241-253.

Hunt, S.D. and Davis, D. (2008), "Grounding supply chain management in resource-advantage theory", *Journal of Supply Chain Management*, Vol.44, No.1, pp. 10-21.

Huo, B., Zhao, X. and Zhou, H. (2014), "The effects of competitive environment on supply chain information sharing and performance: an empirical study in China", *Production and Operations Management*, Vol.23 No.4, pp. 552-569.

Huselid, M., Jackson, S. and Schuler, R. (1997), "Technical and strategic human resource management effectiveness as determinants of firm performance", *Academy of Management Journal,* Vol.40 No.1, pp. 171-188.

Jana, R., 2007. Service Innovation: The Next Big Thing. Business Week, March 29. [available at http://www.businessweek.com/stories/2007-03-29/service-innovation-the-next-big-thingbusinessweek-business-news-stock-market-and-financial-advice].

Jap, S.D. (1999), "Pie-expansion efforts: collaboration processes in buyer-supplier relationships", *Journal of Marketing Research,* Vol.36 No.4, pp. 461-475.

Jap, S.D. (2001), "Perspectives on joint competitive advantages in buyer-supplier relationships", *International Journal of Research in Marketing,* Vol.18 No.1-2, pp. 19-35.

Jarvenpaa, S.L. and Leidner, D.E. (1998), "An information company in mexico: extending the resource-based view of the firm to a developing country context", *Information Systems Research,* Vol.9 No.4, pp. 342-361.

Jayaram, J., Tan, K.C. and Nachiappan, S.P. (2010), "Examining the interrelationships between supply chain integration scope and supply chain management efforts", *International Journal of Production Research*, Vol.48 No.22, pp. 6837-6857.

Johnson, J.L. (1999), "Strategic integration in industrial distribution channels: managing the interfirm relationship as a strategic asset", *Journal of the Academy of Marketing Science*, Vol.27 No.1, pp. 4-18.

Johnson, P.F. and Leenders, M.R. (2004), *Supply's Organizational Roles and Responsibilities*, CAPS Research, Tempe, Arizona.

Johnson, P.F., Klassen, R.D., Leenders, M.R. and Awaysheh, A. (2007), "Utilizing e-business in supply chains: the impact of firm characteristics and teams", *Journal of Operations Management*, Vol.25 No.6, pp. 1255-1274.

Johnston, H.R. and Carrico, S.R. (1988), "Developing capabilities to use information strategically", *MIS Quarterly,* Vol.12 No.1, pp. 37-50.

Jones, P. and Hall, M. (1996), "Productivity and the new service paradigm," in Johns, N. (Ed.), *Productivity Measurement in Hospitality and Tourism*, Cassell, London.

Kathawala, Y. and Abdou, K. (2003), "Supply chain evaluation in the service industry: a framework development compared with manufacturing", *Managerial Auditing Journal*, Vol.18 No.2, pp. 140-149.

Kearns, G.S. and Lederer, A.L. (2003), "A resource-based view of strategic it alignment: how knowledge sharing creates competitive advantage", *Decision Sciences*, Vol.34 No.1, pp. 1-29.

Kenny, D. A., Kashy, D. A. and Bolger, N. (1998), "Data analysis in social psychology". In Gilbert, D., Fiske, S. and Lindzey, G. (Eds.), *The handbook of social psychology*, McGraw-Hill, Boston, MA, pp.233-265.

Kleinaltenkamp, M., Brodie, R. and Frow, P. (2012), "Resource integration", *Marketing Theory*, Vol.12 No.2, pp. 201-205.

Kling, R. (1980), “Social analysis of computing: theoretical perspectives in recent empirical research”, Computing Surveys, Vol.12 No.1, pp. 61-110.

Kohli, R. and Devaraj, S. (2003), “Measuring information technology payoff: A meta-analysis of structural variables in firm-level empirical research”, *Information Systems Research*, Vol.14, No.2, pp. 127-145.

Konsynski, B. and Tiwana, A. (2004), “The improvisation-efficiency paradox in inter-firm electronic networks: governance and architecture considerations”, *Journal of Information Technology*, Vol.19 No.4, pp. 234-243.

Koufteros, X., Vonderembse, M. and Jayaram, J. (2005), “Internal and external integration for product development: the contingency effects of uncertainty, equivocality, and platform strategy”, *Decision Sciences*, Vol.36 No.1, pp. 97-133.

Koufteros, X.A., Cheng, T.C.E. and Lai, K.H. (2007), “Black-box and gray box supplier integration in product development: antecedents, consequences and the moderating role of firm size”, *Journal of Operations Management*, Vol.25 No.4, pp. 847-870.

Krajewski, L. and Wei, J. (2001), “The value of production schedule integration in supply chains”, *Decision Sciences*, Vol.32, No.4, pp. 601-634.

Krishnan, M.S., Ramaswamy, V., Meyer, M.C. and Damien, P. (1999), “Customer Satisfaction for Financial Services: The Role of Products, Services, and Information Technology”, *Management Science*, Vol.45, No.9, pp. 1194-1209.

Kroes, J.R. and Ghosh, S. (2010), “Outsourcing congruence with competitive priorities: impact on supply chain and firm performance”, *Journal of Operations Management*, Vol.28 No.2, pp.124-143.

Kulp, S.C., Lee, H.L. and Ofek, E. (2004), “Manufacturer benefits from information integration with retail customers”, *Management Science*, Vol.50 No.4, pp. 431-444.

Lages, L.F., Mata, J. and Griffith, D.A. (2013), “Change in international market strategy as a reaction to performance decline”, *Journal of Business Research*, Vol.66 No.12, pp. 2600-2611.

Lages, L.F., Mata, J. and Griffith, D.A. (2013), “Change in international market strategy as a reaction to performance decline”, *Journal of Business Research*, Vol.66 No.12, pp. 2600-2611.

Lai, K.H., Wong, C.W.Y. and Cheng, T.C.E. (2010), “Bundling digitized logistics activities and its performance implications”, *Industrial Marketing Management*, Vol.39 No.2, pp. 273-286.

Lancioni, R.A., Smith, M.F. and Oliva, T.A. (2000), “The role of the Internet in supply chain management”, *Industrial Marketing Management*, Vol.29 No.1, pp. 45-56.

Lederer, A.L. and Mendelow, A.L. (1987), "Information resource planning: overcoming difficulties in identifying top management's objectives", *MIS Quarterly*, Vol.11 No.3, pp. 389-400.

Lederer, A.L., Mirchandani, D.A. and Sims, K. (2001), "The search for strategic advantage from the World Wide Web", *International Journal of Electronic Commerce*, Vol.5 No.4, pp. 117-133.

Lee, H. and Choi, B. (2003), "Knowledge management enablers, processes, and organizational performance: an integrative view and empirical examination", *Journal of Management Information Systems*, Vol.20 No.1, pp.179-228.

Lee, H.L. (2002), "Aligning supply chain strategies with product uncertainties", *California Management Review*, Vol.44 No.3, pp. 105-115.

Lee, H.L. and Billington, C. (1992), "Managing supply chain inventory: pitfalls and opportunities", *Sloan Management Review*, Vol.33 No.3, pp. 65-73.

Lee, H.L. and Billington, C. (1995), "The evolution of supply-chain management models and practice at Hewlett-Packard", *Interfaces*, Vol.25 No.5, pp. 42-63.

Lee, H.L. and Whang, S. (2000), "Information sharing in a supply chain", *International Journal of Manufacturing Technology and Management*, and Vol.1 No.1, pp. 1-93.

Lee, H.L. and Whang, S. (2001), "Winning the last mile of e-commerce", *Sloan Management Review*, Vol.42 No.4, pp. 54-62.

Lee, H.L., Padmanabhan, V. and Whang, S. (1997a) "Information distortion in a supply chain: the bullwhip effect", *Management Science*, Vol.43, No.4, pp. 546-558.

Lee, H.L., Padmanabhan, V. and Whang, S. (1997b), "The bullwhip effect in supply chains", *Sloan Management Review*, Vol.38 No.3, pp. 93-102.

Lee, H.L., So, K. and Tang, C. (2000), "The value of information sharing in a two-level supply chain", *Management Science*, Vol.46 No.5, pp. 626-643.

Leiponen, A. (2006), "Managing knowledge for innovation: the case of business-to-business services", *Journal of Product Innovation Management*, Vol.23 No.3, pp. 201-98.

Lemke, F., Clark, M. and Wilson, H. (2011), "Customer experience quality: an exploration in business and consumer contexts using repertory grid technique", *Journal of the Academy of Marketing Science*, Vol.39 No.6, pp. 846-869.

Leuschner, R., Rogers, D.S. and Charvet, F.F. (2013), "A meta-analysis of supply chain integration and firm performance", *Journal of Supply Chain Management*, Vol.49 No.2, pp. 34-57.

Li, G., Yan, H., Wang, S. and Xia, Y. (2005), "Comparative analysis on value of information sharing in supply chains", *Supply Chain Management: An International Journal*, Vol.10 No.1, pp. 34-46.

Li, G., Yang, H.J., Sun, L.Y. and Sohal, A.S. (2009), "The impact of IT implementation on supply chain integration and performance", *International Journal of Production Economics*, Vol.120 No.1, pp. 125-138.

Li, J., Sikora, R., Shaw, M. and Tan, G. (2006), "A strategic analysis of interorganizational information sharing", *Decision Support Systems*, Vol.42 No.1, pp. 251-266.

Liu, X., Yeung, A.C.L., Lo, C.K.Y. and Cheng, T.C.E. (2014), "The moderating effects of knowledge characteristics of firms on the financial value of innovative technology products", *Journal of Operations Management*, Vol.32 No.3, pp. 79-87.

Lockstrom, M., Schadel, J., Harrison, N., Moser, R. and Malhotra, M.K. (2010), "Antecedents to supplier integration in the automotive industry: A multiple-case study of foreign subsidiaries in China", *Journal of Operations Management*, Vol.28 No.3, pp. 240-256.

Lovelock, C.H. (1981), "Why marketing management needs to be different for services," in Donnelly, J.H. and George, W.R. (Eds.), *Marketing of Services*, American Marketing Association, Chicago.

Lu, Y. and Ramamurthy, K. (2011), "Understanding the link between information technology capability and organizational agility: an empirical examination", *MIS Quarterly*, Vol.35 No.4, pp. 931-954

Luftman, J.N. and Brier, T. (1999), "Achieving and sustaining business-IT alignment", *California Management Review*, Vol.42 No.1, pp. 109-122.

Lummus, R.R., Vokurka, R.J. and Alber, K.L. (1998), "Strategic supply chain planning", *Production and Inventory Management Journal*, Vol.39 No.3, pp. 49-58.

Lusch, R.F., Vargo, S.L. and O'Brien, M. (2007), "Competing through service: insights from service dominant logic", *Journal of Retailing*, Vol.83 No.1, pp. 5-18.

Lusch, R.F., Vargo, S.L. and Tanniru, M. (2010), "Service, value networks and learning", *Journal of the Academy of Marketing Science*, Vol.38 No.1, pp. 19-31.

Maglio, P.P. and Spohrer, J. (2008), "Fundamentals of service science", *Journal of the Academy of Marketing Science*, Vol.36 No.1, pp. 18-20.

Malhotra, A., Gosain, S. and El Sawy, O. (2007), "Leveraging standard electronic business interfaces to enable adaptive supply chain partnerships", *Information Systems Research*, Vol.18 No.3, pp. 260-279.

Malhotra, M.K. and Grover, V. (1998), "An assessment of survey research in POM:

from constructs to theory", *Journal of Operations Management*, Vol.16 No.4, pp.407-425.

Markides, C.C. and Williamson, P.J. (1994), "Related diversification, core competences and corporate performance", *Strategic Management Journal*, Vol.15 Summer, pp. 149-165.

Markus, M.L. and Robey, D. (1988), "Information technology and organizational change: causal structure in theory and research", *Management Science*, Vol.34 No.5, pp. 583-598.

Mata, F.J., Fuerst, W.L. and Barney, J.B. (1995), "Information technology and sustained competitive advantage: a resource-based analysis", *MIS Quarterly*, Vol.19 No.4, pp. 487-505.

McAfee, A. (2002), "The impact of enterprise information technology adoption on operational performance: an empirical investigation", *Production and Operations Management*, Vol.11 No.1, pp. 33-53.

McAfee, A. (2011), "What every CEO needs to know about The Cloud", *Harvard Business Review*, Vol.89 No.11, pp.124-132.

McAfee, A. and Brynjolfsson, E. (2008), "Investing in the IT that makes a competitive difference", *Harvard Business Review*, Vol.86 No.7/8, pp. 98-107.

McColgan, E.A. (1997), "How fidelity invests in service professionals", *Harvard Business Review*, Vol.75 No.1, pp. 137-143.

Melville, N., Kraemer, K. and Gurbaxani, V. (2004), "Review: information technology and organizational performance: an integrative model of IT business value", *MIS Quarterly*, Vol.28 No.2, pp. 283-322.

Menor, L.J., Roth, A.V. and Mason, C.H. (2001), "Agility in retail banking: a numerical taxonomy of strategic service groups", *Manufacturing and Service Operations Management*, Vol.3 No.4, pp. 273-292.

Meuter, M.L., Bitner, M.J., Ostrom, A. L. and Brown, S.W. (2005), "Choosing among alternative service delivery modes: an investigation of customer trial of self-service technologies", *Journal of Marketing*, Vol.69 No.2, pp.61-83.

Milgrom, P. and Roberts, J. (1988), "Communication and inventory as substitutes in organizing production", *The Scandinavian Journal of Economics*, Vol.90 No.3, pp. 275-289.

Milner, J.M. and Kouvelis, P. (2002), "On the complementary value of accurate demand information and production and supplier flexibility", *Manufacturing & Service Operations Management*, Vol.4 No.2, 99-113.

Mishra, A.A. and Shah, R. (2009), "In union lies strength: collaborative competence in new product development and its performance effects", *Journal of Operations Management*, Vol.27 No.4, pp. 324-338.

Mishra, S., Modi, S.B. and Animesh, A. (2013), "The relationship between information technology capability, inventory efficiency, and shareholder wealth: a firm-level empirical analysis", *Journal of Operations Management*, Vol.31 No.6, pp. 298-312.

Mithas, S., Krishnan, M.S. and Fornell, C. (2005), "Why do customer relationship management applications affect customer satisfaction?", *Journal of Marketing*, Vol.69 No.4, pp. 201-209.

Mithas, S., Ramasubbu, N. and Sambamurthy, V. (2011), "How information management capability influences firm performance", *MIS Quarterly*, Vol.35 No.1, pp. 237-256.

Mithas, S., Tafti, A. and Mitchell, W. (2013), "How a firm's competitive environment and digital strategic posture influence digital business strategy", *MIS Quarterly*, Vol.37 No.2, pp. 511-536.

Mithas, S., Tafti, A.R., Bardhan, I.R. and Goh, J.M. (2012), "Information technology and firm profitability: mechanisms and empirical evidence", *MIS Quarterly*, Vol.36 No.1, pp. 205-224.

Moeller, S. (2008), "Customer integration – a key to an implementation perspective of service provision", *Journal of Service Research*, Vol.11 No.2, pp. 197-210.

Mohr, J.J. and Nevin, J.R. (1990), "Communication strategies in marketing channels: a theoretical perspective", *Journal of Marketing*, Vol.54 No.4, pp. 36-51.

Mohr, J.J. snf Spekman, R.E. (1994), "Characteristics of partnership success: partnership attributes, communication behavior, and conflict resolution technique", *Strategic Management Journal*, Vol.15 No.2, pp. 135-152.

Mohr, J.J., Fisher, R.J. and Nevin, J.R. (1996), "Collaborative communication in interfirm relationships: moderating effects of integration and control", *Journal of Marketing*, Vol.60 No.3, pp. 103-115.

Monczka, R.M., Peterson, K.J. and Handfield, R.B. (1998), "Success factors in strategic supplier alliances: the buying company perspective", *Decision Sciences*, Vol.29 No.3, pp. 553-573.

Mukhopadhyay, T. and Kekre, S. (2002) "Strategic and operational benefits of electronic integration in B2B procurement processes", *Management Science*, Vol.48 No.10, pp. 1301-1313.

Mukhopadhyay, T., Kekre, S. and Kalathur, S. (1995), "Business value of information technology: a study of electronic data interchange", *MIS Quarterly*, Vol.19 No.2, pp. 137-156.

Mukhopadhyay, T., Rajiv, S. and Srinivasan, K. (1997), "Information technology impact on process output and quality", *Management Science*, Vol.43 No.12, pp. 1645-1659.

Narasimhan, R. and Das, A. (2001), "The impact of purchasing integration and practices on manufacturing performance", *Journal of Operations Management*, Vol.19, No.4, pp. 593-609.

Narasimhan, R. and Jayaram, J. (1998), "Causal linkages in supply chain management: an exploratory study of North American manufacturing firms", *Decision Sciences*, Vol.29 No.3, pp. 579-605.

Narasimhan, R. and Kim, S.W. (2002), "Effect of supply chain integration on the relationship between diversification and performance: evidence from Japanese and Korean firms", *Journal of Operations Management*, Vol.20 No.3, pp. 303-323.

Narasimhan, R., Swink, M. and Viswanathan, S. (2010), "On decisions for integration implementation: an examination of complementarities between product-process technology integration and supply chain integration", *Decision Sciences*, Vol.41 No.2, pp. 355-372.

Nelson, K.M. and Cooprider, J.G. (1996), "The contribution of shared knowledge to IS group performance", *MIS Quarterly*, Vol.20, No.4 pp. 409-429.

Nelson, R.R. and Winter, S.G. (1982), *An Evolutionary Theory of Economic Change*, Belknap Press of Harvard University Press, Cambridge, MA.

Newsted, P.R.; Huff, S.L. and Munro, M.C. (1998), "Survey Instruments in Information Systems", *MIS Quarterly*, Vol.22 No.4, pp.553-553.

Nie, W. and Kellogg, D.L. (1999), „How process of operations management view service operations", *Production and Operations Management*, Vol.8 No.3, pp. 339-355.

Noordewier, T.G., John, G. and Nevin, J.R. (1990), "Performance outcomes of purchasing arrangements in industrial buyer-vendor relationships", *Journal of Marketing*, Vol.54 No.4, pp. 80-93.

Nooteboom, B. (1992), "Information technology, transaction costs and the decision to 'make or buy'", *Technology Analysis & Strategic Management*, Vol.4 No.4, pp. 339-350.

Nyaga, G.N., Whipple, J.M. and Lynch, D.F. (2010), "Examining supply chain relationships: do buyer and supplier perspectives on collaborative relationships differ?", *Journal of Operations Management*, Vol.28 No.2, pp. 101-114.

Office of National Statistics (2009), *ONS Productivity Handbook: A Statistical Overview and Guide*, Palgrave, Basingstoke.

Oh, L.B., Teo, H.H. and Sambamurthy, V. (2012), "The effects of retail channel integration through the use of information technologies on firm performance", *Journal of Operations Management*, Vol.30 No.5, pp. 368-381.

Olsen, D., Call, V. and Wygant, S. (2005, May), "Comparative analyses of parallel paper, phone, and web surveys with and without incentives: what differences do incentive and mode makes?”, paper presented at the 60th Annual Conference of the American Association for Public Opinion Research (AAPOR), Miami Beach, FL.

Olson, J. and Boyer, K. (2003), “Factors influencing the utilization of internet purchasing in small organizations”, *Journal of Operations Management,* Vol.21 No.2, pp. 225-245.

Orlikowski, W.J. and Iacono, C.S. (2001), “Desperately seeking the ’IT’ in IT research: a call to theorizing the IT artifact”, *Information Systems Research,* Vol.12 No.2, pp. 121-134.

Ostrom, A.L., Bitner, M.J., Brown, S.W., Burkhard, K.A., Goul, M., Smith-Daniels, V., Demirkan, H. and Rabinovich, E. (2010), “Moving Forward and Making a Difference: Research Priorities for the Science of Service”, *Journal of Service Research,* Vol.13 No.1, pp.4-36.

Overby, E., Bharadwaj, A. and Sambamurthy, V. (2006), “Enterprise agility and the enabling role of information technology”, *European Journal of Information Systems,* Vol.15 No.2, pp. 120-131.

Pagell, M. (2004), “Understanding the factors that enable and inhibit the integration of operations, purchasing and logistics”, *Journal of Operations Management,* Vol.22 No.5, pp. 459-487.

Pallant, J. (2010), *SPSS Survival Manual (4th ed.),* Open University Press, Maidenhead, UK.

Parasuraman, A., V. Zeithaml, and A. Malhotra (2005), “E-S-QUAL: a multiple-item scale for assessing electronic service quality”, *Journal of Service Research*, Vol.7 No.3, pp. 213-33.

Parasuraman, A., Zeithaml, V.A. and Berry, L.L. (1985), “A conceptual model of service quality and its implications for future research”, *Journal of Marketing,* Vol.49 No.4, pp. 41-50.

Parasuraman, A., Zeithaml, V.A. and Berry, L.L. (1988), “SERVQUAL: a multiple-item scale for measuring consumer perceptions of service quality”, *Journal of Retailing*, Vol.64 No.1, pp. 12-40.

Parasuraman, A., Zeithaml, V.A. and Berry, L.L. (1994), “Reassessment of expectations as a comparison standard in measuring service quality: implications for further research”, *Journal of Marketing*, Vol.58 No.1, pp. 111-124.

Paulraj, A., Lado, A. and Chen, J. (2008), “Inter-organizational communication as a relational competency: antecedents and performance outcomes in collaborative buyer-supplier relationships”, *Journal of Operations Management,* Vol.26 No.1, pp. 45-64.

Pavlou, P. and El Sawy, O. (2006), "From IT leveraging competence to competitive advantage in turbulent environments: the case of new product development", *Information Systems Research*, Vol.17 No.3, pp. 198-227.

Pearcy, D.H. and Giunipero, L.C. (2008), "Using e-procurement applications to achieve integration: what role does firm size play?", *Supply Chain Management: An International Journal*, Vol.13 No.1, pp. 26-34.

Penrose, E.T. (1959), *The Theory of the Growth of the Firm*, John Wiley and Sons, New York.

Peteraf, M. (1993), "The cornerstones of competitive advantage: a resource-based view", *Strategic Management Journal*, Vol.14 No.3, pp. 179-191.

Petersen, K., Handfield, R. and Ragatz, G. (2005), "Supplier integration into new product development: coordinating product, process, and supply chain design", *Journal of Operations Management*, Vol.23 No.3/4, pp. 371-388.

Podsakoff, P.M., MacKenzie, S.B., Lee, J.Y. and Podsakoff, N.P. (2003), "Common method biases in behavioral research: a critical review of the literature and recommended remedies", *Journal of Applied Psychology*, Vol.88 No.5, pp. 879-903.

Poister, T.H., Edwards, L., Pasha, O.Q. and Edwards, J. (2013), "Strategy formulation and performance", *Public Performance & Management Review*, Vol.36 No.4, pp.585-615.

Polit, D.F. and Beck, C.T. (2005), *Essentials of Nursing Research: Methods, Appraisal and Utilization (6th ed.)*, Lippincott Williams & Wilkins, Philadelphia.

Porter M.E. (1991), "Towards a dynamic theory of strategy", *Strategic Management Journal*, Vol.12 No.1, pp. 95-117.

Porter, M. E. (1985), *Competitive Advantage: Creating and Sustaining Superior Performance*, Free Press, Collier Macmillan, New York, NY.

Porter, M.E. and Millar, V.E. (1985) "How information gives you competitive advantage", *Harvard Business Review*, Vol.63 No.4, pp. 149-160.

Powell, T.C. and Dent-Micallef, A. (1997), "Information technology as competitive advantage: the role of human, business, and technology resources", *Strategic Management Journal*, Vol.18 No.5, pp. 375-405.

Prahalad, C.K., V. Ramaswamy, and M.S. Krishnan (2000), "Consumer centricity", *InformationWeek*, (April 10), [available at http://www.informationweek.com/781/prahalad.htm].

Prajogo, D.I., McDermott, C.M. and Jayaram, J (2014), "The role of technological intensity in services on the capability to performance relationships – An examination in the Australian context", *Journal of Engineering and Technology Management*, Vol.31 No.1, pp. 58-72.

Priem, R.L., and Butler, J.E. (2001), “Is the resource-based ‘view’ a useful perspective for strategic management research?”, *Academy of Management Review*, Vol.26 No.1, pp. 22-40.

Pullman, M.E. and Thompson, G. (2003), “Strategies for integrating capacity with demand in service networks”, *Journal of Service Research*, Vol.5, pp.169-183.

Quinn, J.B. and Gagnon, C.E. (1986), “Will service follow manufacturing into decline?”, *Harvard Business Review*, Vol.64 No.6, pp. 95-105.

Rabinovich, E. and Bailey, J. (2004), “Physical distribution service quality in internet retailing: service pricing, transaction attributes, and firm attributes”, *Journal of Operations Management*, Vol.21 No.6, pp. 651-72.

Rabinovich, E., Dresner, M.E. and Evers, P.T. (2003), “Assessing the effects of operational processes and information systems on inventory performance”, *Journal of Operations Management*, Vol.21 No.1, pp. 63-80.

Ragatz, G.L., Handfield, R.B. and Peterson, K.J. (2002), “Benefits associated with supplier integration into new product development under conditions of technology uncertainty”, *Journal of Business Research*, Vol.55 No.5, pp. 389-400.

Rahman, S. and Wu, Y.C.J. (2011), “Logistics outsourcing in China: the manufacturer-cum-supplier perspective”, *Supply Chain Management: An International Journal*, Vol. 16 No. 6, pp. 462-473.

Rai, A. and Tang, X. (2010), “Leveraging IT capabilities and competitive process capabilities for the management of interorganizational relationship portfolios”, *Information Systems Research*, Vol.21 No.3, pp. 516-542.

Rai, A., Patnayakuni, R. and Seth, N. (2006), “Firm performance impacts of digitally enabled supply chain integration capabilities”, *MIS Quarterly*, Vol.30 No.2, pp.225-246.

Rai, A., Pavlou, P. A., Im, G., and Du, S. (2012), “Interfirm IT capability profiles and communications for cocreating relational value: evidence from the logistics industry”, *MIS Quarterly*, Vol.36 No.1, pp. 233-262.

Raj, A. and Sambamurthy, V. (2006), “The growth of interest in services management: opportunities for information systems scholars”, *Information Systems Research*, Vol.17 No.4, pp. 327-331.

Rangaswamy, A. and Van Bruggen, G.H. (2005), “Opportunities and challenges in multichannel marketing: an introduction to the special issue”, *Journal of Interactive Marketing*, Vol.19 No.2, pp. 5-11.

Ray, G., Barney, J.B. and Muhanna, W.A. (2004), “Capabilities, business, processes, and competitive advantage: chossing the dependent variable in empirical tests of the resource-based view”, *Strategic Management Journal*, Vol.25 No.1, pp.

23-37.

Ray, G., Muhanna, W.A. and Barney, J.B. (2005), “IT and the performance of the customer service process: a resource-based analysis”, *MIS Quarterly*, Vol.29 No.4, pp.625-652.

Reich, B. H. and Benbasat, I. (1996), “Measuring the linkage between and information technology objectives”, *MIS Quarterly*, Vol.20 No.1, pp. 55-81.

Reich, B. H. and Benbasat, I. (2000), “Factors that influence the social dimension of alignment between business and information technology objectives”, *MIS Quarterly*, Vol.24 No.1, pp. 81-111.

Rexhausen, D., Pibernik, R. and Kaiser, G. (2012), “Customer-facing supply chain practices—The impact of demand and distribution management on supply chain success”, *Journal of Operations Management*, Vol.30 No.4, pp. 269-281.

Ricardo, D. (1817), *Principles of Political Economy and Taxation*, J. Murry, London.

Roberts, E.S. (1999), “In defence of the survey method: an illustration from user information satisfaction”, *Accounting and Finance*, Vol.39 No.1, pp. 53-78.

Rockart, J.F. (1988), “The line takes the leadership – IS management in a wired society”, *Sloan Management Review*, Vol.29, No.4, pp. 55-64.

Rockart, J.F., Earl, M.J. and Ross, J.W. (1996), “Eight imperatives for the new IT organization”, *Sloan Management Review*, Vol.38 No.1, pp. 43-55.

Rosenzweig, E.D. (2009), “A contingent view of e-collaboration and performance in manufacturing”, *Journal of Operations Management*, Vol.27 No.6, pp.462-478.

Rosenzweig, E.D., Laseter, T. and Roth, A.V. (2011), “Through the service operations looking glass: an empirical model of B2B e-marketplace failures”, *Journal of Operations Management*, Vol.29 No.1-2, pp. 33-48.

Rosenzweig, E.D., Roth, A.V. and Dean Jr., J.W. (2003), “The influence of an integration strategy on competitive capabilities and business performance: an exploratory study of consumer products manufacturers”, *Journal of Operations Management*, Vol.21 No.4, 437-456.

Ross, J.W., Beath, C.M. and Goodhue, D.L. (1996), “Develop Long-term Competitiveness Through IT Assets”, *Sloan Management Review*, Vol.38 No.1, pp. 31-42.

Roth, A.V. and Menor, L.J. (2003), “Insights into service operations management: a research agenda”, *Production and Operations Management*, Vol.12 No.2, pp. 145-164.

Roth, A.V. and Van Der Velde, M. (1991), “Operations as marketing: a competitive service strategy”, *Journal of Operations Management*, Vol.10 No.3, pp. 303-328.

Rumelt, R. (1984), “Towards a Strategic Theory of the Firm,” in Lamb, R. (ed.), *Competitive Strategic Management*, Prentice-Hall, Englewwod Cliffs, NJ, pp. 556-570.

Rungtusanatham, M., Salvador, F., Forza, C. and Choi, T.Y. (2003a), “Supply-chain linkages and operational performance: a resource-based-view perspective”, *International Journal of Operations & Production Management*, Vol.23 No.9, pp. 1084-1099.

Rungtusanatham, M.J., Choi, T.Y., Hollingworth, D.G., Wu, Z. and Forza, C. (2003b), “Survey research in operations management: historical analyses”, *Journal of Operations Management*, Vol.21 No.4, pp.475-488.

Rust, R. (2001), “Editorial: the rise of e-service”, *Journal of Service Research*, Vol.3 No.4, pp. 283-284.

Rust, R. (2004), “A call for a wider range of service research”, *Journal of Service Research*, Vol.6 No.3, p. 211.

Rust, R. and Huang, M. (2012), “Optimizing service productivity”, *Journal of Marketing*, Vol.76 No.2, pp.47-66.

Rust, R.T. and Lemon, K.N. (2001), “E-service and the consumer”, *International Journal of Electronic Commerce*, Vol.5 No.3, pp. 83-99.

Rust, R.T. and Miu, C. (2006), “What academic research tells us about service”, *Communications of the ACM*, Vol.49 No.7, pp. 49-54.

Rust, R.T., and Zahorik, A.J. (1993), “Customer satisfaction, customer retention, and market share”, *Journal of Retailing*, Vol.69 No.2, pp. 193-215.

Sabath, R. and Fontanella, J. (2002), “The unfulfilled promise of supply chain collaboration”, *Supply Chain Management Review*, Vol.6 No.4, pp. 24-29.

Safizadeh, M.H., Field, J.M. and Ritzman, L.P. (2003), “An empirical analysis of financial services processes with a front-office or back-office orientation”, *Journal of Operations Management*, Vol. 21 No.5, pp. 557-576.

Sahin, F. and Robinson, E.P. (2002), “Flow coordination and information sharing supply chairs: review, implications, and directions for future research”, *Decision Sciences*, Vol.33 No.4, pp. 505-536.

Saldanha, T.J.V., Melvilleb, N.P., Ramirezc, R. and Richardsond, V.J. (2013), “Information systems for collaborating versus transacting: impact on manufacturing plant performance in the presence of demand volatility”, *Journal of Operations Management*, Vol.31 No.6, pp.313-329.

Sambamurthy, V. (2001), “Editor’s comments – research in information systems: what we haven’t learned,” *MIS Quarterly*, Vol.21 No.4, pp. v-xv.

Sambamurthy, V. and Zmud, R.W. (1999), “Arrangements for information technology governance: a theory of multiple contingencies”, *MIS Quarterly*, Vol.23 No.2, pp.261-290.

Sambamurthy, V., Bharadwaj, A. and Grover, V. (2003), “Shaping agility through digital options: reconceptualizing the role of information technology in contemporary firms”, *MIS Quarterly,* Vol.27 No.2, pp. 237-63.

Sampson, S.E. and Froehle, C.M. (2006), “Foundations and implications of a proposed unified services theory”, *Production and Operations Management*, Vol.15 No.2, pp. 329-343.

Sampson, S.E. and Spring, M. (2012), “Customer roles in service supply chains and opportunities for innovation”, *Journal of Supply Chain Management*, Vol.48, No.4, pp.30-50.

Sanders, N. (2005), “IT alignment in supply chain relationships: a study of supplier benefits”, *Journal of Supply Chain Management*, Vol.41 No.2, pp. 4-13.

Sanders, N.R. (2007), “An empirical study of the impact of e-business technologies on organizational collaboration and performance”, *Journal of Operations Management*, Vol.25 No.6, pp. 1332-1347.

Sanders, N.R. (2008), “Pattern of information technology use: the impact on buyer-suppler coordination and performance”, *Journal of Operations Management*, Vol.26 No.3, pp. 349-367.

Sanders, N.R. and Premus, R. (2005), “Modeling the relationship between firm IT capability collaboration, and performance”, *Journal of Business Logistics*, Vol.26 No.1, pp. 1-23.

Santangelo, G.D. (2002), “The regional geography of corporate patenting in information and communications technology (ICT): domestic and foreign dimension”, *Regional Studies*, Vol.36 No.5, pp. 495-514.

Santhanam, R. and Hartono, E. (2003), “Issues in Linking Information Technology Capability to Firm Performance”, *MIS Quarterly*, Vol.27 No.1, pp. 125-153.

Saunders, M., Thornhill, A. and Lewis, P. (2009), *Research Methods for Business Students (5th ed.),* Pearson Education, Essex.

Schmenner, R.W. and Swink, M.L. (1998), “On theory in operations management”, *Journal of Operations Management*, Vol.17 No.1, pp. 97-113.

Schoenherra, T. and Swink, M. (2012), “Revisiting the arcs of integration: cross-validations and extensions”, *Journal of Operations Management*, Vol.30 No.1-2, pp. 99-115.

Schroeder R.G., Bates, K.A. and Junttila, M.A. (2002), “A resource-based view of manufacturing strategy and the relationship to manufacturing performance”, *Strategic Management Journal,* Vol.23 No.2, pp. 105-117.

Scott, C. and Westbrook, R. (1991), “New strategic tools for supply chain management”, *International Journal of Physical Distribution and Logistics Management*, Vol.21 No.1, pp. 23-33.

Sengupta, K., Heiser, D. and Koll, L. (2006), “Manufacturing and service supply chain performance: a comparative analysis”, *Journal of Supply Chain Management*, Vol.42 No.4, pp. 4-15.

Setia, P. and Patel, P.C. (2013), “How information systems help create OM capabilities: Consequents and antecedents of operational absorptive capacity”, *Journal of Operations Management*, Vol.31 No.6, pp.409-431.

Sezen, B. (2008), “Relative effects of design, integration and information sharing on supply chain performance”, *Supply Chain Management: An International Journal*, Vol.13 No.3, pp. 233-240

Shang, S. and Seddon, P.B. (2002), “Assessing and managing the benefits of enterprise systems: the business manager’s perspective”, *Information Systems Journal*, Vol.12 No.4, pp. 271-299.

Shankar, V., Smith, A. K., and Rangaswamy, A. (2003), “Customer satisfaction and loyalty in online and offline environments”, *International Journal of Research in Marketing*, Vol.20 No.2, pp. 153-175.

Sinkovics, R.R. and Roath, A.S. (2004), “Strategic orientation, capabilities, and performance in manufacturer – 3PL relationships”, *Journal of Business Logistics*, Vol.25 No.2, pp. 43-64.

Sorenson, O. (2003), “Interdependence and adaptability: organizational learning and the long-term effect of integration”, *Management Science*, Vol.49 No.4, pp. 446-463.

Soteriou, A.C. and Chase, R.B. (1998), “Linking the customer contact model to service quality”, *Journal of Operations Management*, Vol.16 No.4, pp.495-508.

Sousa, R. and Voss, C.A. (2006), “Service quality in multichannel services employing virtual channels”, *Journal of Service Research*, Vol.8, No.4, pp.356-371.

Spohrer, J., Maglio, P., Bailey, J. and Gruhl, D. (2007), “Steps towards a science of service systems”, *Computer*, Vol.40 No.1, pp. 71-77.

Srinivasan, S.S., Anderson, R. and Ponnavolu, K. (2002), “Customer loyalty in e-commerce: an exploration of its antecedents and consequences”, *Journal of Retailing*, Vol.78 No.1, pp. 41-50.

Stalk, G., Evans P. and Shulman, L.E. (1992), “Competing on capabilities: the new rules of corporate strategy”, *Harvard Business Review*, Vol.70 No.2, pp. 57-69.

Stank, T.P., Crum, M. and Arango, M. (1999), “Benefits of inter firm coordination in food industry supply chain”, *Journal of Business Logistics*, Vol.20 No.2, pp. 21-41.

Stank, T.P., Keller, S.B. and Closs, D.J. (2001a), "Performance benefits of supply chain integration", *Transportation Journal*, Vol.41 No.2/3, pp. 32-46.

Stank, T.P., Keller, S.B. and Daugherty, P.J. (2001b), "Supply chain collaboration and logistical service performance", *Journal of Business Logistics,* Vol.22 No.1, pp. 29-48.

Stauss, B. (2005), "A pyrrhic victory: the implications of an unlimited broadening of the concept of services," *Managing Service Quality*, Vol.15 No.3, pp. 219-229.

Stevens, G.C. (1989), "Integrating the supply chain", *International Journal of Physical Distribution and Materials Management*, Vol.19 No.8, pp. 3-8.

Stevens, G.C. (1990), "Successful supply-chain management", *Management Decision,* Vol.28 No.8, pp. 25-30.

Stock, G.N., Greis, N.P. and Kasarda, J.D. (2000), "Enterprise logistics and supply chain structure: the role of fit", *Journal of Operations Management*, Vol.18 No.5, pp. 531-547

Strader, T., Lin, F. and Shaw, M. (1999), "The impact of information sharing on order fulfillment in divergent differentiation supply chains", *Journal of Global Information Management*, Vol.7 No.1, pp. 16-25.

Straub, D., Rai, A. and Klein, R. (2004), "Measuring firm performance at the network level: a nomology of the business impact of digital supply networks", *Journal of Management Information Systems*, Vol.21, No.1, pp. 83-114.

Straub, D.W. and Watson, R.T. (2001), "Transformational issues in researching is and net-enabled organizations", *Information Systems Research*, Vol.12 No.4, pp. 337-345.

Subramani, M. (2004), "How do suppliers benefit from information technology use in supply chain relationships?", *MIS Quarterly,* Vol.28 No.1, pp. 45-73.

Supply-Chain Council. "Supply-Chain Operations Reference Model: Overview of SCOR Version 11.0," www. supply-chain.org, released on December 1, 2012.

Suresh, H. (2004), *What is customer relationship management (CRM)?,* Supply Chain Planet.

Svensson, G. (2004), "A customized construct of sequential service quality in service encounter chains: time, context, and performance threshold", *Managing Service Quality*, Vol.14 No.6, pp. 468-75.

Swafford, P.M., Ghosh, S. and Murthy, N. (2008), "Achieving supply chain agility through IT integration and flexibility", *International Journal of Production Economics*, Vol.116 No.12, pp. 288-297.

Swink, M., Narasimhan, R. and Kim, S.W. (2005), "Manufacturing practices and strategy integration: effects on cost efficiency, flexibility, and market-based performance", *Decision Sciences*, Vol.36 No.3, pp. 427-457.

Swink, M., Narasimhan, R. and Wang, C. (2007), "Managing beyond the factory walls: effects of four types of strategic integration on manufacturing plant performance", *Journal of Operations Management*, Vol.25 No.1, pp. 148-164.

Tabachnick, B.G. and Fidell, L.S. (2012), *Using Multivariate Statistics (6th ed.)*, Pearson, London.

Tai, Y.M., Ho, C.F. and Wu, W.H. (2010), "The performance impact of implementing web-based e-procurement systems", *International Journal of Production Research*, Vol.48 No.18, pp. 5397-5414.

Tallon, P. (2007), "Does IT pay to focus? an analysis of it business value under single and multi-focused business strategies", *Journal of Strategic Information Systems*, Vol.16 No.3, pp. 278-300.

Tallon, P., Kraemer, K.L. and Gurbaxani, V. (2000), "Executives' perceptions of the business value of information technology", *Journal of Management Information Systems*, Vol.16 No.4, pp. 145-173.

Tan, C.W., Benbasat, I. and Cenfetelli, R.T. (2013), "IT-mediated customer service content and delivery in electronic governments: an empirical investigation of the antecedents of service quality", *MIS Quarterly*, Vol.37 No.1, pp. 77-109.

Tan, K.C., Kannan, V.R., Hsu, C.C. and Leong, G.K. (2010), "Supply chain information and relational alignments: mediators of EDI on firm performance", *International Journal of Physical Distribution & Logistics Management*, Vol.40 No.5, pp. 377-94.

Tang, X. and Rai, A. (2012), "The moderating effects of supplier portfolio characteristics on the competitive performance impacts of supplier-facing process capabilities", *Journal of Operations Management*, Vol.30 No.1-2, pp.85-98.

Tapscott, D. and Caston, A. (1993), *Paradigm Shift: The New Promise of Information Technology*, McGraw-Hill. New York, NY.

Teece, D. J., Pisano, G., and Shuen, A. (1997), "Dynamic capabilities and strategic management", *Strategic Management Journal*, Vol.18 No.7, pp.509-533.

Thirumalaia, S. and Sinhab, K.K. (2011), "Customization of the online purchase process in electronic retailing and customer satisfaction: an online field study", *Journal of Operations Management*, Vol.29 No.5, pp. 477-487.

Thompson, G.M. (2011), "Cherry-picking customers by party size in restaurants", *Journal of Service Research*, Vol.14 No.2, pp.201-213.

Thun, J. (2010), "Angles of integration: an empirical analysis of the alignment of internet-based information technology and global supply chain integration", *Journal of Supply Chain Management*, Vol.46 No.2, pp. 30-44.

Tippins, M.J. and Sohi, R.S. (2003), “IT competency and firm performance: is organizational learning a missing link?”, *Strategic Management Journal*, Vol.24 No.8, pp. 745-761.

Tracey, M., Lim, J. and Vonderembse, M.A. (2005), “The impact of supply-chain management capabilities on business performance”, *Supply Chain Management: An International Journal*, Vol.10 No.3, pp. 179-191.

Tsang, J.H.Y. and Antony, F. (2001), “Total quality management in UK service organisations: some key findings from a survey”, *Managing Service Quality*, Vol.11 No.2, pp. 132-141.

Tsikriktsis, N., Lanzolla, G. and Frohlich, M. (2004), “Adoption of e-processes by service firms: an empirical study of antecedents”, *Production and Operations Management*, Vol.13 No.3, pp. 216-229.

Uzzi, B. (1997), “Social structure and competition in interfirm networks: the paradox of embeddedness”, *Administrative Science Quarterly*, Vol.42 No.1, pp. 35-67.

Van Ark, B., Mahony, M. and Timmer, M.P. (2008), “The productivity gap between Europe and the United States: trends and causes”, *Journal of Economic Perspectives*, Vol.22 No.1, pp. 25-44.

Van Der Vaart, J.T. and Van Donk, D.P. (2008), “A critical review of survey-based research in supply chain integration”, *International Journal of Production Economics*, Vol.111 No.1, pp. 42-55.

Van Der Valk, W. and Rozemeijer, F. (2009), “Buying business services: towards a structured service purchasing process”, *Journal of Services Marketing*, Vol.23 No.1, pp. 3-10.

Vargo, S.L. and Lusch, R.F. (2008), “Service-dominant logic: continuing the evolution”, *Journal of the Academy of Marketing Science*, Vol.36 No.1, pp. 1-10.

Vargo, S.L., and Lusch, R.F. (2004a), “Evolving to a new dominant logic for marketing”, *Journal of Marketing*, Vol.68 No.1, pp. 1-17.

Vargo, S.L., and Lusch, R.F. (2004b), “The four service marketing myths: remnants of a goods-based, manufacturing model”, *Journal of Service Research*, Vol.6 No.4, pp. 324-435.

Vickery, S.K., Jayaram, J., Droge, C. and Calantone, R. (2003), “The effects of an integrative supply chain strategy on customer service and financial performance: an analysis of direct versus indirect relationships”, *Journal of Operations Management*, Vol.21 No.5, pp. 523-39.

Vogelstein, F. and Hjelt, P. (2001), “Features/Corp Special Report”, *Fortune Magazine*, April 30, p. 142.

Vogt, P.W. (2005), *Dictionary of statistics and methodology: a nontechnical guide for the social sciences*, Sage Publications, Thousand Oaks.

Von Nordenflycht, A. (2007), “Is public ownership bad for professional service firms? Adagency ownership, performance, and creativity”, *Academy of Management Journal*, Vol.50 No.2, pp. 429-445.

Von Nordenflycht, A. (2010), “What is a professional service firm? Toward a theory and taxonomy of knowledge intensive firms”, *Academy of Management Review*, Vol.35 No.1, pp. 155-174.

Voss, C. (2000), “Developing an eService strategy”, *Business Strategy Review*, Vol.11 No.1, pp. 21-33.

Voss, C., Roth, A.V. and Chase, R.B. (2008), “Experience, service operations strategy, and services as destinations: foundations and exploratory investigation”, *Production and Operations Management*, Vol.17 No.3, pp. 247-266.

Voss, C.A. and Hsuan, J. (2009), “Service architecture and modularity”, *Decision Sciences*, Vol.40 No.3, pp. 541-569.

Voss, C.A., Roth, A.V., Rosenzweig, E.D., Blackmon, K. and Chase, R.B. (2004), “A tale of two countries’ conservatism, service quality, and feedback on customer satisfaction”, *Journal of Service Research*, Vol.6, No.3, pp.212-230.

Wade, M. and Hulland, J. (2004), “Review: the resource-based view and information systems research: review, extension, and suggestions for future research”, *MIS Quarterly*, Vol.28 No.1, pp.107-142.

Wang, E.T.G. and Wei, H. (2007), “Interorganizational governance value creation: coordinating for information visibility and flexibility in supply chains”, *Decision Sciences*, Vol.38 No.4, pp. 647-674.

Wang, W., Nelson, S. and Alberta, J.M. (2013), “Estimation of causal mediation effects for a dichotomous outcome in multiple-mediator models using the mediation formula”, *Statistics in Medicine*, Vol.32 No.24, pp. 4211-4228.

Ward, P.T. and Duray, R. (2000), “Manufacturing strategy in context: environment, competitive strategy and manufacturing strategy”, *Journal of Operations Management*, Vol.18 No.2, pp.123-138.

Weber, M.M. and Kantamneni, S.P. (2002), “POS and EDI in retailing: an examination of underlying benefits and barriers”, *Supply Chain Management: An International Journal*, Vol.7 No.5 pp.311-317.

Wei, J.C. and Krajewski, L (2000), “A model for comparing supply chain schedule integration approaches”, *International Journal of Production Research*, Vol.38 No.9, pp. 2099-2123.

Weill, P. and Broadbent, M. (1998), *Leveraging the New Infrastructure: How Market Leaders Capitalize on Information Technology*, Harvard Business School Press, Boston, MA.

Weill, P. and Ross, J. (2004), *IT Governance: How Top Performers Manage IT*

Decision Rights for Superior Results, Harvard Business School Press, Boston, MA.

Weill, P., Subramani, M. and Broadbent, M. (2002), “Building IT infrastructure for strategic agility”, *Sloan Management Review,* Vol.44 No.1, pp. 57-65.

Wernerfelt, B. (1984), “A resource-based view of the firm”, *Strategic Management Journal*, Vol.5 No.2, pp. 171-180.

Wiengarten, F., Humphreys, P., McKittrick, A. and Fynes, B. (2013), “Investigating the impact of e-business applications on supply chain collaboration in the German automotive industry”, *International Journal of Operations & Production Management*, Vol.33 No.1, pp. 25-48

Wiengarten, F., Pagell, M. Ahmed, M.U., and Gimenez, C. (2014), “Do a country’s logistical capabilities moderate the external integration performance relationship?”, *Journal of Operations Management*, Vol.32 No.1-2, pp. 51-63.

Wilkinson, J.W., Cerullo, M.J., Raval, V. and Wong-On-Wing, B. (2000), *Accounting Information Systems*. John Wiley and Sons, Inc, New York.

Williams, D.B., Roh, J., Tokarb, T. and Swink, M. (2013), “Leveraging supply chain visibility for responsiveness: the moderating role of internal integration”, *Journal of Operations Management*, Vol.31 No.7-8., pp. 543-554.

Williamson, O.E. (1975), *Markets and Hierarchies: Economics and Antitrust Implications*, The Free Press, New York.

Williamson, O.E. (1985), *The Economic Institutions of Capitalism*, The Free Press, New York, NY.

Williamson, O.E. (1991), “Strategizing, economizing and economics organization”, *Strategic Management Journal*, Vol.12 No.8, pp. 75-94.

Williamson, O.E. (1993), “Calculativeness, trust, and economic organization”, *Journal of Law and Economics*, Vol.36 No.4, pp. 453-486.

Wind, J. and Rangaswamy, A. (2001), “Customerization: the next revolution in mass customization”, *Journal of Interactive Marketing*, Vol.15 No.1, pp. 13-32.

Wind, Y. and Mahajan, V. (2002), “Convergence marketing”, *Journal of Interactive Marketing*, Vol.16 No.2, pp. 64-79.

Wong, C.Y., Boon-itt, S. and Wong, C.W.Y. (2011), “The contingency effects of environmental uncertainty on the relationship between supply chain integration and operational performance”, *Journal of Operations Management,* Vol.29 No.6, pp. 604-615.

World Bank (2009), *World Development Report*, World Bank, Washington, DC.

Wu, F., Mahajan, V. and Balasubramanian, S. (2003), “An analysis of e-business adoption and its impact on business performance”, *Journal of the Academy of*

Marketing Science, Vol.31 No.4, pp. 425-447.

Xue, L., Ray, G. and Sambamurthy, V. (2013), “The impact of supply-side electronic integration on customer service performance”, *Journal of Operations Management*, Vol.31 No.6, pp. 363-375.

Yao, Y., Kohli, R., Sherer, S.A. and Cederlund, J. (2013), “Learning curves in collaborative planning, forecasting, and replenishment (CPFR) information systems: an empirical analysis from a mobile phone manufacturer”, *Journal of Operations Management*, Vol.31 No.6, pp.285-297.

Zaheer, A. and Bell, G.G. (2005), “Benefiting from network position: firm capabilities, structural holes, and performance”, *Strategic Management Journal*, Vol.26 No.9, pp. 809-825.

Zeithaml, V. and Binter, M.J. (1996), *Services Marketing*, McGraw-Hill, New York.

Zeithaml, V. and Bitner. M. (2003), *Services marketing: integrating customer focus across the firm (3rd ed.)*, The McGraw-Hill Company, New York, NY.

Zeithaml, V.A., Berry, L.L. and Parasuraman, A. (1996), “The behavioral consequences of service quality”, *Journal of Marketing*, Vol.60 No.2, pp. 31-46.

Zeithaml, V.A., Parasuraman, A. and Malhotra, A. (2002), “Service quality delivery through web sites: a critical review of extant knowledge”, *Academy of Marketing Science Journal*, Vol.30 No.4, pp. 362-375.

Zhang, C. and Dhaliwal, J. (2009), “An investigation of resource-based and institutional theoretic factors in technology adoption for operations and supply chain management”, *International Journal of Production Economics*, Vol.120 No.1, pp. 252-69.

Zhang, X., Van Donk, D.P. and Van Der Vaart, T. (2011), “Does ICT influence supply chain management and performance?: A review of survey based research”, *International Journal of Operations & Production Management*, Vol.31, No.11, pp. 1215-1247.

Zhao, X., Huo, B., Flynn, B.B. and Yeung, J.H.Y. (2008), “The impact of power and relationship commitment on the integration between manufacturers and customers in a supply chain”, *Journal of Operations Management*, Vol.26 No.3, pp. 368-388.

Zhao, X., Huo, B., Selen, W. and Yeung, J. (2011), “The impact of internal integration and relationship commitment on external integration”, *Journal of Operations Management*, Vol.29 No.1-2, pp. 17-32.

Zhao, X., Xie, J. and Leung, J. (2002a), “The impact of forecasting model selection on the value of information sharing in a supply chain”, *European Journal of Operational Research*, Vol.142 No.2, pp. 321-344.

Zhao, X., Xie, J. and Zhang, W.J. (2002b), “The impact of information sharing and ordering coordination on supply chain performance”, *Supply Chain Management: An International Journal*, Vol.7 No.1, pp. 24-40.

Zhou, H. and Benton, W.C. (2007), “Supply chain practice and information sharing”, *Journal of Operations Management*, Vol.25 No.6, pp. 1348-1365.

Zhu, K. and Kraemer, K. (2005), “Post-adoption variations in usage and value of e-business by organizations: cross-country evidence from the retail industry”, *Information Systems Research*, Vol.16 No.1, pp. 61-84.

Zhu, K. and Kraemer, K.L. (2002), “E-commerce metrics for net-enhanced organizations: assessing the value of e-commerce to firm performance in the manufacturing sector”, *Information Systems Research*, Vol.13 No.3, pp. 275-295.

Zhu, K., Kraemer, K.L., Xu, S. and Dedrick, J. (2004), “Information technology payoff in e-business environments: an international perspective on value creation of e-business in the financial services industry”, *Journal of Management Information Systems*, Vol.21 No.1, pp. 17-54.

Zuckerman, A (2005), ‘‘What’s working (and what isn’t) in integrated supply chain technology”, *World Trade*, Vol.18 No.6, pp.50-55.

APPENDICES

Appendix 1.1: Initial email invitation

Subject: Durham University - Information Systems and Operational Performance Survey

Dear Mr A. Smith,

I am a doctoral researcher from Durham Business School at Durham University. For my doctorate, I am conducting research investigating the effects of information systems (IS) on operational performance. As an Operations Director for Company A, you could provide me with invaluable insights that could help advance my research. I would therefore appreciate it if you could complete the questionnaire (see link below).

Link to Information Systems and Operational Performance Survey

Completing the questionnaire should take about 10 and no more than 15 minutes. All replies will be treated with the strictest confidence. A summary of results will be sent to all respondents that request it upon completion of the research.

The aim of my research is to investigate the role of supply chain integration capabilities on the contribution of Information Systems to operational performance. I focus on service establishments in the UK. The results of this research will provide insights into ways of improving operational performance of companies by enhancing their supply chain process abilities, particularly the abilities to deal with the dynamic environment.

If you are willing to assist me in this research, and feel that this research is applicable to your company, please click the above link to start the questionnaire.

If you require any further information, please do not hesitate to contact me by replying to this message.

Kind regards,
Teng Teng

Teng Teng
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Durham Business School
Ranked 55th in the World and top ten in the UK in the Financial Times Global MBA ranking

Appendix 1.2: Information systems and operational performance questionnaire

The aim of this survey is to gather information from service establishments, in order to examine the effects of information systems (IS) on operational performance. Please take a few minutes to provide us with feedback about your experience with IS capabilities and supply chain integration process of your company.

This questionnaire contains three parts - Information Systems, Supply Chain Integration, and Operational Performance. Please indicate in the space provided the degree to which each statement applies to you. There are no right or wrong answers to the questions, please try to complete ALL of the questions.

Completing the questionnaire should take about 10 and no more than 15 minutes. All replies will be treated with the strictest confidence. A summary of results will be sent to all respondents that request it upon completion of the research.

All replies will be treated in the strictest confidence. In order to maintain confidentiality, the first five questions (Question 1 to 5) will be detached from this questionnaire on its receipt and the information of these questions will be used only to send participants a summary of the results.

If you have any further questions about this research, please do not hesitate to contact me.

I look forward to receiving your completed questionnaire and very much appreciate your support.

Yours faithfully,

Teng Teng
Durham Business School
Durham University
Email: teng.teng@durham.ac.uk

Please indicate your company profile in terms of:

Q1. Contact Name (optional):
Q2. Position (optional):
Q3. Email Address (optional):
Q4. Company Name (optional):
Q5. Postal Address (optional):

Q6. Please indicate the industrial sector your company is in:

☐	Electricity, gas and water supply	☐	Wholesale and retail trade
☐	Hotels and restaurants	☐	Transport, storage and communications
☐	Banks, insurance companies, and other financials	☐	Real estate, renting and business activities
☐	Education	☐	Health and social work
☐	Other services Other services (please specify):		

Q7. How many employees are at your company?									
☐	Less than 100	☐	100 – 199	☐	200 – 499	☐	500 – 999	☐	1000 or more

Information Systems

IS capabilities are company-specific IT assets and abilities that influence how post-implementation IT applications and IT-related resources are used in the supply chain environment, including IT for supply chain activities, flexible IT infrastructure, and IT operations shared knowledge.

IT for supply chain activities refers to a company's use of IT for processing transactions, co-ordinating activities, and facilitating collaboration with suppliers and customers through information sharing.

Please indicate whether or not your company has implemented the following IT applications in your operations processes:

Please tick ALL of the IT applications that implemented in your company.

Q8. IT for Supply Chain Activities
☐ 1. Enterprise Resource Planning (ERP) System
☐ 2. Advanced Material Requirement Planning (MRP) II System
☐ 3. Advanced planning and scheduling
☐ 4. Production planning system
☐ 5. Production scheduling system
☐ 6. Process monitoring system
☐ 7. Supplier account management system
☐ 8. Supply chain management system

☐	9. Inventory management system
☐	10. Purchase management system
☐	11. Web-enabled invoices and/or payments
☐	12. Collaborative business forecasting with suppliers (via EDI/web-enabled applications)
☐	13. Scanning/imaging technology
☐	14. Network with agents/brokers
☐	15. Web-enabled customer interaction
☐	16. Call Tracking / Customer Relationship Management (CRM) System
☐	17. Computer Telephony Integration (CTI)
☐	18. Customer-service expert/knowledge-based system
☐	19. Web-enabled customer order entry
☐	20. Collaborative business forecasting with customers (via EDI/web-enabled applications)
☐	21. Other IT application(s) Other IT application(s) (please specify)

Flexible IT infrastructure refers to a company's ability to deploy a shareable platform that supports a foundation for data management, a communications network, and an application portfolio.

Please indicate the extent to which you agree with the following statements in terms of your flexible IT infrastructure:

Q9. Flexible IT Infrastructure		*	
1. Our company has established corporate rules and standards for hardware and operating systems to ensure platform compatibility.	Strongly	1 2 3 4 5 6 7	Strongly
2. Our company has identified and standardized data to be shared across systems and operations department.		1 2 3 4 5 6 7	

*4=Neither Agree or Disagree

IT operations shared knowledge refers to the knowledge that the operations manager possesses about how IT can be effectively used to achieve the supply chain processes and operational activities.

Please indicate the extent to which you agree with the following statements in terms of your IT operations shared knowledge:

Q10. IT Operations Shared Knowledge		*	
1. IT Managers understand the process of the operations department.	Strongly Disagree	1 2 3 4 5 6 7	Strongly Agree
2. IT Managers understand the strategies of the operations department.		1 2 3 4 5 6 7	
3. There is a common understanding between managers in IT and operations departments regarding how to use IT to improve operational performance.		1 2 3 4 5 6 7	

*4=Neither Agree or Disagree

Supply Chain Integration

Please indicate the extent of integration or information sharing between your company and your **suppliers** in the following areas:

Q11. Supplier Integration					*				
1. The level of information exchange with our suppliers through information networks.	Not at all	1	2	3	4	5	6	7	Extensive
2. The establishment of quick ordering systems with our suppliers.		1	2	3	4	5	6	7	
3. The level of strategic partnership with our suppliers.		1	2	3	4	5	6	7	
4. The participation level of our suppliers in the design stage.		1	2	3	4	5	6	7	
5. Our suppliers share their production and delivery schedule with us.		1	2	3	4	5	6	7	
6. Our supplier shares inventory / staffing availability (or data) with us.		1	2	3	4	5	6	7	
7. We share our production plans with our suppliers.		1	2	3	4	5	6	7	
8. We share our demand forecasts with our suppliers.		1	2	3	4	5	6	7	
9. We share our inventory / staffing levels (or data) with our suppliers.		1	2	3	4	5	6	7	
10. We help our suppliers to improve their process to better meet our needs.		1	2	3	4	5	6	7	

*4=Somewhat Extensive

Please indicate the extent of integration or information sharing between your company and your **customers** in the following areas:

Q12. Customer Transactions					*				
1. The level of linkage with our customers through information networks.	Not at all	1	2	3	4	5	6	7	Extensive
2. The level of computerisation for our customers' ordering.		1	2	3	4	5	6	7	
3. The establishment of quick ordering systems with our customers.		1	2	3	4	5	6	7	

*4=Somewhat Extensive

Q13. Customer Connection					*				
1. The level of communication with our customers.	Not at all	1	2	3	4	5	6	7	Extensive
2. Follow-up with our customers for feedback.		1	2	3	4	5	6	7	
3. The frequency of period contacts with our customers.		1	2	3	4	5	6	7	

*4=Somewhat Extensive

Q14. Customer Collaboration		1	2	3	4*	5	6	7	
1. Our customers share Point of Sales (POS) information with us.	Not at all	1	2	3	4	5	6	7	Extensive
2. Our customers share demand forecast with us.		1	2	3	4	5	6	7	
3. We share our production plan with our customers.		1	2	3	4	5	6	7	
4. We share our inventory / staffing availability (or data) with our customers.		1	2	3	4	5	6	7	

*4=Somewhat Extensive

Operational Performance

Please rate your company's operational performance in each of the following areas as compared to the performance of your competitors in the industry:

Q15. Cost		1	2	3	4*	5	6	7	
1. Provide low cost service	Much Worse than Competition	1	2	3	4	5	6	7	Much Better than Competition
2. High labour productivity		1	2	3	4	5	6	7	
3. Cost effectiveness of process technology		1	2	3	4	5	6	7	
Q16. Quality									
1. Provide consistent level of service (reliability)		1	2	3	4	5	6	7	
2. Perceived quality (customer's perception)		1	2	3	4	5	6	7	
3. Provide accurate information (credibility)		1	2	3	4	5	6	7	
4. Provide timely information (responsiveness)		1	2	3	4	5	6	7	
5. Conformance (degree to which service meets standards)		1	2	3	4	5	6	7	
6. Speed of service / reduce wait times		1	2	3	4	5	6	7	
7. Perform promised service on time		1	2	3	4	5	6	7	

*4=Equal to Competition

This is the end of the questionnaire. Thank you very much for your time and effort!

Appendix 6.1: Frequencies analysis of items in Flexible IT Infrastructure (ITINF)

ITINF_1 Established corporate rules and standards					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	4	2.6	2.6	2.6
	Disagree	5	3.2	3.2	5.8
	Slightly Disagree	19	12.2	12.2	17.9
	Neither Agree or Disagree	37	23.7	23.7	41.7
	Slightly Agree	43	27.6	27.6	69.2
	Agree	29	18.6	18.6	87.8
	Strongly Agree	19	12.2	12.2	100.0
	Total	156	100.0	100.0	

ITINF_2 Identified and standardised data					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	4	2.6	2.6	2.6
	Disagree	7	4.5	4.5	7.1
	Slightly Disagree	22	14.1	14.1	21.2
	Neither Agree or Disagree	34	21.8	21.8	42.9
	Slightly Agree	46	29.5	29.5	72.4
	Agree	26	16.7	16.7	89.1
	Strongly Agree	17	10.9	10.9	100.0
	Total	156	100.0	100.0	

Appendix 6.2: Frequencies analysis of items in IT Operations Shared Knowledge (ITOSK)

ITOSK_1 IT Managers understand operations process					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	3	1.9	1.9	1.9
	Disagree	11	7.1	7.1	9.0
	Slightly Disagree	16	10.3	10.3	19.2
	Neither Agree or Disagree	39	25.0	25.0	44.2
	Slightly Agree	39	25.0	25.0	69.2
	Agree	28	17.9	17.9	87.2
	Strongly Agree	20	12.8	12.8	100.0
	Total	156	100.0	100.0	

ITOSK_2 IT Managers understand operations strategies					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	5	3.2	3.2	3.2
	Disagree	10	6.4	6.4	9.6
	Slightly Disagree	21	13.5	13.5	23.1
	Neither Agree or Disagree	38	24.4	24.4	47.4
	Slightly Agree	36	23.1	23.1	70.5
	Agree	24	15.4	15.4	85.9
	Strongly Agree	22	14.1	14.1	100.0
	Total	156	100.0	100.0	

ITOSK_3 Common understanding IT-Operations managers					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	3	1.9	1.9	1.9
	Disagree	15	9.6	9.6	11.5
	Slightly Disagree	23	14.7	14.7	26.3
	Neither Agree or Disagree	43	27.6	27.6	53.8
	Slightly Agree	34	21.8	21.8	75.6
	Agree	22	14.1	14.1	89.7
	Strongly Agree	16	10.3	10.3	100.0
	Total	156	100.0	100.0	

Appendix 6.3: Frequencies analysis of items in Supplier Integration (SI)

SI_1 Information exchange with our suppliers					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Not at all	17	10.9	10.9	10.9
	2	27	17.3	17.3	28.2
	3	41	26.3	26.3	54.5
	4 Somewhat Extensive	29	18.6	18.6	73.1
	5	18	11.5	11.5	84.6
	6	16	10.3	10.3	94.9
	7 Extensive	8	5.1	5.1	100.0
	Total	156	100.0	100.0	

SI_2 Quick ordering systems with our suppliers					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Not at all	16	10.3	10.3	10.3
	2	21	13.5	13.5	23.7
	3	36	23.1	23.1	46.8
	4 Somewhat Extensive	36	23.1	23.1	69.9
	5	21	13.5	13.5	83.3
	6	17	10.9	10.9	94.2
	7 Extensive	9	5.8	5.8	100.0
	Total	156	100.0	100.0	

SI_3 Strategic partnership with our suppliers					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Not at all	11	7.1	7.1	7.1
	2	17	10.9	10.9	17.9
	3	30	19.2	19.2	37.2
	4 Somewhat Extensive	37	23.7	23.7	60.9
	5	28	17.9	17.9	78.8
	6	23	14.7	14.7	93.6
	7 Extensive	10	6.4	6.4	100.0
	Total	156	100.0	100.0	

SI_4 Participation level of our suppliers in the design stage					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Not at all	21	13.5	13.5	13.5
	2	19	12.2	12.2	25.6
	3	26	16.7	16.7	42.3
	4 Somewhat Extensive	35	22.4	22.4	64.7
	5	28	17.9	17.9	82.7
	6	21	13.5	13.5	96.2
	7 Extensive	6	3.8	3.8	100.0
	Total	156	100.0	100.0	

SI_5 Our suppliers share their production and delivery schedule with us					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Not at all	17	10.9	10.9	10.9
	2	17	10.9	10.9	21.8
	3	26	16.7	16.7	38.5
	4 Somewhat Extensive	39	25.0	25.0	63.5
	5	29	18.6	18.6	82.1
	6	19	12.2	12.2	94.2
	7 Extensive	9	5.8	5.8	100.0
	Total	156	100.0	100.0	

SI_6 Our supplier shares inventory / staffing availability (or data) with us					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Not at all	20	12.8	12.8	12.8
	2	23	14.7	14.7	27.6
	3	25	16.0	16.0	43.6
	4 Somewhat Extensive	39	25.0	25.0	68.6
	5	28	17.9	17.9	86.5
	6	16	10.3	10.3	96.8
	7 Extensive	5	3.2	3.2	100.0
	Total	156	100.0	100.0	

SI_7 We share our production plans with our suppliers					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Not at all	19	12.2	12.2	12.2
	2	16	10.3	10.3	22.4
	3	31	19.9	19.9	42.3
	4 Somewhat Extensive	42	26.9	26.9	69.2
	5	26	16.7	16.7	85.9
	6	15	9.6	9.6	95.5
	7 Extensive	7	4.5	4.5	100.0
	Total	156	100.0	100.0	

SI_8 We share our demand forecasts with our suppliers					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Not at all	16	10.3	10.3	10.3
	2	18	11.5	11.5	21.8
	3	27	17.3	17.3	39.1
	4 Somewhat Extensive	35	22.4	22.4	61.5
	5	29	18.6	18.6	80.1
	6	20	12.8	12.8	92.9
	7 Extensive	11	7.1	7.1	100.0
	Total	156	100.0	100.0	

SI_9 We share our inventory / staffing levels (or data) with our suppliers					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Not at all	20	12.8	12.8	12.8
	2	20	12.8	12.8	25.6
	3	29	18.6	18.6	44.2
	4 Somewhat Extensive	44	28.2	28.2	72.4
	5	25	16.0	16.0	88.5
	6	14	9.0	9.0	97.4
	7 Extensive	4	2.6	2.6	100.0
	Total	156	100.0	100.0	

SI_10 We help our suppliers to improve their process					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Not at all	15	9.6	9.6	9.6
	2	16	10.3	10.3	19.9
	3	24	15.4	15.4	35.3
	4 Somewhat Extensive	37	23.7	23.7	59.0
	5	31	19.9	19.9	78.8
	6	20	12.8	12.8	91.7
	7 Extensive	13	8.3	8.3	100.0
	Total	156	100.0	100.0	

Appendix 6.4: Frequencies analysis of items in Customer Transactions (CT)

CT_1 Linkage with our customers through information networks					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Not at all	9	5.8	5.8	5.8
	2	11	7.1	7.1	12.8
	3	34	21.8	21.8	34.6
	4 Somewhat Extensive	44	28.2	28.2	62.8
	5	27	17.3	17.3	80.1
	6	21	13.5	13.5	93.6
	7 Extensive	10	6.4	6.4	100.0
	Total	156	100.0	100.0	

CT_2 Computerization for our customers' ordering					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Not at all	13	8.3	8.3	8.3
	2	15	9.6	9.6	17.9
	3	32	20.5	20.5	38.5
	4 Somewhat Extensive	37	23.7	23.7	62.2
	5	25	16.0	16.0	78.2
	6	23	14.7	14.7	92.9
	7 Extensive	11	7.1	7.1	100.0
	Total	156	100.0	100.0	

CT_3 Quick ordering systems with our customers					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Not at all	10	6.4	6.4	6.4
	2	18	11.5	11.5	17.9
	3	30	19.2	19.2	37.2
	4 Somewhat Extensive	32	20.5	20.5	57.7
	5	31	19.9	19.9	77.6
	6	23	14.7	14.7	92.3
	7 Extensive	12	7.7	7.7	100.0
	Total	156	100.0	100.0	

Appendix 6.5: Frequencies analysis of items in Customer Connection (CCnt)

CCnt_1 Communication with our customers					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Not at all	4	2.6	2.6	2.6
	2	8	5.1	5.1	7.7
	3	31	19.9	19.9	27.6
	4 Somewhat Extensive	34	21.8	21.8	49.4
	5	32	20.5	20.5	69.9
	6	33	21.2	21.2	91.0
	7 Extensive	14	9.0	9.0	100.0
	Total	156	100.0	100.0	

CCnt_2 Follow-up with our customers for feedback					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Not at all	6	3.8	3.8	3.8
	2	11	7.1	7.1	10.9
	3	26	16.7	16.7	27.6
	4 Somewhat Extensive	41	26.3	26.3	53.8
	5	31	19.9	19.9	73.7
	6	30	19.2	19.2	92.9
	7 Extensive	11	7.1	7.1	100.0
	Total	156	100.0	100.0	

CCnt_3 Frequency of period contacts with our customers					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Not at all	7	4.5	4.5	4.5
	2	11	7.1	7.1	11.5
	3	27	17.3	17.3	28.8
	4 Somewhat Extensive	36	23.1	23.1	51.9
	5	32	20.5	20.5	72.4
	6	28	17.9	17.9	90.4
	7 Extensive	15	9.6	9.6	100.0
	Total	156	100.0	100.0	

Appendix 6.6: Frequencies analysis of items in Customer Collaboration (CClb)

CClb_1 Customers share Point of Sales information with us					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Not at all	16	10.3	10.3	10.3
	2	22	14.1	14.1	24.4
	3	35	22.4	22.4	46.8
	4 Somewhat Extensive	37	23.7	23.7	70.5
	5	22	14.1	14.1	84.6
	6	14	9.0	9.0	93.6
	7 Extensive	10	6.4	6.4	100.0
	Total	156	100.0	100.0	

CClb_2 Customers share demand forecast with us					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Not at all	15	9.6	9.6	9.6
	2	28	17.9	17.9	27.6
	3	33	21.2	21.2	48.7
	4 Somewhat Extensive	36	23.1	23.1	71.8
	5	26	16.7	16.7	88.5
	6	13	8.3	8.3	96.8
	7 Extensive	5	3.2	3.2	100.0
	Total	156	100.0	100.0	

CClb_3 We share our production plan with customers					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Not at all	14	9.0	9.0	9.0
	2	29	18.6	18.6	27.6
	3	33	21.2	21.2	48.7
	4 Somewhat Extensive	36	23.1	23.1	71.8
	5	26	16.7	16.7	88.5
	6	13	8.3	8.3	96.8
	7 Extensive	5	3.2	3.2	100.0
	Total	156	100.0	100.0	

CClb_4 We share our inventory/staffing availability (or data) with customers					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Not at all	18	11.5	11.5	11.5
	2	28	17.9	17.9	29.5
	3	43	27.6	27.6	57.1
	4 Somewhat Extensive	34	21.8	21.8	78.8
	5	23	14.7	14.7	93.6
	6	7	4.5	4.5	98.1
	7 Extensive	3	1.9	1.9	100.0
	Total	156	100.0	100.0	

Appendix 6.7: Frequencies analysis of items in Cost

Cost_1 Provide low cost service					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Much Worse than Competition	1	.6	.6	.6
	2	6	3.8	3.8	4.5
	3	19	12.2	12.2	16.7
	4 Equal to Competition	65	41.7	41.7	58.3
	5	27	17.3	17.3	75.6
	6	24	15.4	15.4	91.0
	7 Much Better than Competition	14	9.0	9.0	100.0
	Total	156	100.0	100.0	

Cost_2 High labour productivity					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Much Worse than Competition	1	.6	.6	.6
	2	4	2.6	2.6	3.2
	3	12	7.7	7.7	10.9
	4 Equal to Competition	53	34.0	34.0	44.9
	5	45	28.8	28.8	73.7
	6	27	17.3	17.3	91.0
	7 Much Better than Competition	14	9.0	9.0	100.0
	Total	156	100.0	100.0	

Cost_3 Cost effectiveness of process technology					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Much Worse than Competition	1	.6	.6	.6
	2	3	1.9	1.9	2.6
	3	20	12.8	12.8	15.4
	4 Equal to Competition	52	33.3	33.3	48.7
	5	38	24.4	24.4	73.1
	6	34	21.8	21.8	94.9
	7 Much Better than Competition	8	5.1	5.1	100.0
	Total	156	100.0	100.0	

Appendix 6.8. Frequencies analysis of items in Quality

Quality_1 Provide consistent level of service (reliability)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Much Worse than Competition	1	.6	.6	.6
	2	1	.6	.6	1.3
	3	3	1.9	1.9	3.2
	4 Equal to Competition	40	25.6	25.6	28.8
	5	51	32.7	32.7	61.5
	6	36	23.1	23.1	84.6
	7 Much Better than Competition	24	15.4	15.4	100.0
	Total	156	100.0	100.0	

Quality_2 Perceived quality (customer's perception)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Much Worse than Competition	1	.6	.6	.6
	2	1	.6	.6	1.3
	3	5	3.2	3.2	4.5
	4 Equal to Competition	37	23.7	23.7	28.2
	5	52	33.3	33.3	61.5
	6	35	22.4	22.4	84.0
	7 Much Better than Competition	25	16.0	16.0	100.0
	Total	156	100.0	100.0	

Quality_3 Provide accurate information (credibility)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Much Worse than Competition	1	.6	.6	.6
	2	1	.6	.6	1.3
	3	3	1.9	1.9	3.2
	4 Equal to Competition	41	26.3	26.3	29.5
	5	51	32.7	32.7	62.2
	6	43	27.6	27.6	89.7
	7 Much Better than Competition	16	10.3	10.3	100.0
	Total	156	100.0	100.0	

Quality_4 Provide timely information (responsiveness)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Much Worse than Competition	1	.6	.6	.6
	2	1	.6	.6	1.3
	3	6	3.8	3.8	5.1
	4 Equal to Competition	42	26.9	26.9	32.1
	5	51	32.7	32.7	64.7
	6	41	26.3	26.3	91.0
	7 Much Better than Competition	14	9.0	9.0	100.0
	Total	156	100.0	100.0	

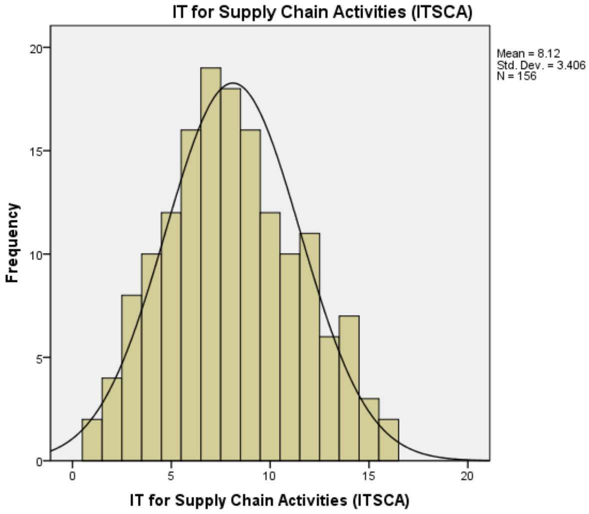
Quality_5 Conformance (degree to which service meets standards)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Much Worse than Competition	1	.6	.6	.6
	2	2	1.3	1.3	1.9
	3	5	3.2	3.2	5.1
	4 Equal to Competition	41	26.3	26.3	31.4
	5	45	28.8	28.8	60.3
	6	41	26.3	26.3	86.5
	7 Much Better than Competition	21	13.5	13.5	100.0
	Total	156	100.0	100.0	

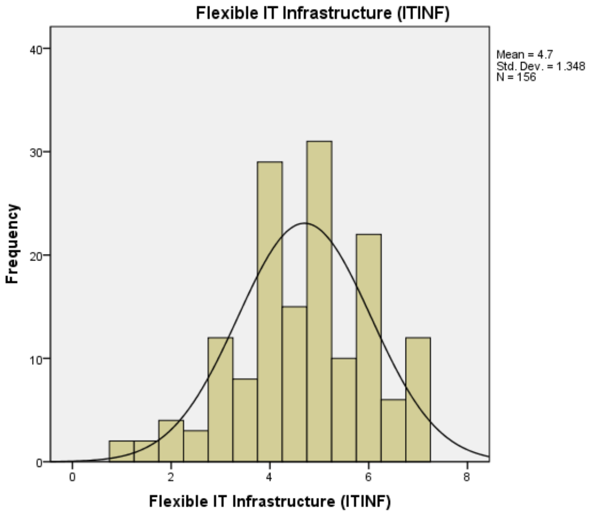
Quality_6 Speed of service / reduce wait times					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Much Worse than Competition	1	.6	.6	.6
	2	1	.6	.6	1.3
	3	18	11.5	11.5	12.8
	4 Equal to Competition	51	32.7	32.7	45.5
	5	44	28.2	28.2	73.7
	6	28	17.9	17.9	91.7
	7 Much Better than Competition	13	8.3	8.3	100.0
	Total	156	100.0	100.0	

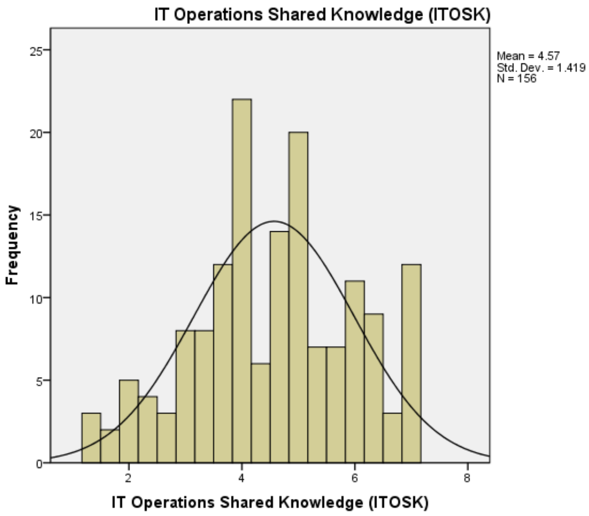
Quality_7 Perform promised service on time					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Much Worse than Competition	1	.6	.6	.6
	2	2	1.3	1.3	1.9
	3	14	9.0	9.0	10.9
	4 Equal to Competition	44	28.2	28.2	39.1
	5	38	24.4	24.4	63.5
	6	40	25.6	25.6	89.1
	7 Much Better than Competition	17	10.9	10.9	100.0
	Total	156	100.0	100.0	

Appendix 6.9: Normal probability plots for each set of variables

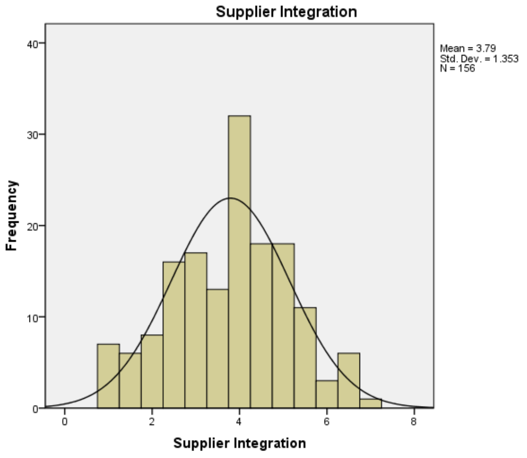
Appendix 6.9.1: Normal probability plots for independent variables

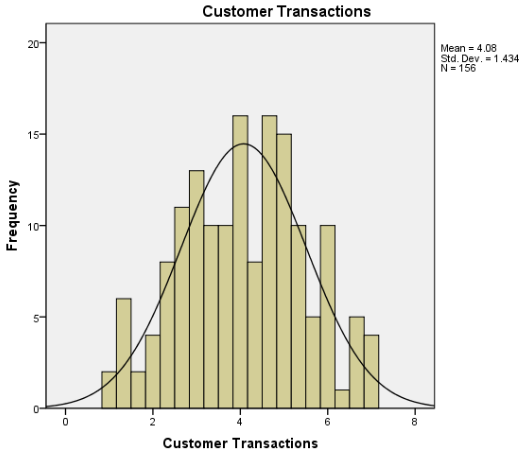


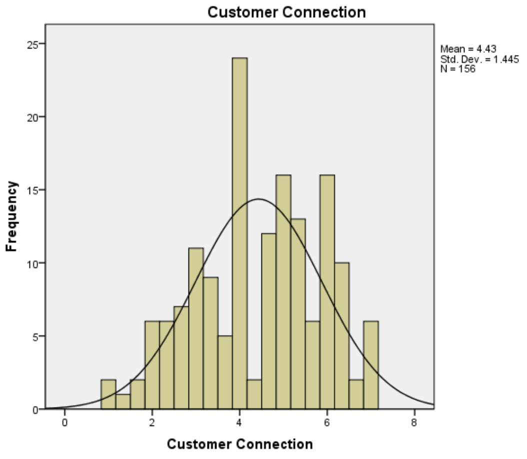


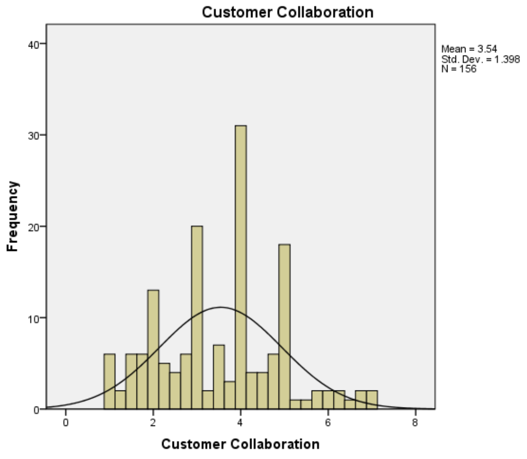


Appendix 6.9.2: Normal probability plots for mediator variables

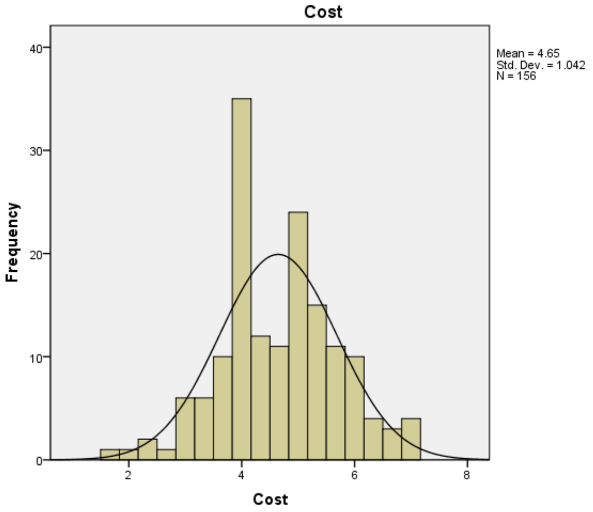


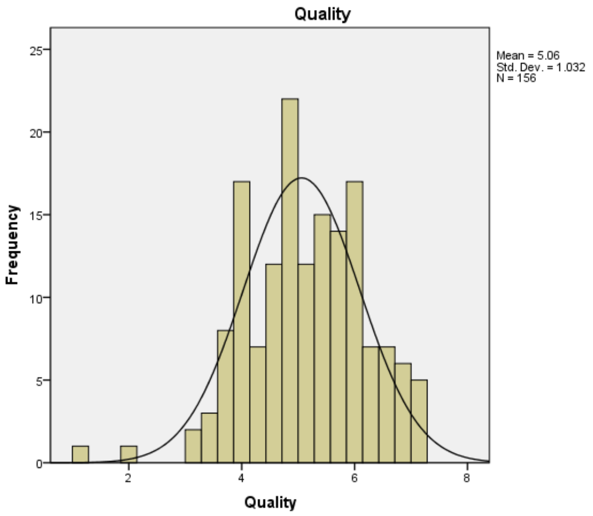




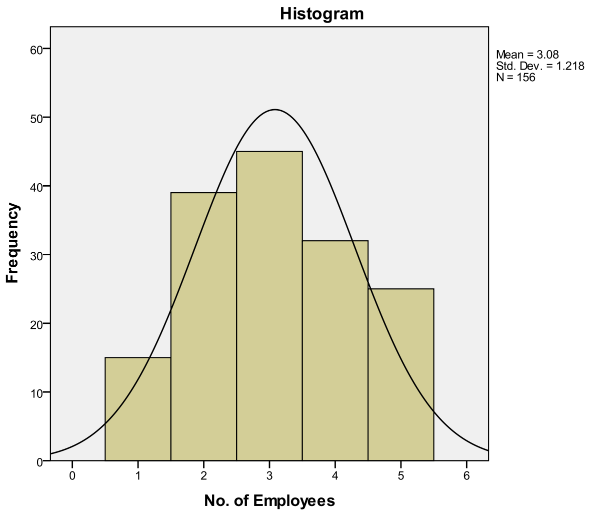


Appendix 6.9.3: Normal probability plots for dependent variables





Appendix 6.9.4: Normal probability plots for control variables



Appendix 6.10.1: Communalities

Communalities		
Items	**Initial**	**Extraction**
ITINF_1 Established corporate rules and standards	1.000	.866
ITINF_2 Identified and standardised data	1.000	.874
ITOSK_1 IT Managers understand operations process	1.000	.842
ITOSK_2 IT Managers understand operations strategies	1.000	.932
ITOSK_3 Common understanding IT-Operations managers	1.000	.858
SI_1 Information exchange with our suppliers	1.000	.681
SI_2 Quick ordering systems with our suppliers	1.000	.651
SI_3 Strategic partnership with our suppliers	1.000	.755
SI_4 Participation level of our suppliers in the design stage	1.000	.752
SI_5 Our suppliers share their production and delivery schedule with us	1.000	.726
SI_6 Our supplier shares inventory / staffing availability (or data) with us	1.000	.767
SI_7 We share our production plans with our suppliers	1.000	.784
SI_8 We share our demand forecasts with our suppliers	1.000	.741
SI_9 We share our inventory / staffing levels (or data) with our suppliers	1.000	.724
SI_10 We help our suppliers to improve their process	1.000	.787
CT_1 Linkage with our customers through information networks	1.000	.794
CT_2 Computerization for our customers' ordering	1.000	.828
CT_3 Quick ordering systems with our customers	1.000	.717
CCnt_1 Communication with our customers	1.000	.911
CCnt_2 Follow-up with our customers for feedback	1.000	.871
CCnt_3 Frequency of period contacts with our customers	1.000	.898
CClb_1 Customers share Point of Sales information with us	1.000	.741
CClb_2 Customers share demand forecast with us	1.000	.928
CClb_3 We share our production plan with customers	1.000	.929
CClb_4 We share our inventory/staffing availability (or data) with customers	1.000	.722
Cost_1 Provide low cost service	1.000	.711
Cost_2 High labour productivity	1.000	.786
Cost_3 Cost effectiveness of process technology	1.000	.711
Quality_1 Provide consistent level of service (reliability)	1.000	.879
Quality_2 Perceived quality (customer's perception)	1.000	.798
Quality_3 Provide accurate information (credibility)	1.000	.881
Quality_4 Provide timely information (responsiveness)	1.000	.862
Quality_5 Conformance (degree to which service meets standards)	1.000	.812
Quality_6 Speed of service / reduce wait times	1.000	.687
Quality_7 Perform promised service on time	1.000	.751
Extraction Method: Principal Component Analysis.		

Appendix 6.10.2: Results of variable-specific measure of sampling adequacy (MSA)

Variables (Items)	Variable-specific MSA
ITINF_1	.759
ITINF_2	.755
ITOSK_1	.819
ITOSK_2	.774
ITOSK_3	.888
SI_1	.921
SI_2	.920
SI_3	.940
SI_4	.898
SI_5	.911
SI_6	.892
SI_7	.934
SI_8	.905
SI_9	.911
SI_10	.940
CT_1	.875
CT_2	.851
CT_3	.837
CCnt_1	.895
CCnt_2	.897
CCnt_3	.899
CClb_1	.925
CClb_2	.787
CClb_3	.782
CClb_4	.940
Cost_1	.779
Cost_2	.885
Cost_3	.873
Quality_1	.911
Quality_2	.906
Quality_3	.907
Quality_4	.904
Quality_5	.921
Quality_6	.908
Quality_7	.909

Appendix 6.10.3: Items Correlations (1/4)

		1	2	3	4	5	6	7	8	9	10
1.	**ITINF_1**	1									
2.	**ITINF_2**	.759	1								
3.	**ITOSK_1**	.336	.303	1							
4.	**ITOSK_2**	.249	.257	.870	1						
5.	**ITOSK_3**	.306	.332	.729	.830	1					
6.	**SI_1**	.153	.142	.223	.201	.251	1				
7.	**SI_2**	.096	.115	.288	.249	.266	.705	1			
8.	**SI_3**	.216	.269	.215	.231	.247	.632	.640	1		
9.	**SI_4**	.208	.258	.322	.329	.402	.501	.525	.665	1	
10.	**SI_5**	.224	.305	.330	.325	.438	.471	.535	.651	.746	1
11.	**SI_6**	.218	.260	.323	.330	.439	.483	.489	.618	.802	.776
12.	**SI_7**	.230	.307	.314	.355	.417	.560	.531	.686	.688	.723
13.	**SI_8**	.248	.327	.329	.364	.390	.531	.485	.618	.614	.701
14.	**SI_9**	.239	.287	.292	.312	.352	.410	.352	.580	.675	.620
15.	**SI_10**	.255	.286	.345	.359	.389	.624	.614	.793	.718	.683
16.	**CT_1**	.092	.061	.168	.142	.230	.443	.398	.310	.255	.272
17.	**CT_2**	.100	.089	.212	.182	.285	.388	.397	.276	.185	.241
18.	**CT_3**	-.016	.041	.211	.282	.321	.395	.379	.298	.194	.347
19.	**CCnt_1**	.209	.211	.307	.318	.292	.257	.303	.342	.234	.279
20.	**CCnt_2**	.274	.265	.301	.293	.268	.313	.369	.416	.329	.352
21.	**CCnt_3**	.210	.241	.297	.316	.269	.282	.296	.388	.348	.354
22.	**CClb_1**	-.043	-.026	.101	.138	.108	.264	.225	.244	.220	.298
23.	**CClb_2**	-.052	-.019	.182	.253	.242	.335	.363	.341	.365	.380
24.	**CClb_3**	-.054	-.021	.179	.253	.242	.333	.358	.338	.363	.375
25.	**CClb_4**	-.062	-.033	.130	.216	.256	.365	.347	.315	.299	.369
26.	**Cost_1**	.209	.216	.248	.186	.157	.219	.187	.171	.129	.153
27.	**Cost_2**	.147	.124	.202	.235	.197	.318	.347	.315	.196	.239
28.	**Cost_3**	.178	.193	.337	.411	.361	.263	.257	.285	.299	.320
29.	**Quality_1**	.243	.203	.264	.264	.283	.271	.355	.392	.351	.339
30.	**Quality_2**	.196	.103	.214	.235	.233	.158	.301	.354	.240	.267
31.	**Quality_3**	.246	.183	.226	.226	.255	.168	.227	.309	.236	.201
32.	**Quality_4**	.266	.202	.254	.241	.264	.233	.264	.368	.297	.256
33.	**Quality_5**	.246	.199	.292	.268	.309	.235	.298	.354	.262	.266
34.	**Quality_6**	.221	.101	.262	.230	.262	.295	.385	.305	.266	.286
35.	**Quality_7**	.267	.147	.273	.250	.283	.304	.341	.314	.268	.261

Correlation coefficients of .130 or greater are significant at $p<.05$

Appendix 6.10.3: Items Correlations (2/4)

	11	12	13	14	15	16	17	18	19	20
1. ITINF_1										
2. ITINF_2										
3. ITOSK_1										
4. ITOSK_2										
5. ITOSK_3										
6. SI_1										
7. SI_2										
8. SI_3										
9. SI_4										
10. SI_5										
11. SI_6	1									
12. SI_7	.709	1								
13. SI_8	.648	.825	1							
14. SI_9	.749	.681	.721	1						
15. SI_10	.686	.740	.700	.640	1					
16. CT_1	.256	.243	.231	.145	.284	1				
17. CT_2	.253	.261	.270	.140	.306	.740	1			
18. CT_3	.304	.324	.365	.182	.354	.631	.704	1		
19. CCnt_1	.177	.274	.361	.284	.342	.501	.501	.505	1	
20. CCnt_2	.251	.337	.372	.341	.418	.445	.493	.440	.840	1
21. CCnt_3	.259	.398	.471	.359	.393	.436	.423	.461	.843	.838
22. CClb_1	.259	.321	.336	.257	.243	.345	.305	.423	.281	.354
23. CClb_2	.323	.442	.429	.370	.336	.341	.292	.389	.274	.360
24. CClb_3	.320	.442	.427	.368	.333	.340	.298	.396	.271	.361
25. CClb_4	.317	.454	.404	.315	.374	.389	.346	.382	.211	.270
26. Cost_1	.116	.171	.182	.096	.177	.226	.140	.234	.227	.170
27. Cost_2	.158	.243	.243	.076	.260	.361	.292	.337	.299	.287
28. Cost_3	.252	.311	.370	.215	.295	.371	.261	.340	.294	.284
29. Quality_1	.249	.278	.294	.258	.332	.385	.277	.276	.437	.413
30. Quality_2	.190	.256	.236	.246	.273	.294	.219	.187	.399	.372
31. Quality_3	.210	.206	.235	.249	.247	.375	.265	.237	.402	.360
32. Quality_4	.233	.230	.246	.230	.294	.444	.286	.246	.376	.362
33. Quality_5	.213	.223	.215	.192	.281	.397	.302	.187	.345	.321
34. Quality_6	.275	.307	.293	.225	.266	.412	.279	.252	.432	.368
35. Quality_7	.247	.281	.259	.204	.320	.445	.303	.250	.405	.373

Correlation coefficients of .130 or greater are significant at $p<.05$

Appendix 6.10.3: Items Correlations (3/4)

		21	22	23	24	25	26	27	28	29	30
1.	**ITINF_1**										
2.	**ITINF_2**										
3.	**ITOSK_1**										
4.	**ITOSK_2**										
5.	**ITOSK_3**										
6.	**SI_1**										
7.	**SI_2**										
8.	**SI_3**										
9.	**SI_4**										
10.	**SI_5**										
11.	**SI_6**										
12.	**SI_7**										
13.	**SI_8**										
14.	**SI_9**										
15.	**SI_10**										
16.	**CT_1**										
17.	**CT_2**										
18.	**CT_3**										
19.	**CCnt_1**										
20.	**CCnt_2**										
21.	**CCnt_3**	1									
22.	**CClb_1**	.386	1								
23.	**CClb_2**	.391	.738	1							
24.	**CClb_3**	.390	.738	.999	1						
25.	**CClb_4**	.287	.589	.732	.733	1					
26.	**Cost_1**	.163	.164	.086	.078	.149	1				
27.	**Cost_2**	.295	.199	.253	.248	.233	.560	1			
28.	**Cost_3**	.315	.208	.314	.317	.308	.500	.667	1		
29.	**Quality_1**	.383	.124	.237	.234	.158	.353	.497	.415	1	
30.	**Quality_2**	.327	.092	.168	.165	.135	.234	.387	.282	.841	1
31.	**Quality_3**	.344	.091	.184	.181	.142	.300	.379	.360	.842	.795
32.	**Quality_4**	.340	.130	.202	.199	.153	.295	.407	.391	.827	.751
33.	**Quality_5**	.290	.045	.184	.181	.118	.289	.457	.396	.809	.765
34.	**Quality_6**	.365	.139	.234	.229	.214	.382	.483	.396	.718	.639
35.	**Quality_7**	.383	.140	.228	.226	.217	.258	.466	.390	.798	.681

Correlation coefficients of .130 or greater are significant at p<.05

Appendix 6.10.3: Items Correlations (4/4)

	31	32	33	34	35
1. ITINF_1					
2. ITINF_2					
3. ITOSK_1					
4. ITOSK_2					
5. ITOSK_3					
6. SI_1					
7. SI_2					
8. SI_3					
9. SI_4					
10. SI_5					
11. SI_6					
12. SI_7					
13. SI_8					
14. SI_9					
15. SI_10					
16. CT_1					
17. CT_2					
18. CT_3					
19. CCnt_1					
20. CCnt_2					
21. CCnt_3					
22. CClb_1					
23. CClb_2					
24. CClb_3					
25. CClb_4					
26. Cost_1					
27. Cost_2					
28. Cost_3					
29. Quality_1					
30. Quality_2					
31. Quality_3	1				
32. Quality_4	.908	1			
33. Quality_5	.820	.827	1		
34. Quality_6	.710	.708	.606	1	
35. Quality_7	.739	.730	.713	.767	1

Correlation coefficients of .130 or greater are significant at p<.05

Appendix 6.10.4: Structure matrix

Items	1	2	3	4	5	6	7	8
ITINF_1	.217	.258	-.059	.282	-.203	.174	.922	.010
ITINF_2	.282	.162	-.019	.289	-.222	.173	.929	-.013
ITOSK_1	.308	.262	.143	.911	-.272	.255	.302	.100
ITOSK_2	.318	.250	.229	.960	-.285	.259	.223	.071
ITOSK_3	.391	.281	.231	.911	-.223	.193	.311	.183
SI_1	.704	.236	.303	.169	-.199	.344	.084	.528
SI_2	.699	.326	.288	.226	-.246	.329	-.004	.488
SI_3	.840	.368	.297	.181	-.350	.273	.197	.245
SI_4	.855	.295	.332	.362	-.256	.165	.217	.083
SI_5	.840	.275	.386	.380	-.292	.216	.250	.158
SI_6	.858	.238	.336	.389	-.180	.119	.241	.154
SI_7	.865	.250	.459	.364	-.311	.238	.260	.140
SI_8	.815	.245	.452	.370	-.407	.264	.288	.117
SI_9	.782	.239	.380	.336	-.336	.051	.290	-.060
SI_10	.876	.295	.317	.349	-.352	.245	.236	.246
CT_1	.281	.429	.368	.155	-.413	.338	.046	.832
CT_2	.269	.288	.319	.220	-.450	.226	.069	.870
CT_3	.324	.223	.429	.282	-.476	.336	-.039	.751
CCnt_1	.275	.422	.263	.291	-.937	.275	.176	.375
CCnt_2	.360	.388	.347	.264	-.921	.233	.245	.335
CCnt_3	.367	.361	.395	.282	-.939	.249	.205	.265
CClb_1	.268	.092	.844	.097	-.360	.196	-.029	.245
CClb_2	.396	.212	.960	.231	-.324	.201	-.062	.204
CClb_3	.393	.208	.961	.231	-.323	.197	-.064	.208
CClb_4	.395	.159	.827	.204	-.204	.237	-.070	.316
Cost_1	.148	.303	.104	.167	-.162	.830	.213	.135
Cost_2	.242	.472	.228	.183	-.254	.870	.063	.291
Cost_3	.294	.396	.321	.400	-.262	.797	.150	.204
Quality_1	.330	.931	.179	.248	-.381	.436	.175	.196
Quality_2	.267	.882	.126	.207	-.356	.284	.099	.108
Quality_3	.224	.935	.149	.220	-.342	.329	.198	.171
Quality_4	.269	.925	.169	.231	-.318	.356	.217	.228
Quality_5	.259	.894	.118	.276	-.262	.374	.194	.226
Quality_6	.304	.804	.197	.227	-.349	.476	.106	.241
Quality_7	.288	.859	.197	.248	-.338	.394	.161	.276

Extraction Method: Principal Component Analysis.

Rotation Method: Oblimin with Kaiser Normalization.

Appendix 7.1: Multicollinearity and independent errors tests (Model 1 to 8)

Appendix 7.1.1: Multicollinearity and independent errors tests (Model 1)

	Step 1		**Step 2**		**Step 3**	
	Collinearity Statistics		Collinearity Statistics		Collinearity Statistics	
Model	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
1 (Constant)						
Industry1 Education	.697	1.434	.697	1.434	.697	1.434
Industry2 Hotels	.600	1.667	.600	1.667	.600	1.667
Industry3 Banks	.577	1.732	.577	1.732	.577	1.732
Industry4 Wholesale	.348	2.875	.348	2.875	.348	2.875
Industry5 Business	.332	3.011	.332	3.011	.332	3.011
Industry6 Transport	.443	2.255	.443	2.255	.443	2.255
Industry7 Health	.549	1.822	.549	1.822	.549	1.822
Firm Size	.847	1.180	.847	1.180	.847	1.180
2 (Constant)						
Industry1 Education	.688	1.454	.688	1.454	.687	1.455
Industry2 Hotels	.597	1.674	.597	1.674	.594	1.683
Industry3 Banks	.497	2.012	.497	2.012	.497	2.013
Industry4 Wholesale	.343	2.918	.343	2.918	.342	2.926
Industry5 Business	.315	3.173	.315	3.173	.314	3.182
Industry6 Transport	.431	2.319	.431	2.319	.431	2.319
Industry7 Health	.506	1.978	.506	1.978	.498	2.010
Firm Size	.801	1.248	.801	1.248	.770	1.299
ITSCA	.762	1.312	.762	1.312	.730	1.369
ITINF	.813	1.231	.813	1.231	.778	1.285
ITOSK	.830	1.205	.830	1.205	.708	1.412
Supplier Integration					.697	1.435
Durbin-Watson	2.081		1.995		2.005	

Step 1: Dependent Variable – Supplier Integration

Step 2: Dependent Variable – Cost

Step 3: Dependent Variable – Cost (Mediator: Supplier Integration)

Appendix 7.1.2: Multicollinearity and independent errors tests (Model 2)

	Step 1		Step 2		Step 3	
	Collinearity Statistics		Collinearity Statistics		Collinearity Statistics	
Model	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
1 (Constant)						
Industry1 Education	.697	1.434	.697	1.434	.697	1.434
Industry2 Hotels	.600	1.667	.600	1.667	.600	1.667
Industry3 Banks	.577	1.732	.577	1.732	.577	1.732
Industry4 Wholesale	.348	2.875	.348	2.875	.348	2.875
Industry5 Business	.332	3.011	.332	3.011	.332	3.011
Industry6 Transport	.443	2.255	.443	2.255	.443	2.255
Industry7 Health	.549	1.822	.549	1.822	.549	1.822
Firm Size	.847	1.180	.847	1.180	.847	1.180
2 (Constant)						
Industry1 Education	.688	1.454	.688	1.454	.687	1.455
Industry2 Hotels	.597	1.674	.597	1.674	.594	1.683
Industry3 Banks	.497	2.012	.497	2.012	.497	2.013
Industry4 Wholesale	.343	2.918	.343	2.918	.342	2.926
Industry5 Business	.315	3.173	.315	3.173	.314	3.182
Industry6 Transport	.431	2.319	.431	2.319	.431	2.319
Industry7 Health	.506	1.978	.506	1.978	.498	2.010
Firm Size	.801	1.248	.801	1.248	.770	1.299
ITSCA	.762	1.312	.762	1.312	.730	1.369
ITINF	.813	1.231	.813	1.231	.778	1.285
ITOSK	.830	1.205	.830	1.205	.708	1.412
Supplier Integration					.697	1.435
Durbin-Watson	2.081		1.973		1.923	

Step 1: Dependent Variable – Supplier Integration

Step 2: Dependent Variable – Quality

Step 3: Dependent Variable – Quality (Mediator: Supplier Integration)

Appendix 7.1.3: Multicollinearity and independent errors tests (Model 3)

	Step 1		Step 2		Step 3	
	Collinearity Statistics		Collinearity Statistics		Collinearity Statistics	
Model	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
1 (Constant)						
Industry1 Education	.697	1.434	.697	1.434	.697	1.434
Industry2 Hotels	.600	1.667	.600	1.667	.600	1.667
Industry3 Banks	.577	1.732	.577	1.732	.577	1.732
Industry4 Wholesale	.348	2.875	.348	2.875	.348	2.875
Industry5 Business	.332	3.011	.332	3.011	.332	3.011
Industry6 Transport	.443	2.255	.443	2.255	.443	2.255
Industry7 Health	.549	1.822	.549	1.822	.549	1.822
Firm Size	.847	1.180	.847	1.180	.847	1.180
2 (Constant)						
Industry1 Education	.688	1.454	.688	1.454	.686	1.458
Industry2 Hotels	.597	1.674	.597	1.674	.587	1.703
Industry3 Banks	.497	2.012	.497	2.012	.488	2.050
Industry4 Wholesale	.343	2.918	.343	2.918	.340	2.944
Industry5 Business	.315	3.173	.315	3.173	.314	3.189
Industry6 Transport	.431	2.319	.431	2.319	.430	2.324
Industry7 Health	.506	1.978	.506	1.978	.500	1.999
Firm Size	.801	1.248	.801	1.248	.792	1.263
ITSCA	.762	1.312	.762	1.312	.731	1.367
ITINF	.813	1.231	.813	1.231	.812	1.231
ITOSK	.830	1.205	.830	1.205	.781	1.281
Customer Transactions					.810	1.235
Durbin-Watson	2.012		1.995		1.901	

Step 1: Dependent Variable – Customer Transactions

Step 2: Dependent Variable – Cost

Step 3: Dependent Variable – Cost (Mediator: Customer Transactions)

Appendix 7.1.4: Multicollinearity and independent errors tests (Model 4)

	Step 1		Step 2		Step 3	
	Collinearity Statistics		Collinearity Statistics		Collinearity Statistics	
Model	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
1 (Constant)						
Industry1 Education	.697	1.434	.697	1.434	.697	1.434
Industry2 Hotels	.600	1.667	.600	1.667	.600	1.667
Industry3 Banks	.577	1.732	.577	1.732	.577	1.732
Industry4 Wholesale	.348	2.875	.348	2.875	.348	2.875
Industry5 Business	.332	3.011	.332	3.011	.332	3.011
Industry6 Transport	.443	2.255	.443	2.255	.443	2.255
Industry7 Health	.549	1.822	.549	1.822	.549	1.822
Firm Size	.847	1.180	.847	1.180	.847	1.180
2 (Constant)						
Industry1 Education	.688	1.454	.688	1.454	.686	1.458
Industry2 Hotels	.597	1.674	.597	1.674	.587	1.703
Industry3 Banks	.497	2.012	.497	2.012	.488	2.050
Industry4 Wholesale	.343	2.918	.343	2.918	.340	2.944
Industry5 Business	.315	3.173	.315	3.173	.314	3.189
Industry6 Transport	.431	2.319	.431	2.319	.430	2.324
Industry7 Health	.506	1.978	.506	1.978	.500	1.999
Firm Size	.801	1.248	.801	1.248	.792	1.263
ITSCA	.762	1.312	.762	1.312	.731	1.367
ITINF	.813	1.231	.813	1.231	.812	1.231
ITOSK	.830	1.205	.830	1.205	.781	1.281
Customer Transactions					.810	1.235
Durbin-Watson	2.012		1.973		1.923	

Step 1: Dependent Variable – Customer Transactions

Step 2: Dependent Variable – Quality

Step 3: Dependent Variable – Quality (Mediator: Customer Transactions)

Appendix 7.1.5: Multicollinearity and independent errors tests (Model 5)

	Step 1		Step 2		Step 3	
	Collinearity Statistics		Collinearity Statistics		Collinearity Statistics	
Model	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
1 (Constant)						
Industry1 Education	.697	1.434	.697	1.434	.697	1.434
Industry2 Hotels	.600	1.667	.600	1.667	.600	1.667
Industry3 Banks	.577	1.732	.577	1.732	.577	1.732
Industry4 Wholesale	.348	2.875	.348	2.875	.348	2.875
Industry5 Business	.332	3.011	.332	3.011	.332	3.011
Industry6 Transport	.443	2.255	.443	2.255	.443	2.255
Industry7 Health	.549	1.822	.549	1.822	.549	1.822
Firm Size	.847	1.180	.847	1.180	.847	1.180
2 (Constant)						
Industry1 Education	.688	1.454	.688	1.454	.644	1.553
Industry2 Hotels	.597	1.674	.597	1.674	.583	1.716
Industry3 Banks	.497	2.012	.497	2.012	.485	2.063
Industry4 Wholesale	.343	2.918	.343	2.918	.336	2.973
Industry5 Business	.315	3.173	.315	3.173	.313	3.195
Industry6 Transport	.431	2.319	.431	2.319	.431	2.320
Industry7 Health	.506	1.978	.506	1.978	.506	1.978
Firm Size	.801	1.248	.801	1.248	.799	1.251
ITSCA	.762	1.312	.762	1.312	.704	1.420
ITINF	.813	1.231	.813	1.231	.776	1.289
ITOSK	.830	1.205	.830	1.205	.778	1.286
Customer Connection					.696	1.437
Durbin-Watson	1.908		1.995		1.931	

Step 1: Dependent Variable – Customer Connection

Step 2: Dependent Variable – Cost

Step 3: Dependent Variable – Cost (Mediator: Customer Connection)

Appendix 7.1.6: Multicollinearity and independent errors tests (Model 6)

Model	Step 1		Step 2		Step 3	
	Collinearity Statistics		Collinearity Statistics		Collinearity Statistics	
	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
1 (Constant)						
Industry1 Education	.697	1.434	.697	1.434	.697	1.434
Industry2 Hotels	.600	1.667	.600	1.667	.600	1.667
Industry3 Banks	.577	1.732	.577	1.732	.577	1.732
Industry4 Wholesale	.348	2.875	.348	2.875	.348	2.875
Industry5 Business	.332	3.011	.332	3.011	.332	3.011
Industry6 Transport	.443	2.255	.443	2.255	.443	2.255
Industry7 Health	.549	1.822	.549	1.822	.549	1.822
Firm Size	.847	1.180	.847	1.180	.847	1.180
2 (Constant)						
Industry1 Education	.688	1.454	.688	1.454	.644	1.553
Industry2 Hotels	.597	1.674	.597	1.674	.583	1.716
Industry3 Banks	.497	2.012	.497	2.012	.485	2.063
Industry4 Wholesale	.343	2.918	.343	2.918	.336	2.973
Industry5 Business	.315	3.173	.315	3.173	.313	3.195
Industry6 Transport	.431	2.319	.431	2.319	.431	2.320
Industry7 Health	.506	1.978	.506	1.978	.506	1.978
Firm Size	.801	1.248	.801	1.248	.799	1.251
ITSCA	.762	1.312	.762	1.312	.704	1.420
ITINF	.813	1.231	.813	1.231	.776	1.289
ITOSK	.830	1.205	.830	1.205	.778	1.286
Customer Connection					.696	1.437
Durbin-Watson	1.908		1.973		1.996	

Step 1: Dependent Variable – Customer Connection

Step 2: Dependent Variable – Quality

Step 3: Dependent Variable – Quality (Mediator: Customer Connection)

Appendix 7.1.7: Multicollinearity and independent errors tests (Model 7)

	Step 1		Step 2		Step 3	
	Collinearity Statistics		Collinearity Statistics		Collinearity Statistics	
Model	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
1 (Constant)						
Industry1 Education	.697	1.434	.697	1.434	.697	1.434
Industry2 Hotels	.600	1.667	.600	1.667	.600	1.667
Industry3 Banks	.577	1.732	.577	1.732	.577	1.732
Industry4 Wholesale	.348	2.875	.348	2.875	.348	2.875
Industry5 Business	.332	3.011	.332	3.011	.332	3.011
Industry6 Transport	.443	2.255	.443	2.255	.443	2.255
Industry7 Health	.549	1.822	.549	1.822	.549	1.822
Firm Size	.847	1.180	.847	1.180	.847	1.180
2 (Constant)						
Industry1 Education	.688	1.454	.688	1.454	.673	1.486
Industry2 Hotels	.597	1.674	.597	1.674	.595	1.680
Industry3 Banks	.497	2.012	.497	2.012	.478	2.091
Industry4 Wholesale	.343	2.918	.343	2.918	.338	2.959
Industry5 Business	.315	3.173	.315	3.173	.306	3.265
Industry6 Transport	.431	2.319	.431	2.319	.428	2.336
Industry7 Health	.506	1.978	.506	1.978	.485	2.062
Firm Size	.801	1.248	.801	1.248	.781	1.280
ITSCA	.762	1.312	.762	1.312	.739	1.354
ITINF	.813	1.231	.813	1.231	.791	1.264
ITOSK	.830	1.205	.830	1.205	.756	1.323
Customer Collaboration					.835	1.198
Durbin-Watson	2.143		1.995		1.925	

Step 1: Dependent Variable – Customer Collaboration

Step 2: Dependent Variable – Cost

Step 3: Dependent Variable – Cost (Mediator: Customer Collaboration)

Appendix 7.1.8: Multicollinearity and independent errors tests (Model 8)

	Step 1		Step 2		Step 3	
	Collinearity Statistics		Collinearity Statistics		Collinearity Statistics	
Model	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
1 (Constant)						
Industry1 Education	.697	1.434	.697	1.434	.697	1.434
Industry2 Hotels	.600	1.667	.600	1.667	.600	1.667
Industry3 Banks	.577	1.732	.577	1.732	.577	1.732
Industry4 Wholesale	.348	2.875	.348	2.875	.348	2.875
Industry5 Business	.332	3.011	.332	3.011	.332	3.011
Industry6 Transport	.443	2.255	.443	2.255	.443	2.255
Industry7 Health	.549	1.822	.549	1.822	.549	1.822
Firm Size	.847	1.180	.847	1.180	.847	1.180
2 (Constant)						
Industry1 Education	.688	1.454	.688	1.454	.673	1.486
Industry2 Hotels	.597	1.674	.597	1.674	.595	1.680
Industry3 Banks	.497	2.012	.497	2.012	.478	2.091
Industry4 Wholesale	.343	2.918	.343	2.918	.338	2.959
Industry5 Business	.315	3.173	.315	3.173	.306	3.265
Industry6 Transport	.431	2.319	.431	2.319	.428	2.336
Industry7 Health	.506	1.978	.506	1.978	.485	2.062
Firm Size	.801	1.248	.801	1.248	.781	1.280
ITSCA	.762	1.312	.762	1.312	.739	1.354
ITINF	.813	1.231	.813	1.231	.791	1.264
ITOSK	.830	1.205	.830	1.205	.756	1.323
Customer Collaboration					.835	1.198
Durbin-Watson	2.143		1.973		1.899	

Step 1: Dependent Variable – Customer Collaboration

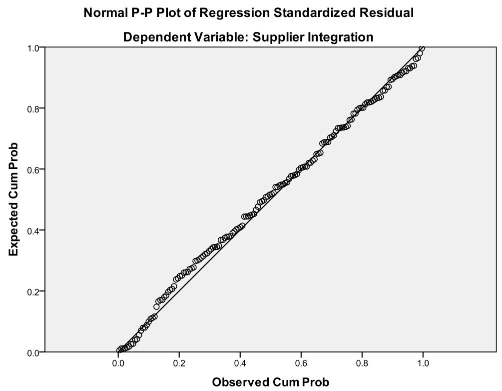
Step 2: Dependent Variable – Quality

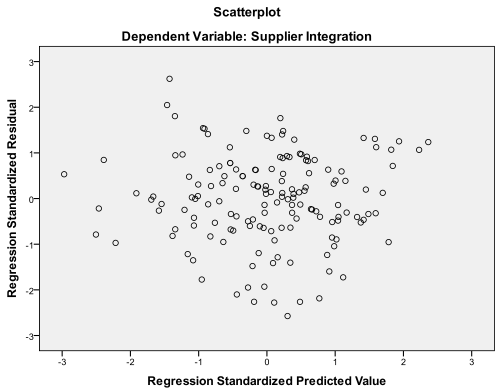
Step 3: Dependent Variable – Quality (Mediator: Customer Collaboration)

Appendix 7.2: Normal probability plots and Scatterplots (Model 1 to 8)

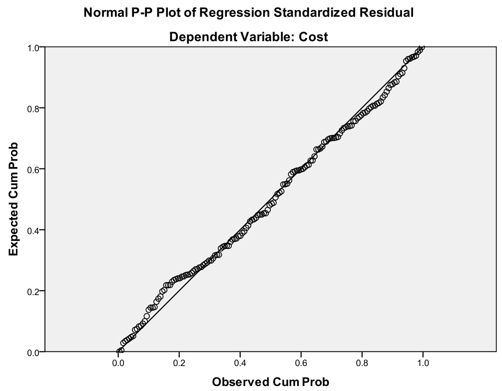
Appendix 7.2.1: Normal probability plots of the regression standardised residual & Scatterplots of the standardised residuals (Model 1)

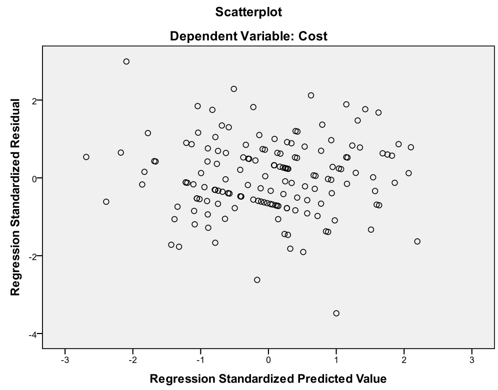
Step 1



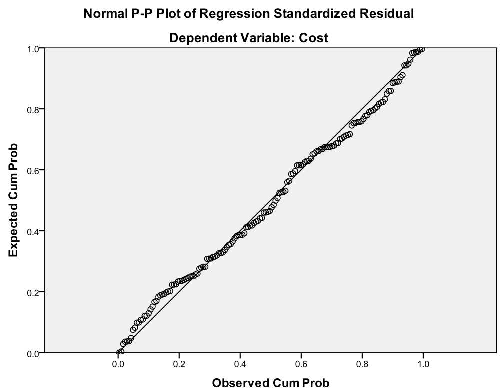


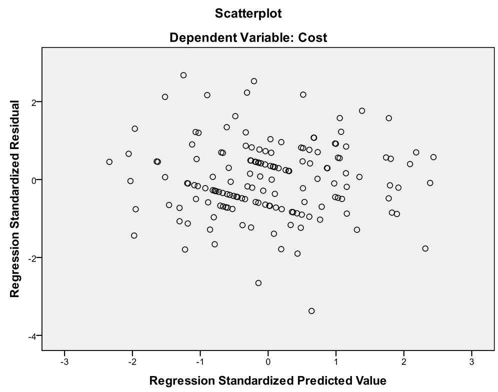
Step 2





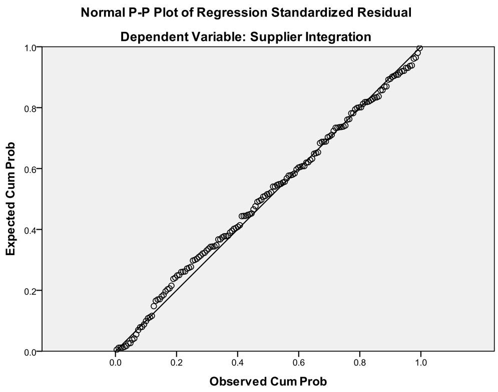
Step 3

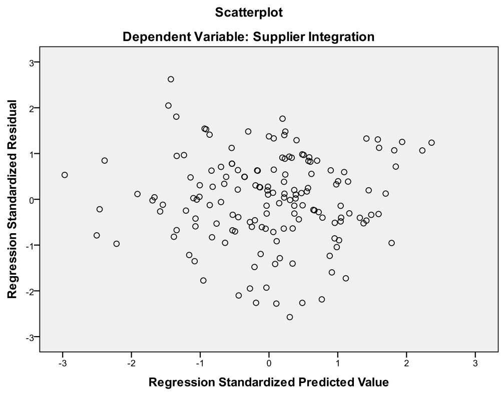




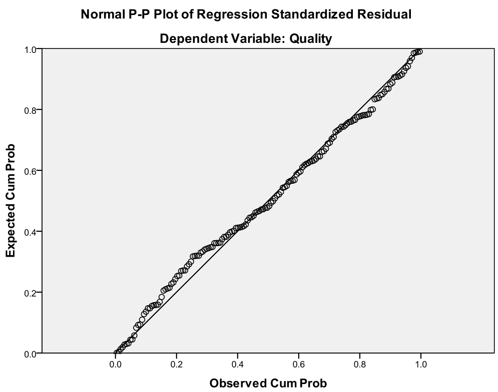
Appendix 7.2.2: Normal probability plots of the regression standardised residual & Scatterplots of the standardised residuals (Model 2)

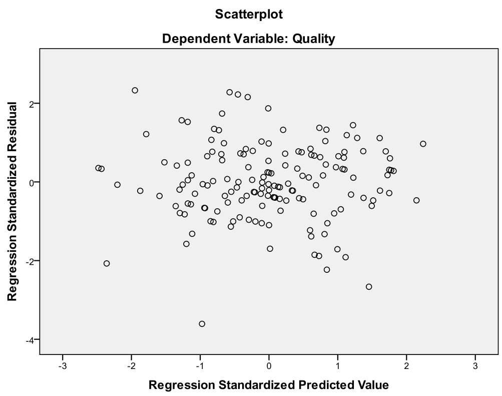
Step 1



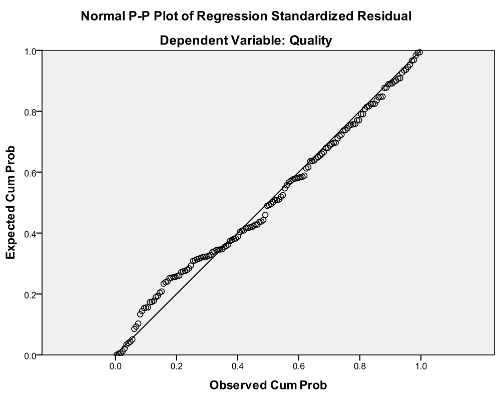


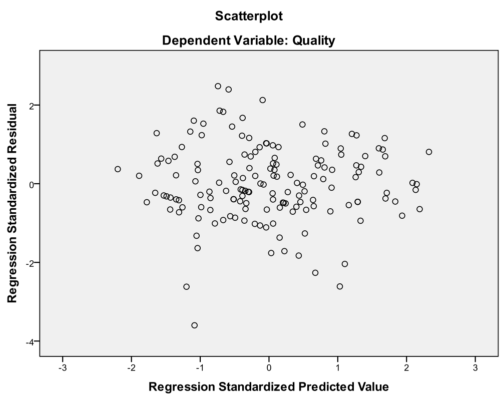
Step 2





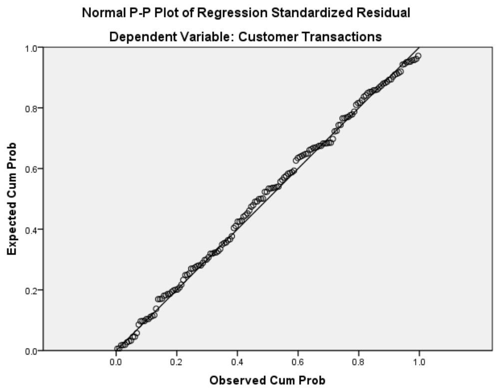
Step 3

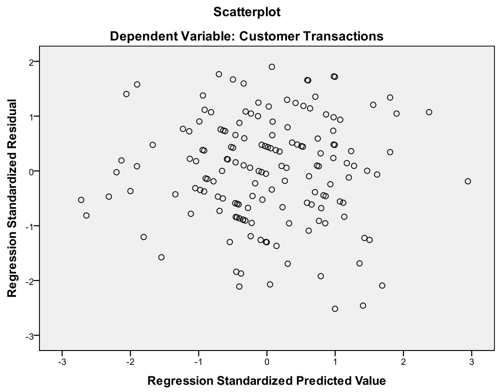




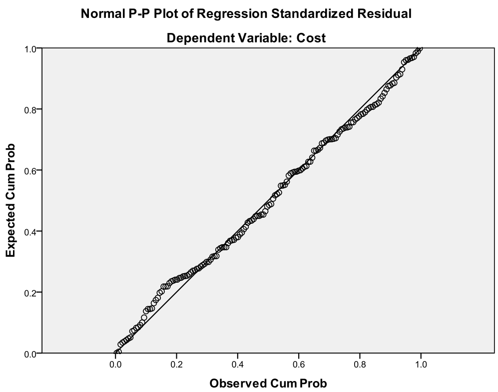
Appendix 7.2.3:Normal probability plots of the regression standardised residual & Scatterplots of the standardised residuals (Model 3)

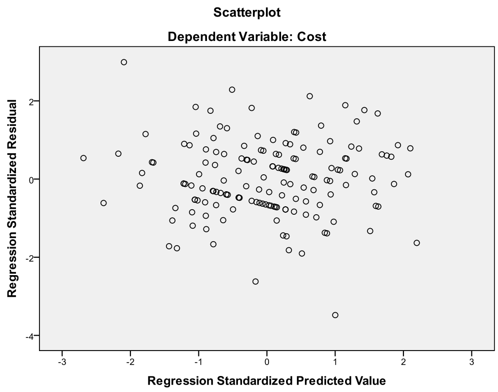
Step 1



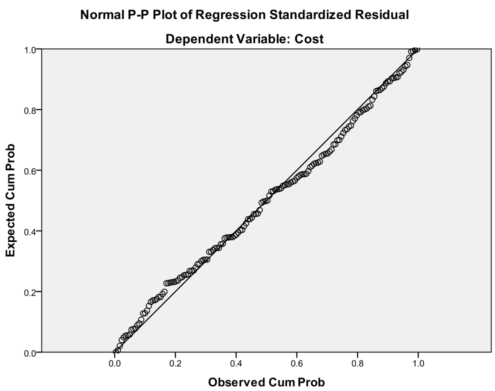


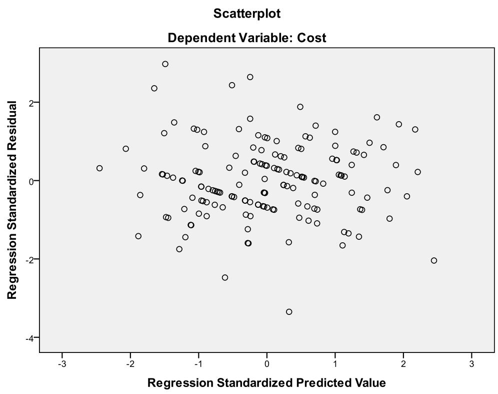
Step 2





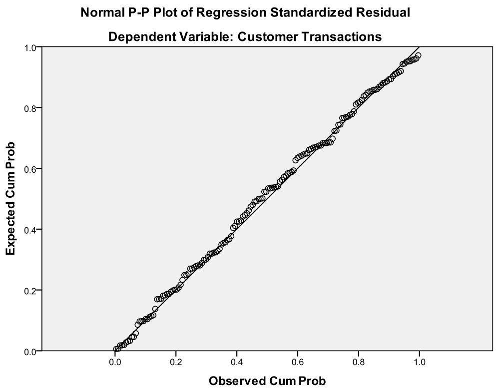
Step 3

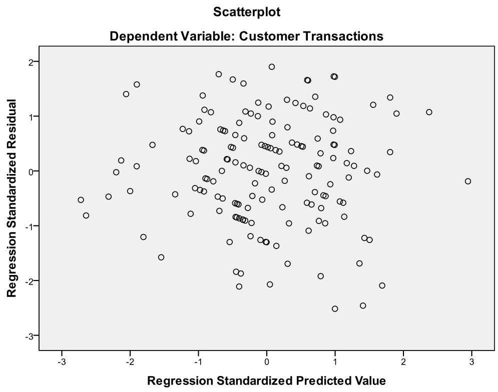




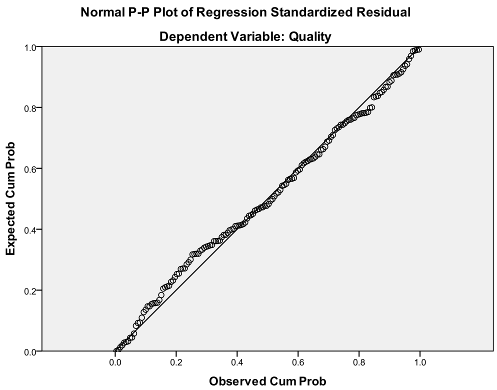
Appendix 7.2.4: Normal probability plots of the regression standardised residual & Scatterplots of the standardised residuals (Model 4)

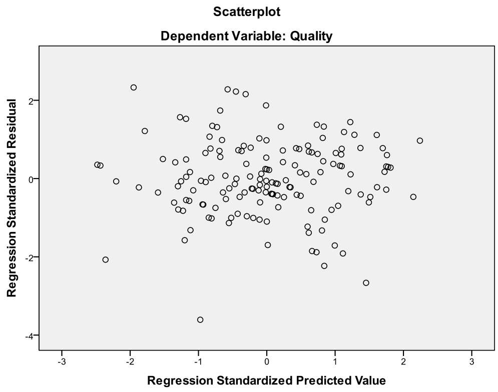
Step 1



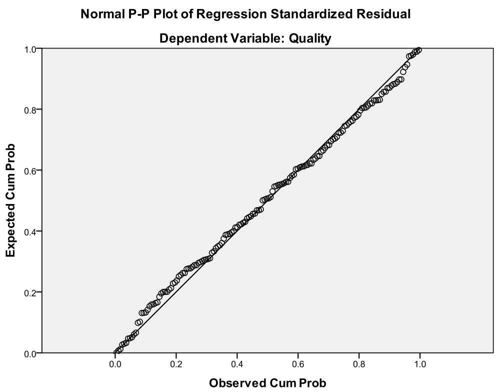


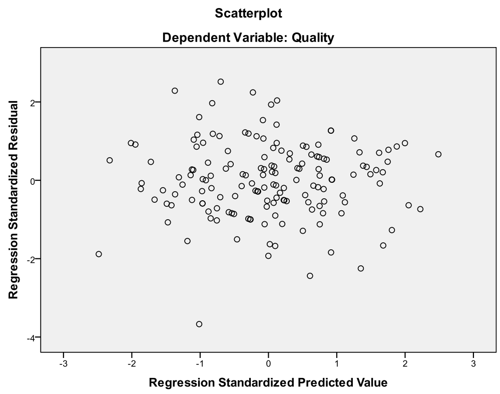
Step 2





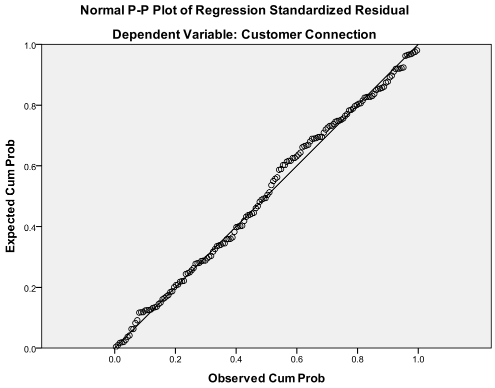
Step 3

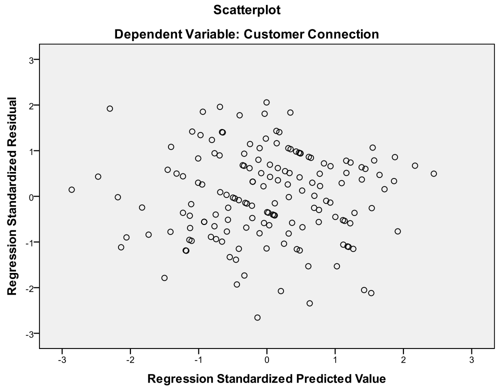




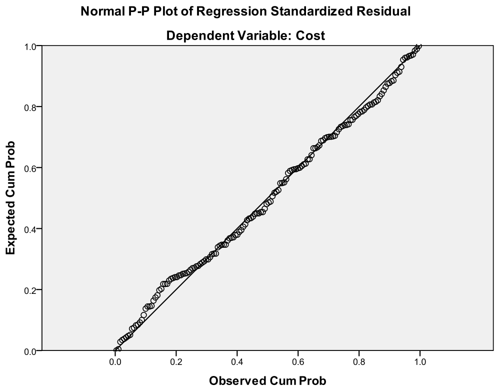
Appendix 7.2.5: Normal probability plots of the regression standardised residual & Scatterplots of the standardised residuals (Model 5)

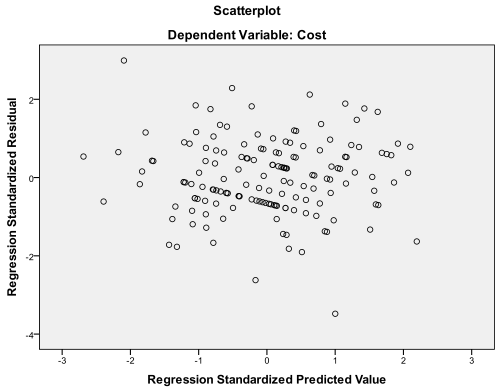
Step 1



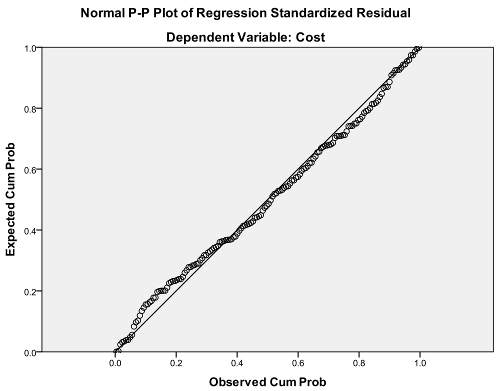


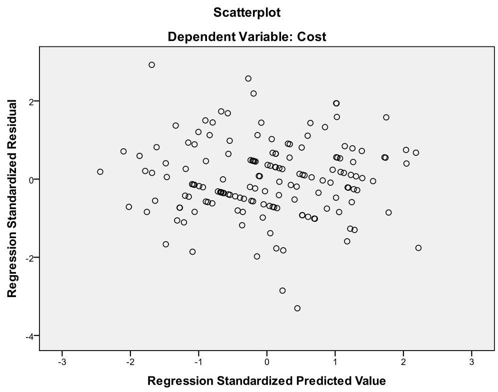
Step 2





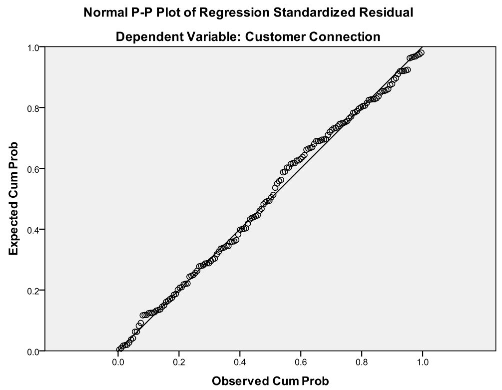
Step 3

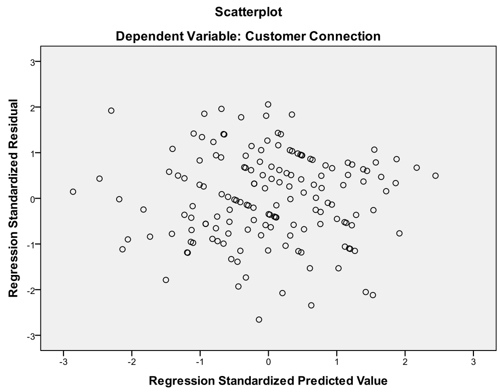




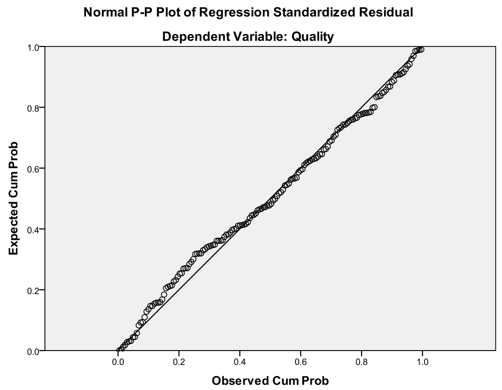
Appendix 7.2.6: Normal probability plots of the regression standardised residual & Scatterplots of the standardised residuals (Model 6)

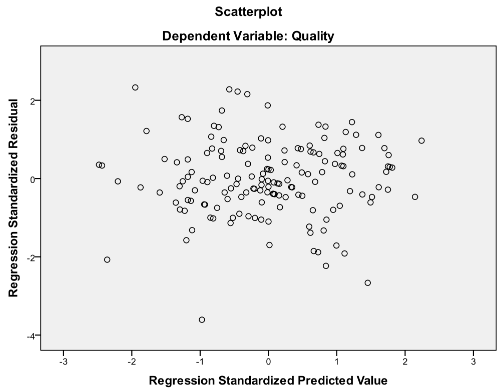
Step 1



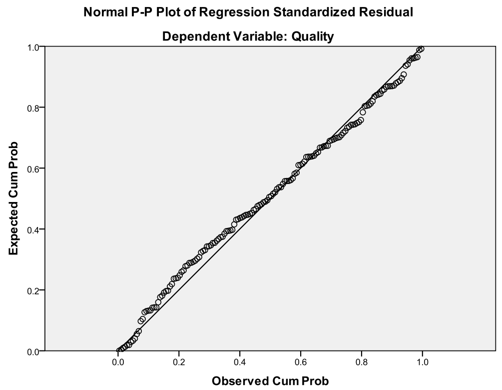


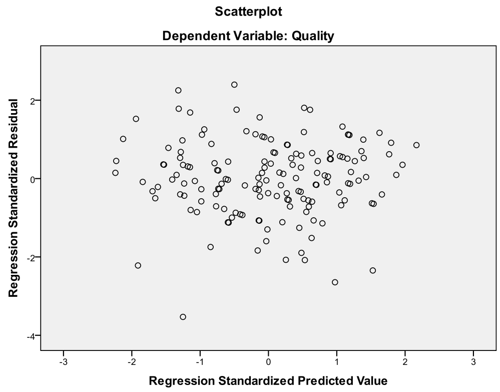
Step 2





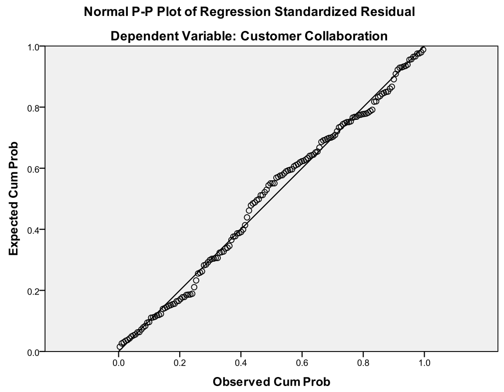
Step 3

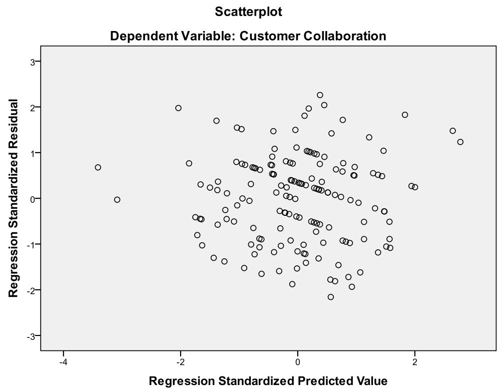




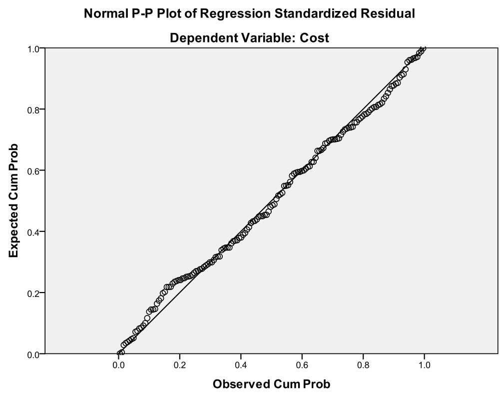
Appendix 7.2.7: Normal probability plots of the regression standardised residual & Scatterplots of the standardised residuals (Model 7)

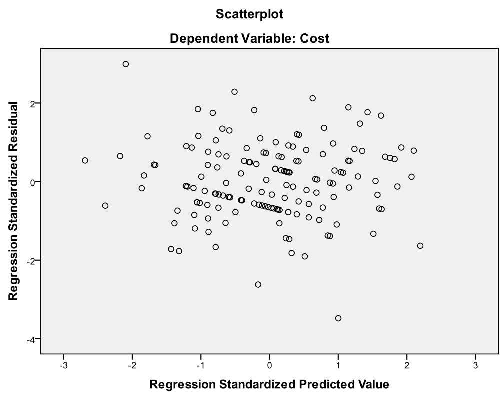
Step 1



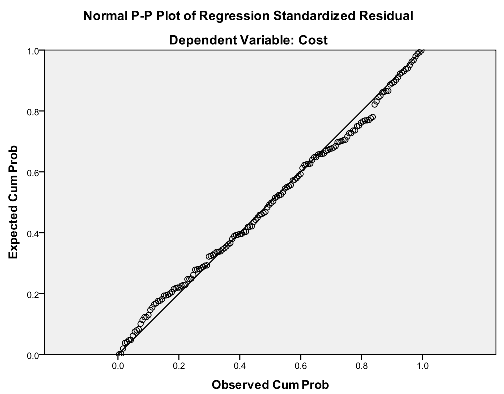


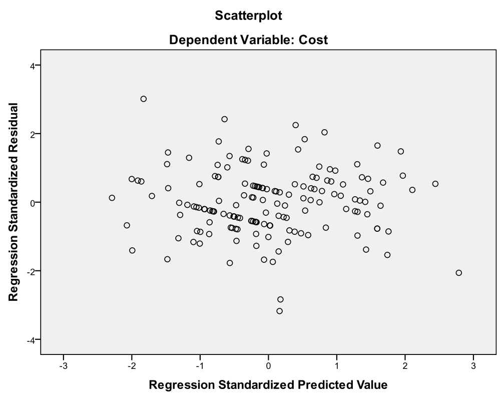
Step 2





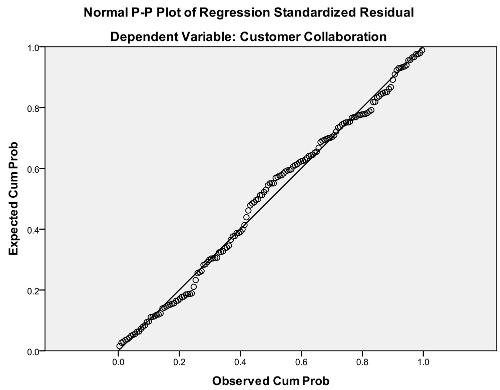
Step 3

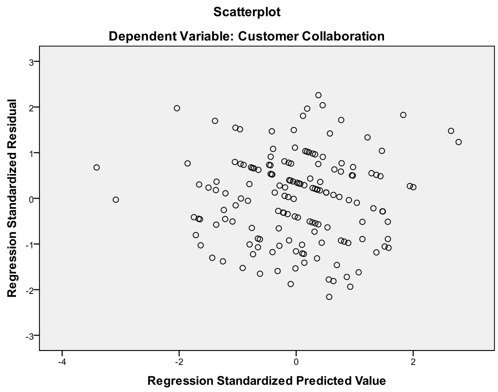




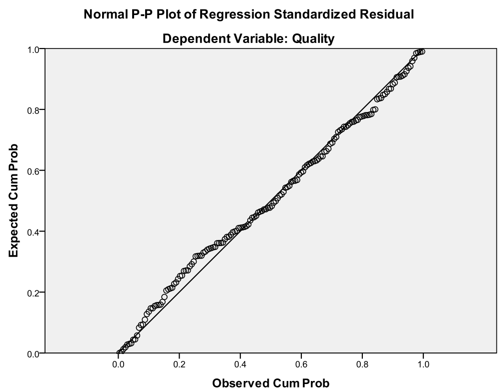
Appendix 7.2.8: Normal probability plots of the regression standardised residual & Scatterplots of the standardised residuals (Model 8)

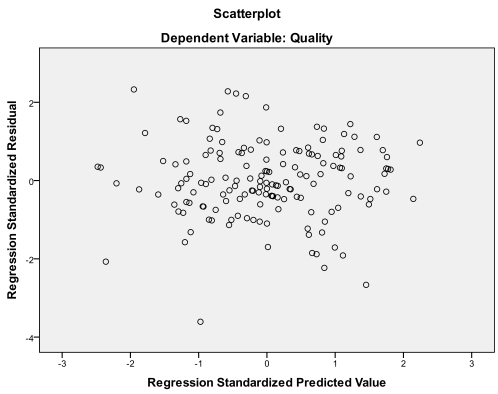
Step 1



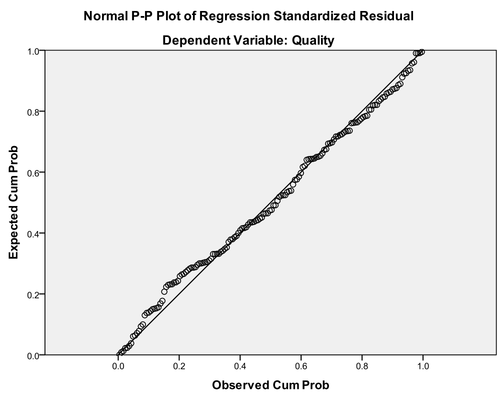


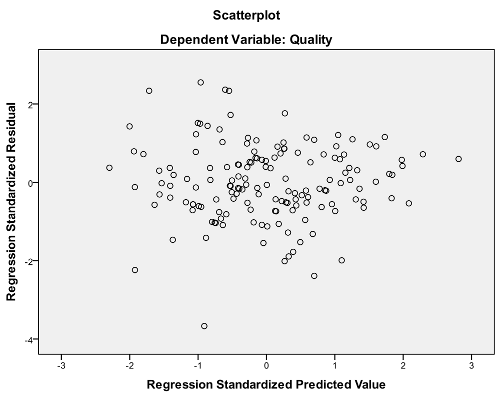
Step 2





Step 3





Appendix 7.3: Table results of split-sample validation tests*

Model	Step	Data	ANOVA	R^2	ΔR^2	Sig. Coefficients*
1	1	Full	5.698***	.303	.262***	ITSCA, ITINF, ITOSK
		75%	3.304**	.239	.202***	ITSCA, ITINF, ITOSK
	2	Full	2.783**	.175	.149***	ITSCA, ITOSK
		75%	2.098*	.166	.104**	ITSCA, ITOSK
	3	Full	2.947**	.198	.172***	ITSCA, ITOSK, SI
		75%	2.069*	.178	.116**	ITSCA
2	1	Full	5.698***	.303	.262***	ITSCA, ITINF, ITOSK
		75%	3.304**	.239	.202***	ITSCA, ITINF, ITOSK
	2	Full	3.061**	.189	.123***	ITSCA, ITOSK
		75%	2.171*	.171	.081*	ITSCA, ITOSK
	3	Full	3.837***	.244	.177***	SI
		75%	2.475**	.205	.116**	SI
3	1	Full	3.079**	.190	.104**	ITSCA, ITOSK
		75%	1.995*	.159	.075*	ITOSK
	2	Full	2.783**	.175	.149***	ITSCA, ITOSK
		75%	2.098*	.166	.104**	ITSCA, ITOSK
	3	Full	3.952***	.249	.222***	ITSCA, ITOSK, CT
		75%	2.871**	.231	.169***	CT
4	1	Full	3.079**	.190	.104**	ITSCA, ITOSK
		75%	1.995*	.159	.075*	ITSCA, ITOSK
	2	Full	3.061**	.189	.123***	ITSCA, ITOSK
		75%	2.171*	.171	.081*	ITOSK
	3	Full	4.370***	.268	201***	CT
		75%	3.358***	.260	.170***	CT
5	1	Full	5.723***	.304	.196***	APP, ITINF, ITOSK
		75%	4.614***	.304	.161***	ITSCA, ITOSK
	2	Full	2.783**	.175	.149***	ITSCA, ITOSK
		75%	2.098*	.166	.104**	ITSCA, ITOSK
	3	Full	3.123**	.208	.181***	ITOSK, CCNT
		75%	2.242*	.190	.128**	
6	1	Full	5.723***	.304	.196***	ITSCA, ITINF, ITOSK
		75%	4.614***	.304	.161***	ITSCA, ITOSK
	2	Full	3.061**	.189	.123***	ITSCA, ITOSK
		75%	2.171*	.171	.081*	ITOSK
	3	Full	4.329***	.266	.200***	CCNT
		75%	2.900**	.232	.143**	CCNT
7	1	Full	2.587**	.165	.119***	ITSCA, ITINF, ITOSK
		75%	1.533(ns)	.127	.089*	ITOSK
	2	Full	2.783**	.175	.149***	ITSCA, ITOSK
		75%	2.098*	.166	.104**	ITSCA, ITOSK
	3	Full	3.215***	.212	.186***	ITSCA, ITOSK, CCLB
		75%	2.333*	.196	.134**	ITSCA, CCLB

8	1	Full	2.587**	.165	.119***	ITSCA, ITINF, ITOSK
		75%	1.533(ns)	.127	.089*	ITOSK
	2	Full	3.061**	.189	.123***	ITSCA, ITOSK
		75%	2.171*	.171	.081*	ITSCA, ITOSK
	3	Full	3.464***	.225	.158***	ITSCA, ITOSK, CCLB
		75%	2.305*	.194	.105**	

*Only block 2 statistics in hierarchical regression for each step are shown in the table.
*Only significant coefficients of independent and mediator variables are shown in the table.

Where:

ITSCA: IT for supply chain activities
ITINF: Flexible IT infrastructure
ITOSK: IT operations shared knowledge

SI: Supplier integration
CT: Customer transactions
CCNT: Customer connection
CCLB: Customer collaboration

Appendix 7.4: Mediators correlation matrix

	1	2	3	4
1 Supplier Integration	1			
2 Customer Transactions	.398**	1		
3 Customer Connection	.427**	.554**	1	
4 Customer Collaboration	.456**	.439**	.377**	1

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

Appendix 7.5.1: Additional meditation analysis results (Model 1 and 2)

Model coefficients (Model 1 and 2)

Model	1			2		
Outcome variable:	Cost	SI	Cost	Quality	SI	Quality
	Model coefficients (total effects)	Model coefficients	Model coefficients	Model coefficients (total effects)	Model coefficients	Model coefficients
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
Constant	2.7795***	-.2137***	2.8094	4.1317***	-.2137***	4.1771***
ITSCA	.0711**	.0795*	.0600	.0554*	.0795*	.0385
ITINF	.0766	.1952*	.0494	.1150	.1952*	.0735
ITOSK	.1978**	.3617***	.1472	.1605**	.3617***	.0836
Indust_1	.0680	-.2304	.1002	-.6004	-.2304	-.5514
Indust_2	-.2862	-.4074	-.2293	-.5909	-.4074	-.5043
Indust_3	.4902	.1181	.4737	-.3785	.1181	-.4036
Indust_4	.0961	.2442	.0619	-.3307	.2442	-.3826
Indust_5	.0598	.2386	.0265	-.4734	.2386	-.5242
Indust_6	-.0458	-.0294	-.0416	-.2008	-.0294	-.1945
Indust_7	.1290	.7063	.0303	-.1214	.7063	-.2715
FirmSize	-.0120	.2087	-.0412	-.1498	.2087	-.1941
SI			.1397*			.2126**
R^2	.1753	.3033	.1983	.1895	.3033	.2436
Adjusted R^2	.1123	.2500	.1310	.1276	.2500	.1801
F	2.7829*	5.6980***	2.9468**	3.0606**	5.6980***	3.8374***

* p<.05
** p<.01
*** p<.001

Indirect effect(s) on Cost through: SI

	Effect	SE(mc)	LLCI	ULCI
ITSCA	.0111	.0074	.0011	.0245
ITINF	.0273	.0181	.0027	.0602
ITOSK	.0505	.0270	.0090	.0968

Indirect effect(s) on Quality through: SI

	Effect	SE(mc)	LLCI	ULCI
ITSCA	.0169	.0087	.0047	.0327
ITINF	.0415	.0214	.0111	.0806
ITOSK	.0769	.0287	.0338	.1268

Appendix 7.5.2: Additional meditation analysis results (Model 3 and 4)

Model coefficients (Model 3 and 4)

Model	3			4		
Outcome variable:	Cost	CT	Cost	Quality	CT	Quality
	Model coefficients (total effects)	Model coefficients	Model coefficients	Model coefficients (total effects)	Model coefficients	Model coefficients
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
Constant	2.7795***	2.1896**	2.2994***	4.1317***	2.1896**	3.6398
ITSCA	.0711**	.0893*	.0515*	.0554*	.0893*	.0353
ITINF	.0766	.0157	.0732	.1150	.0157	.1115
ITOSK	.1978**	.2507**	.1428*	.1605**	.2507**	.1042
Indust_1	.0680	-.4086	.1576	-.6004	-.4086	-.5086
Indust_2	-.2862	-.8553	-.0986	-.5909	-.8553	-.3987
Indust_3	.4902	-.9378	.6958	-.3785	-.9378	-.1678
Indust_4	.0961	-.4910	.2037	-.3307	-.4910	-.2204
Indust_5	.0598	-.3686	.1406	-.4734	-.3686	-.3906
Indust_6	-.0458	-.2757	.0147	-.2008	-.2757	-.1388
Indust_7	.1290	-.6534	.2723	-.1214	-.6534	.0254
FirmSize	-.0120	.1292	-.0403	-.1498	.1292	-.1788
CT			.2193***			.2247***
R^2	.1753	.1904	.2491	.1895	.1904	.2683
Adjusted R^2	.1123	.1286	.1861	.1276	.1286	.2069
F	2.7829*	3.0789**	3.9525***	3.0606**	3.0789**	4.3700***

* p<.05
** p<.01
*** p<.001

Indirect effect(s) on Cost through: CT

	Effect	SE(mc)	LLCI	ULCI
ITSCA	.0196	.0097	.0055	.0372
ITINF	.0034	.0201	-.0290	.0373
ITOSK	.0550	.0239	.0203	.0974

Indirect effect(s) on Quality through: CT

	Effect	SE(mc)	LLCI	ULCI
ITSCA	.0201	.0099	.0057	.0378
ITINF	.0035	.0208	-.0299	.0388
ITOSK	.0563	.0241	.0208	.0992

Appendix 7.5.3: Additional meditation analysis results (Model 5 and 6)

Model coefficients (Model 5 and 6)

Model	5			6		
Outcome variable:	Cost	CCnt	Cost	Quality	CCnt	Quality
	Model coefficients (total effects)	Model coefficients	Model coefficients	Model coefficients (total effects)	Model coefficients	Model coefficients
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
Constant	2.7795***	2.0366**	2.4631***	4.1317***	2.0366**	3.6477***
ITSCA	.0711**	.1161***	.0531	.0554*	.1161***	.0278
ITINF	.0766	.2161	.0431	.1150	.2161	.0637
ITOSK	.1978**	.2416*	.1602*	.1605**	.2416*	.1031
Indust_1	.0680	-1.8324	.3527	-.6004	-1.8324	-.1649
Indust_2	-.2862	-.9571	-.1375	-.5909	-.9571	-.3634
Indust_3	.4902	-1.0117	.6474	-.3785	-1.0117	-.1381
Indust_4	.0961	-.6755	.2010	-.3307	-.6755	-.1702
Indust_5	.0598	-.4045	.1227	-.4734	-.4045	-.3773
Indust_6	-.0458	-.1223	-.0268	-.2008	-.1223	-.1717
Indust_7	.1290	.0316	.1241	-.1214	.0316	-.1289
FirmSize	-.0120	-.0547	-.0035	-.1498	-.0547	-.1368*
CCnt			.1554*			.2376***
R^2	.1753	.3042	.2076	.1895	.3042	.2665
Adjusted R^2	.1123	.2510	.1411	.1276	.2510	.2049
F	2.7829*	5.7233***	3.1227***	3.0606**	5.7233***	4.3292***

* p<.05
** p<.01
*** p<.001

Indirect effect(s) on Cost through: CCnt

	Effect	SE(mc)	LLCI	ULCI
ITSCA	.0180	.0095	.0046	.0351
ITINF	.0336	.0196	.0064	.0698
ITOSK	.0375	.0201	.0088	.0737

Indirect effect(s) on Quality through: CCnt

	Effect	SE(mc)	LLCI	ULCI
ITSCA	.0276	.0109	.0114	.0473
ITINF	.0514	.0242	.0157	.0943
ITOSK	.0574	.0242	.0217	.1011

Appendix 7.5.4: Additional meditation analysis results (Model 7 and 8)

Model coefficients (Model 7 and 8)

Model	7			8		
Outcome variable:	Cost	CClb	Cost	Quality	CClb	Quality
	Model coefficients (total effects)	Model coefficients	Model coefficients	Model coefficients (total effects)	Model coefficients	Model coefficients
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
Constant	2.7795***	1.0087	2.6210	4.1317***	1.0087	3.9776***
ITSCA	.0711**	.0771*	.0590*	.0554*	.0771*	.0436
ITINF	.0766	-.1733*	.1039	.1150	-.1733*	.1415
ITOSK	.1978**	.3089***	.1492*	.1605**	.3089***	.1133
Indust_1	.0680	1.1107	-.1066	-.6004	1.1107	-.7701
Indust_2	-.2862	.3885	-.3472	-.5909	.3885	-.6503
Indust_3	.4902	1.3390	.2798	-.3785	1.3390	-.5831
Indust_4	.0961	.6176	-.0010	-.3307	.6176	-.4251
Indust_5	.0598	.8840	-.0791	-.4734	.8840	-.6085
Indust_6	-.0458	.4810	-.1213	-.2008	.4810	-.2743
Indust_7	.1290	1.2973	-.0749	-.1214	1.2973	-.3196
FirmSize	-.0120	.1868	-.0414	-.1498	.1868	-.1783*
CClb			.1571*			.1528*
R^2	.1753	.1650	.2124	.1895	.1650	.2252
Adjusted R^2	.1123	.1012	.1464	.1276	.1012	.1602
F	2.7829*	2.5869**	3.2146***	3.0606**	2.5869**	3.4644***

* p<.05

** p<.01

*** p<.001

Indirect effect(s) on Cost through: CClb

	Effect	SE(mc)	LLCI	ULCI
ITSCA	.0121	.0076	.0017	.0261
ITINF	-.0272	.0183	-.0618	-.0023
ITOSK	.0485	.0234	.0144	.0907

Indirect effect(s) on Quality through: CClb

	Effect	SE(mc)	LLCI	ULCI
ITSCA	.0118	.0075	.0016	.0256
ITINF	-.0265	.0177	-.0591	-.0024
ITOSK	.0472	.0228	.0142	.0885