國立交通大學

資訊管理研究所

博　士　論　文

企業導入企業資源規劃系統對供應鏈管理能力之影響

The Relationship between Benefits of ERP Systems Implementation and Its impacts on Firm Performance of SCM

研 究 生： 蘇宜芬

指導教授： 楊　千 博士

中華民國九十八年六月

企業導入企業資源規劃系統對供應鏈管理能力之影響

學生：蘇宜芬　　　　　　　　　　　　　指導教授：楊　千

國立交通大學資訊管理研究所博士班

摘要

企業所面臨的環境更複雜競爭更劇烈，已不能以單打獨鬥方式面對客戶多變的需求。因此供應鏈設計成為企業重要的核心能力。為提升供應鏈管理能力，企業必須借重資訊系統。因而以企業流成為導向設計的企業資源規劃系統(Enterprise resource planning, ERP) 橫掃產業界。許多組織不惜耗費巨額資金以導入企業資源規劃系統，而企業資源規劃系統也被視為提升供應鏈管理效能不可或缺的要素。然而，導入 ERP 系統既昂貴，也可能具風險。因此資訊經理人必須審慎評估，以有限的資源投資在正確的資訊系統上。是否 ERP 對供應鏈管理能力的提升具有正面的影響力？我們的研究焦點因而置於此。

本研究首先著眼於近年來相關的供應鏈管理與企業資源規劃議題：第一，對供應鏈管理與企業資源規劃做定義；第二，回顧過去的相關文獻，提出概念性架構以闡明企業資源規劃的效益與供應鏈管理能力，並檢視前者對後者的影響；第三，資料的蒐集以台灣資訊科技產業為主，並透過專家深入訪談與問卷方式取得資料。架構模型以結構方程模型作分析。研究結果得到五大企業資源規劃效益中的三大效益 – 營運、管理、與策略效益對供應鏈管理能力具正面影響。而資訊科技與組織效益不具顯著影響效力。同時，超過百分之八十的受訪者認為企業應該先行導入企業資源規劃系統，作為企業資訊的骨幹，再行考量部署其他資訊系統 – 如供應鏈管理系統，較能彰顯效益。

關鍵字：企業資源規劃、供應鏈管理、企業系統、結構方程模型、調查。

The Relationship between Benefits of ERP Systems Implementation and Its impacts on Firm Performance of SCM

Student: Yi-fen Su Advisor: Chyan Yang

Institute of Information Management
National Chiao Tung University

ABSTRACT

Supply chain design is becoming a core competency. The Enterprise Resource Planning (ERP) system is expected to be an integral component of Supply Chain Management (SCM). Installing an ERP system is, however, expensive and risky. IT managers must decide how to use their limited resources and invest in the right product. Can an ERP system directly improve SCM competency? Our research is therefore focusing on the relationship between ERP and SCM.

First, definitions of SCM and definitions of ERP are provided. Second, a review of past research on ERP and SCM is presented to illustrate the ERP benefits and supply chain competencies. A conceptual framework was proposed. The framework is featuring the ERP benefits and supply chain competences, and examines the impacts of the former on the latter. Third, the data collected from Taiwanese IT firms through experts interviewing and survey. The framework was evaluated using a structural equation analysis. The results confirm the operational, managerial, and strategic benefits of ERP for the SCM competency, but not the IT infrastructure and organizational benefits as significant predictors of them. Moreover, more than 80% of respondents think it necessary to first adopt an ERP system as the backbone of company operations before deploying other enterprise systems (ES), such as the SCM system.

Keywords: Enterprise resource planning (ERP), Supply chain management (SCM), Enterprise system (ES), Structural equation model (SEM), Survey.

ACKNOWLEDGEMENTS

I wish to acknowledge my thanks to all the individuals who assisted me during the process of conducting this research. Without their guidance and support this research would not be possible.

Words cannot express the gratitude I have for my advisor Prof. Chyan Yang for his tireless support. His wisdom and guidance was greatly appreciated.

I would also like to extend my gratitude to my dissertation committee: Prof. Wei-Tzen Yang, Prof. Gwo-Hshiung Tzeng, Prof. Chi-Chun Lo, and Prof. Duen-Ren Liu. They provided me advice, guidance, and expertise, as well as kind support, until I completed this dissertation. The influences they have had on me are too great to enumerate here.

I also want to thank Professors: Prof. Po-Lung Yu and Prof. Han-Lin Li who encouraged and advised me during my doctoral studies.

Particularly, I am thankful to my special friends Dr. Tzu-Chang Yeh and Dr. Jia-Jane Shuai for their invaluable and timely help during various stages of this dissertation.

Lastly, my deep appreciation is extended to my parents, husband, and son – for being a constant source of inspiration, comfort and love, for years of encouragement and acceptance of gender-free responsibilities at home, and for sharing my tears, sweat, laughter, and joys during the long year of doctoral study.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

The globalization of competition means that apart from ensuring their own successful operation, firms that hope to survive must establish highly responsive supply chains, with up-, mid-, and downstream partners. How to best improve corporate SCM capabilities in order to improve overall supply chain performance has therefore become an important issue in corporate management (Fine, 1998; Park et al., 2005; Whit et al., 2005). As Kuei et al. (2002) have pointed out, SCM is a network of autonomous or semi-autonomous business entities collectively responsible for procurement, manufacturing and distribution activities associated with one or more families of related products. Enterprises in the supply chain are likely to increase control over their suppliers and enhance their SCM competencies by gaining power from information. To meet these new challenges and the need for a competent supply chain, companies around the world have invested heavily in Information Technology (IT), and take advantage of IT systems to radically alter the conduct of business in both domestic and global markets. In particular, many firms have implemented company-wide systems called ERP systems, which are designed to integrate and optimize various business processes, such as order entry and production planning, across the entire firm (Mabert et al., 2001). This investment has also made possible the sharing of large amounts of information along the supply chain, and has enabled real-time collaboration between supply chain partners, providing organizations with forward visibility, thus improving inventory management and distribution. ERP, which allows for the transmission and processing of information necessary for synchronous decision making, can be viewed as an essential enabler of SCM activities (Akkermans et al., 2003; Hsu et al., 2007; Sanders, 2007).

1.1 Research Background and Problems

Early ERP systems, however, did not have the improvement of supply chain management as their objective. Their initial focus was executing and integrating internally-oriented applications that support finance, accounting, manufacturing, order entry, and human resources. Satisfaction of internal requirements for information integration and for solutions that will improve SCM competencies, while obviously desirable, is insufficient, and firms expect new information systems to also enable them to swiftly respond to the varied needs of their customers, to share appropriate real-time information, and to establish excellent relationships with supply chain partners. Consequently, many organizations have also addressed supply chain issues with their ERP system, in addition to implementing an integrated version of it internally (Davenport and Brooks, 2004).

When ERP systems are fully realized in a business organization, they can be expected to yield many benefits, such as reduction of cycle time, faster transactions, better financial management, the laying of the groundwork for e-commerce, linking the entire organization together seamlessly, providing instantaneous information, and making tacit knowledge explicit (Mabert et al., 2001; Davenport and Brooks, 2004; Shang and Seddon, 2000; Murphy and Simon, 2002; Al-Mashari et al., 2003). ERP can provide the digital nervous system and the backbone in an organization to respond swiftly to customers and suppliers (Cox et al., 2000; Mabert et al., 2001). As reported in Akkermans et al. (2003), ERP systems are widely believed to contribute to SCM in technical areas such as standardization, transparency and globalization. ERP systems are a leading tool for this purpose, and are always expected to be an integral component of SCM (Sawy et al., 1999; Nah et al., 2001; Themistocleous et al., 2002). The potential benefits of an integrated ERP system are such that many organizations are willing to undertake the difficult process of conversion.

Adopting an integrated ERP system, however, has mixed results in terms of a firm's performance, and some academic research is much more suspicious of its benefits. First of all, implementing an ERP system is costly and risky; it requires a large amount of capital, and its inflexibility makes it often difficult to implement across all departments within a large corporation (Mabert et al., 2001). Some businesses have invested enormous sums of money in ERP or IT without positive results (Gupta and Kohli, 2006; Ehie and Madsen, 2005; Roach, 1991; Pentland, 1989; Strassman, 1990).

Hitt et al. (2002), on the other hand, produced multiyear, multi-firm ERP implementation and financial data that shows evidence of short-run gain during implementation, but a lack of post-implementation data at the time they conducted their study meant they were unable to estimate the long-run impact. Gattiker and Goodhue (2004) argued that high interdependence among organizational sub-units contributes to positive ERP-related effects because of ERPs ability to coordinate activities and facilitate information flows. When differentiation among sub-units is high, however, organizations may incur ERP-related compromise or design costs. A survey by Mabert et al. (2003a) found some improvements in managers' perceptions of performance, but that few firms had reduced direct operational costs. In addition, Hendricks et al. (2007) observed improvements only in profitability, not in stock returns. Data for improvements in profitability is also stronger in the case of early adopters of ERP systems. Although their results are not uniformly positive across the different enterprise systems (ES, including ERP, SCM, and CRM systems), they are encouraging in the sense that despite the high implementation costs, they do not find persistent evidence of negative performance associated with ES investments.

More recent evidence has, on the contrary, demonstrated large benefits and uncovered significant productivity gains from IT investments: for example, as reported in McAfee (2002), an in-depth case study of an ERP implementation and its effects on performance at a single firm. This longitudinal research presents initial evidence of a causal link between IT adoption and subsequent improvement in operational performance measures, as well as evidence of the timescale for these benefits. Hunton et al. (2002) experimentally tested the relationship between ERP and performance by presenting 63 certified analysts at a financial services firm with the hypothetical case of a company, and comparing these analysts' initial earning forecasts with their forecasts after they are told that the hypothetical firm has committed to invest in an ERP system. The results show that the revision in earnings is positive, thereby providing supports for the hypothesis that implementation of ERP systems has a positive effect on performance. Huang et al. (2007) proposed an integrated theoretical model that demonstrated that the company's implementation of ERP has a positive effect on the process capital of its Intellectual Capital (IC); the process capital then affects the customer capital, which ultimately translates into business performance.

Many academic researchers have contributed by confirming the relationship between SCM and firm performance (Du, 2007; Hong and Jeong, 2006; Closs and Mollenkopf, 2004; Narasimhan and Kim, 2002; Byrd and Davidson, 2003; Gunasekaran et al., 2004) or by confirming the relationship between ERP implementation and firm performance (Hendricks et al., 2007; Mabert et al., 2001, 2003a; McAfee, 2002; Hitt et al., 2002; Gupta and Kohli, 2006; Ehie and Madsen, 2005; Laframboise and Reyes, 2005; Kumar and Harms, 2004; Kalling, 2003). Moreover, determining how to integrate various ERP modules into SCM, for planning, control and execution of materials, resources and operations has recently become important (Koh et al., 2006; Wang et al., 2006; Samaranayake and Toncich, 2007; Ho, 2007). Research focusing on the relationship between ERP benefits and SCM competencies is limited and inconclusive (Hsu et al., 2007). Accordingly, the current research addresses this gap in the literature by analyzing the ERP benefits and SCM competencies. The evidence that the Taiwanese IT industry has had a highly successful growth experience with SCM competencies shows that it can be documented, and lessons can be learned. This dissertation proposes a conceptual framework featuring the ERP benefits and SCM competencies, and examines the impacts of the former on the latter. It adds to our cumulative understanding of the relationship of ERP systems and SCM competencies and it guides current and future efforts at decision making on selection of enterprise systems and on improvement of SCM competencies.

This dissertation presents a Structural Equation Modeling (SEM) to analyze the relationship between ERP benefits and SCM competencies. Hypotheses derived from the key benefits of adopting ERP system and related SCM practices presented by previous authors. An empirical survey was conducted to collect data from Taiwanese IT companies listed in the Taiwan Stock Exchanges on several aspects of firm competencies and supply chain performance that adopted ERP systems and/or SCM systems. Results from the model are analyzed and implications for the model are discussed.

1.2 Research Objectives and Defining the Problem Area

Business organizations today are facing a more complex and competitive environment than ever before. Business success is no longer a matter of analyzing only the individual firm, but rather the chain of delivering and supplying organizations. Managing multiparty collaboration in a supply chain is a very difficult task because there are so many parties involved in the supply chain operation, each with its own resources and objectives. Member enterprises in the chain need to cooperate with their business partners in order to satisy customers' needs and to maximize their profit. There is no single authority over all the chain members. Cooperation is through negotiation rather than central management and control. The interdependence of multistage processes also requires real-time cooperation in operation and decision-making across different tasks, functional areas, and organizational boundaries in order to deal with problems and uncertainties (Jain, 2008; Whit et al., 2005). As a result, to remain successful and to be competitive, managers of organizations must use technology to improve firm and supply chain performance.

Information and communications technologies have become major components of the competitive strategy of many businesses. This strategic emphasis has made it possible for mangers to integrate information and communications technologies throughout the organization and link all business units together. Currently, a popular approach to the development of an integrated enterprise-wide system, the adoption of enterprise resource planning (ERP), is sweeping across industry (Akkermans et al., 2003). Successful implementation of ERP has been publicized by such software vendors as SAP, J. D. Edward, Baan, and Oracle. Considered more broadly, an ERP system is an example of enterprise systems, other fast-growing developments – supply chain management software and e-commerce – also have intra- or inter-organizational integration at their core. Two research questions follow from these considerations:

1. Can an ERP system directly improve SCM competencies?
2. Is it necessary to first adopt an ERP system as the backbone of company operations before deploying other enterprise systems (ES), such as the SCM system?

The definition of ERP used in the present research is as stated by Wallace and Kremzar (2001): "An enterprise-wide set of management tools that balances demand and supply, containing the ability to link customers and suppliers into a complete supply chain, employing proven business processes for decision making, and providing high degrees of cross-functional integration among sales, marketing, manufacturing, operations, logistics, purchasing, finance, new product development, and human resources, thereby enabling people to run their business with high levels of customer service and productivity, and simultaneously lower costs and inventories; and providing the foundation for effective e-commerce."

The term "supply chain" is used in the present research in the spirit of the value chain concept. A supply chain is a dynamic process and involves the constant flow of information, materials, and funds across multiple functional areas both within and between chain members (Jain et al., 2008). Such a holistic approach is consistent with the integrated way today's global business managers are planning and controlling the flow of goods and services to the marketplace.

1.3 Overview of the Research Process

Figure 1.1 shows the conceptual model based on the discussion in this chapter. The model encompasses and relies on two areas: benefits of ERP systems implementation as referred to in the classification of ERP benefits, and SCM competencies.

Figure 1.2 presents an overview of the research process. The researcher's ultimate objective was testing hypotheses based on the model (Figure 1.1). Furthermore, the investigator undertook several site visits to business entities with operating ERP systems.

Based on the site visits to business entities with operating ERP systems, structured interviews with experienced practitioners and a review of the relevant literature, the researcher elaborated on the model in Figure 1.1 and Figure 1.3, eventually producing the model presented in Chapter 3. Conceptual definitions of the variables in the model were developed based on the literature and the interviewing of experts. Based on this model, the researcher developed specific, testable hypotheses.

Next, the domain of the relevant construct is initially specified, and the items are subsequently developed based on the conceptual definition. Based on the constructs, we develop a questionnaire draft. The preliminary instrument is pilot tested and reviewed by IT managers from five Taiwanese IT firms, doctoral students and EMBA students. The items are modified following a pre-test of the survey instrument with a sample of five experts, using the same data collection methods, following procedures recommended by Churchill (1997). The pre-tests indicate that the questionnaire is deemed appropriate to examine the relationship between ERP and SCM in Taiwanese IT firms.

Although the plant is the unit of analysis in the model, the survey respondents are the selected chief information officers, IT personnel, or operating managers who have implemented ERP systems or have been responsible for SCM. Since the research questions involve understanding the effects of ERP systems, the domain is restricted to plants that are actually running ERP systems. In order to elicit completed questionnaires from individuals meeting these criteria, the researcher administered the questionnaire using one of two forms: e-mail or regular mail. Survey data is collected from a sample of Taiwanese IT companies listed in the Taiwan Stock Exchanges (TSE), mainly on electronics manufacturers (including: PC systems, peripherals, communications, consumer electronics, and computer components) and semi-conductors-related manufacturers (including: foundry, IC design, packaging and testing, mask, and equipment/material provider), and screened according to whether they have operational ERP systems.

After administering the survey, the researcher evaluated the measurement properties of the instrument. The researcher performed exploratory and confirmatory factor analysis, checked for violations of certain assumptions and calculated construct reliabilities. Based on these analyses the investigator purified the instrument by deleting problematic items and making other changes to the measurement model. Finally, the researcher used the survey data to evaluate the propositions in the research model.

1.4 Outline of the Dissertation

Chapter 1 defined and described ERP and SCM. It described the problem area; and it presented the research questions, an overview of the research process and the importance of the research. Chapter 2 presents relevant literature on ERP benefits and firm competencies of SCM and other important concepts. Chapter 3 presents the model, defines the constructs, discusses their operationalizations and states the hypotheses. Chapter 4 uses the data to establish the instrument's measurement validity. Chapter 5 analyses the model measurement. Chapter 6 discusses the findings and implications. Chapter 7 makes conclusions and remarks. It also presents the major contributions to the academic community and its implications practitioners and the limitations of the work and suggested future research directions.

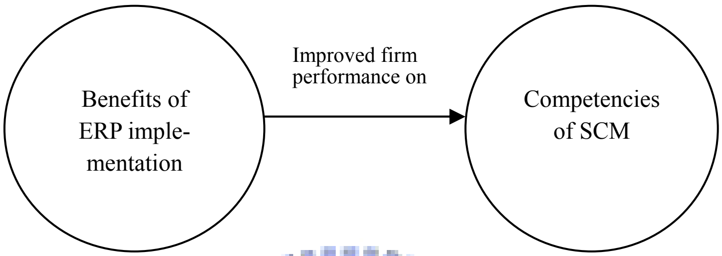

Figure 1.1 Conceptual Model – Influence of ERP systems implementation on firm competencies of SCM

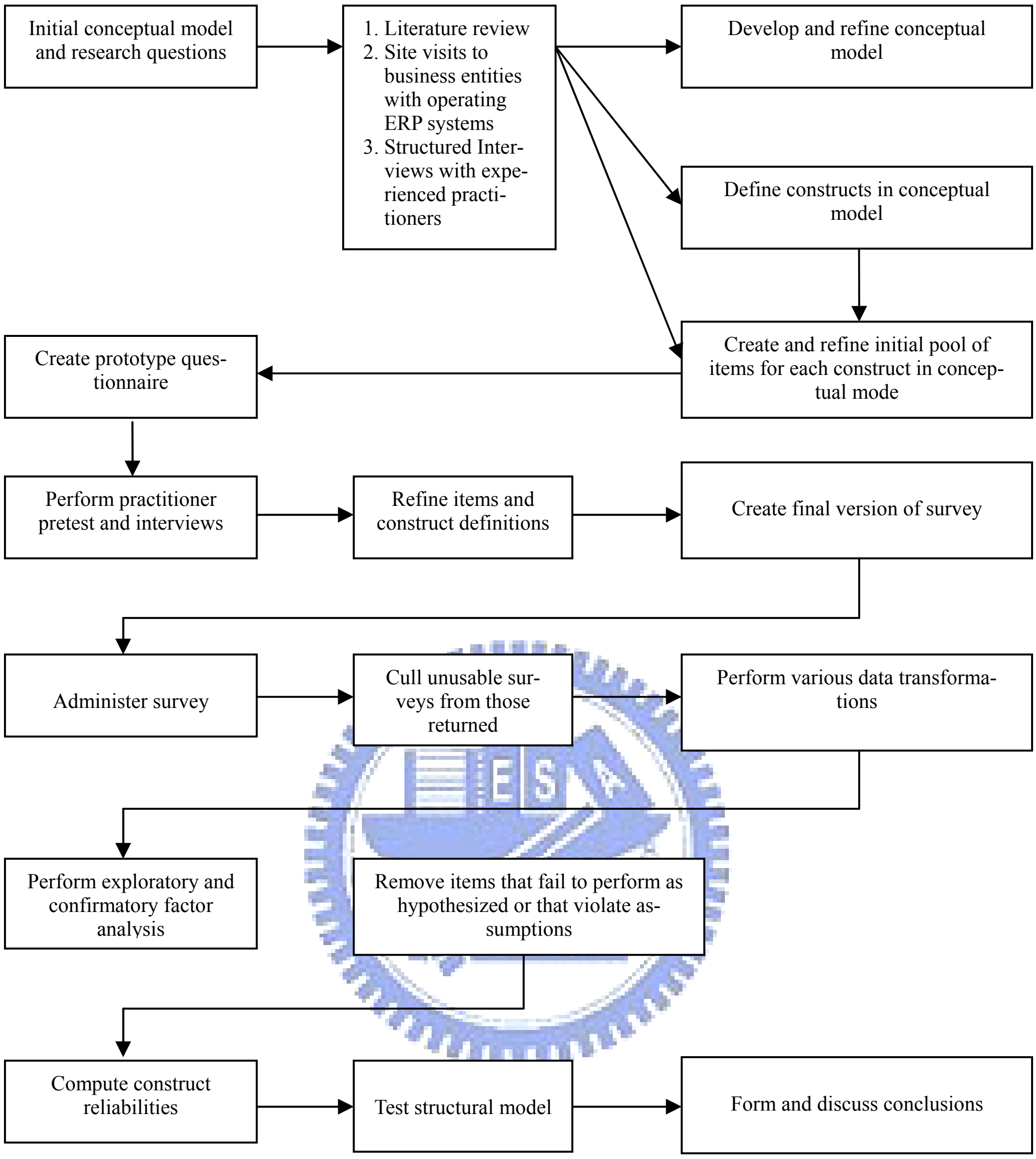

Figure 1.2 Dissertation process overview

ERP Benefits

Operational benefits

The operational benefits are those arising from automating cross functional processes.

IT infrastructure benefits

The IT infrastructure benefit consists of the typical IT department benefits arising from reduction in cost of maintaining legacy systems.

Managerial benefits

The managerial category includes benefits that arise from the use of data to better plan and manage production, manpower, inventory and physical resources and from the monitoring and control of financial performance of products, customers, business lines and geographic area.

Strategic benefits

The strategic benefit category focuses on the benefits that arise from the system ability to support business growth.

Organizational benefits

The organizational benefits category captures the benefits derived from facilitation business learning, empowerment of staff and higher employee morale and satisfaction.

Improved firm performance on →

SCM Competencies

Operational process

Within the operational process, firm competencies include customer integration, internal integration, and supplier integration whether material or service suppliers. Customer integration builds lasting distinctiveness with customers of choice. Internal integration links internally performed work to support customer requirements, and supplier integration links externally performed work into a seamless congruency with internal work processes.

Planning and control process

The planning process includes competencies of technology and planning integration and measurement integration. Technology and planning integration refers to information systems capable of supporting the wide variety of operational configurations needed to serve diverse market segments. Measurement integration refers to the development of measurement systems that facilitate segmental strategies and processes.

Behavioral process

In the behavioral process, relationship integration refers to the ability to develop and maintain a shared mental framework with customers and suppliers regarding inter -enterprise dependency and principles of collaboration.

Figure 1.3 The domain definitions of linking ERP benefits and firm competencies of SCM.

CHAPTER 2

LITERATURE REVIEW

Research into the relationships among ERP, SCM and firm performance has increasingly applied theories and concepts from the strategic literature. The resource based view (RBV) of the firm is a particularly appropriate theoretical framework for studying the performance implications of SCM and ERP (Zsidisin et al., 2003; Sinkovics and Roath, 2004; Kalling, 2003; Tarafdar and Gordon, 2007). It complements traditional industrial organizational theory by recognizing the competitive value of resources/capabilities/competencies, and how they combine with and influence strategies pursued by a firm. Within a supply chain, resources and strategies include those that reflect inter-firm activity. We therefore suggest that ERP benefits play an important role in enhancing SCM competencies. Once a firm has adopted its ERP system and infrastructure, it is in a position to leverage relationships within the supply chain (Kovacs and Paganelli, 2003; Davenport and Brooks, 2004; Akyuz and Rehan, 2008). It follows that how a firm adopts an ERP system should be considered simultaneously with consideration of enhancing its SCM competencies. Drawing from the literature, we posit that the benefits of adopting an ERP system include that it is an enabler and antecedent of creating SCM competencies of enterprise. The related literature and conceptual framework underlying the study are presented next.

2.1 Supply Chain Management

Supply chain management (SCM) is a 21st century paradigm of IT infrastructure. It focuses on globalization and information management tools that integrate procurement, operations, and logistics from raw materials to customer satisfaction. Further, it increases manufacturing flexibility, transportation speed, and information availability, as well as management complexity. In recognition of this potential, practicing managers and academic researchers have realized that SCM has been a major component of competitive strategy to enhance organizational productivity and profitability (Kovacs and Paganelli, 2003; Themistocleous et al., 2004; Akyuz and Rehan, 2008).

Not everyone, however, means the same thing by the term “supply chain management.” SCM has evolved from the field of logistics. Its development was initially along the lines of physical distribution and transportation (Lamming, 1996). The term “supply chain management” first appeared in 1982. Around 1990, academics first described SCM from a theoretical point of view to clarify the difference from more traditional approaches and names, to managing material flow and the associated information flow (Cooper et al., 1997). Cooper et al. (1997) provide a valuable review of 13 early SCM definitions: a solid argument that SCM and logistics are not identical. The term supply chain management has grown in popularity over the past two decades, with much research being done on the topic.

The Council of Supply Chain Management Professionals (CSCMP) (2004) (formerly The council of Logistics Management (CLM)), a leading professional organization promoting SCM practice, education, and development, defines SCM as: “SCM encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities, including coordination and collaboration with suppliers, intermediaries, third-party service providers, and customers”. In essence, supply chain management integrates supply and demand management within and across companies. CSCMP emphasizes that SCM encompasses the management of supply and demand, sourcing of raw materials and parts, manufacturing and assembly, warehousing and inventory tracking, order entry and order management, and distribution and delivery to the customer.

Several authors have defined supply chain management. Christopher (1998) and Simchi-Levi et al. (2000) define supply chain management as “the integration of key business processes among a network of interdependent suppliers, manufacturers, distribution centers, and retailers in order to improve the flow of goods, services, and information from original suppliers to final customers, with the objectives of reducing system-wide costs while maintaining required service levels" (as cited in Stapleton et al., 2006, p. 108). The Global Supply Chain Forum (GSCF) defines supply chain management as "the integration of key business processes from end user through original suppliers, that provides products, services, and information that adds value for customers and other stakeholders" (as cited in Lambert et al., 1998, p.1).

SCM concerns the integrated and process-oriented approach to the design, management and control of the supply chain, with the aim of producing value for the end customer, by both improving customer service and lowering cost (Bowersox and Closs, 1996; Giannoccaro and Pontrandolfo, 2002).

According to Li et al. (2006) the dual purpose of SCM is to improve the performance of an individual organization as well as that of the entire supply chain. CLM definitions clearly establish that SCM is more broadly conceived than merely "logistics outside the firm" (Lambert, 2004; Lambert et al., 1998). Recent research supports this conception, portraying SCM as a strategic level concept (Stank et al., 2005). Mentzer et al. (2001) consider SCM as a systemic, strategic coordination of business functions within an organization and between organizations within the supply chain, for improving the long-term performance of individual companies and the supply chain as a whole. The emphasis of each of these definitions is on the objective of SCM to create a distinctive advantage by maximizing the total value of products and services (Stank et al., 2005).

Furthermore, Lummus and Vokurka (1999) add that SCM links all the departments within an organization as well as all its trading partners. There is mutual collaboration and companies work together to make the whole supply chain competitive. Information technology is widely used to share information and generate demand forecasts. The underlying idea in

SCM is that the entire process must be viewed as a single system. The core competencies of individual organizations are determined and are cashed on, to create enhanced competitive advantage for the supply chain.

By the 1990s, firms recognized the necessity of collaboration with suppliers and customers in order to create superior customer value. This movement titled supply chain management or value chain management shifted a company's focus from within an enterprise to managing across firm boundaries.

Deloitte Consulting survey reported that only 2% of North American manufacturers ranked their supply chains as world class although 91% of them ranked SCM as important to their firms's success (Thomas, 1999). Thus, while it is clear that SCM is important to organizations, effective management of the supply chain does not appear to have been realized.

Bowersox and Closs (1996) argued that to be full effective in today's competitive environment, firms must expand their integrated behavior to incorporate customers and suppliers. This extension of integrated behaviors, through external integration, is referred to by Bowersox and Closs (1996) as supply chain management. In this contex, the philosophy of SCM turns into the implementation of supply chain management: a set of activities that carries out the philosophy.

SCM has been receiving increased attention from all fronts, namely academicians, consultants, and business managers (Tan et al., 2002; Croom et al., 2000; Van Hoek, 1998) since the early 1990s. Organizations have recognized that SCM is the key to building sustainable competitive edge (Jones, 1998) in the 21st century. SCM has been widely talked about in prior literature from various viewpoints (Croom et al., 2000) such as purchasing, logistics/distribution/transportation, operations and manufacturing management, organizational behavior, and management information systems. Industrial organization and transaction cost analysis (Ellram, 1990; Williamson, 1975), resourced based and resource-dependency theory (Rungtusanatham et al., 2003), competitive strategy (Porter, 1985), and social-political perspective (Stern and Reve, 1980) are some of the aspects of SCM that have been discussed in past literature.

Generally, SCM has three levels. Some have restricted its meaning to apply to only the "relational" activities between a buyer and seller (Ellram, 1991). A second use includes all "upstream" suppliers of a firm. Yet a third takes a "value chain" approach, in which all activities required to bring a product to the marketplace are considered part of the supply chain. Manufacturing and distribution functions are thus included as part of the flow of goods and services in the chain (Davenport and Brooks, 2004; Kovacs and Paganelli, 2003; Dobler and Burt, 1996; Lee and Billington, 1993).

The term "supply chain" is used in the present research in the spirit of the value chain concept. A supply chain is a dynamic process and involves the constant flow of information, materials, and funds across multiple functional areas both within and between chain members (Jain et al., 2008). Such a holistic approach is consistent with the integrated way today's global business managers are planning and controlling the flow of goods and services to the marketplace.

2.2 Competencies of SCM

The literature on SCM is quite vast and dispersed across many areas, such as purchasing and supply, logistics and transportation, marketing, organizational dynamics, information management, strategic management, and operations management. In recent years, supply chain design and its competencies and performance have received much attention from researchers and practitioners. To properly conduct research into constructing the SCM competencies, we need to survey the literature on the subject of competency itself, and on SCM competencies and on SCM measures.

From the RBV viewpoint, all firms have capabilities; however, a firm will usually focus on certain capabilities consistent with its strategy, and the firm's most important capabilities are called competencies (Barney, 1991). Accordingly, competencies emphasize technological and production expertise at a specific point along the value chain (Stalk and Shulman, 1992; Vickery et al., 1993; Cleveland et al., 1989). Bowersox et al. (1999) identified that a competency reflects the synthesis of selected logistical capabilities into a logically coherent and manageable set of circumstances sufficient to gain and maintain supply chain collaborations. Closs and Mollenkopf (2004) proposed a framework that identifies six firm competencies critical for SCM and is based on the work of Bowersox et al. in 1999. Each competency is composed of multiple underlying capabilities, which guide philosophies and processes to complete specific logistics and supply chain activities and to overcome obstacles that undermine both internal and external integration of value-added supply chain operations. The competencies leading to high supply chain performance can be grouped into: customer integration, internal integration, material and service supplier integration, technology and planning integration, measurement integration, and relationship integration (see Figure 1). Furthermore, Closs and Mollenkopf (2004) developed a measurement model that considers both firm and supply chain performance using 13 logistics and supply chain variables representing five key performance areas, including: customer service, cost management, quality, productivity, and asset management. Gunasekaran et al. (2004) suggested a framework for measuring the performance of a supply chain that consisted of three levels: strategic, tactical, and operational. Park et al. (2005) proposed a framework for the balanced supply chain scorecard (BSCS) that considers the literature on the BSC and SCM, SCM solutions, and product characteristics. The framework shows the objectives in four perspectives of the BSCS: financial perspective, customer perspective, business process perspective, and learning and growth perspective.

In the literature survey we identified the SCM competencies and, referring mainly to the framework of Bowersox et al. (1999) (see Figure 2.1), we analyzed the impact of ERP benefits on the SCM competency, and grouped the items into three constructs; and from that literature we selected 20 items that are proposed as the content of SCM competencies (see Table 1). These constructs are: operational, planning and control, and behavioral process.

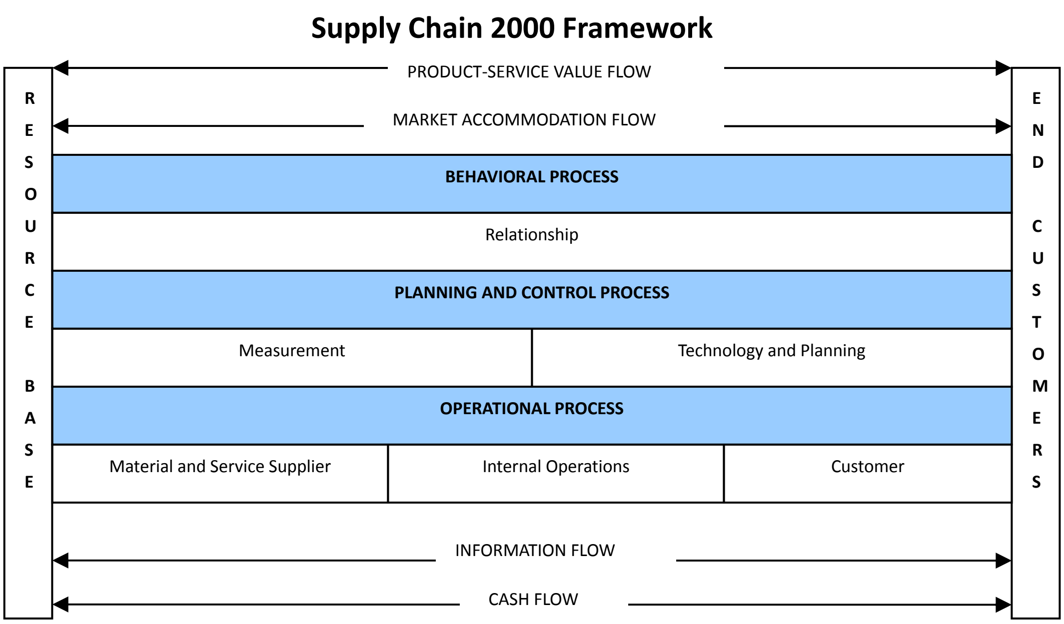

Figure 2.1 21st Century Supply chain framework
Source: Bowersox et al. (1999)

2.3 Enterprise Resource Planning

Different researchers have suggested different ways of defining ERP: that is, from a business, technical or functional perspective. One way of looking at ERP is as a combination of business processes and information technology. Davenport and Brooks (2004) proposed that implementing ERP systems brings many benefits to the organization, including reduction of cycle time, improving information flow, rapid generation of financial information, promotion of E-business, and assistance in development of new organizational strategies. From a technical perspective, ERP was designed to overcome the operational problems that companies experienced with earlier information systems. Bendoly and Schoenherr (2005) maintains that ERP systems should not be looked at simply as tools that have a fixed and measurable output, but rather as comprising a technological infrastructure designed to support the capability of all other tools and processes used by a firm. Functionally, an ERP system primarily supports the management and administration of the deployment of resources within a single organization. One significant feature of an ERP system is that core corporate activities, such as manufacturing, human resources, finance, and supply chain management, are automated, and are improved considerably by incorporating best practices, so as to facilitate greater managerial control, speedy decision making and huge reduction of business operational cost. The definition of ERP used in the present research is as stated by Wallace and Kremzar (2001):

"An enterprise-wide set of management tools that balances demand and supply, containing the ability to link customers and suppliers into a complete supply chain, employing proven business processes for decision making, and providing high degrees of cross-functional integration among sales, marketing, manufacturing, operations, logistics, purchasing, finance, new product development, and human resources, thereby enabling people to run their business with high levels of customer service and productivity, and simultaneously lower costs and inventories; and providing the foundation for effective e-commerce."

2.4 ERP Benefits

Many firms install ERP systems to improve the flow of information across sub-units (Kalling, 2003). Data standards eliminate the burden of reconciling or translating information that is inconsistently defined across two or more sub-units. Data standards also do away with the potential for translation or reconciliation errors as well as ambiguity about a field's true meaning (Wade and Hulland, 2004). The integration provided by ERP also reduces the administrative costs of sharing information, since many manual activities involved with keying and translating information from one system to another are eliminated. Finally, since the single database makes data universally available as it is updated, ERP improves the timeliness of information. Enhancing this flow enables the centralization of administrative activities, such as payroll and accounting. Furthermore, it allows better operational coordination, such as improving material flows among plants or information flows from sales offices to plants. ERP can also enhance centralized decision-making at the divisional or corporate level as information from various sub-units is centralized and standardized in a timely fashion (Davenport and Brooks, 2004). Because it allows better coordination, ERP is sometimes credited with fostering an inter-functional process approach to business, rather than a functionally oriented one. Many firms also install ERP systems to replace existing IT infrastructure as well as to reduce maintenance costs and the costs of future IT improvements. With ERP systems the vendor develops and maintains the software and thus spreads the costs of doing so among numerous customers.

For years organizations have striven to realize the benefits of ERP, ES and IT investments. Integrated ERP systems affect all aspects of a business (Kalling, 2003; Hong and Kim, 2002). Dhillon (2005) claimed that real benefits reside not within the IT domain but, rather, in the changes in the organizational activities that the IT system has enabled.

Several researchers have classified the types of ERP benefits, and have indicated that some approaches may be appropriate techniques for evaluating the performance or benefits of ERP systems. Irani and Love (2001) proposed a framework for meeting the challenges associated with categorizing benefits that is based on the work of Harris (1996). In a case study of an MRPII investment, it was observed that as one moves from strategically oriented IS projects through tactical to operationally oriented projects, the benefits accrued go from those that are generally intangible and non-quantitative in nature to more tangible and quantitative ones for strategic, tactical and operational benefits. The benefits of ERP systems include streamlined business processes, improved planning, improved decision making, and reduction of inventories.

Mabert et al. (2000) surveyed about 500 business executives, and revealed the following performance outcomes of ERP: quickened response time, increased interaction across the enterprise, improved order management, improved customer interaction, improved on-time delivery, improved supplier interaction, lowered inventory levels, improved cash management, and reduced direct operating costs. Stratman and Roth (2002), using 36 measures, defined eight theoretical ERP competency constructs. They posited a portfolio of managerial, technical and organizational skills and expertise as necessary antecedents to improving business function once an ERP system has become operational and functionally stable. They argued that a firm's ERP competency must be used effectively in order to truly harness the capabilities of an ERP system for competitive advantage. Vemuri and Shailendra (2006) developed a set of initial measurement items for each ERP competency. Shang and Seddon (2000) classified the different types of ERP benefits into five groups as follows: IT infrastructure, operational, managerial, strategic and organizational benefits. The IT infrastructure category consists of the typical IT department benefits arising from reduction in cost of maintaining legacy systems. It is an indication of an organization's competency in matching IT capabilities with the changing, cross-functional business requirements of the enterprise. The operational benefits are those that arise from automating cross-functional processes. They encompass both efficiency-based and effectiveness-based performance improvements in order to capture the enterprise-wide business benefits. The managerial category includes benefits that arise from the use of data to better plan and manage production, manpower, inventory and physical resources and from the monitoring and control of the financial performance of products, customers, business lines and the geographic area. The strategic benefit category focuses on the benefits that arise from the system's ability to support business growth. Rapidly changing business needs may require operations strategy planners to continually evaluate cross-functional business goals, and redefine the information systems' capabilities. The strategic benefits of ERP can support these goals. The organizational benefits category captures the benefits derived from facilitating business learning, empowerment of staff and higher employee morale and satisfaction. Those studies have addressed the classification and content of ERP benefits. On the basis of the literature review presented above, we finally developed a framework consisting of five constructs and 32 measures.

In summary, as seen from the previous literature review of the different classification of ERP benefits, they revolve around business process, IT infrastructure or technical items, and strategic perspective. Stratman and Roth (2002) conceptual model of ERP competence can serve as a useful framework for evaluating the benefits of ERP systems. However, this framework does not link the competence to managerial and IT infrastructure competence as recommended by Harris (1996) and Shang and Seddon (2000). Both B'urca et al. (2005) and Biehl (2005) benefits categories also discussed less about strategic. Davenport and Brooks (2004) that there are different types of benefits from ERP system and some are likely to arise earlier than others. However, this research is interested in the relationship between benefits of ERP systems implementation and its impacts on firm competencies of SCM. We believe that to integrate the categories of benefits from Harris (1996) and Shang and Seddon (2000) might be the most appropriate technique for evaluating the benefits of ERP system. Since they emphasized the importance of gathering information from all employment levels to evaluate the benefits gained from ERP systems. This integrated classification of benefits may help to examine the relationship with firm competencies of SCM. It is mainly based on the model of Shang and Seddon (2000) and Harris (1996), and merges the benefits and measures we have proposed.

2.5 The Impact of ERP on SCM

In the past decade, nearly all literature on ERP has focused on reasons for implementation and on the challenges of the implementation project itself. Several distinct research streams on ERP are observed in the recent literature. Several studies have demonstrated a relationship between ERP benefits and SCM: for example, Akkermans et al. (2003). Although the initial focus of ERP was "within the organization," many organizations have addressed supply chain challenges with their ERP systems (Davenport and Brooks, 2004).

Although there is no analytical framework for measuring the impacts of ERP systems on SCM competencies, Byrd and Davidson (2003) have examined how the antecedents, IT department technical quality, IT plan utilization, and top management of IT positively affected IT impact on the supply chain. Wade and Hulland (2004) provide an overview of the literature on IT-related resources and their impact on firm strategy and performance, where IT covers all of the information systems, including ERP systems. Akkermans et al. (2003) studied the future impact of ERP systems on SCM. Their panel experts saw only a modest role for ERP in improving future supply chain effectiveness, and a clear risk of ERP actually limiting progress in SCM. Moreover, they identified key limitations of current ERP systems in providing effective SCM support. The problem is that the first generation of ERP products has been designed to integrate the various operations of an individual firm, whereas in modern SCM, the unit of analysis has become a network of organizations, making these ERP products inadequate in the new economy. There is a new generation of ERP, however. ERP II extends business processes, opens application architectures, provides vertical-specific functionality, and is capable of supporting global enterprise processing requirements (Zrimsek, 2003). On the basis of the literature review presented above, we believe that the relationship between ERP and SCM suggested by the above-mentioned authors may be useful in the development of our research model and hypotheses.

CHAPTER 3

RESEARCH MODEL AND HYPOTHESIS DEVELOPMENT

When understanding the phenomenon of an ERP system adoption and SCM, it is helpful to have a framework within which to work and from which testable hypotheses can be drawn. A theoretical framework enables predictions to be made about the likely outcome of the relationship between ERP adoption and SCM competencies. It enables observed business behavior to be evaluated and therefore provides better explanations of the motivations form the implementation of ERP systems and its impact on firm competencies of SCM.

3.1 Research Model

The research model is shown in Figure 3.1. The definitions of various constructs in it are summarized in Table 3.1. In this study, the authors base the research model on selected literature on ERP and on SCM. As discussed earlier, although some researchers have given their attention to the contribution of ERP systems to supply chain coordination, the goal of this research is to examine in more detail ERP benefits' impact on SCM competency. Thus, this research model encompasses and relies on two areas: ERP benefits as referred to in the classification of ERP benefits, in Shang and Seddon (2000), and SCM competencies, based on the 21st Century Logistics framework as extended by Bowersox et al. (1999). The model includes five constructs for ERP benefits, namely: operational, managerial, strategic, IT infrastructure, and organizational benefits, and three constructs for SCM competencies, namely: operational, planning and control, and behavioral processes. Based on Shang and Seddon's (2000) classification of ERP benefits, Stratman and Roth's (2002) competencies of ERP, and Vemuri and Shailendra's (2006) measurement items, we conclude and hypothesize that ERP benefits are antecedents to improving SCM competencies after an ERP system is operational and functionally stable. Therefore, this model investigates the relationships between the benefits of ERP adoption and SCM competencies. A more detailed description of SCM competencies and ERP benefits follows.

3.1.1 The constructs of SCM competencies

To improve firm performance, a firm needs to enhance its competences in SCM. The 21st Century Logistics framework identifies three categories of firm competences as critical for logistics and supply chain management (Figure 2.1). Each competence is composed of multiple underlying capabilities, which guide philosophies and processes to complete specific logistics and supply chain activities. Based on this framework and suggestions from experts who have recently gone or are currently going through ERP systems implementations or being responsible for SCM in Taiwanese IT industry, we identify the firm competences that may be impacted by ERP benefits and may lead to high supply chain performance and group them into three constructs. These are operational process integration, planning and control process integration, and behavioral process integration.

3.1.1.1 Operational process integration competencies of SCM

As Bowersox et al. (1999) and Closs and Mollenkopf (2004) defined in the 21st Century Logistics framework, operations involve the processes that facilitate order fulfillment and replenishment across the supply chain. In the operational context, integration is essential internally as well as with customers and suppliers. Customer integration builds on the philosophies and activities that develop customer intimacy and is the competency that builds lasting competitive advantage. Internal integration focuses on the joint activities and processes within a firm that coordinates functions related to procurement, manufacturer, and customer distribution. Supplier integration also focuses on activities that create close ties with material and service providing supply chain partners. Competency in this area links externally performed activities into a seamless flow with internal work processes. Firms that desire to excel must blend their operating processes into those of supply partners in order to meet increasingly broad and demanding customer expectation. Nowadays, the IT industry is shifting from push methods driven by anticipated sales to pull methods that focus on delivering value to customers through rapid response to demand. To do this profitably, firms must strip redundancy and duplication of materials and effort from supply chain operations. The task is all the more challenging because it is not limited to internal activities. It requires linking internal work processes with those of material and service providers. Thus, an important integration decision is how many material and service suppliers to include in synchronized operations. That is, integrating operations with material and service suppliers to form a seamless flow of internal and external work overcomes the financial barriers of vertical ownership while retaining many of the benefits. A successful SCM of operational process integration, cross-functional unification, standardization, simplification, compliance, structural adaptation, operational fusion, and supplier management capabilities must be developed.

3.1.1.2 Planning and control process integration competencies of SCM

The planning and control process includes competences of technology and planning integration refers to information systems capable of supporting the wide variety of operational configuration needed and to the development of measurement systems that facilitate segmental strategies and processes to serve diverse market segments (Bowersox et al., 1999). Across the supply chain, information technology and measurement systems must facilitate planning and control of integrated operations. As Bowersox et al. (1999) explain in the 21^{st} Century Logistics framework, success of technology and planning integration rests upon six capabilities: information management, internal communications, connectivity, collaborative forecasting and planning, and activity-based and total cost management. Information management focuses on supply chain resource allocation through seamless transactions across the total order-to-delivery cycle. Internal communication uses technological systems to exchange information across functional boundaries in a timely, responsive, and usable format. Connectivity extends internal communications capability to supply chain partners. Collaborative forecasting and planning involves customers and suppliers developing a shared vision supported by a mutual commitment to jointly generated action plans. Activity-based and total cost management uses activity-based costing, budgeting, and measurement to obtain a comprehensive picture of the cost/revenue contribution of a specific customer or product. Operational excellence must be supplemented and supported by integrated planning and measurement competences. This process involves joining technologies to monitor, control, and facilitated overall supply chain performance.

3.1.1.3 Behavioral process competencies of SCM

The behavioral process rests on the quality of the basic business relationship between partners. In a competitive environment, single enterprises acting alone cannot fully achieve all management goals. The problem is that different firms typically operate under different management philosophies and pursue divergent goals. Relationship integration refers to the ability to develop and maintain a shared mental framework with customers and suppliers regarding inter-enterprise dependency and principles of collaboration (Bowersox et al., 1999). Quality relationships can improve trust among a firm's members, and further promote their attitude to and intentions of knowledge sharing in an organization (Yang and Chen, 2007). The relationship integration category is a competence that enables firms to build lasting distinctiveness with customers of choice and to share a mentality with customers and suppliers regarding interdependency and principles of collaboration. Role specificity is the capability to clarify leadership processes and establish shared, as contrasted with individual, enterprise responsibility. Information sharing involves the willingness to exchange key technical, financial, operational and strategic information with others in the supply chain. Any firm seeking supply chain performance must demonstrate strong commitment to the customization required for effective customer and relationship integration. Bowersox et al. (1999) suggested, in the Supply Chain 2000 framework and assessment process, that the best way to start the search for integration gaps is by reviewing how a firm coordinates with customers and relationships. Thus, it is clear that consistent success ultimately depends on a firm's competence to create value for customers by providing products and services at prices that cover total cost and provide a profit to meet customers' needs.

3.1.2 The constructs of ERP benefits

Markus and Tanis (2000) and Markus et al. (2000) identify various reasons that motivate organizations to implement ERP systems. They also suggest that there should be a connection between the reasons for adoption of ERP systems and the benefits. Shang and Seddon (2000) compiled an ERP benefits list from ERP vendor success stories published on the World Wide Web. Follow-up interviews and analysis led Shang and Seddon (2000) to classify the different types of ERP benefits into five categories. Stratman and Roth (2002) identified eight theoretically important ERP competences and Vemuri and Shailendra (2006) developed a set of initial measurement items for each competences of ERP. Based on Shang and Seddon's classification of ERP benefits, Stratman and Roth's competences of ERP, we must also heed the suggestions of experts who have recently been or are currently going through ERP or SCM systems implementations in Taiwanese IT industry. We conclude that ERP benefits may improve firm competences in SCM.

3.1.2.1 The operational benefits of ERP

Shang and Seddon (2000) determined that the operational benefits of an ERP system arise from automating cross functional process. They encompass both efficiency-based and effectiveness-based performance improvements in order to capture the enterprise-wide business benefits. Those benefits are expected to improve day-to-day operations (short-term impact), which include improved inventory control, improved cash management, and reduction in operating costs (Stratman and Roth, 2002). They will also lead to improvements in production, information and customer service quality. Today's ERP solutions offer even more benefits. Many vendors have begun to enhance their offerings with extended supply chain applications in an effort to create a seamless, integrated information flow, from suppliers through manufacturing and distribution. ERP is a suite of application modules that can link back-office operations to front-office operations, as well as internal and external supply chains (Verville and Halingten, 2003). Latamore (1999) has argued that a core ERP system for operational function must include applications for forecasting, production scheduling, material planning, inventory control, warehouse management, etc.

3.1.2.2 The managerial and organizational benefits of ERP

The managerial benefits arise from the use of databases to plan better and for better management of production, manpower, inventory and physical resources. Also, firms are getting benefits from monitoring and controlling of financial performance in the contexts of products, customers, business lines and geographic area (Shang and Seddon, 2000). Since ERP systems can automate business processes and enable process changes, one would expect them to offer all of the above types of benefits. Also, since process knowledge is dynamic, organizations may derive benefits from procedures and practices that continuously allow fundamental business processes to be improved in a systematic fashion (Roth et al., 1994). That is, managerial benefits are expected to improve the day-to-day business process (long-term impact) which reflects long-term benefits. Those benefits include improving customer responsiveness, customer satisfaction, on-time delivery, and decision making. They are provided by centralizing the database and built-in data analysis capabilities. Furthermore, ERP systems provide information benefits to process and resources management (Stratman and Roth, 2002; King and Teo, 1996; Guha et al., 1997). Furthermore, firms are likely to increase control over their suppliers by gaining power from information (Cox et al., 2000; Nah et al., 2001), and ERP applications, or similar integration solutions, are a leading tool for this purpose (Sawy et al.,1999; Themistocleous et al., 2002). When an ERP system is implemented, the advantage of business process skills is demonstrated by understanding of how the business operates, and the ability to predict the impact of a particular decision or action on the rest of the enterprise. At the same time, those benefits, such as production orders, capability planning, resource allocation, production tracking and reporting, inventory management, waste/reject tracking, etc., also meet the competences needs of supply chains (Latamore , 1999).

3.1.2.3 The strategic and IT infrastructure benefits of ERP

The strategic benefits of ERP are a consequence of the system's ability to support business growth, reduce the cost of maintaining legacy systems, and capture the benefits derived from facilitation business learning, empowerment of staff and higher levels of employee morale and satisfaction (Shang and Seddon, 2000). IT infrastructure benefit of ERP is an indication of an organization's competence in matching IT capabilities with the changing, cross-functional business requirements of the enterprise. Several studies suggest that it is critical that a firm's information technology systems support the strategic goals of the firm (Sampler, 1998). Strategic and IT infrastructure benefit help to ensure that IT development goals are aligned with the needs of the organization (Segars et al., 1998). Dynamically changing business needs may require operations strategy planners to continually evaluate cross-functional business goals and define the information systems capabilities that are required to support these goals. Thus, a formal strategic benefit and IT infrastructure benefit is posited to contribute to the quality of this ongoing activity, especially activity that can leverage supply chain processes to enhance performance need in each particular operating arena.

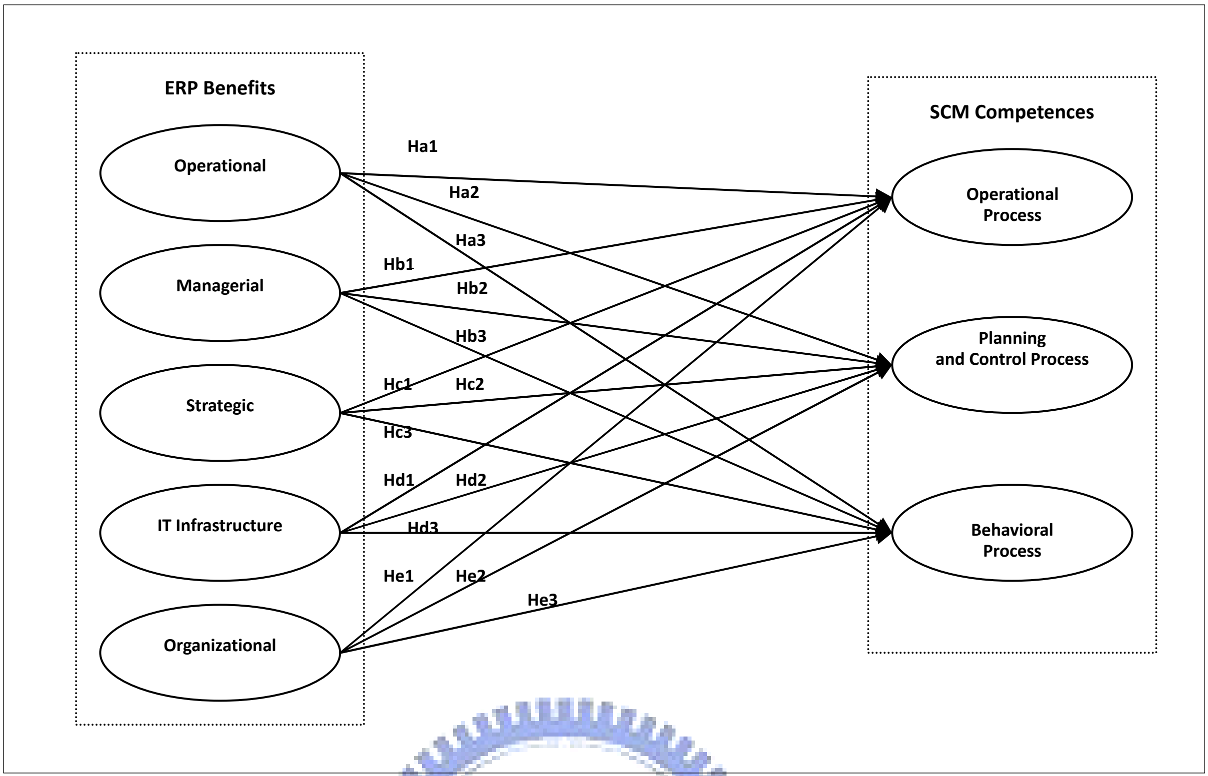

Figure 3.1 The proposed conceptual model and research hypotheses

Table 3.1. Definitions and constructs in the model

Construct	Definitions	Key References
Operational benefits	The benefits of ERP systems that result from automating cross functional processes, the use of data to better plan and manage production, manpower, inventory and physical resources, and from the monitoring and control of financial performance of products, customers, business lines and geographic areas.	Shang and Seddon (2000); Stratman and Roth (2002); Verville and Halingten (2003); Latamore (1999)
Managerial benefits	Managerial benefits are expected to improve the day-to-day business process (long-term impact), reflecting long-term benefits such as improved customer responsiveness, improved customer satisfaction, on-time delivery, and improved decision making.	Shang and Seddon (2000); Stratman and Roth (2002); Roth et al. (1994); Stratman and Roth (1999); King and Teo (1996); Guha et al. (1997); Cox et al. (2000); Nah et al. (2001); Sawy et al. (1999); Themistocleous et al. (2002)
Strategic benefits	Focuses on the benefits that arise from the system's ability to support business growth, reduce the cost of maintaining legacy systems, and capture the benefits derived from facilitating business learning, empowerment of staff and higher employee morale and satisfaction.	Shang and Seddon (2000); Sampler (1998); Segars et al. (1998)
IT infrastructure benefits	Involving building business flexibility, IT cost reduction, and increased IT infrastructure capability.	Shang and Seddon (2000)
Organizational benefits	Relating to support organizational changes, facilitate business learning, empowering, and build common visions.	Shang and Seddon (2000)
Operational process integration	Firm has the competences to support customer requirements, and supplier integration links externally performed work into a seamless congruency with internal work processes.	Closs and Mollenkopf (2004); Bowersox et al. (1999); Hsu et al. (2007); Akyuz and Rehan (2008); Venkatesh (2006); Vemuri and Shailendra (2006)
Planning & control process integration	Planning and control process integration refers to information systems to support the wide variety of operational configurations needed to serve diverse market segments, and the capabilities to develop the measurement systems that facilitate segmental strategies and process.	Closs and Mollenkopf (2004); Bowersox et al. (1999); Latamore (1999); Kelle and Akbulut (2005); Bendoly and Jacobs (2005)
Behavioral process integration	Firm has the competences to build lasting distinctiveness with customers of choice; also refers to the ability to develop and maintain a shared mental framework with customers and suppliers regarding inter-enterprise dependency and principles of collaboration.	Closs and Mollenkopf (2004); Bowersox et al. (1999); Bendoly and Jacobs (2005); Stock et al. (2000); Segars et al. (1998)

3.2 Research Hypothesis

3.2.1 ERP benefits and the operational process of SCM

As Closs and Mollenkopf (2004) defined it in the 21st Century Logistics framework, the operational process involves the processes that facilitate order fulfillment and replenishment across the supply chain. Effective order fulfillment requires coordination both within a firm and among supply chain partners. Within the operational process, firm competencies include customer integration, internal integration, and supplier integration (Figure 2.1). Customer integration is a competency that enables firms to build lasting distinctiveness with customers of choice. Internal integration involves cross-functional planning, sourcing, manufacturing and delivery to achieve excellence throughout the enterprise. Integrating operations with material and service suppliers to form a seamless flow of internal and external work can retain many of the benefits. Supplier integration links externally performed work into a seamless congruency with internal work processes (Closs and Mollenkopf, 2004; Bowersox et al., 1999).

Today's ERP solutions offer even more benefits. Many vendors have begun to enhance their offerings with extended supply chain applications in an effort to create a seamless, integrated information flow, from suppliers through manufacturing and distribution. Hsu et al. (2007) provide empirical support for the impact of operations capabilities on SCM practices. That result is consistent with resource-based and competency-based views of the firm. ERP is a suite of application modules that can link back-office to front-office operations, as well as internal and external supply chains. Akyuz and Rehan (2008) intend to discuss the requirements for forming an e-supply chain from different perspectives, including integration with the legacy systems, ERP systems, internal and external business processes and business decision support. Since ERP systems can automate business processes and enable process changes, one would expect them to improve the SCM competencies in operational process and improve customer responsiveness and satisfaction (Venkatesh, 2006). Bowersox et al. (1999) and Vemuri and Shailendra (2006) have developed a set of scales to directly measure the SCM competencies and ERP benefits, and these form the basis of our measurement items and our hypothesis. Hence, in our model, the SCM competencies in operational process are driven by ERP benefits. In order to examine what categories of ERP benefits can predict SCM competency, the following research model and hypotheses are given:

Ha1: The operational benefits of ERP positively affect SCM competencies in the operational process;

Hb1: The managerial benefits of ERP positively affect SCM competencies in the operational process;

Hc1: The strategic benefits of ERP positively affect SCM competencies in the operational process;

Hd1: The IT infrastructure benefits of ERP positively affect SCM competencies in the operational process;

He1: The organizational benefits of ERP positively affect SCM competencies in the operational process.

3.2.2 ERP benefits and the planning and control process of SCM

The term "planning and control process" refers to the design, application, and coordination of information to enhance purchasing, manufacturing, customer order fulfillment, and resource planning. This competency includes access to databases that enable sharing of appropriate information among supply chain participants. It also addresses the question of the transaction systems required to initiate and process replenishment and customer orders (Closs and Mollenkopf, 2004; Bowersox et al., 1999).

ERP systems are created by centralizing the database and building-in data analysis capabilities. These actions provide information benefits to process and resources management. When an ERP system is implemented, the advantage of business control process skills is demonstrated through an understanding of how the business operates and by the ability to predict the impact of a particular decision or action on the rest of the enterprise. At the same time, those benefits, such as production orders, capability planning, resource allocation, production tracking and reporting, inventory management, and waste or reject tracking, also meet the competencies needs of supply chains (Latamore, 1999). Kelle and Akbulut (2005) maintained that ERP software provides a variety of tools that can support supply chain integration. They based their analysis on the inventory management aspects of supply chain coordination, and their results can be used in enterprise software to measure the potential monetary value of policy coordination, to promote cooperation, and to minimize the total supply chain system cost. As reported in Bendoly and Jacobs (2005), that ERP software can be used to help firms create value, such as by eliminating information asymmetries, allowing simultaneous access to same data for planning and control, and providing on-time and real time information to jointly generated action plans.

Hence, the research contained in the above-mentioned literature and the classification of the ERP benefits of Shang and Seddon (2000) form the basis of our scale items and hypotheses. In our model, SCM competencies in the planning and control process are driven by ERP benefits. Therefore, the following research model and hypotheses are given:

Ha2: The operational benefits of ERP positively affect SCM competencies in the planning and control process;

Hb2: The managerial benefits of ERP positively affect SCM competencies in the planning and control process;

Hc2: The strategic benefits of ERP positively affect SCM competencies in the planning and control process;

Hd2: The IT infrastructure benefits of ERP positively affect SCM competencies in the planning and control process;

He2: The organizational benefits of ERP positively affect SCM competencies in the planning and control process.

3.2.3 ERP benefits and the behavioral process of SCM

The term "behavioral process" refers to the behavior that fosters supply chain coordination. It includes relationship integration. Relationship integration is a competency that enables firms to share a mentality with customers and suppliers regarding interdependence and principles of collaboration. Successful relationships require managers to rethink the way they conduct business with suppliers and customers so that the benefits of integrated and focused supply chain strategies can be achieved. Efforts must focus on providing the best end-customer value regardless of where along the supply chain the necessary competencies exist. Thus, it is clear that consistent success ultimately depends on the ability to visualize and develop cooperative relationships (Closs and Mollenkopf, 2004; Bowersox et al., 1999).

Bendoly and Jacobs (2005) argued that ERP can be used to facilitate inter- and intra-organization communication and collaboration needs, laying the foundation for external integration. Stock et al. (2000) asserted that higher levels of external integration are characterized by activities in collaboration with those of its suppliers and customers, and by a greater blurring of organizational distinctions between the logistics activities of the firm and those of its suppliers and customers. For years organizations have striven to realize the benefits of ERP and of information technology investments. Adopting ERP systems can mean capturing the benefits derived from facilitating business learning, and may support these goals. Segars et al. (1998) have developed a set of scales to capture the domain of ERP benefits, and these form the basis of our items and related hypotheses about the benefits of ERP. In our model, the

SCM competencies in the behavioural process are driven by ERP benefits. Therefore, the following research model and hypotheses are given:

Ha3: The operational benefits of ERP positively affect SCM competencies in the behavioral process;

Hb3: The managerial benefits of ERP positively affect SCM competencies in the behavioral process;

Hc3: The strategic benefits of ERP positively affect SCM competencies in the behavioral process;

Hd3: The IT infrastructure benefits of ERP positively affect SCM competencies in the behavioral process;

He3: The organizational benefits of ERP positively affect SCM competencies in the behavioral process.

CHAPTER 4

RESEARCH INSTRUMENT DEVELOPMENT AND CONTENT VALIDITY

In this chapter, the instruments for this research are developed and tested. The scale development and refinement is based upon a two-stage approach Churchill's (1979). In stage one, precise definitions and measurement items for each construct are established, together with tentative indications of reliability and validity. In stage two, the study further refine and validate the measures using survey data collected on the scales developed in stage one.

4.1 Stage 1 Scale Development

This study has adapted Churchill's (1979) widely used methodology for multi-item instrument development. The complexity inherent in many business processes cannot be adequately measured with a single item. Multi-item scales can reduce measurement error and provide a more robust measure of complex variables by combining several individual items.

In the first stage, the study identifies the constructs of ERP benefits and SCM competencies that are hypothesized to be important antecedents of successfully creating SCM competencies. Our point of departure for construct definition and measurement item selection is a literature review encompassing the areas of ERP and SCM in strategic management, operations management, organizational behavior, and information technology.

4.1.1 Construct domain specification

The first step is to specify the domain of the various ERP benefit constructs and SCM competency constructs. This was followed by iterations among site visits, interviews, and further literature reviews. In total, this study conducted two site visits to businesses and plants that one is large size company and the other is small size company. Both companies had operational ERP systems, where the study gathered first-hand knowledge about ERP systems and SCM competencies at multiple levels in the organization, including users, IT technicians, engineers, production planners, supervisors, managers, and consultants. Visits were supplemented by structured and unstructured interviews with executives knowledgeable about ERP systems, SCM, and adoption practices. This iterative process resulted in this research framework which identified the constructs of ERP benefits and SCM competencies. This is followed by the generation of a pool of items for each construct. Items were drawn from the literature and the researchers own empirical investigations of ERP/SCM firms based upon site visits and extensive interviews with executives and consultants involved with ERP implementation.

4.1.2 Item generation and structured interview

Proper generation of measurement items of a construct determines the validity and reliability of an empirical research. The very basic requirement for a good measure is content validity, which means the measurement items contained in an instrument should cover the major content of a construct (Churchill, 1979). Content validity is usually achieved through a comprehensive literature review and interviews with practitioners and academicians. A list of initial items for each construct was generated based on a comprehensive review of relevant literature. The general literature bases for items in each construct are briefly discussed below.

The constructs for ERP benefits (operational benefits, managerial benefits, strategic benefits, IT infrastructure benefits, and organizational benefits) were generated based on previous ERP literature (Shang and Seddon, 2000; Stratman and Roth, 2002; Verville and Halingten, 2003). The items for operational, managerial, organizational and strategic benefits of ERP were generated through ERP literature, manufacturing literature, outsourcing literature, and marketing literature (Shang and Seddon, 2000; Stratman and Roth, 2002; Sampler, 1998; Segars et al., 1998). The IT infrastructure benefits were generated through ERP literature, information system literature, and enterprise systems literature (Shang and Seddon, 2000).

The constructs for SCM competencies (operational process, planning and control process, and behavioral process) were generated based on previous SCM literature (Closs and Mollenkopf, 2004; Bowersox et al., 1999) (Table 3.1).

Base on the literature, this study develop a questionnaire draft. The questionnaire draft was translated into Chinese using the translation/retranslation method. This method was conducted by two translators independently translating the English questionnaire into Chinese versions, and then, the other two translating the Chinese versions back into English. The latter English versions were compared with the original one to make sure that the meanings were consistent with the original concepts (Mullen, 1995). Once item pools were created, items for the various constructs were reviewed by six academicians and re-evaluated through structured interviews with three practitioners. The focus was to check the relevance of each construct's definition and clarity of wordings of sample questionnaire items. Based on the feedback from the academicians and practitioners, redundant and ambiguous items were either modified or eliminated. New items were added whenever deemed necessary. The result was the following number of items in each pool entering manual factor sorting analysis. There were a total of 8 pools and 61 items (Table 4.1).

ERP Benefits

Operational benefits	6
Managerial benefits	7
Strategic benefits	6
IT infrastructure benefits	6

Organizational benefits	6
SCM Competencies	
Operational process	9
Planning and control process	10
Behavioral process	5
Synthesis	6
Total	61

4.1.3 Measure purification

Once the initial item pool was generated, the items were purified in order to remove the potential for measurement error from the new scales. A manual factor sorting technique (Segars et al., 1998) was used to establish tentative scale reliability and validity, as well as to assess potential problems with the unidimensionality of the constructs. The manual sorting procedure was conducted iteratively, using independent panels of four to five expert judges in each of four separate sorting administrations. These judges all had recent industry experience with the implementation and use of ERP systems or had experience with supply chain management in a manufacturing environment. Three were senior consulting managers who had many years of experience with multiple ERP implementations.

Each expert judge was given a questionnaire containing short descriptions of each of the proposed benefit and competency constructs, together with a randomized list of all of the items generated from the literature and prior sorting rounds. In each round, the panel of expert judges was asked to assign each item to one of the defined constructs. Items that were not consistently grouped into their target constructs during this process were considered for rewording or elimination if the item did not adequately fit the construct. In addition, initial judge panels were also asked to suggest additional competencies relevant to effective ERP adoption and additional items describing the provided competence constructs. Consequently, the final set of eight constructs encompasses the scope of ERP benefits and SCM competencies, and the resultant set of items constituted the domains of each ERP benefit and SCM competency construct.

To assess the pretest scale reliability of the qualitative judgements made during the sorting process, two measures were used as indicators: Perreault & Leigh's measure (Perreault and Leigh, 1989), and item placement ratios (Moore and Benbasat, 1991). The Perreault and Leigh statistic measures the observed proportion of agreement between judges that is greater than would be expected from chance. Unlike prior measures of inter-judge agreement, such as Cohen's Kappa (Cohen, 1960), the Perreault and Leigh statistic explicitly includes the number of defined categories in its calculation. This avoids the overly conservative characteristics of earlier measure (Perreault and Leigh, 1989; Rust and Cooil, 1994). A value of 1.0 indicates perfect inter-judge agreement, while a value of zero indicates that the observed agreement is exactly what would be expected by chance. The item placement ratios assess both the validity of the generated items and the reliability of the proposed measurement scales. If there is a high degree of inter-judge agreement, then the percentage of items placed in the target construct will also be high. In addition, scales based on constructs with a high percentage of corrected item placement can be considered to have a high degree of construct validity and also exhibit the potential to be reliable (Moore and Benbasat, 1991).

4.1.4 Results of item purification sorting process

The definitions of various constructs in it are summarized in Table 4.2. Table 4.3 presents the final round of item-placement ratios for the scales using Moore and Benbasat's (1991) format, which provides additional insight into the performance of the proposed measurement scales. Each of the benefit and competency scales is listed on the rows of the table.

For example, the operational benefits of ERP scale has 6 items, so perfect item placement for this scale would be a score of 30 (6 items x 5 judges). In this case, only 23 judge-items were classified as intended, while 5 were classified under managerial benefits and 2 under strategic benefits. The item-placement ratio for operational benefits thus equals 26/30 or 77%. According to Moore and Benbasat (1991), an item placement ratio of 70% or greater is generally considered acceptable. All of the scales met or exceeded this criterion for the final sorting round.

Two pre-tests were conducted. Participants were asked to identify any confusion. Five EMBA students with business experiences performed the first pre-test. After the pre-test, the questionnaire was revised. The second pre-test was conducted on five IT managers from five Taiwanese IT firms. Minor modifications were incorporated into the final questionnaire (Appendix). The pre-tests indicate that the questionnaire is deemed appropriate to examine the relationship between ERP and SCM in Taiwanese IT firms (Churchill, 1997). A seven-point Likert scale anchored at "strongly disagree" (1), "strongly agree" (7), and "neither agree nor disagree" (4) is used to collect most responses, while some questions involved absolute numbers, percentages or binary variables. The final questionnaire had an embedded triangulation structure to reduce data bias (Jick, 1979) and was divided into:

(1) General data;

(2) Benefits for adopting ERP systems, and

(3) Firm competencies of SCM after adopting ERP systems

The final questionnaire consists of three parts (**Appendix**). The part of general data includes 8 questions pertaining to industry, number of employees, estimated revenue, the primary reason for adopting ERP system, type of ERP and SCM related software used, which modules of ERP system implementing, and the number of months and years since the ERP system initiatives. The parts of benefits for adopting ERP systems and firm competencies of SCM after adopting ERP systems include total of 47 items for eight constructs pertaining to the ERP benefits and firm competencies of SCM, as well as including 6 synthesis questions pertaining to the total impact of ERP adoption on firm competencies of SCM (Appendix).

Table 4.1 Original and final measurement scales and items: Standardized path loadings from CFA

Construct and items	Standard Path Loading
ERP benefits and associated items:	
Operational benefits:	
My firm has better control of business operating expenses and decreased operations cost after adopting ERP system.	0.761
My firm has reduced production cycle times and increased inventory turns.	0.903
My firm has increased power user involvement by user training for operational tasks	0.944
My firm has improved quality management and control.	0.964
My firm meets customer needs proactively and more efficiently.	0.845
My firm has less time and fewer errors in order process.	0.848
Managerial benefits:	
My firm increased the capability of tailoring products to meet specific needs of customer, and improving resource management to support customization.	0.893
My firm has more effective decision making by workers.	0.881
My firm's ERP system has increased delivery flexibility	0.669
My firm's ERP system has reduced ordering and invoice complexity	0.849
My firm has increased partnership with customer and vendor by information sharing.	0.754
My firm has improved quality management and quality control.	0.778
My firm's ERP system has enhanced the capability to reduce the time between order receipt and customer delivery.	dropped
Strategic benefits:	
My firm has supported for business growth.	0.906
My firm has supported for business alliance.	0.628
My firm increased the capability of building business innovations and absorb radical change routinely	0.922
My firm has built cost leadership by reducing inventory-carrying cost and lower labor cost.	0.826
My firm has generated product differentiation including customization.	0.783
My firm has built external linkages to have better connectivity with customer and supplier.	0.700

Organizational benefits:	
My firm has changed organizational management processes in breadth and broader horizon.	0.984
My firm has facilitated organizational learning and training for access of enterprise information.	0.988
My firm has training for decision making skills and worker empowerment for taking actions.	0.983
My firm has built common vision.	0.893
My firm has better employee morale and satisfaction.	0.801
My firm has related to support organizational changes.	0.763
IT Infrastructural benefits:	
My firm has built business flexibility for current and future changes.	0.867
My firm has reduced in cost of maintaining legacy systems.	0.902
My firm has increased IT infrastructure capability.	0.813
My firm has integrated and has real time to effectively support information.	0.797
My firm has standard procedures across different locations.	0.702
My firm has presented a single interface to customer and has consolidated multiple different systems of the same type.	0.870
SCM competencies scales and associated items:	
Behavioral process competencies:	
My firm has increased customer response time and percentage of resolving customer's first call	0.740
My firm has kept maintenance and modification of customer focus to continuously match changing expectations.	0.678
My firm has developed of a common vision of the total value creation process and planning clarity concerning shared responsibility.	0.639
Our trading partners respect the confidentiality of the information they receive from us.	0.729
Our trading partners have willingness to exchange key technical, financial, operational, and strategic information.	0.734
Operational process competencies:	
My firm has increased product quality and customer's product return rate.	0.816
My firm has improved responsiveness to urgent order.	0.807
My firm is being expanded to reflect more enterprise wide integrated processes.	0.761

My firm has established the cross-functional policies and procedures to facilitate synchronous operations.	0.797
My firm streamlines ordering, receiving and other paperwork from suppliers.	0.872
My firm is able to handle difficult nonstandard orders.	0.860
My firm is able to produce products characterized by numerous features options, sizes and colors.	dropped
My firm is able to rapidly adjust capacity so as to accelerate or decelerate production in response to changes in customer demand.	dropped
My firm has extended management to include hierarchical structure of suppliers' suppliers.	dropped
Control and planning process competencies:	
My firm is able to facilitate supply chain resource allocation through seamless transactions across the total order-to-delivery cycle.	0.777
My firm is able to exchange information between our trading partners and us in a timely, responsive, and usable format.	0.748
My firm collaborates in forecasting and planning with partners.	0.749
My firm collaborates to develop shared visions and mutual commitment to jointly generated action plans.	0.782
My firm has continuous quality improvement program.	0.807
My firm is able to develop comprehensive functional performance measurement capability.	0.810
My firm has increased inventory accuracy and better material control.	dropped
My firm has increased delivery flexibility	dropped
My firm has enhanced purchase order fill rate	dropped
My firm has reduced ordering and invoice complexity.	dropped

Table 4.2 SCM competences and ERP benefits definitions

Operational process:		
SOP1	Relevancy	Maintenance and modification of customer focus to continuously match changing expectations.
SOP2	Responsiveness	Accommodation of unique and/or unplanned customer requirements.
SOP3	Cross-functional unification	Operations of potentially synergistic activities into manageable operational processes.
SOP4	Standardization	Establishment of cross-functional policies and procedures to facilitate synchronous operations.
SOP5	Operational fusion	Linkage of systems and operational interfaces to reduce duplication, redundancy, and dwell while maintaining operational synchronization.
SOP6	Supplier management	Extended management to include hierarchical structure of suppliers' suppliers.
Planning and control process:		
SPCP1	Information management	Commitment and capability to facilitate supply chain resource allocation through seamless transactions across the total order-to-delivery cycle.
SPCP2	Internal communication	Capability to exchange information across internal functional boundaries in a timely, responsive, and usable format.
SPCP3	Connectivity	Capability to exchange information with external supply chain partners in a timely, responsive, and usable format.
SPCP4	Collaborative forecasting and planning	Customer collaboration to develop shared visions and mutual commitment to jointly generated action plans.
SPCP5	Functional assessment	The development of comprehensive functional performance measurement capability.
SPCP6	Activity-based and total cost methodology	Adoption and commitment to activity-based costing, budgeting, and measurement of comprehensive identification of cost/revenue contribution of a specific entity such as a product.
Behavioral process:		
SBP1	Role specificity	Clarity concerning leadership process and establishment of shared versus individual enterprise responsibility.
SBP2	Guidelines	Rules, policies, and procedures to facilitate in-

		ter-enterprise collaboration, leverage, and conflict resolution.
SBP3	Information sharing	Willingness to exchange key technical , financial, operational, and strategic information.
SBP4	Gain/risk sharing	Framework and willingness to apportion fair share reward and penalty.
SBP5	Strategic alignment	Development of a common vision of the total value creation process and planning clarity concerning shared responsibility.
Operational benefits:		
EOP1	Cost reduction	For better control of business operating expenses, decreased operations cost.
EOP2	Cycle time reduction	Complex assortments, shorter cycle times, less inventory.
EOP3	Productivity improvement	Power user involvement in user training for operational tasks
EOP4	Quality improvement	Improved quality management and control.
EOP5	Customer service improvement	Meet customer needs proactively and more efficiently.
EOP6	Error reduction	Less time and fewer errors in order process.
Managerial benefits:		
EMN1	Resource management	Tailoring products to meet specific needs of customer, and improving resource management to support customization.
EMN2	Decision-making and planning	More effective decision making by workers.
EMN3	Performance improvement	Reduce cost, increase revenues, and improve market value.
EMN4	Partnership with customer and vendor.	Management within and outside the firm's boundaries between groups
EMN5	Scheduling	Allows users to generate supply chain schedules addressing customer needs.
EMN6	Quality management	Improved quality management and quality control.
Strategic benefits:		
ESTG1	Worldwide expan-	Support for business growth

	sion	
ESTG2	Business alliance	Support for business alliance
ESTG3	Business innovations	Building business innovations and absorb radical change routinely
ESTG4	Cost leadership	Building cost leadership by reduce inventory-carrying cost and lower labor cost.
ESTG5	Product differentiation	Generate product differentiation including customization
ESTG6	External linkages	Building external linkages to have better connectivity with customer and supplier.
IT infrastructural benefits:		
EIT1	Flexibility	Building business flexibility for current and future changes
EIT2	IT cost reduction	Reduction in cost of maintaining legacy systems.
EIT3	Enabling e-commerce	Increased IT infrastructure capability
EIT4	Information management	Integrated and real time to effectively support information.
EIT5	Improve IT architecture	Standardize procedures across different locations.
EIT6	Single interface	Present a single interface to customer and consolidate multiple different systems of the same type
Organizational benefits:		
EOG1	Changing work patterns	Change management processes; breadth and broader horizon.
EOG2	Organizational learning	Facilitating organizational learning and training for access of enterprise information.
EOG3	Empowerment	Training for decision making skills and worker empowerment for taking actions.
EOG4	Common vision	Building common vision
EOG5	employee morale	Better employee morale and satisfaction
EOG6	Behavior	Training for decision making skills.

Table 4.3 Pretest item-placement ratios (Final sorting round, n = 5)

Intended ERP Benefits and SCM competencies (No. of items in scale)	Actual Classifications: Operational benefits	Managerial benefits	Strategic benefits	IT infrastructure benefits	Organizational benefits	Operational process	Planning and control process	Behavioral process	Synthesis	Total*	Item Placement Ratio
Operational benefits (6)	23	5	2							30	77%
Managerial benefits (6)	3	25	1		1					30	83%
Strategic benefits (6)	1	3	25	1						30	83%
IT infrastructure benefits (6)	6	1	1	22						30	73%
Organizational benefits (6)	1	1	6	1	21					30	70%
Operational process (6)						27	2	1		30	90%
Planning and control process (6)						4	26			30	87%
Behavioral Process (5)						2	5	18		25	72%
Synthesis (6)	3	1				2	2		22	30	73%

Total Item Placements: 265 Hits: 209 Overall Hit Ratio: 79%

*Total number of item placements (number of items in scale x number of judges (5)).

4.2 Stage 2 Empirical Scale Refinement and Validation

The manual sorting or scale purification process produced refined multi-item scales for the constructs described in previous section. The panels of practitioner experts were qualified to assess the content validity of the proposed items and constructs, and the results of the sorting process indicate that the new scales exhibit some degree of reliability and validity. However, further empirical testing is required to ensure that the scales have the characteristics needed to form a solid foundation for theory building in the area of the relationship between ERP benefits and SCM competencies. Following the scale purification process (stage 1), Churchill (1979) suggests the development of measurement instrument norms as the final step in new scale development. In stage 2, this was performed using data collected through a mailed survey.

4.2.1 Content validity analysis

A scale is said to have content validity if the scale's items form a representative sample of the theoretical domain of the construct (Churchill, 1979; Pedhazur and Schmelkin, 1991). The usual method of ensuring content validity is an extensive review of the literature. In addition to the literature review, the expert judges performing the manual sorts were asked to suggest any missing items that might be needed to measure the defined constructs. Thus, the literature review and input from expert industry judges together establish the content validity of the construct scales.

4.2.2 Unidimensionality analysis

Measurement scales are considered to be unidimensional if the items in the scale measure a single construct. Unidimesionality is a necessary condition for reliable and valid scales (Anderson and Gerbing, 1988). Confirmatory factor analysis (CFA) can be used to assess scale unidimensionality (Hatcher, 1994). A measurement model was specified for each construct that linked each of the measurement items, and these errors were allowed to freely correlate with each other (Bollen, 1989). Nonsignificant error term correlations were removed, and the overall fit of the model was examined.

The goodness-of-fit index (GFI) is a common measure of model fit (Ahire et al., 1996.)

4.2.3 Survey methods

In the second stage, survey data was collected from a sample of Taiwanese IT companies which listed in the Taiwan Stock Exchanges (TSE) are screened according to the companies with operational ERP systems or SCM systems or both systems. Empirical, confirmatory analyses using the items tapping into each of all the constructs and measurement items defined in stage 1 to produced refined scales. Each items scale had measurement properties that fit into the commonly accepted guidelines for reliability and validity. The authors screened the candidates by accessing the database of TSE and the companies' websites. Finally, 138 firms were included in the sample population. To be convenient for the respondents, the questionnaire was delivered to the presidents of the 138 firms in two forms: e-mail or regular mail. Along with the questionnaire, a personalized letter was sent to the president. The letter asked that he/she select the proper strategic business units (SBU) in his/her company and forward the questionnaires to the selected IT/MIS managers. To encourage participation, all the informants were assured that their response would be kept confidential and will only be shown in an aggregated form. The authors also promised to give a copy of the results to all respondents. Initially, participants' reliability control took place through data analysis. Reliability criteria were based on the result of the four triangulated questions. In case the responses of a participant exceeded the limit of reliability criteria, the questionnaire was excluded. Reliability limit was set up to two wrong answers of the triangulated questions, or one wrong response to these questions. A data analysis method was used. After reducing bias, by excluding unreliable responses, the remaining questionnaires were analyzed using SPSS14.0 and the measurement model was estimated using AMOS 7.0. A total of 504 questionnaires are delivered. After several follow-up e-mails and phone calls, 298 responses are received. The response rate for firms is 59.12 percent. The reliability control has shown that 4.3 percent of respondents were unreliable, as they had no logical sequence or structure, and therefore, excluded from the sample. For example, they reported that their primary reason to adopt an ERP system is to enhance the firm performance on SCM. However, they then claimed that the ERP system did not enhance their SCM performance, but regardless, their firm was satisfied from the ERP system. Moreover, some of these respondents ticked the same answer box for all questions, which again shows that these answers were unreliable. Finally, a total of 285 usable responses are received from 76 IT or ERP/SCM related managers, 158 lower-middle IT or ERP/SCM related managers and 51 others (who gave their job titles as "Director" or "Vice-President") employed by 138 companies. The valid responses include companies with a range of annual revenues from USD$10 millions to $800 millions, and workforces of 90 to 25000 employees. The total process of data collection started from Q1 2006 and ended in Q2 2007. Table 4.4 presents a summary of the demographic characteristics of the respondents.

Table 4.4 Demographic characteristics of the respondents

		Percentage(%)
Type of industry	Computer manufacturers:	
	PC systems	35.5
	Peripherals	8.4
	Communications	3.5
	Consumer electronics	7.0
	Computer components	7.0
	Semiconductors:	
	Foundry	4.9
	IC design	9.8
	Packaging and testing	5.9
	Mask	1.0
	Equipment/Material	10.9
	Others	4.2
	IT strategy consultants	1.8
Total Assets (USD)	< 30,000,000	39.7
	30,000,000 ~ 100,000,000	37.9
	100,000,001 ~ 200,000,000	8.1
	200,000,001 ~ 300,000,000	2.8
	>300,000,000	11.5
Annual Turnover (USD)	<30,000,000	8.5
	30,000,000 ~ 150,000,000	62.9
	150,000,001 ~ 300,000,000	13.9
	300,000,001 ~ 900,000,000	7.7
	>900,000,000	7.0
Number of Employee	< 100	12.3
	101 ~ 500	44.0
	501 ~ 1,000	18.5
	1,001 ~ 2,000	14.7
	>2,000	10.5
ERP System Implementation (Month)	< 6	7.2
	7 ~ 12	42.2
	13 ~ 24	29.9
	>24	20.7
ERP System on line (Year)	< 0.5	8.3
	0.5 ~ 1	25.0
	1 ~ 2	23.2
	>2	43.5
Job Classification	Top IT/ERP/SCM	27.1
	Middle IT/ERP/SCM	55.4
	Others	17.9

4.2.4 The background of Data Collection

The present study is based on the Taiwanese IT industry, and mainly consists of electronics manufacturers and semiconductor-related manufacturers (see Table 4.4), for two reasons:

1. **Taiwan is a major player in and contributor to the world IT industry**

Taiwan has achieved outstanding results in IT over the past two decades (Chang and Yu, 2001). Taiwan-made IT products dominate the world market in many categories. The world market share exceeds 50 %. The semiconductor manufacturing and electronics manufacturing industry (IT industry) especially have evolved to prominence in Taiwan's recent economic development. The country currently ranks third in computer manufacturing and fourth in the semiconductor industry (Foundry ranked No.1; IC design ranked No.2) in the world (ITIS Project, MOEA, 2008). Keeping pace with thaw in the political relations between Taiwan and China, Taiwan's IT industries have been playing a key role in that country — which, of course, has earned a reputation as "the world's workshop." For instance, Taiwan's leading notebook computer manufacturers — who have, at times, enjoyed a world market share in excess of 70% — began moving their production sites to China in 2001. All of Taiwan's notebook production lines have now been relocated to China. Most of China's share of the global notebook market can thus actually be attributed to the contributions by Taiwanese firms. In addition, the 2008 global IT industry competitiveness report issued by Britain's Economist Intelligence Unit (EIU) ranked Taiwan sixth out of the 64 countries rated in terms of IT industry competitiveness, behind only the U.S., Japan, South Korea, Britain, and Australia. As for IT industry labor productivity, Taiwan leads the world, with output value of US$386,413 per IT industry employee. The industry's structure is the predominant reason for this high productivity (EIU, 2008).

2. **Taiwan has delivered the best practices of SCM**

In the IT industry, product life cycle is extremely short. Companies need to deliver new products before they have any market value. In the Taiwanese IT industry, the main type of business is original equipment manufacturing (OEM) and original design manufacturing (ODM). An OEM/ODM business is different from an own brand manufacturing (OBM) business in many respects. With OBM, companies can entirely control their marketing activities. In the case of OEM/ODM, on the other hand, firms are not involved in their OEM/ODM customers' sales/marketing activities. Companies isolated from the end-customer base still need to satisfy customer needs and react to new ones immediately. They are compelled to closely cooperate with all of the members in the supply chain so as to be able to react to unexpected changes. To cope with the rapid changes in customer needs and the extremely short product life cycles, the cross-functional cooperation of information systems in the IT industry may be more important than in those industries with a longer product life cycle. In today's fast-changing business environment, the Taiwanese IT industry depends heavily on its highly-effective SCM to achieve superb performance. It is important to understand the supply chain network in Taiwan, since that supply chain network may influence organizational effectiveness. For instance, Foxconn, which is a contractor for such world-famous products as the iPod and iPhone, relies on the support of its ERP system (SAP) to perform varied, high-quality, low-cost production tasks. Foxconn is also the major supplier to leading brand name companies such as Cisco, Dell, HP, Nokia, Sony, etc. (Foxconn, 2008).

Many scholars have conducted research into the SCM of firms in some developed countries (Benton and Maloni, 2005; Mabert, et al., 2001; Lim and Palvia, 2001). These studies cover many types of industries, such as the chemical, pharmaceutical, bioengineering, automobile, etc. They also include a wide range of high-technology firms. The IT industry in developing countries, such as Taiwan, China, and Korea, has not, however, been comprehensively studied. The present study therefore presents the results of an empirical study of the impact of implementation of ERP on SCM competencies by IT manufacturers in Taiwan. Survey data is collected from a sample of Taiwanese IT companies listed in the Taiwan Stock Exchanges (TSE), mainly on electronics manufacturers (including: PC systems, peripherals, communications, consumer electronics, and computer components) and semiconductors-related manufacturers (including: foundry, IC design, packaging and testing, mask, and equipment/material provider), and screened according to whether they have operational ERP systems (see Table 2). Refined scales employing items drawn from constructs and measurement items referred to in the relevant literature are used to conduct empirical, confirmatory analyses. Each item's scale has measurement properties that fit into the commonly accepted guidelines for reliability and validity.

CHAPTER 5

ANALYSIS AND RESULTS

Once the data was collected, it was analyzed with the following objectives in mind: purification, factor structure (initial validity), unidimensionality, and reliability. The methods that were used for each analysis are corrected-item total correlation (for purification), exploratory factor analysis (for factor structure and initial validity), structural equation modeling (for unidimensionality), Cronbach's alpha (for reliability).

5.1 The Measurement Model

The need to purify the items before administering factor analysis is emphasized by Churchill (1979). Purification is carried out by examining the corrected-item total correlation (CITC) score of each item with respect to a specific dimension of a construct. The CITC score of each item with respect to a specific dimension of a construct. The CITC score is a good indicator of how well each item contributes to the internal consistency of a particular construct as measured by the Cronbach's alpha coefficient (Cronbach, 1951). Items were deleted if their CITC scores were below .30 (Dunn et al., 1994), unless there are clear reasons for keeping the items in spite of low item total correlation (see Table 5.2). On the other hand, certain items with CITC scores above .30 may also be removed if their deletion can dramatically improve the overall reliability of the specific dimension. This can be determined by examining the "alpha if deleted" score.

The reliability (internal consistency) of the items comprising each dimension was examined using Cronbach's alpha. Following the guideline established by Nunnally (1978), an alpha score of higher than .70 is generally considered to be acceptable.

After purifying the items, an exploratory factor analysis (EFA) was first conducted to check whether the proposed factor structures are indeed consistent with the actual data. The factor structures suggested by the EFA match the one proposed in the research model. The various loadings are shown in Table 5.1. Second, multiple regression also was conducted to verify the impacts of ERP benefits on SCM competencies (Table 5.5). The measurement model was estimated using SPSS 14.0. The properties of the measurement model are summarized in Table 5.2. Third, confirmatory factor analysis (CFA) was conducted to assess the measurement model; then, the structural relationships were examined. In this measurement model, no unidirectional path was specified between any latent variables. Instead, a covariance was estimated to connect each latent variable with every other latent variable. This measurement model was estimated using AMOS 7.0.

EFA is useful in discovering potential latent sources of variance and covariance in observed measurements. Items with good measurement properties should exhibit high factor loadings on the latent factor of which they are indicators, and small factor loadings on the factors that are measured by differing sets of indicators. Therefore, such results provide some evidence of initial validity of measurement items (Segars and Grover, 1998). To ensure the high quality of instrument development process, .50 was used as the cutoff score for factor loading. Items with loadings lower that .50 and items with serious cross-loadings (i.e. an item loaded very close to .50 on more than one factor) were removed. To streamline the final results, factor loadings lower than .40 were not reported (Table 5.1). Moreover, the stability of the factors was analyzed by measuring the ratio of respondents to items, and the Tinsley and Tinsley (1987) guideline of having a minimal ratio between 5 and 10 was followed.

Even though EFA is useful at identifying underlying factor structure and thus providing initial unidimensionality (convergent validity) and discriminant validity, EFA initially assumes that the measurement errors of the items are uncorrelated. In practice, however, there is always some degree of error correlations among items and this cannot be detected by EFA

(Raghunathan et al., 1999). On the other hand, according to Gerbing and Anderson (1988) and Segars and Grover (1998), EFA does not provide an explicit test of unidimensionality. Unidimensionality can be defined as the existence of one latent trait or construct underlying a set of measures (McDonald, 2000; Hattie, 1985). In fact, Gerbing and Anderson stat that "factors in an exploratory analysis do not correspond directly to the constructs represented by each set of indicators because each factor from exploratory analysis is defined as a weight sum of all observed variables in the analysis" (p.189). More recently, the structural equation modeling (SEM) has been gaining increasing popularity due to its robustness and flexibility in establishing unidimensionality. The research will thus use SEM to test unidimensionality of each construct.

One of the most widely used SEM software is AMOS. Using AMOS, it is possible to specify, test, and modify the measurement model. Model-data fit was evaluated based on multiple fit indexes. The Chi-square is perhaps the most popular index to evaluate the goodness of fit of the model. It measures the difference between the sample covariance and the fitted covariance. However, the Chi-square index is sensitive to sample size and departures from multivariate normality. Therefore, it has been suggested that it must be interpreted with caution in most applications (Joreskog and Sorbom, 1989). Some of the other measures of overall model fit are goodness of fit index (GFI), adjusted goodness of fit index (AGFI), comparative fit index (CFI), normed-fit index (NFI), and Root Mean Squared Error of Approximation (RMSEA) indicates the average discrepancy between the elements in the sample covariance matrix and the model-generated covariance matrix. RMSEA values range from 0 to 1, with smaller values indicating better model; values below .08 signify good fit (Browne and Cudeck, 1992).

Table 5.1: Exploratory factor analysis loading

Con-struct	Items	Component 1	2	3	4	5	6	7	8	Community
Organi zational	EPRD1	**0.907**	0.085	0.212	0.143	0.138	0.147	0.027	0.026	**0.938**
	EPRD2	**0.910**	0.067	0.224	0.131	0.135	0.120	0.030	0.028	**0.934**
	EPRD3	**0.912**	0.070	0.225	0.151	0.133	0.120	0.025	0.007	**0.942**
	EPRD4	**0.866**	0.090	0.188	0.141	0.116	0.111	0.008	0.093	**0.847**
	EPRD5	**0.811**	0.035	0.227	0.128	0.106	0.160	0.116	0.087	**0.784**
	EPRD6	**0.779**	0.004	0.271	0.165	0.078	0.089	0.109	0.107	**0.745**
Strategic	ESIP1	0.049	**0.780**	-0.065	0.144	0.159	0.176	0.186	0.227	**0.777**
	ESIP2	0.058	**0.595**	0.011	0.275	0.170	0.197	0.167	0.120	**0.544**
	ESIP3	0.079	**0.804**	-0.022	0.160	0.168	0.192	0.197	0.136	**0.801**
	ESIP4	0.051	**0.805**	0.049	0.072	0.179	0.160	0.216	0.093	**0.772**
	ESIP5	0.046	**0.767**	0.042	0.111	0.201	0.096	0.278	0.075	**0.736**
	ESIP6	0.065	**0.720**	0.017	0.168	0.128	0.177	0.117	0.170	**0.641**
IT Infra-structure	EIT1	0.187	0.083	**0.796**	0.211	0.082	0.037	0.103	0.053	**0.742**
	EIT2	0.198	0.080	**0.815**	0.203	0.161	0.104	0.067	0.045	**0.795**
	EIT3	0.215	-0.029	**0.826**	0.180	0.046	0.082	0.037	0.070	**0.778**
	EIT4	0.229	-0.031	**0.816**	0.177	0.034	0.071	0.050	0.064	**0.763**
	EIT5	0.202	-0.096	**0.791**	-0.022	0.055	0.054	-0.018	0.110	**0.694**
	EIT6	0.261	0.055	**0.758**	0.251	0.136	0.150	0.082	0.109	**0.769**
Opera-tional	EOP1	0.167	0.121	0.262	**0.675**	0.175	0.182	0.209	0.089	**0.682**
	EOP2	0.208	0.240	0.189	**0.746**	0.203	0.213	0.143	0.157	**0.824**
	EOP3	0.191	0.230	0.207	**0.776**	0.149	0.224	0.190	0.175	**0.873**
	EOP4	0.222	0.239	0.228	**0.784**	0.182	0.201	0.195	0.135	**0.903**
	EOP5	0.153	0.138	0.231	**0.758**	0.219	0.138	0.219	0.148	**0.806**
	EOP6	0.189	0.201	0.213	**0.780**	0.158	0.137	0.180	0.076	**0.812**
Opera-tional Process	SOP1	0.124	0.144	0.099	0.188	**0.754**	0.179	0.144	0.199	**0.742**
	SOP2	0.110	0.187	0.103	0.156	**0.690**	0.233	0.096	0.272	**0.696**
	SOP3	0.146	0.198	0.170	0.225	**0.649**	0.201	0.069	0.193	**0.643**
	SOP4	0.149	0.186	0.046	0.174	**0.761**	0.135	0.109	0.171	**0.728**
	SOP5	0.116	0.239	0.045	0.109	**0.804**	0.185	0.082	0.186	**0.807**
	SOP6	0.155	0.148	0.145	0.124	**0.746**	0.229	0.191	0.227	**0.779**
Manage-rial	EMN1	0.125	0.289	0.090	0.182	0.200	**0.774**	0.071	0.187	**0.820**
	EMN2	0.098	0.325	0.023	0.131	0.228	**0.756**	0.142	0.159	**0.802**
	EMN3	0.175	0.115	0.160	0.116	0.225	**0.631**	0.189	0.107	**0.579**
	EMN4	0.131	0.260	0.058	0.274	0.161	**0.716**	0.181	0.148	**0.756**
	EMN5	0.235	0.146	0.142	0.196	0.174	**0.677**	0.237	0.111	**0.692**
	EMN6	0.170	0.143	0.162	0.147	0.248	**0.691**	0.265	0.115	**0.720**
Planning & Con-trol	SPCP1	0.077	0.395	-0.011	0.201	0.182	0.292	**0.529**	0.205	**0.642**
	SPCP2	0.006	0.452	0.012	0.149	0.079	0.234	**0.568**	0.169	**0.639**
	SPCP3	0.064	0.373	0.012	0.241	0.096	0.247	**0.575**	0.129	**0.619**
	SPCP4	0.082	0.344	0.089	0.201	0.078	0.202	**0.675**	0.140	**0.695**
	SPCP5	0.056	0.254	0.141	0.249	0.238	0.145	**0.718**	0.146	**0.764**
	SPCP6	0.094	0.244	0.118	0.227	0.168	0.208	**0.726**	0.146	**0.753**
Behav-ioral Process	SBP1	0.070	0.194	0.071	0.171	0.107	0.184	0.197	**0.688**	**0.635**
	SBP2	0.086	0.124	0.158	0.091	0.228	0.109	0.035	**0.684**	**0.589**
	SBP3	0.068	0.108	0.087	0.059	0.260	0.037	0.152	**0.643**	**0.533**
	SBP4	0.049	0.158	-0.005	0.173	0.148	0.161	0.016	**0.758**	**0.637**
	SBP5	0.018	0.151	0.119	0.040	0.230	0.122	0.200	**0.700**	**0.680**
Eigenvalues		18.244	5.649	2.543	2.486	1.684	1.676	1.440	1.130	
% of Variance		38.817	12.018	5.412	5.290	3.584	3.567	3.063	2.404	
Cumulative %		38.817	50.835	56.246	61.537	65.121	68.687	71.750	74.154	

Table 5.2: Summary of the measurement model

Construct	Indicator	Mean	Std. Dev.	Principal components scores	Item-to total correlation	Standard Loading	Cronbach alpha	Composite Reliability	Average Variance Extracted estimates
	EOP1	5.45	0.607	0.682	0.762	0.761			
	EOP2	5.69	0.602	0.824	0.858	0.903			
Operational	EOP3	5.73	0.638	0.873	0.895	0.944	0.954	0.936	0.775
	EOP4	5.71	0.679	0.903	0.925	0.964			
	EOP5	5.53	0.653	0.806	0.848	0.845			
	EOP6	5.53	0.647	0.812	0.854	0.848			
	EMN1	5.63	0.594	0.820	0.823	0.893			
	EMN2	5.62	0.578	0.802	0.807	0.881			
Managerial	EMN3	5.21	0.537	0.579	0.665	0.669	0.918	0.925	0.653
	EMN4	5.63	0.583	0.756	0.785	0.849			
	EMN5	5.36	0.633	0.692	0.755	0.754			
	EMN6	5.32	0.615	0.720	0.773	0.778			
	ESTG1	5.27	0.607	0.777	0.796	0.906			
	ESTG2	5.49	0.659	0.544	0.636	0.628			
Strategic	ESTG3	5.22	0.592	0.801	0.820	0.922	0.915	0.992	0.642
	ESTG4	5.22	0.598	0.772	0.797	0.826			
	ESTG5	5.21	0.661	0.736	0.778	0.783			
	ESTG6	5.37	0.688	0.641	0.727	0.700			
	EOG1	5.34	.627	.938	.944	.984			
	EOG2	5.35	.631	.934	.942	.988			
Organizational	EOG3	5.36	.632	.942	.948	.983	0.966	0.965	0.822
	EOG4	5.35	.614	.847	.876	.893			
	EOG5	5.44	.661	.784	.839	.801			
	EOG6	5.52	0.648	0.745	0.804	0.763			
	EIT1	5.66	0.622	0.742	0.780	0.867			
IT	EIT2	5.61	0.660	0.795	0.824	0.902			
Infrastructure	EIT3	5.35	0.659	0.778	0.819	0.813	0.925	0.928	0.685
	EIT4	5.26	0.683	0.763	0.809	0.797			

	EIT5	5.01	0.870	0.694	0.712	0.702			
	EIT6	5.49	0.715	0.769	0.808	0.870			
Behavioral Process	SBP1	4.79	0.596	0.635	0.645	0.740	0.831	0.958	0.500
	SBP2	4.95	0.612	0.589	0.607	0.678			
	SBP3	4.85	0.614	0.533	0.577	0.639			
	SBP4	4.86	0.616	0.637	0.654	0.729			
	SBP5	4.76	0.649	0.680	0.662	0.734			
Operational Process	SOP1	5.22	0.552	0.742	0.790	0.816	0.924	0.989	0.672
	SOP2	5.19	0.579	0.696	0.759	0.807			
	SOP3	5.17	0.633	0.643	0.721	0.761			
	SOP4	5.22	0.552	0.728	0.760	0.797			
	SOP5	5.16	0.585	0.807	0.834	0.872			
	SOP6	5.18	0.591	0.779	0.816	0.860			
Control and Planning Process	SPCP1	5.20	0.649	0.642	0.715	0.777	0.902	0.984	0.607
	SPCP2	5.16	0.622	0.639	0.701	0.748			
	SPCP3	5.29	0.714	0.619	0.697	0.749			
	SPCP4	5.29	0.725	0.695	0.747	0.782			
	SPCP5	5.33	0.720	0.764	0.762	0.807			
	SPCP6	5.42	0.660	0.753	0.770	0.810			

5.2 Instrument Reliability and Validity

To validate our measurement model, content validity, construct validity (including Cronbach alpha), convergent validity, and discriminant validity were assessed. Content validity was established by ensuring consistency between the measurement items and the extant literature. This was done by interviewing senior practitioners and pilot-testing the instrument. For the construct validity, the items were tested for scale reliability. Various reliability test results are shown in Table 5.2, which summarizes the item-to-total correlations and principal component scores for the sample. Item-to-total correlations exceed 0.30 (Dunn et al., 1994) in all cases. The principal component scores meet minimal levels of 0.30 and above in all cases (Hair et al., 1998). Thus, all of the scales reflect unidimensional characteristics. The reliability (internal consistency) of the items comprising each dimension was examined using Cronbach's alpha. Following the guideline established by Nunally (1978), an alpha score of higher than .70 is generally considered to be acceptable. The Cronbach alpha ranges from .831 to .966 for the eight constructs, and are thus also satisfactory, as coefficient alphas meet or exceed 0.70 in all instances (Nunnally, 1978), indicating a high internal consistency. Except for one item in the behavioural process integration construct of SCM competencies, all the items were retained. The construct validity is also tested for convergent and discriminant validity. We assessed convergent validity by reviewing the t tests for the factor loadings and by examining composite reliability and average variance extracted from the measures (Hair et al., 1998). Although many studies have used 0.5 as the threshold reliability of the measures, 0.7 is a recommended value for a reliable construct (Chin, 1998). As shown in Table 5.2, our composite reliability values range from 0.925 to 0.992. For the average variance extracted by a measure, a score of 0.5 indicates acceptability (Fornell and Larcker, 1981). The average variances extracted by our measures range from 0.500 to 0.822, which are above or equal to the acceptability value. In addition, Table 5.3 exhibits the loadings of the measures in our research model. As expected, all measures are significant on their path loadings at the level of 0.01. Finally, we verified the discriminant validity of our instrument by comparing the average variance extracted (AVE) (Fornell and Larcker, 1981) from each latent construct to the square of the correlation between this construct and every other construct, which has been used by some IS studies (Segars and Grover, 1998). The result, in Table 5.4, confirms the discriminant validity: the square of the average variance extracted for each construct is greater than the levels of correlations involving the construct. The results of the inter-construct correlations also show that each construct shares larger variance with its own measures than with other measures.

Table 5.3 Loadings of the measures

Construct	Items	Standard Loading	Standard Error	t-value	Construct	Items	Standard Loading	Standard Error	t-value
Opera-	EOP1	0.761	0.054	15.695	Orga-	EOG1	0.984	0.064	19.386
tional	EOP2	0.903	0.047	21.048	niza-	EOG2	0.988	0.065	19.483
	EOP3	0.944	0.048	23.065	tional	EOG3	0.983	0.065	19.353
	EOP4	0.964	0.049	24.123		EOG4	0.893	0.065	17.027
	EOP5	0.845	0.054	18.636		EOG5	0.801	0.072	14.848
	EOP6	0.848				EOG6	0.763		
Man-	EMNG1	0.893	0.065	16.937	Opera-	SOP1	0.816		
agement	EMNG2	0.881	0.064	16.631	tional	SOP2	0.807	0.066	15.795
	EMNG3	0.669	0.063	11.831	Process	SOP3	0.761	0.074	14.533
	EMNG4	0.849	0.065	15.856		SOP4	0.797	0.063	15.508
	EMNG5	0.754	0.073	13.663		SOP5	0.872	0.064	17.680
	EMNG6	0.778				SOP6	0.860	0.065	17.317
Strateg-	ESTG1	0.906			Plan-	SPCP1	0.777		
ic	ESTG2	0.628	0.085	14.477	ning &	SPCP2	0.748	0.069	13.291
	ESTG3	0.922	0.077	10.172	Control	SPCP3	0.749	0.080	13.312
	ESTG4	0.826	0.077	14.702	Process	SPCP4	0.782	0.080	14.034
	ESTG5	0.783	0.084	13.266		SPCP5	0.807	0.079	14.572
	ESTG6	0.700	0.079	12.609		SPCP6	0.810	0.072	14.633
IT	EIT1	0.867			Beha-	SBP1	0.740		
frastruc-	EIT2	0.902	0.052	21.371	vioral	SBP2	0.678	0.089	10.563
struc-	EIT3	0.813	0.056	17.578	Process	SBP3	0.639	0.089	9.973
ture	EIT4	0.797	0.059	17.002		SBP4	0.729	0.090	11.331
	EIT5	0.702	0.081	13.922		SBP5	0.734	0.095	11.407
	EIT6	0.870	0.058	19.902					

Table 5.4 Comparison of AVE and squared roots correlations

Var.	EOP	EMNG	ESTG	EIT	EOG	SOP	SPCP	SBP
EOP	**0.801**							
EMNG	0.215	**0.901**						
ESTG	0.604	0.390	**0.808**					
EIT	0.524	0.457	0.610	**0.880**				
EOG	0.153	0.520	0.355	0.546	**0.828**			
SOP	0.532	0.235	0.565	0.503	0.324	**0.705**		
SPCP	0.750	0.266	0.692	0.662	0.314	0.526	**0.779**	
SBP	0.547	0.381	0.647	0.565	0.367	0.442	0.561	**0.820**

* The shaded numbers in the diagonal row are square roots of the average variance extracted.

5.3 Results of Multiple Regression Analysis

The first analysis focuses on comparing the impacts of ERP benefits in each region to the SCM competency measure. The five constructs, each composed of six items of ERP benefits, are used as independent variables in a series of regression models, with each SCM competency individually treated as a dependent variable. To provide a clearer picture of the role of the ERP benefits in affecting SCM competency, Table 5.5 reports the results of all regression models. Standardized beta coefficients are shown in the table for all significant ($p < .05$) variables. Model significance is also reported in the R^2column. All R^2values are significant at $p < .001$.

In the model, R^2values show that this model accounts for 45% of the variance in the operational process, 62% of the variance in the planning and control process, and 30% of the variance in the behavioral process. That is, 30% or more of the variation in three constructs of SCM competencies is explained by most of the ERP benefits. Three of five constructs of ERP benefits explained most of 17 measures of SCM competencies. There are operational, managerial, and strategic benefits of ERP. IT infrastructure benefits explained some SCM competencies; but organizational benefits could not predict any of them. That is, most of the results support the corresponding hypotheses. Strategic and managerial benefits are the most common significant predictor variables relative to SCM competencies. Managerial benefit is a significant predictor for the operational process of SCM competencies (Beta coefficient is .32). Strategic benefit is a significant predictor for the planning and control process and the behavioural process (Beta coefficients are .45 and .30.) These findings will be compared with the results of the structural model, and will be discussed below. A summary of the hypotheses test results is provided in Table 5.7.

Table 5.5 Multiple regression results

		Standardized coefficients Beta					
SCM competences		ERP Benefits					
Items	**Competences**	**Operational**	**Management**	**Strategic**	**IT Infrastructure**	**Organizational**	R^2
SOP		0.20	0.32	0.21	0.11		0.45
SOP1	Relevancy	0.23	0.30	0.13			0.31
SOP2	Responsiveness	0.19	0.33	0.17			0.33
SOP3	Cross-functional unification	0.20	0.24	0.18			0.34
SOP4	Standardization	0.21	0.25	0.19			0.29
SOP5	Operational fusion	0.25	0.28	0.13			0.31
SOP6	Supplier management	.	0.34	0.17			0.36
SPCP		0.24	0.24	0.45			0.62
PCP1	Information management	0.13	0.26	0.41			0.47
SPCP2	Internal communication		0.22	0.50			0.42
SPCP3	Connectivity	0.19	0.20	0.38			0.42
SPCP4	Collaborative forecasting and planning	0.21	0.18	0.37			0.40
SPCP5	Functional assessment	0.30	0.16	0.31			0.41
SPCP6	Activity-based and total cost methodology	0.26	0.22	0.28			0.41
SBP			0.26	0.30	0.15		0.30
SBP1	Role specificity	0.17	0.21	0.22			0.25
SBP2	Guidelines		0.18	0.19	0.19		0.17
SBP3	Information sharing		0.15	0.22	0.12		0.13
SBP4	Gain/risk sharing		0.20	0.25	0.13		0.19
SBP5	Strategic alignment	0.15	0.19	0.17			0.18

5.4 Results of the Structural Model Analysis

The structural model tested in the present study is shown in Figure 2. This model was estimated using AMOS 7.0. The χ^2 statistic of 2.073 is within the acceptable limit (Byrne, 1989). Several goodness of fit indices of the measurement model have been widely used in IS research and are presented in Table 5.6. The Tucker-Lewis index, also known as the non-normed fit index (NNFI), and the comparative fit index (CFI) are all above 0.90, suggesting a good fit between the structural model and the data. RMSEA is well below the suggested threshold value of 0.08 (Browne and Cudeck, 1992). The parsimony-adjusted NFI of the revised model is 0.848, which is significantly above the suggested value of 0.60. Williams and Hazer (1986) indicate highly acceptable levels of parsimony and fit of the overall model. All of these fit indices are acceptable, suggesting that the overall structural model provides a good fit with the data. The results of estimating the structural model are presented in Figure 5.1.

Table 5.6 Fit indices of structural model

χ^2	2091
df	1009
χ^2/df	2.073
Normed fit index (NFI)	0.848
Tucker-Lewis index	0.909
Comparative fit index (CFI)	0.915
GFI	0.756
RMR	0.024
RMSEA	0.061
Lower bound	0.058
Upper bound	0.065

The squared multiple correlation (SMC) values, which are similar to R^2 in regression analysis, show that this model accounts for 50% of the variance in the operational process, 70% of the variance in the planning and control process, and 41% of the variance in the behavioural process. Most of the paths are significant and positive, supporting the corresponding hypotheses, except for the organizational process and IT infrastructure. These findings are discussed below. A summary of the hypotheses test results is provided in Table 5.7.

Figure 5.1 and Table 5.7 show the results, and illustrate that the SCM competencies in the operational process, the planning and control process and the behavioural process were positively influenced by ERP benefits. These results basically support all of our hypotheses.

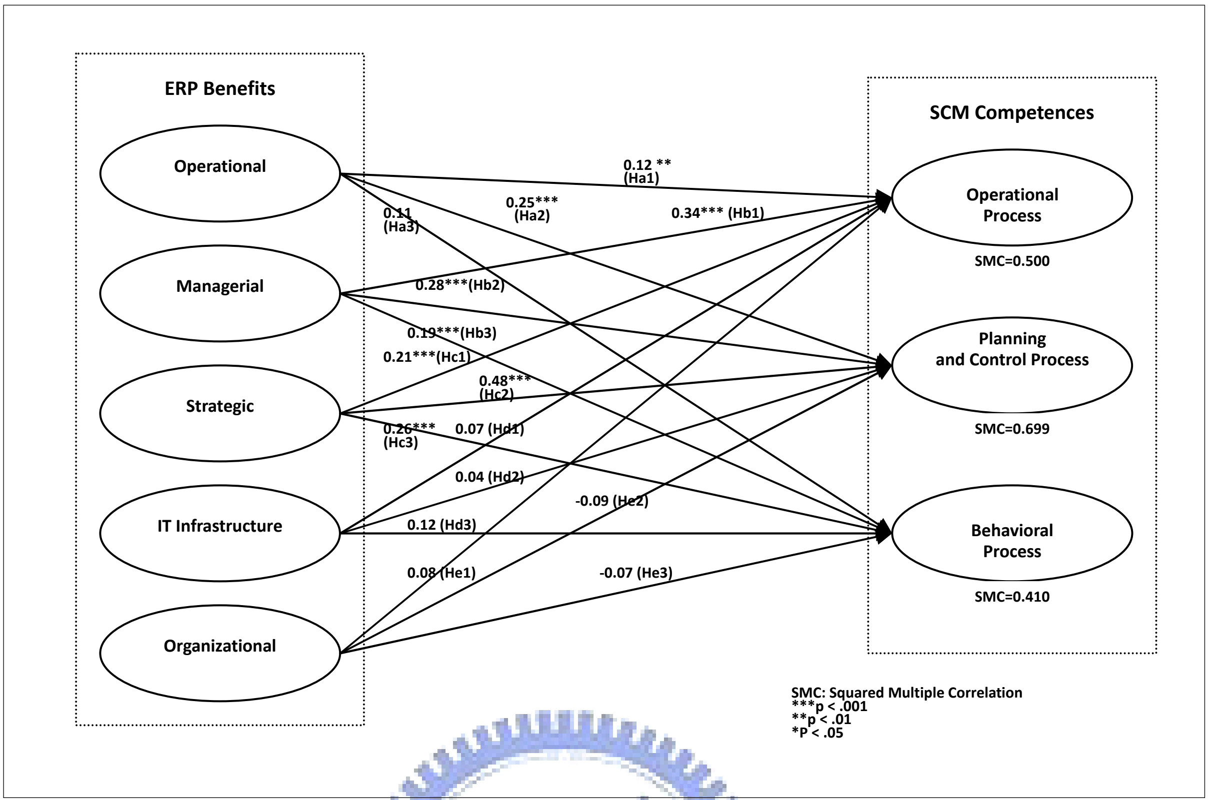

Figure 5.1 Structural Model Results

Table 5.7 Summary of the Structural Model

Hypotheses	Beta coefficients	Path Coefficients	Results
Ha1: The operational benefits of ERP positively affect SCM competences in operational process.	0.20	0.12	Supported
Hb1: The managerial benefits of ERP positively affect SCM competences in operational process.	0.32	0.34	Supported
Hc1: The strategic benefits of ERP positively affect SCM competences in operational process.	0.21	0.21	Supported
Hd1: The IT infrastructure benefits of ERP positively affect SCM competences in operational process.	0.11	0.07	Not supported
He1: The organizational benefits of ERP positively affect SCM competences in operational process.		0.08	Not supported
Ha2: The operational benefits of ERP positively affect SCM competences in planning and control process.	0.24	0.25	Supported
Hb2: The managerial benefits of ERP positively affect SCM competences in planning and control process.	0.24	0.28	Supported
Hc2: The strategic benefits of ERP positively affect SCM competences in planning and control process.	0.45	0.48	Supported
Hd2: The IT infrastructure benefits of ERP positively affect SCM competences in planning and control process.		0.04	Not supported
He2: The organizational benefits of ERP positively affect SCM competences in planning and control process.		-0.09	Not supported
Ha3: The operational benefits of ERP positively affect SCM competences in behavioral process.		0.11	Not supported
Hb3: The managerial benefits of ERP positively affect SCM competences in behavioral process.	0.26	0.19	Supported
Hc3: The strategic benefits of ERP positively affect SCM competences in behavioral process.	0.30	0.26	Supported
Hd3: The IT infrastructure benefits of ERP positively affect SCM competences in behavioral process.		0.12	Not supported
He3: The organizational benefits of ERP positively affect SCM competences in behavioral process.		-0.07	Not supported

CHAPTER 6

DISCUSSION OF STRUCTURAL EQUATION MODEL AND HYPOTHESES TESTING RESULTS

The main objective of this study is to investigate the relationship between ERP benefits and SCM competencies. The findings show how ERP benefits impact on SCM competencies. Table 5.5 summarizes the results of multiple regression, and Figure 5.1 shows the results of the structural equation model (SEM). The results of the two methods are nearly all consistent, and some interesting propositions thereby suggest themselves.

6.1 The Impact on the Operational Process

There are six items in the operational process of the SCM construct (Table 4.2). The regression results (Table 5.5) strongly support the hypotheses Ha1, Hb1, Hc1 ($0.20^{***\,+}$, 0.32^{***}, 0.21^{***}), and the SEM results (Figure 5.1) —the hypotheses Ha1, Hb1, Hc1— are also supported ($0.12^{**\,\&}$, 0.34^{***}, 0.21^{***}), demonstrating that SCM competencies in the operational process are positively impacted by operational, managerial, and strategic benefits of ERP (Table 5.5). Especially, the high beta coefficients of some items, such as relevance (SOP1, 0.30), responsiveness (SOP2, 0.33), and supplier management (SOP6, 0.34), mean that the construct of managerial ERP benefits is the dominant predictor for SCM competencies in the operational process. Besides, both regression and SEM results show that the impact of IT infrastructure and organizational benefits (Hd1, He1) are not significant. Both results can be interpreted to mean that operational, managerial, and strategic benefits of ERP enhance SCM competencies

---

[+] ***:beta coefficient is significant at $p < .001$; **: $p < .01$; *: $p < .05$

[&] ***:path coefficient is significant at $p < .001$; **: $p < .01$; *: $p < .05$

in the operational process.

6.2 The Impact on the Planning and Control Process

There are six items in the planning and control process of the SCM construct (Table 4.2). From the regression results (Table 5.5) it can be concluded that the hypotheses Ha2, Hb2, Hc2 are strongly supported (0.24^{***}, 0.24^{***}, 0.45^{***}), and from the SEM results (Figure 5.1), that the hypotheses Ha2, Hb2, Hc2 are also supported (0.25^{***}, 0.28^{***}, 0.48^{***}), demonstrating that SCM competencies in the planning and control process are positively impacted by the operational, managerial, and strategic benefits of ERP. Especially, the strategic benefit of ERP is the most dominant predictor for SCM competencies in the planning and control process, because the beta coefficients of some items are high, such as information management (SPCP1, 0.41), internal communication (SPCP2, 0.50), connectivity (SPCP3, 0.38), collaborative forecasting and planning (SPCP4, 0.37), and functional assessment (SPCP5, 0.31). Just as with the construct of the operational process, both regression and SEM results show that the impact of IT infrastructure and organizational benefits (Hd2, He2) are not significant. Both results can be interpreted as indicating the operational, managerial, and strategic benefits of ERP enhanced SCM competencies in the planning and control process.

6.3 The Impact on the Behavioral Process

There are five items in the behavioral process of the SCM construct (Table 4.2). The regression results (Table 5.5) support the hypotheses Hb3, Hc3 (0.26^{***}, 0.30^{***}), and in the SEM results (Figure 5.1), the hypotheses Hb3, Hc3 are also supported (0.19^{***}, 0.26^{***}), demonstrating that the managerial and strategic benefits of ERP have the most impact on SCM competencies in the behavioral process. Both regression and SEM results indicate that the organizational benefit of ERP (He3) is not a significant predictor of the behavioral process.

CHAPTER 7

CONCLUSIONS AND REMARKS

This chapter provides (1) Conclusions and discussion, (2) Summary of research findings and major contributions for implications for practitioners, (3) Limitations of the research and recommendations for future research.

7.1 Conclusions and Discussion

The purpose of this paper was to propose and test a model of the relationship between the benefits to Taiwanese IT industries of their adoption of ERP systems and their impacts on SCM competencies. A number of important findings emerge that have both theoretical and managerial implications.

7.1.1 The operational, managerial, and strategic benefits are significant predictors for the SCM

A significant contribution of this study is the empirical test of theoretical assumptions in the extant literature of the influence of ERP benefits on SCM competencies. It confirms that of the five constructs of ERP benefits, the three that positively impact on SCM competencies are operational, managerial, and strategic benefits. This finding underscores the important role an ERP system plays in the functioning of supply chain organizations. The unequivocally positive results are not surprising, yet differ from those of most other studies, such as Hitt et al. (2002), Akkermans et al. (2003), Hendricks et al. (2007), and McAfee (2002). Three possible explanations for the remarkable finding are as follows:

1. Manpower and knowledge background of the Taiwanese IT industry

Much of Taiwanese IT firms' technology, and a considerable proportion of their knowledge, were transferred from the U.S. (Chow et al., 2008), Europe, and Japan. As we know, the United States and European countries have always been leaders in applying information systems. Moreover, a considerable number of Taiwanese IT firms' managers have been educated, worked, or trained in the U.S. (Chow et al., 2008), Europe, or Japan, and have obtained first-hand experience of using ERP systems or observed the adoption of these systems in those industrialized countries. Accordingly, the experience and knowledge background of those managers may contribute to the adoption of ERP systems.

2. The center-to-satellite network structure of the Taiwanese IT industry

In terms of size, many of Taiwan's semiconductor manufacturers or electronics firms are large enterprises. TSMC, UMC, Foxconn, Acer, and ASUS are typical examples. Nevertheless, some Taiwanese IT firms are small and medium-size enterprises (SMEs). The scale of manufacturing SMEs in Taiwan is smaller than of those in the United States (U.S. manufacturing SMEs typically have up to 1000 employees). No matter the size of those IT firms, their customers include such well-known large European and American companies as Intel, IBM, Apple, Dell, HP, Compaq, and Nokia. In contrast, the vast majority of the suppliers of those Taiwanese IT companies are SMEs. The manufacturing SMEs in Taiwan, however, have strong networks, and play an important role for much larger organizations within their multiple supply chains. Consequently, those SMEs operate in a satellite-type network structure around the larger Taiwanese IT companies. The success of the center-to-satellite network structure has greatly enhanced the competitiveness of Taiwanese IT manufacturers (Chen et al., 2008).

For large Taiwanese IT firms, ERP systems have been successfully used as the internal integration tool to centralize IS, which are often at multiple locations. In addition to internal process integration, the scope of systems integration has extended to collaborative supply chains partnerships, where suppliers are typically represented by SMEs. In order to facilitate information transmission and communication with partners, those SMEs (IT firms or upstream/downstream parts suppliers and satellite factories) have also adopted ERP systems or information systems. The systems thus satisfy the needs of large foreign customers to stay in close touch with their parts and components suppliers, and enhance overall supply chain performance. Furthermore, the government of Taiwan has systematically commissioned international firms to assist domestic manufacturers to adopt ERP systems. The MOEA's (Ministry of Economic Affairs, R.O.C.) Project A is one such example. Satisfying the needs of customers and responding to the requirements of globalization and SCM thus inevitably becomes part of system specifications during the assessment, selection, and adoption stages. As a result, the enterprises in the supply chain not only have effective integrated processes within a business, but also have synchronization of the operations of all partners in the supply chain. That is, ERP implementations in these Taiwanese companies have a significant impact on other companies, both large and small, within the global supply chain.

3. Effectiveness of system adoption

The informatization of Taiwanese large and medium-size IT firms makes them a model for the country's other firms and industries. Although the adoption of ERP systems at big firms is a relatively large and complex undertaking, the adequate budgeting and relatively good consulting, talent, and technical support resources at such firms work to good effect (Chen, et al., 2008). On the other hand, the experts consulted for this study mentioned that since many small firms previously were poorly informatized, they have little historical burden during the adoption process, making system adoption much simpler than at large firms. These small firms invariably embark on a full-scale upgrading campaign when they decide to deploy a new system, and can often rely on consulting and assistance from their larger customers. In other words, the less well established a firm is in IS/ES/ERP, the less it will be locked in into its existing information infrastructure, and the more beneficial will be its use of ERP. Another possible issue is that while early adopters may have received some competitive advantages, late ones generally have benefited from upgraded systems and a better implementation knowledge base (Mabert et al., 2003b). For these reasons, small firms can also achieve excellent

IS/ES/ERP system effectiveness, which enables them to significantly enhance their SCM capabilities. As reported in Mabert et al. (2003b), companies of different sizes approach ERP implementations differently across a range of issues. The benefits differ by company size. Larger companies report improvements in financial measures, whereas smaller companies report better performance in manufacturing and logistics.

To sum up, the comments from the follow-up interviews and the analysis of data brought out the fact that the operational cost was reduced for those Taiwanese IT firms that adopted an ERP system, probably because of the process improvement, which in turn is a result of better information flow among all of the entities in the supply chain. Better information flow leads to cycle time reduction, since, apart from the internal functions improvements, the supply chain will be better equipped to answer customers' real-time demands. Answering real-time demands in turn leads to an overall increase of productivity, and of product and delivery quality. Furthermore, such firms strip redundancy and duplication of materials from supply chain operations. The managerial benefits of ERP, which include better resource management and improved decision making and planning, performance improvement, partnership management, scheduling, and quality management, are (with a path coefficient of .34) the most important factors impacting the operational process of SCM. For example, they now know how many material and service suppliers to include in synchronized operations. Moreover, strategic benefits of ERP, which include building external linkages and extending the value chain, improve those firms' ability to make important integration decisions.

7.1.2 The IT infrastructural and organizational benefits are not significant predictors of SCM

Another important finding is that IT infrastructural and organizational benefits of ERP do not directly impact SCM competencies. The comments from the follow-up interviews suggest two possible explanations for this finding:

1. The need for flexible management and further system modifications

According to a prominent consulting company that responded to this study, compared to the relationships between consultants and managers in large companies, which are mostly contractual, project-based, and formal, the relationships between consultants and owner-managers in SMEs are mostly friendly, informal, and trust-based. As the experts mentioned, Taiwanese IT firms' internal operations were sometimes excessively flexible during that time when their level of informatization was still low. While flexible management may have led to administrative complexity, it may also have enabled these firms to satisfy their customers' varied needs. For instance, Taiwan's Notebook PC manufacturers have had to flexibly adjust or even eliminate many relevant time-consuming management steps in order to fulfill such nearly-impossible customer demands as Dell's 973 and 982 shipment policies (973 requires shipment of 97% of orders within three days; the current 982 policy requires shipment of 98% of orders within two days). It has often been necessary to flexibly schedule employee overtime in order to fill orders on time. While this flexible approach to management has certainly resolved many short-term problems in the face of growing competition and increasingly exacting demands, it is gradually cracking under the burden it must withstand.

Nevertheless, many firms expect to retain a certain degree of flexibility and some of their past habits after adopting an ERP system, even when such flexibility entails tax issues. In particular, SMEs with relatively fluid organization structure and dynamic strategic planning seek greater flexibility. Although ERP software is a holistic solution with pre-existing modules and functions, many Taiwanese firms have also emphasized keeping modifications to the source code to a minimum. Those companies — perhaps for the reasons discussed above — demand a degree of system modification during the adoption stage greater than that sought by European and American firms. As reported in Bennet and Robson (2002), although over 95% of SMEs use external advice, some owners strongly believe they know their business very well. This makes them very skeptical about new advice from external sources. Researchers agree that the role of the negotiation process for management consultants working with SMEs is more important and challenging than it is in large companies (Dalley and Hamilton, 2000; Chen et al., 2008). Because the integrative design of ERP systems increases the complexity involved in source code modifications, however, most companies significantly underestimate the effort required for modifications. Modifications not only lead to increased costs and implementation times; they also make further upgrades of the system difficult (Mabert et al., 2003a, 2003b).

This study's analysis of IT infrastructure and organizational performance makes it clear that these two benefits of ERP do not have positive impacts on corporate SCM competencies, and some items may even have a negative effect on SCM. While this finding is somewhat at odds with the results presented in the literature review, it is not surprising. As some studies in the literature have noted, organizational collaboration and information sharing, in turn, are expected to improve organizational performance. The complexity of organizational collaboration and investing in information technologies may facilitate it (Sanders, 2007). Insufficient managerial capabilities, strategic change and complexity, and excessively flexible operating control procedures may, however, cause management complexity and wasted time at SMEs (Bennett and Smith, 2004; Riemenschneider et al., 2003). In addition, the initial confusion that ensues after a new system's adoption may temporarily obscure many of the system's benefits. The literature includes suggestions that the time factor be taken into consideration when assessing the effect of ERP system adoption on corporate performance (Hendricks et al., 2007; Hitt et al., 2002; McAfee, 2002; Mabert et al., 2003a).

2. The impact of the Chinese market

It deserves to be mentioned that as SMEs globalize, Taiwanese SMEs unite against foreign competitors, and have made aggressive outbound investments in Southeast Asia and China. As the roles of Asian nations in the world economy grow, especially those of China and the other BRIC countries (Brazil, Russia and India), the substantial impact of Taiwan's SMEs on the Pacific region is increasing (Chen et al., 2008). Taiwanese IT firms also have moved most if not all of their production sites to China, and these companies are, in fact, among the major behind-the-scenes drivers of China's status as "the world's workshop." Nevertheless, as many multinational firms have noted, many systems in the newly-opened China market are either ineffective or at variance with international practice. The best-known examples involve China's tax procedures. Firms with plants in China that wish to use the same information system or ERP system to handle tax matters often encounter the dilemma of contradictory specifications.

The differences between the data from Western countries and Taiwanese data suggest different managerial perceptions of how ERP benefits impact SCM competencies or firm performance. More important, they suggest that perceptions of how these components influence SCM competencies may be affected by different worldviews and, perhaps, international cultural differences. Thus, the association between supply chain components and organizational performance may differ_according to place. As a result, in view of the legal system, organizational culture, and habits prevailing in China, it is not surprising that ERP-based IT infrastructure and organization have little short-term positive effect on SCM competencies.

Last, this study found that three of the five benefits of ERP have a positive impact on SCM competencies, while the remaining two benefits have no positive effect. When the study questionnaire asked whether it would be feasible for a firm to adopt a specialized SCM system in order to improve supply chain management instead of first adopting an ERP system, however, more than 80% of respondents felt that it was necessary to first adopt an ERP system to serve as a corporate information framework before the deployment of other corporate information systems (such as an SCM system) could achieve the desired effect. Accordingly, our research result is also consistent with the literature (Mabert et al., 2001), and supports the finding that the ERP system can successfully become the backbone of company operations in the new economy. It is neither a myth nor merely imitative behavior. The immediate and current issue for IT managers is less whether to adopt an ERP system and more how to best plan that adoption so that firm and supply chain performance are enhanced.

7.2 Major contributions to the academic community and its implications for practitioners

The results of this study have several important implications for practitioners. Primarily, as today's competition shifts from among organizations to between supply chains, organizations are increasingly adopting ERP systems, aiming to enhance their SCM competencies, reduce SCM costs, and secure competitive advantage. However, doubts linger over the potential effectiveness of ERP systems. The findings of this study confirm that adopting an ERP system is indeed an effective competitive strategy, and that implementation of an ERP system strongly impacts a firm's SCM competencies.

Secondly, this study defines the five constructs of ERP benefits and three constructs of SCM competencies, to determine which aspects actually have a substantive impact on SCM competencies. The study discovered that among the operational, managerial, and strategic benefit areas of implementing ERP, the strategic benefits were the strongest, managerial benefits were second and operational benefits were third. No significant impacts were noted for IT infrastructure and organizational benefits areas. From the results, we recommend that it would be best to choose an ERP system to serve as the backbone of enterprise systems and to raise firm competencies of SCM. Whether to implement an SCM system or other ES depends on the budget of the enterprise. No matter whether an SCM system or other ES is called for, these must be built on the integrated and real-time information collected by an ERP system. Only then will the benefits of the system be fully achieved. Moreover, when selecting ERP modules, priority should be given to operational functionality, followed by managerial and strategy related modules. Although our research results reveal that operational benefits rank third in terms of greatest impact, because operational functions collect transaction processing data that then serve as the base data for all modules, the introduction of ERP modules with operational functionality should take precedence.

Thirdly, this study noted the expensive cost of ERP systems. But analyzing the scale of enterprises surveyed for this study, notes that a high rate (around 70%) of SMEs (capitalized under 100M USD) implement ERP systems. With the lowering of the cost-benefit ratio for such software, frequent functionality updates, low cost of localized ERP systems and multinational software vendors implementations among larger corporations reaching the saturation point in market trends, the numerous advantages afforded by streamlined solutions for SMEs add up to a considerable incentive for SME-scale enterprises to implement ERP systems.

Fourthly, in the case of the Taiwan IT industry, when recommending that an enterprise implement ERP, improving the user interface can help raise the enterprise's acceptance of new software, when it's inappropriate to request substantial system modifications of the software vendor. This can also reduce future complexities of system upgrades and generally raise the effectiveness of implementations.

7.3 Limitations of the Research and Recommendations for Future Research

The study developed ways of measuring ERP benefits' impact on the SCM competencies model. Although validity and reliability checks were performed on the measurements, if we can use more measurements for firm competencies drawn from the ERP software or consultant companies, instead of self-reporting by the firms, the results will be more convincing. The limitation is that it seems that most of the consultant companies either did not keep records or did not trace back or evaluate the firm's performance after the project was finished.

Future research based on the results of this study could integrate financial data of the surveyed enterprises, analyzing how much Taiwanese IT firms invested in IT software as a percentage of their total turnover, to enable more accurate analysis of the size of the firms, the amount invested in IT software, the SCM competencies, and the firm performance. As well as, could perform a comparative analysis of the effect on performance of adoption of an ERP system alone, adoption of an SCM system alone, and simultaneous adoption of both system types. Furthermore, while the sample consisted of Taiwanese IT industry companies, it might be better to collect data from IT industry companies of other countries, such as Korea, Singapore, and China.

REFERENCES

Ahire, S. L., Golhar, D. Y., and Waller, M. A. (1996), "Development and validation of TQM implementation constructs", *Decision Sciences*, 27(1), 23-56.

Akkermans, H. A., Bogerd , P., Yucesan, E., and van Wassenhove, L. N. (2003), "The impact of ERP on supply chain management: exploratory findings from a European Delphi study", *European Journal of Operational Research*, 146 (2), 284-301.

Akyuz, G.A. and Rehan, M. (2009), "Requirements for forming an 'e-supply chain'", *International Journal of Production Research*, 47(12), 3265-3287.

Al-Mashari, M., Al-Mudimigh, A., and Zairi, M. (2003), "Enterprise resource planning: a taxonomy of critical factors", *European Journal of Operational Research*, 146(2), 352-364.

Anderson, J. C. and Gerbing, D. W. (1988), "Structural Equation Modeling in Practice: a Review and Recommended Two-step Approach", *Psychological Bulleting*, 103, 411-423.

Anderson, J. C. and Gerbing, D. W. (1991), "Predicting the performance of measures in a confirmatory factor analysis with a pretest assessment of their substantive validities," *Journal of Applied Psychology*, 76(5), 732-741.

Barney, J. (1991), "Firm resources and sustained competitive advantage", *Journal of Mannagement*, 17, 99-120.

Bendoly, E. and Schoenherr, T. (2005), "ERP system and implementation-process benefits: implications for B2B e-procurement", International Journal of Operations and Production Management, 25(4), 304-319.

Bendoly, E. and Jocobs, F.R. (2005), Strategic ERP extensions and use, Stanford, California: Stanford University Press.

Bennet, R. and Robson, J. (2002), "The small business service: business support, use, fees and satisfaction: econometric estimates", *Centre for Business Research Working Paper Series*, WP 181, University of Cambridge, Retrieved July 20, 2008 from http://www.econ.cam.ac.uk/cgi-bin/cbr_wp3.pl?conf_file=cbr.conf&terms=bennet&series=cbrwps&criteria=All&boolean=AND&case=Insensitive.

Bennett, R. J. and Smith, C. (2004), "The selection and control of management consultants by small business clients", *International Small Business Journal*, 22(5), 435-462.

Benton, W. C. and Maloni, M. (2005), "The influence of power driven buyer/seller relationships on supply chain satisfaction", *Journal of Operations Management*, 23(1), 1-22.

Biehl, M. (2005), "Selecting internal and external supply chain functionality – the case of ERP systems versus electronic marketplaces", *Journal of Enterprise Information Management*, 18(4), 441-457.

Bollen, K. A. (1989), Structural equations with latent variables, New York: Wiley.

Bowersox, D. J. and Closs, D. J. (1996), Logistical Management: The Integrated Supply Chain Process, McGraw-Hill.

Bowersox, D. J., Closs, D. J., and Stank, T. P. (1999), 21st century logistics: Making supply chain integration a reality, Oak Brook, IL: Council of Logistics Management.

Browne, M. W. and Cudeck, R. (1993), Alternative Ways of Assessing Model Fit, In Bollen, K. A. and Long, J. S. (Eds.), Testing Structural Equation Models (pp. 445-455), Sage Publication, Newbury Park, CA.

Browne, M. W. and Cudeck, R. (1992), "Alternative ways of assessing model fit", *Sociological Methods and Research*, 21(2), 230-258.

B'urca, S., Fynes, B., and Marshall, D. (2005), "Strategic technology adoption: extending ERP across the supply chain", *The Journal of Enterprise Information Management*, 18(4), 427-440.

Byrd, T. A. and Davidson, N. W. (2003), "Examining possible antecedents of IT impact on the supply chain and its effect on firm performance", *Information & Management*, 41(2), 243-255.

Byrne, B. M. A. (1989), Primer of LISEREL: Basic applications and programming for confirmatory factor analytic model. New York, NY: Springer-Verlag.

Chang, C. Y. and Yu, P. L. (2001), Made by Taiwan: Booming in information technology era. Singapore: World Scientific Publishing.

Chen, R., Sun, C., Helms, M. M., and Jih, W. (2008), "Role negotiation and interaction: An exploratory case study of the impact of management consultants on ERP system implementation in SMEs in Taiwan", *Information Systems Management*, 25(2), 159-173.

Chin, W. W. (1998), Partial least squares approach to structural equation modeling. In: G. A. Marcoulides (ed.), Modern Methods for Business Research. Mahwah, NJ: Lawrence Erlbaum Associates, 295-336.

Chow, W. S., Madu, C. N., Kuei, C., Lu, M. H., Lin, C., and Tseng, H. (2008), "Supply chian management in the US and Taiwan: An empirical study", *The international Journal of Management Science, Omega*, 36(5), 665-679.

Christopher, M. (1998), Logistics and Supply-Chain Management: Strategies for Reducing Cost and Improving Service, Prentice-Hall, London.

Churchill, G. A. A. (1979), "Paradigm for developing better measures of marketing constructs", *Journal of Marketing Research*, 16(3), 64-73.

Cleveland, G., Schroeder, R.G., and Anderson, J.C. (1989), "A theory of production competency", *Decision science*, 20(4), 655-668.

Closs, D. J. and Mollenkopf, D. A. (2004), "A global supply chain framework", *Industrial Marketing Management* , 33(1), 37-44.

Cohen, J. A. (1960), "A coefficient of agreement for nominal scales", *Educational and Psychological Measurement*, 20(1), 37-46.

Croom, S., Romano, P., and Giannakis M. (2000), "Supply chain management: An analytical framework for critical literature review", *European Journal of Purchasing and Supply*

Management, 6(1), 67–83.

Cooper, M. C., Lambert, D. M., and Pagh, J. D. (1997), "Supply chain management: more than a new name for logistics", *The International Journal of Logistics Management*, 8(1), 1-13.

Cox, A., Sanderson, J., and Watson, G. (2000), "Wielding Influence", *Supply Chain Management*, 57(7), 30-33.

Cronbach, L. J. (1951), "Coefficient Alpha and the Internal Structure of Tests", *Psychometrika*, 16(3), 297-335.

Dalley, J. and Hamilton, B. (2000), "Knowledge, context and learning in the small business", *International Small Business Journal*, 18(3), 51-59.

Davenport, T. H. and Brooks, J. D. (2004), "Enterprise systems and the supply chain", *Journal of Enterprise Information Management*, 17(1), 8-19.

Dhillon, G. (2005), "Gaining benefits from IS/IT implementation: Interpretations from case studies", *International Journal of Information Management* , 25(6); 502-515.

Dobler, D. W. and Burt, D. N. (1996), Purchasing and supply management: Text and cases. (6th edition). New York, NY: McGraw-Hill.

Du, L. (2007), "Acquiring competitive advantage in industry through supply chain integration: a case study of Yue Yuen industrial holdings Ltd.", *Journal of Enterprise Information Management*, 20(5), 527-543.

Dunn, S. C., Seaker, R. F., and Waller, M. A. (1994), "Latent variables in business logistics research: Scale development and validation", *Journal of Business Logistics*, 15(2); 145-172.

Ehie, I. C. and Madsen, M. (2005), "Identifying critical issues in enterprise resource planning (ERP) implementation", *Computers in Industry*, 56(6), 545-557.

Ellram, L. M. (1990), "The Supplier Selection Decision in Strategic Partnerships", *Journal of*

Purchasing and Materials Management, 26(4), 8–14.

Ellram, L. M. (1991), "Supply chain management: the industrial organization perspective", *International Journal of Physical Distribution and Logistics Management*, 21(1), 13-22.

Fine, C. H. (1998), Clockspeed: Winning industry control in the age of temporary advantage. Perseus Books, Boulder.

Fornell, C. and Larcker, D. F. (1981), "Evaluating structural equation models with unobservable variables and measurement error", *Journal of Marketing Research*, 18(1), 39-50.

Gattiker, T. F. and Goodhue, D. L. (2004), "Understanding the local-level costs and benefits of ERP through organizational information processing theory", *Information & Management,* 41(4), 431-443.

Gerbing, D. W. and Anderson, J. C. (1988), "Evaluating structural equation methods, Number of indicators per factor, and improper solutions on structural equation modeling fit indices", *Structural Equation Modeling*, 2(2), 119-144.

Giannocearo, L. and Pontrandolfo, P. (2002), "Inventory management in supply chains: A reinforcement learning approach", *International Journal of Production Economics*, 78(2), 153-161.

Guha, S., Grover, V., Kettinger, W. J. and Teng, J. T. C. (1997)," Business process change and organizational performance: Exploring an antecedent model", *Journal of Management Systems,* 14(1), 119-154.

Gunasekaran, A., Patel, C. and McGaughey, R. E. (2004), "A framework for supply chain performance measurement", *International Journal of Production Economics*, 87(3), 333-347.

Gupta, M. and Kohli, A. (2006), "Enterprise resource planning systems and its implications for operations function", *Technovation*, 26(6), 687-696.

Hair, J. F., Anderson, R. F., Tatham, R. L., and Black, W. C. (1998), Multivariate data analysis.

(5th ed.), Englewood Cliffs, NJ: Prentice Hall.

Harris, S. (1996), Human communication and information systems, NCC Blackwell, Oxford.

Hatcher, L. (1994), A step-by-step approach to using the SAS system for factor analysis and structural equation modelling, Cary, NC: SAS Institute.

Hattie, J. (1985), "Methodology review: Assessing unidimensionality of tests and items", *Applied Psychological Measurement*, 9(3), 139-164.

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,* 25(1), 65-82.

Hitt, L. M., Wu, D. J., and Zhou, X. (2002), "Investment in enterprise resources planning: Business impact and productivity measures", *Journal of Management Information Systems,* 19(1), 71-98.

Ho, C. J. (2007), "Measuring system performance of an ERP-based supply chain", *International Journal of Production Research*, 45(6), 1255-1277.

Hong, K. K. and Kim, Y. G. (2002), "The critical success factors for ERP implementation: an organizational fit perspective", *Information and Management* , 40(1), 25-40.

Hong, P. and Jeong, J. (2006), "Supply chain management practices of SMEs: from a business growth perspective", *Journal of Enterprise Information Management* , 19(3); 292-302.

Hsu, C. C., Tan, K. C., Kannan, V. R., and Keong Leong, G. (2009), "Supply chain management practices as a mediator of the relationship between operations capability and firm performance", *International Journal of Production Research*, 47(3), 835-855.

Huang, S. Y., Lin, C. W., Wong, S. L., and Tsai, M. C. (2007), "The impact of ERP implementation on business performance-an integrated investigation model", *International Journal of Manufacturing Technology and Management*, 12(4), 342-359.

Hunton, J. E., McEwen, R. A., and Wier, B. (2002), "The reaction of financial analysts to enterprise resource planning (ERP) implementation plans", *Journal of Information Systems*, 16(1); 31-40.

Irani, Z. and Love, P. E. D. (2001), “The propagation of technology management taxonomies for evaluating investments in information systems”, *Journal of Management Information Systems* , 17(3), 161-177.

Jain, V., Wadhwa, S., and Deshmukh, S. G. (2009), “Select supplier-related issues in modeling a dynamic supply chain: potential, challenges and direction for future research”, *International Journal of Production Research*, 47(11), 3013-3039.

Jick, T.D. (1979), "Mixing qualitative and quantitative methods: triangulation in accumulation", *Administrative Science Quarterly*, 24(4), 602-611.

Jones, C. (1998), “Moving beyond ERP: Making the missing link”, *Logistics Focus*, 6(7), 2–7.

Joreskog, K. G. and Sorbom D. (1989), LISREL 7 users’ reference guide, Scientific Software Inc., Chicago, IL.

Kalling, T. (2003), “ERP systems and the strategic management processes that lead to competitive advantage”, *Information Resources Management Journal*, 16(4), 46-67.

Kelle, P. and Akbulut, A. (2005), “The role of ERP tools in supply chain information sharing, cooperation, and cost optimization”, *International Journal of Production Economics*, 93-94, 41-52.

King, W. R. and Teo, T. S. H. (1996), “Key dimensions of facilitators and inhibitors for the strategic use of information technology”, *Journal of Management Information Systems,* 12(4), 35-53.

Koh, S. C. L., Saad, S., Arunachalam, S., and Dagenham, U. K. (2006), “Competing in 21st century supply chain through supply chain management and enterprise resource planning integration”, *International Journal of Physical Distribution & Logistics Management* , 36(6), 455-465.

Kovacs, G. L. and Paganelli, P. (2003), “ A planning and management infrastructure for large, complex, distributed projects – beyond ERP and SCM”, *Computers in Industry*, 51(2), 165-183.

Kuei, C. H., Madu, C., and Lin, W. C. C. (2002), “Developing supply chain strategies based on the survey of supply chain quality and technology management”, *International Journal of Quality and Reliability Management*, 19(7), 889-901.

Kumar, S. and Harms, R. (2004), “Improving business processes for increased operational efficiency: a case study”, *Journal of Manufacturing Technology Management*, 15(7), 662-674.

Laframboise, K. and Reyes, F. (2005), “Gaining competitive advantage from integrating enterprise resource planning and total quality management”, *Journal of Supply Chain Management*, 41(3), 49-64.

Lambert, D. M. (2004), “The eight essential supply chain management processes”, *Supply Chain Management Review*, 8(6), 18-27.

Lambert, D. M., Cooper, M. C., and Pagh, J. D. (1998), "Supply chain management: Implementation issues and research opportunities," *International Journal of Logistics Management*, 9(2), 1-20.

Lamming, R. C. (1996), “Squaring lean supply with supply chain management”, *International Journal of Operations and Production Management*, 16(2), 183-196.

Latamore, B. (1999), “ERP in the new millennium”, APICS magazine– The performance Advantage, June, 29-32.

Lee, H. L. and Billington, C. (1993), “Material management in decentralized supply chains”, *Operations Research*, 41(5), 835-847.

Li, S., Ragu-Nathan, B., Ragu-Nathan, T. S., and Rao, S. (2006), “The impact of supply chain management practices on competitive advantage and organizational performance”, *Omega*, 34(2), 107-124.

Lim, D. and Palvia, P. C. (2001), "EDI in strategic supply chain: impact on customer service", *International Journal of information Management*, 21(3), 193-211.

Lummus, R. R. and Vokurka, R. J. (1999), "Defining supply chain management: A historical perspective and practical guidelines", *Industrial Management & Data Systems*, 99(1), 11-17.

Mabert, V. A., Soni, A., and Venkataraman, M. A. (2000), "Enterprise resource planning survey of U.S. manufacturing firms", *Production and Inventory Management Journal*, 41(2), 52-58.

Mabert, V. A., Soni, A., and Venkataramanan, M. A. (2001), "Enterprise resource planning: common myths versus evolving reality", *Business Horizons*, 44(3), 69-76.

Mabert, V. A., Soni, A., and Venkataramanan, M.A. (2003a) "Enterprise resource planning: managing the implementation process", *European Journal of Operational Research*, 146(2), 302-314.

Mabert, V. A., Soni, A., and Venkataramanan, M. A. (2003b), "The impact of organization size on enterprise resource planning (ERP) implementations in the US manufacturing sector", Omega: *The International Journal of Management Science*, 31(3), 235-246.

Markus, M. L. and Tanis, C. (2000), The enterprise systems experience from adoption to success, in: Zmud, R.W. (Ed.), Framing the Domains of IT Research: Glimpsing the Future Through the Past, (Pinnafles Education Rewources Inc., Cincinnati, Oh, 173-207).

Markus, M. L., Tanis, C., and Fenema, P. C. (2000), "Multisite ERP implementations", *Communications of the ACM,* 43 (4), 42-46.

McAfee, A. (2002), "The impact of enterprise information technology adoption on operational performance: an empirical investigation", *Production and Operations Management*, 11(1), 33-53.

McDonald, R. P. (2000), "A basis for multidimensional item response theory", *Applied Psychological Measurement*, 24(2), 99-114

Mentzer, J. T., DeWitt, W., Keebler, J. S., Soonhoong M., Nix, N. W., Smith, C. D., and Zacharia, Z. G. (2001), "Defining supply chain management", *Journal of Business Logistics*, 22(2), 1-25.

Moore, G. C. and Benbasat, I. (1991). "Development of an instrument to measure the perceptions of adopting an information technology innovation", *Information Systems Research*, 2(2), 192-222.

Mullen, M. R. (1995), "Measurement equivalence in cross-national research", *Journal of International Business Studies*, 26(3), 573-596.

Murphy, K. E. and Simon, S. J. (2002), "Intangible benefits valuation in ERP projects", *Information Systems Journal*, 12(4), 301-320.

Nah, E., Lau, J. and Kwang, J. (2001), "Critical factors for successful implementation of enterprise systems", *Business Process Management Journal*, 7(3), 285-296.

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*, 20(3), 303-323.

Nunnally, J. C. (1978), Psychometric theory (2^{nd} ed.). New York, NY: McGraw-Hill.

Park, J. H., Lee, J. K., and Yoo, J. S. (2005), "A framework for designing the balanced supply chain scorecard", *European Journal of Information Systems*, 14(4), 335-346.

Pedhazur, E. J. and Schmelkin, L. P. (1991). Measurement, design, and analysis: An integrated approach. Hillsdale, NJ: Lawrence Erlbaum Associates.

Pentland, B. T. (1989), "Use and productivity in personal computing", Proceedings of the Tenth International Conference on Information Systems. Boston, MA, 211-222.

Perreault, W. D., Jr., and Leigh, L. E. (1989), "Reliability of nominal data based on qualitative judegements", *Journal of Marketing Research*, 26(2), 135-148.

Porter, M. E. (1985), Competitive advantage: Creating and sustaining superior performance, The Free Press, New York.

Raghunathan, B., Raghunathan, T. S., Tu, Q. (1999), "Dimensionality of the strategic grid framework: the construct and its measurement", *Information System Research*, 10(4), 343-355.

Riemenschneider, C. K., Harrison, D. A., and Mykytyn, P. P. (2003), "Understannding IT adoption decisions in small business: integrating current theories", Information & Management , 40(4), 269-285.

Roach, S. (1991), "Services under stage – the restructuring imperative", *Harvard Business Review*, 69(5), 82-90.

Roth, A. V., Marucheck, A. S., Kemp, A., and Trimble, D. (1994)," The knowledge factory for accelerated learning practices", *Planning Review*, 46(1), 26-32.

Rungtusanatham, M., Salvador, F., Forza, C., and Choi, T. Y. (2003), "Supply chain linkage and operational performance, a resource-based view perspective", *International Journal of Operations and Production Management*, 23(9), 1084–1099.

Rust, R. T., and Cooil, B. (1994), "Reliability measures for qualitative data: Theory and implications", *Journal of Marketing Research*, 31(1), 1-14.

Samaranayake, P. and Toncich, D. (2007), "Integration of production planning, project management and logistics systems for supply chain management", *International Journal of Production Research*, 45(22), 5417-5447.

Sampler, J. L. (1998), "Redefining industry structure for the information age", *Strategic Management Journal,* 19(4), 343-355.

Sanders, N. R. (2007), "An empirical study of the impact of e-business technologies on organizational collaboration and performance", *Journal of Operations Management*, 25(6), 1332-1347.

Sawy, O. A. E., Malhotra, A., Gosain, S. and Young, K. M. (1999), "IT intensive value innovation in the electronic economy: Insights form Marshall industries", *MIS Quarterly,* 23(3), 305-335.

Segars, A. H. and Grover, V. (1998), "Strategic information of the construct and its measurement", *MIS Quarterly*, 22(2), 139-163.

Segars, A. H., Grover, V., and Teng, J. T. C. (1998), "Strategic information systems planning: Planning system dimensions, internal coalignment, and implications for planning effectiveness", *Decision Sciences*, 29 (2), 303-345.

Shang, S. and Seddon, P. B. (2000), "A comprehensive framework for classifying the benefits of ERP systems", Proceedings of the Sixth Americas Conference on Information Systems. Long Beach, CA, 1005-1014.

Simchi-Levi, D., Kaminsky, P., and Simchi-Levi, E. (2000), Designing and managing the supply chain, 1st Ed., Irwin McGraw-Hill, New York, NY.

Sinkovics, R. R. and Roathe, A. S. (2004), "Strategic orientation, capabilities, and performance in manufacturer-3PL relationships", *Journal of Business Logistics*, 25(1), 43-64.

Stalk, G., Evans P., and Shulman, L. E. (1992), "Competing on capabilities: The new roles of corporate strategy", *Harvard Business Review*, 70(2), 57-69.

Stank, T. P., Davis, B. R., and Fugate, B. S. (2005), "A strategic framework for supply chain oriented logistics", *Journal of Business Logistics*, 26(2), 27-45.

Stapleton D., Hanna J. B., and Ross, J. B. (2006), "Enhancing supply chain solutions with the application of Chaos theory", *Supply Chain Management,* 11(2), 108-114.

Stern, L. and Reve, T. (1980), "Distribution channels as political economies: A framework for competitive analysis", *Journal of Marketing*, 44(1), 52–64.

Stock, G. N., Greis, N. P., Kasarda, J. D. (2000), "Enterprise logistics and supply chain structure: the role of fit", *Journal of Operations Management*, 18(6), 531-547.

Strassman, J. K. (1990), The business value of computers. New Canaan, CT: Economics Press.

Stratman, J. K. and Roth, A. V. (2002), "Enterprise resource planning (ERP) competency constructs: Two-stage multi-item scale development and validation", *Decision Science*, 33(4), 601-628.

Tan, K. C., Lyman, S. B., and Wisner, J. D. (2002), "Supply chain management: A strategic perspective", *International Journal of Operations and Production Management*, 22(6), 14–631.

Tarafdar, M. and Gordon S. R. (2007), "Understanding the influence of information systems competencies on process innovation: A resource-based view", *Journal of Strategic Information Systems*, 16(4), 353-392.

Themistocleous, M., Irani Z. and O'keefe, R. M. (2002), "Enterprise applicationiIntegration: An emerging technology for integrating ERP and supply chain", *EXIS 2002* (Gdansk, Poland).

Themistocleous, M., Irani, Z., and Love, P.E.D. (2004), "Evaluating the integration of supply chain information systems: a case study", *European Journal of Operational Research*, 159(2), 393-405.

Thomas, J. (1999), "Why your supply chain doesn't work", *Logistics Management and Distribution Report*, 38(6), 42-44.

Tinsley, H. E. and Tinsley, D. J. (1987), "Use of factor analysis in counseling psychology research", *Journal of Counseling Psychology*, 34(4), 414-424.

Van Hoek, R., Commandeur, H. and Vos, B. (1998), "Reconfiguring Logistics Systems through Postponement Strategies", *Journal of Business Logistics*, 19(1), 33-54.

Verville, J. and Halingten, A. (2003), “Information searches: a two-dimensional approach for ERP acquisition decision”, *Journal of Information Science,* 29(3), 203-209.

Venkatesh, V. (2006), “Where to go from here? Thoughts on future directions for research on individual-level technology adoption with a focus on decision making”, *Decision Science*, 37(4), 497-518.

Vemuri, K. V. and Shailendra, C. P. (2006), “Improvement in operational efficiency due to ERP systems Implementation: Truth or myth?” *Information Resources Management Journal* , 19(2), April-June, 18-36.

Vickery, S. K., Droge, C., and Markland, R. E. (1993), “Production competence and business strategy: do they affect business performance?” *Decision Sciences*, 24(2), 435-455.

Wade, M. and Hulland, J. (2004), “The resource-based view and information systems research: review, extension, and suggestions for future research”, *MIS Quarterly*, 28(1), 107-142.

Wallace, T. F. and Kremzar, M. H. (2001), ERP: Making it Happen (The implementer’s Guide to Success with Enterprise Resource Planning), Wiley, New York, p.5.

Wang, E. T. G., Tai, J. C. F., and Wei, H. L. (2006), “A virtual integration theory of improved supply-chain performance”, *Journal of Management Information Systems*, 23(2), 41-64.

Whit, A., Eaniel, E. M., and Mohdzain, M. (2005), “The role of emergent information technologies and systems in enabling supply chain agility”, *International Journal of Information Management*, 25(5), 396-410.

Williams, L. J. and Hazer, J. T. (1986), “Antecedents and consequences of satisfaction and commitment in turnover models – A reanalysis using latent variable structural equation methods”, *Journal of Applied Psychology*, 71(2), 219-231.

Williamson, O. (1975), Markets and hierarchies: Analysis and antitrust implications, The Free Press, New York, NY.

Yang, C., and Chen, L. (2007), "Can organizational knowledge capabilities affect knowledge sharing behaviour?" *Journal of Information Science,* 33(1), 95-109.

Zrimsek, B. (2003), II vision. US symposium/ITxpo, 23-27, Gartner Research (25C, SPG5, 3/03), SanDiego.

Zsidisin, G. A., Ellram, L. M., and Ogden, J. (2003), "The relationship between purchasing and supply management's perceived value and participation in strategic supplier cost management activities", *Journal of Business Logistics,* 24(3), 129-154.

Council of Supply Chain Management Professionals, www.cscmp.org.

Foxconn. Retrieved July 15, 2008 from http: //www.foxconn.com.tw/GlobalFootprint.htm.

Industry & Technology Intelligence Services (ITIS), MOEA. Retrieved July 15, 2008 from http://itisweb3.itis.org.tw/itisppt/Freeppt/slide.aspx?pre_id=1256

Britain's Economist Intelligence Unit (EIU). Retrieved July 15, 2008 from http: //countryanalysis.eiu.com/country_reports

Appendix

Questionnaire:

Benefits of adopting ERP systems

(Responses are given on a seven-point Likert scale, according to the opinion of the respondent, where 1=Strongly Disagree, 4=Neither agree nor disagree, 7=Strongly agree).

A - Operational benefits:

1. My firm has better control of business operating expenses and decreased operations cost after adopting ERP system.
2. My firm has reduced production cycle times and increased inventory turns.
3. My firm has increased power user involvement by user training for operational tasks
4. My firm has improved quality management and control.
5. My firm meets customer needs proactively and more efficiently.
6. My firm has less time and fewer errors in order process.

B - Managerial benefits:

1. My firm increased the capability of tailoring products to meet specific needs of customer, and improving resource management to support customization.
2. My firm has more effective decision making by workers.
3. . My firm's ERP system has increased delivery flexibility
4. My firm's ERP system has reduced ordering and invoice complexity
5. My firm has increased partnership with customer and vendor by information sharing.
6. My firm has improved quality management and quality control.

C - Strategic benefits:

1. My firm has supported for business growth.
2. My firm has supported for business alliance.

3. My firm increased the capability of building business innovations and absorb radical change routinely
4. My firm has built cost leadership by reducing inventory-carrying cost and lower labor cost.
5. My firm has generated product differentiation including customization.
6. My firm has built external linkages to have better connectivity with customer and supplier.

D – IT infrastructural benefits:

1. My firm has built business flexibility for current and future changes.
2. My firm has reduced in cost of maintaining legacy systems.
3. My firm has increased IT infrastructure capability.
4. My firm has integrated and has real time to effectively support information.
5. My firm has standard procedures across different locations.
6. My firm has presented a single interface to customer and has consolidated multiple different systems of the same type.

E – Organizational benefits:

1. My firm has changed organizational management processes in breadth and broader horizon.
2. My firm has facilitated organizational learning and training for access of enterprise information.
3. My firm has training for decision making skills and worker empowerment for taking actions.
4. My firm has built common vision.
5. My firm has better employee morale and satisfaction.
6. My firm has related to support organizational changes.

F - Synthesis:

1. ERP system has fulfilled your firm's motives/ or needs for adopting it.

   □Yes □ No

2. ERP system has enhanced the firm performance of SCM? □ Yes □ No

3. Please rate your firm's performance of adopting ERP system relative to competitors. □ (where 1= Worst than competitors, 4 = Comparable with competitors, 7 = Better than competitors)

Firm competency of SCM after adopting ERP systems

(Responses are given on a seven-point Likert scale, according to the opinion of the respondent, where 1=Strongly Disagree, 4=Neither agree nor disagree, 7=Strongly agree).

A – Operational process perspective:

1. My firm has increased product quality and customer's product return rate.
2. My firm has improved responsiveness to urgent order.
3. My firm is being expanded to reflect more enterprise wide integrated processes.
4. My firm has established the cross-functional policies and procedures to facilitate synchronous operations.
5. My firm streamlines ordering, receiving and other paperwork from suppliers.
6. My firm is able to handle difficult nonstandard orders.

B – Planning and control process perspective:

1. My firm is able to facilitate supply chain resource allocation through seamless transactions across the total order-to-delivery cycle.
2. My firm is able to exchange information between our trading partners and us in a timely, responsive, and usable format.
3. My firm collaborates in forecasting and planning with partners.
4. My firm collaborates to develop shared visions and mutual commitment to jointly generated action plans.

5. My firm has continuous quality improvement program.
6. My firm is able to develop comprehensive functional performance measurement capability.

C –Behavioral Process perspective:

1. My firm has increased customer response time and percentage of resolving customer's first call
2. My firm has kept maintenance and modification of customer focus to continuously match changing expectations.
3. My firm has developed of a common vision of the total value creation process and planning clarity concerning shared responsibility.
4. Our trading partners respect the confidentiality of the information they receive from us.
5. Our trading partners have willingness to exchange key technical, financial, operational, and strategic information.

E - Synthesis:

1. SCM competency was not impacted by ERP system? □ Yes □ No.
2. Is it necessary to adopt ERP system to enhance the firm performance of SCM? □ where 1=Strongly Disagree, 4=Neither agree nor disagree, 7=Strongly agree.
3. My firm is able to provide operational managers with sufficient and timely information to manage logistical activities. □ where 1=Strongly Disagree, 4=Neither agree nor disagree, 7=Strongly agree.

General Information about your firm

1. Has your organization embarked upon a program aimed specially at implementing an Enterprise Resource Planning (ERP) system? □ Yes □ No.

   If your answer is Yes, how long? _____ years.

2. Has your organization embarked upon a program aimed specially at implementing an Supply Chain Management (SCM) system? □ Yes □ No.

   If your answer is Yes, how long? ______ years.

3. Number of employees in your company:

   □ 1-100 □ 101-500 □ 501-1000 □ 1001-2000 □ Over 2000

4. Your present job title:

   □ CEO/President □ Director □ Manager □ Other (Please indicate___)

5. Your present job function (mark all that apply):

   □ Corporate Executive □ Manufacturing Production □ Transportation

   □ Purchasing □ Distribution □ Sales □Other (please indicate_________)

6. The years you have stayed at this organization:

   □ Under 2 years □ 2-5 years □ 6-10 years □ over 10 years

7. What percentage of your business transactions with your customers is done electronically?

   □ Less than 10% □ 10-30% □ 30-50% □ 50-80% □ More than 80%

8. Please mark the position of your company in the supply chain (mark all that apply):

   □ Raw material supplier □ Component supplier □ Assembler

   □ Sub-assembler □ Manufacturer □ Distributor □ Wholesaler

   □ Retailer

Publication List

Journal:

1. Chyan Yang and Yi-fen Su. 2009. "The relationship between benefits of ERP systems implementation and its impacts on firm performance of SCM", *Journal of Enterprise Information Management*, has been accepted for publication.
2. Yifen Su and Chyan Yang. "A structural equation model for analyzing the impact of ERP on SCM", *Expert Systems With Applications*, 48(3), has been accepted for publication and should appear in 48(3) of the journal. (SCI, impact factor: 1.177)
3. Chyan Yang and Yifen Su. "Why ERP systems are indispensable to supply chain management?", *European Journal of Operational Research*, has been decided that your paper can be published (status: Accept/Minor Revision/Reduce Length). (SCI, impact factor: 1.096)

Proceedings (International conference):

1. Chyan Yang and Yi-fen Su, 2006. "Why ERP systems are indispensable to supply chain management: A case study in Taiwanese IT industry", *SCMIS2006 Proceedings of the 4th International Conference on Supply Chain Management & Information Systems*. Page 9-16.
2. J.J. Shuai, Yi-fen Su, and Chyan Yang. 2007. "The impact of ERP implementation on corporate supply chain performance", *IEEM 2007: 2007 IEEE International Conference on Industrial Engineering and Engineering Management*, 2007, p 1644-1648 (EI)
3. Chyan Yang and Yi-fen Su. 2008. "The impact of ERP implementation on corporate SCM performance: from an operational and information integration perspective", *IEEM 2008: 2008 IEEE International Conference on Industrial Engineering and Engineering Management*, 2008, p 1668-1672 (EI)